Energy Fuels Resources Corporation

Whirlwind Mine
Plan of Operations

PREPARED FOR:

BUREAU OF LAND MANAGEMENT- COLORADO
GRAND JUNCTION FIELD OFFICE
2815 H ROAD
GRAND JUNCTION, COLORADO 81506

AND

BUREAU OF LAND MANAGEMENT – UTAH
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PREPARED BY:
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INTRODUCTION

Energy Fuels Resources Corporation (Energy Fuels) proposes to reopen two underground uranium mines as a combined operation called the Whirlwind Mine. The two mines, the Packrat Mine and Urantah Decline, were previously permitted with the State of Colorado and BLM. The Packrat Mine operated from the 1950s up to 1990 while the Urantah Decline was started in 1979, but ceased production in 1981 shortly after accessing the ore body. Both mines shut down due to depressed uranium prices and were later reclaimed in 2002 by their respective operators, Umetco Minerals Corporation (Umetco) and Cotter Corporation (Cotter). The reclamation was successful and the reclamation bonds on these properties were released in 2005.

The Whirlwind Mine is located approximately 5 miles southwest of Gateway, Colorado in Mesa County. The Whirlwind property, which straddles the Colorado/Utah state line, consists of 206 unpatented claims in the Beaver Mesa Mining District of the Uravan Mineral Belt. In Mesa County, Colorado, the claims lie in: Protracted Block (PB) 52 (Section 31), T51N, R19W; Section 6, T50N, R19W; Section 35, PB 41 (Section 25), PB 42 (Section 26), and PB 43 (Section 36) of T51N, R20W; and, Sections 1, 2, 11 and 12 of T50N, R20W, New Mexico Principal Meridian (NMPM). In Grand County, Utah, the claims lie in: Sections 17, 18, 19, 20, and 21; and PB 37 (Section 4), PB 38 (Section 5), PB 40 (Section 7), PB 41 (Section 8), and PB 42 (Section 9) of T25S, R26E, Salt Lake Based Meridian (SLBM). The claim block encompasses approximately 4,890 acres. The unpatented claims are on public land administered by the U.S. Bureau of Land Management (BLM). The mineral rights are controlled by Energy Fuels through long-term lease agreements with the claim owners.

The Beaver Mesa Mining District has seen production of radium, vanadium, and uranium ores since early in the 20th century. Numerous underground mines on the Whirlwind property and surrounding land within one mile of the claim group perimeter have produced in excess of 7,000,000 pounds U₃O₈ and nearly 24,000,000 pounds V₂O₅. In addition to the Packrat Mine and Urantah Decline, the claim block includes all or portions of the following mines: Bonanza, Lost Dutchman, Hubbard, Lumsden #2, Rajah 49, Austin #4, and the Rajah 30. Ore production is derived from fluvial sandstones, mostly in the upper part of the Salt Wash member of the Morrison Formation.
Historically, the uranium ore body was typically accessed through adits or tunnels driven from the side of the canyon walls. Most of the previous mining operations included construction of haul roads and dumping of waste rock along the sides of the canyon. The Lost Dutchman Mine, which is an unreclaimed pre-law mine (i.e., mine that shut down prior to the enactment of state and federal reclamation laws) is a good example of what these older mines looked like during operation. The mine was accessed by a narrow road along the edge of the canyon and waste rock was dumped directly into an ephemeral drainage that flows into Lumsden Canyon. Umetco was able to successfully reclaim the post-law canyon wall adits in the area along with associated roads and waste dumps in the early 2000s; however, the steep terrain and surface drainage issues made this reclamation work challenging.

Energy Fuels evaluated the potential environmental impacts of various mining alternatives in developing a long-range mine plan for the claim block. This evaluation indicated that potential impacts to soil, vegetation, water, and other natural resources could be minimized by concentrating surface disturbing activities in the vicinity of the Urantah Decline, where the topography is flatter and surface drainage can be controlled relatively easily. This area became the focal point for the design of the Whirlwind Mine surface facilities including primary access roads, buildings, ore stockpiles, waste rock disposal, and surface drainage controls. Secondary access to the Packrat Mine portals was also incorporated into the mine design to provide adequate mine ventilation and an emergency escape way. Surface disturbance at the Packrat Mine, which is located on the side of Lumsden Canyon, is limited to a narrow access road and small pad area. The Packrat area will not be used for disposal of waste rock or primary ore haulage.

The mine plan calls for the disturbance of about 24 acres (22.6 acres in Colorado and 1.4 acres in Utah), much of which was previously disturbed and reclaimed by the former mine operators. The largest single surface disturbance is the mine waste rock pile which encompasses approximately 10 acres and is designed for the life of the mine. This pile will extend eastward from the Whirlwind portal (formerly the Urantah Decline portal) within the gently sloping area between County Road 5/10 to the north and the natural hillside to the south. The north facing side of the waste dump will be graded, topsoiled, and revegetated concurrently as the pile expands to minimize visual impacts and sediment loading of surface water runoff.
Surface water will be routed around the waste pile and other surface facilities via permanent diversion channels. Surface drainage within the disturbed area, with the exception of the ore pad, will be routed to a sediment pond via ditches and culverts. Drainage from the ore pad area will be routed to a concrete sump that will overflow to a double-lined tank. The tank will also be used to store excess ground water pumped from the underground workings. This water will be treated using a portable trailer-mounted system prior to discharge to an ephemeral drainage that flows into Lumsden Canyon.

Pumping and discharge of mine water will only occur intermittently at the Whirlwind Mine. Previous studies by Umetco demonstrated that the Salt Wash sandstone contains very little water due to a limited recharge area. Most of the mine water originates from underground seeps into the ore zone from small aquifers located above the mine in the Burro Canyon Formation and the Brushy Basin member of the Morrison Formation. Historic and more recently collected water quality data indicate that the mine water will require treatment for radionuclides prior to discharge. Leach testing of the ore also indicates a potential for generating elevated levels of radionuclides in surface water runoff from stockpiled ore. As an added environmental precaution, the ore pad will be lined and graded to drain to the treatment plant tank. All stockpiled ore will also be removed from the mine surface area prior to future reclamation.

Energy Fuels is submitting a 112d permit for a Designated Mining Operation (DMO) to the Colorado Division of Reclamation, Mining and Safety (DRMS). The DMO designation is based on the need to treat ground water prior to discharge. The majority of the surface facilities for the operation are located in Mesa County, Colorado; however, six of the seven proposed new ventilation shafts are located in Grand County, Utah. Installation and reclamation of these ventilation shafts will be addressed in a Notice of Intent to Commence Small Mining Operations (i.e., five acres or less surface disturbance) with the Utah Division of Oil, Gas and Mining. It is anticipated that reclamation bonds for the project will be held by both DRMS and DOGM in accordance with agreements in place between BLM and these state agencies.

The permittee for this site is Energy Fuels Resources Corporation. The name has been shortened throughout this application to Energy Fuels or EFRC.
The site is located approximately five miles southwest of Gateway (see Map B-1). Areas of proposed surface disturbance are shown on Maps C-1B and C-2. These areas are delineated with solid red lines and include the Whirlwind portal area, Packrat portal area, power drop pad areas for both the Whirlwind and Packrat, one existing vent shaft (i.e., 10-Straight), and seven proposed vent shafts (one in Colorado and six in Utah). The proposed surface disturbance in Colorado totals 22.6 acres and is located principally in the northwest corner of Section 36 and the south half of Section 35, T51N, R29W, NMPM. The proposed surface disturbance in Utah totals 1.38 acres and is located in Section 9, T25S, R26E, SLBM.

The potential area of underground mining extends to the limits of the claim block except where limited by topography and land ownership. These potentially affected lands are delineated with a dashed red line on Map C-1B. The Rajah 30 Mine has also been excluded from the limits of underground mining because it is flooded. A minimum of 200 feet will be maintained between the Whirlwind Mine underground workings and the existing Rajah 30 Mine workings. The legal description of the affected land in both Colorado and Utah follow.

Colorado: A tract of land located within Sections 35 and 36 of T51N, R20W, NMPM, Sections 1, 2, 11, and 12 of T50N, R20W, NMPM Mesa County, Colorado.

Utah: A tract of land located within Sections 8, 9, 17, 20, and 21 of T25S, R26E, SLBM, Grand County, Utah.

The DRMS requires that a permit area be established around the proposed surface disturbance. This permit area is shown on Maps C-1A & B and C-2 in blue. For consistency, boundaries are also shown for the Utah vent shafts; however, a permit area boundary is not required by DOGM. The total DRMS permit area is 31.19 acres and
encompasses all proposed surface disturbance within Colorado. A legal description of the DRMS permit area follows.

Parcel 1 – Main Mine Area

Beginning at the Southwest corner of Section 35 T 51 N R20W thence N 58°22'51" E a distance of 4350.68'; which is the point of beginning,

thence N 49°26'00" W a distance of 242.17';
thence N 75°20'15" W a distance of 441.06';
thence N 28°17'11" W a distance of 101.19';
thence N 05°52'00" E a distance of 286.64';
thence N 43°24'17" E a distance of 158.92';
thence N 59°01'10" W a distance of 51.22';
thence N 46°12'13" W a distance of 65.39';
thence N 03°32'54" E a distance of 109.02';
thence N 04°41'24" E a distance of 58.94';
thence N 16°16'08" E a distance of 120.37';
thence N 41°01'25" E a distance of 88.06';
thence N 48°49'43" E a distance of 81.91';
thence N 66°54'51" E a distance of 71.21';
thence N 73°18'35" E a distance of 80.46';
thence N 24°45'09" E a distance of 108.42';
thence N 43°43'41" E a distance of 185.44';
thence N 30°50'26" E a distance of 139.06';
thence N 10°09'07" E a distance of 92.93';
thence N 03°52'45" W a distance of 114.32';
thence N 32°57'08" E a distance of 162.94';
thence N 20°39'46" E a distance of 133.78';
thence N 04°55'53" E a distance of 31.73';
thence N 15°35'37" W a distance of 133.42';
thence N 05°32'02" W a distance of 127.24';
thence N 01°06'19" W a distance of 136.00';
thence N 39°08'54" E a distance of 202.08';
thence S 35°09'02" E a distance of 165.50';
thence S 04°56'03" E a distance of 275.13';
thence S 33°20'22" W a distance of 161.46';
thence N 79°15'05" W a distance of 52.84';
thence S 21°50'43" W a distance of 210.18';
thence S 34°39'17" W a distance of 87.84';
thence S 34°27'24" W a distance of 64.03';
thence S 02°16'35" E a distance of 115.70';
thence S 11°26'36" W a distance of 89.34';
thence S 32°59'46" W a distance of 191.87';
thence S 34°52'04" W a distance of 254.20';
thence S 72°08'40" W a distance of 167.08';
thence S 41°27'51" W a distance of 153.16';
thence S 14°47'49" W a distance of 169.85';
thence S 22°20'07" E a distance of 79.54';
thence S 86°38'19" E a distance of 38.88';
thence N 53°59'22" E a distance of 211.54';
thence S 52°06'16" E a distance of 291.70';
thence N 88°24'38" E a distance of 86.66';
thence S 87°16'58" E a distance of 524.16';
thence N 26°34'37" E a distance of 187.94';
thence S 82°21'38" E a distance of 237.14';
thence S 07°16'45" E a distance of 206.20';
thence S 48°51'26" E a distance of 247.11';
thence S 30°54'13" W a distance of 502.07';
thence S 65°39'29" W a distance of 407.98';
thence N 81°51'49" W a distance of 398.45';
which is the point of beginning, having an area of 1,310,641.72 square feet, 30.088 acres

Parcel 2 – Mine Shaft #1 (existing Ten Straight Shaft) in Packrat Mine

Beginning at the Southwest corner of Section 35 T 51 N R20W
thence N 14°17'00" E a distance of 1580.62';
which is the point of beginning,

thence N 90°00'00" E a distance of 100.00';
thence N 00°00'00" E a distance of 100.00';
thence N 90°00'00" W a distance of 100.00';
thence S 00°00'00" E a distance of 100.00';
which is the point of beginning,

having an area of 10000.00 square feet, 0.230 acres

Parcel 3 – Mine Shaft #2 (Shaft C1) in Whirlwind Mine

Beginning at the Southwest corner of Section 35 T 51 N R20W
thence S 27°30'14" E a distance of 416.72';
which is the point of beginning,

thence S 00°00'00" E a distance of 100.00';
thence N 90°00'00" E a distance of 100.00';
thence N 00°00'00" E a distance of 100.00';
thence N 90°00'00" W a distance of 100.00';
which is the point of beginning, having an area of 10,000.00 square feet, 0.230 acres
Parcel 4 – Whirlwind Mine Power Drop

Beginning at the Southwest corner of Section 35 T 51 N R20W
thence N 35°49'04" E a distance of 868.22';
which is the point of beginning,

thence N 90°00'00" E a distance of 100.00';
thence N 00°00'00" E a distance of 100.00';
thence N 90°00'00" W a distance of 100.00';
thence S 00°00'00" E a distance of 100.00';
which is the point of beginning, having an area of 10000.00 square feet, 0.230 acres

Parcel 5 – Packrat Power Drop

Beginning at the Southwest corner of Section 35 T 51 N R20W
thence N 36°50'37" E a distance of 4800.06';
which is the point of beginning,

thence S 79°26'55" E a distance of 71.64';
thence N 01°06'59" W a distance of 112.14';
thence N 24°34'02" W a distance of 109.93';
thence N 90°00'00" W a distance of 42.85';
thence S 11°00'55" W a distance of 141.09';
thence S 38°00'18" E a distance of 76.76';
which is the point of beginning, having an area of 17959.28 square feet, 0.412 acres

Up to six additional shafts will be placed in workings of the mine in Utah. These sites will be permitted with the DOGM. Each of these shafts will have a disturbed area of 0.23 acres (nominal disturbance of 100 feet by 100 feet), therefore, the total disturbed area in Utah is 1.38 acres.

The entire surface area to be impacted is on public lands managed by the BLM. Mineral rights are controlled through unpatented mining claims. The unpatented mining claims and their owners are listed in Exhibit 4.
Table 2-1 summarizes the permit areas and disturbed areas in Colorado and Utah.

Table 2-1

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Map B-1, shown below, is an index map which shows the general location of the site. Scale is 1”=3600’.

MAP B-1-General Location Map
The Whirlwind Mine will be operated by Energy Fuels Resources Corporation (EFRC or Energy Fuels). BLM Claim numbers are listed in Exhibit 4. Contact and tax information for Energy Fuels is:

Frank Filas  
Energy Fuels Resources Corporation  
44 Union Blvd  
Suite 600  
Lakewood, CO 80228  
(303)-974-2146

Tax ID: 55-0912046
The mine is located entirely on public land managed by the BLM. The mineral rights are controlled through unpatented mining claims, which are illustrated on Map N-1 (see Appendix G). Energy Fuels has legal right to enter through the provisions of the 1872 Mining Law, claims held by Energy Fuels, and long-term lease agreements with the other claim holders. All claims are listed below and copies of the lease agreements are presented in Appendix G. Appendix G is considered confidential.

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DESCRIPTION OF OPERATIONS

EXHIBIT 5

- Section 1 – Background Information
- Section 2 – Underground Mine Operations
- Section 3 – Surface Facilities
- Section 4 – Surface and Underground Mine Equipment
- Section 5 – Waste Rock Handling Plan
- Section 6 – Ore Stockpile Area
- Section 7 – Water Treatment Area
- Section 8 – Topsoil Stockpile Areas and Sediment Pond Excavation
- Section 9 – Fuel and Oil Storage Areas
- Section 10 – Warehouse and Maintenance Shops
- Section 11 – Mine Offices and Shower Facilities
- Section 12 – Designated Parking and Storage Areas
- Section 13 – Mine Access Roads and Pads
- Section 14 – Utilities
- Section 15 – Solid Waste Storage
- Section 16 – Ventilation Shafts
- Section 17 – Maps and Conceptual Design
- Section 18 – Water Management
- Section 19 – Mining Schedule
- Section 20 – General Area Road Use and Maintenance
1. Background Information

The ore deposit is located in the Salt Wash Member of the Morrison Formation, which consists of interbedded fine-grained sandstone (about 60 percent) and mudstone (40 percent). The ore is located within the upper (i.e., Top Rim) red sandstone of the Salt Wash and occurs in areas of reduced gray sandstone and where the sandstone is in contact with gray or green mudstone bands. The uranium and vanadium mineralization occurs in bands that range in thickness from a few inches to in excess of eight feet. The average ore thickness is 2.7 to 3.0 feet. The ore body is located below approximately 500 to 750 feet of cover and can be accessed through adits located on the side of canyon walls and declines and shafts. For a full discussion of area geology, see Exhibit 14.

1.1 Urantah Decline

The Urantah Mine was started by Pioneer Uravan in September 1979. It consists of a 3,200-foot-long, single-entry decline that accesses the ore body at a six percent grade plus approximately 700 feet of drift in the Salt Wash member. The decline is supported by steel sets through the Brushy Basin member of the Morrison Formation, which is predominantly shales and mudstones. Both the decline and drifts are about nine feet high by twelve feet wide. Approximately 2,800 tons of ore had been mined when the mine was closed in September 1981. The mine was later acquired by Cotter Corporation, but remained idle until it was reclaimed in the fall of 2002.

Little Maverick Mining Company reopened the mine under a prospect permit (P-2005-008) in 2005. Energy Fuels is currently conducting exploration activities under this permit through a lease agreement with Little Maverick. Surface disturbance associated with exploration activities have included opening up an access road, uncovering a buried concrete pad, and building a working pad on top of the reclaimed waste pile (see Map C-1A). The mine portal was reclaimed with a bat gate; therefore, no excavation was required to access the old workings.

Underground exploration activities have included rehabilitating the existing workings to gain safe access to the ore body plus geological and environmental sampling. Energy Fuels plans to collect a bulk ore sample by driving a drift between the Urantah Decline and the Packrat Mine (see Map C-1B).
1.2 Packrat Mine

The Packrat Mine is an older mine that probably was first developed in the 1950’s and consists of several miles of drifts with numerous stopes or rooms mined off of each drift. The three Packrat Mine portals are located approximately one-half mile north of the Whirlwind portal and almost 300 feet lower in elevation. The Packrat portals access the Salt Wash directly from the side of Lumsden Canyon (see Maps C-1A and C-2).

The mine workings extend in a southwesterly direction though the Salt Wash unit (see Map C-1B), which is relatively flat lying (the formations dips to the northeast at one to three degrees). Early miners used track methods to mine most drifts. The drifts in the south part of the mine are still relatively small with a width of about six feet. The northern drifts were later widened and extended using rubber tired equipment and are typically nine feet high by twelve feet wide. The Packrat Mine had two ventilation shafts; a sixty-inch diameter shaft near the end of the northern workings and a thirty-six-inch shaft called Ten Straight near the end of the southern workings. The larger ventilation shaft was backfilled as part of reclamation, but the Ten Straight is still open and protected by a metal grate.

The Packrat Mine operated until 1990 when depressed uranium prices caused it to go on standby. Umetco later reclaimed the mine surface area in 2002. Energy Fuels reopened the mine in early 2007 under prospect permit P-2007-003. Under this permit, the road to the Packrat and the main portal were reopened. A small pad area (less than 0.6 acre) was established in front of the portal. This work was completed in May 2007 and is not shown on Map C-1A. Energy Fuels is currently establishing ventilation and rehabilitating portions of the Packrat Mine so that exploration activities can be safely conducted.

This permit application outlines further modifications to the site for the full mine operation. Surface disturbances associated with exploration activities are included in this application so that the 112d Permit will incorporate and supersede existing exploration permits.
2. Underground Mine Operations

Energy Fuels plans to reopen the Urantah Decline and Packrat Mine as a single combined underground uranium-vanadium mine operation called the Whirlwind Mine. The mine will operate one to three shifts per day five days per week. Initially, ten to twelve employees will mine approximately 100 tons of ore per day. As the mine expands and more headings are opened up, up to twenty-four employees may work at the mine and production will increase to an average of 200 tons of ore per day. The mine has a projected life of ten years based on known and inferred resources.

2.1 Mine Design
Based on existing exploration data, the mine will be initially expanded to the west and south in the direction of the proposed vent shafts shown on Map C-1B. The thin and irregular nature of the ore body makes it difficult to define the exact location and extent of future mining. Exploration drilling from the surface and long-hole drilling from existing underground workings will ultimately determine the optimum location of future drifts and production stopes. The maximum limit of underground mining is shown on Map C-1B.

Future underground mining operations may connect with adjacent mines in the area such as the Lumsden No. 2 and Rajah 49. This would be done primarily for mine ventilation purposes although some older stopes could also be mined. No additional surface disturbance is anticipated at this time because ventilation fans would be installed underground and ore and waste would all be hauled out through the Whirlwind Decline. Before connecting with older mine workings in the area, Energy Fuels will consult with the BLM regarding potential environmental impacts to bats (see Exhibits 10 and 15), ground water (see Exhibit 14), and other resources. Appropriate mitigation measures would be developed at that time to minimize identified environmental impacts.

2.2 Mine Plan
Nine-foot high by twelve-foot wide drifts will be driven through known ore-bearing zones to provide access for production mining. The drifts also provide access for geologic mapping, long-hole drilling, rib scanning, and collecting samples. This geologic data will be used to develop detailed mine planning and stope development for each drift.

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The ore will be mined using a modified room-and-pillar system. This mining method is a common method for mining in uranium-bearing sandstone and is designed to follow the irregular configuration of the individual ore bodies. The ore seams vary in height with an average seam thickness of approximately three feet. The waste to ore ratio also varies depending on the thickness of the ore and splits within the ore seams. The mines in this area have typically averaged 2 to 3.5 tons of waste per 1 ton of ore.

The existing workings in both the Urantah Decline and Packrat Mine will require rehabilitation prior to the start of full-scale mining. This will include cleaning up rock falls, bolting of the back where needed, establishing ventilation, and installing sumps and pumping stations for the lower portions of the mine where ground water collects. Once the mine meets Mine Safety and Health Administration (MSHA) safety requirements, the existing drifts will be extended into known ore zones. These drifts will have nominal dimensions of nine feet high by twelve feet wide. The 600 to 700-foot proposed drift between the Whirlwind Tunnel and the Packrat Mine will be started first and may be completed under the bulk sampling provisions of the prospect permit. A portion of the existing southern drift of the Packrat Mine will also be enlarged to accommodate modern rubber-tired mine equipment.

As the mine expands, seven ventilation shafts will be added as shown on Map C-1B. The location of these vent shafts may change by several hundred feet depending on the ultimate location of the drift and ventilation needs. The ventilation shafts will typically be 72 inches in diameter and cased; however, shaft diameters may vary depending on the drill contractor’s equipment. The steel casing will be grouted where it passes through aquifers to prevent intermixing of waters between formations.

The ore zone does not naturally contain ground water at this location; however, ground water is seeping into the Whirlwind mine from aquifers located above the mine workings. This water is entering the mine where the Whirlwind decline intersects sandstone lenses near the base of the Brushy Basin member. Ground water is also entering around the casing of the Ten Straight vent shaft into the Packrat Mine and through open drill holes and fractures in the formation. Initially, Energy Fuels will need to pump water out of the mine because water has collected in low areas of the mine during the past fifteen to twenty-five years. This water will be treated prior to being discharged to a nearby
ephemeral drainage. Once the mine is operating, the water flowing into the mine will be used in mining operations for drilling and dust suppression. Energy Fuels has obtained a water right to use this water. As discussed in Exhibits 8 and 14, mine water discharge will not be required or will only be needed intermittently during active mining operations.

Energy Fuels plans to implement a program for minimizing ground water inflows into the mine workings. This will include evaluating the seepage around the casing of the Ten Straight vent shaft and grouting the casing to plug off or reduce water inflows. Historic drill holes encountered during mining that are open and producing water will also be plugged or grouted. It is believed that this will reduce the amount of water entering the ore bearing zone from above thus preserving some of this water in the upper aquifers while lessening the amount of water that will be treated at the Whirlwind surface area. Additional details regarding ground water control are presented in Exhibit 8.

2.3 Mine Operations

A typical equipment list for the underground operation is presented in Section 4 of this exhibit. Jacklegs operating on compressed air will be utilized to drill the blast holes and rock-bolt holes in the drifts and production areas. A larger jumbo drill may also be used in the development areas if conditions warrant. The ore averages about three feet in thickness but the drifts are approximately nine feet in height while the stopes or rooms are a minimum of six to seven feet in height. In order to avoid excessive dilution of the ore, much of the waste will need to be drilled and shot separately from the ore using what is referred to as “split shooting.”

Blasting operations will be conducted in accordance with MSHA regulations (30 CFR Parts 56 and 57). Blast holes will be loaded with a blasting cap, chemical booster, and a mixture of ammonium nitrate and fuel oil (ANFO) prills. The blasts will be initiated using a non-electric system (nonels) with the hole pattern, firing sequence, and delays designed to allow for optimum breakage and minimum ore dilution. Explosives and detonators will be initially stored in powder magazines located on the surface near the portal. These magazines will be relocated underground once the mine expands in size. Explosives will be transported from the magazines to the working face in accordance with MSHA regulations (30 CFR Part 56 and 27 CFR Part 55).
The ore and waste rock will be mucked out using small diesel loaders. Ore will be hauled to the surface using low-profile, diesel-powered haul trucks (commonly called buggies). Some of the waste produced during later development and production may be disposed of underground.

Back support will consist of installing five-foot to eight-foot-long mechanical split-set roof bolts. Bolting will be performed as necessary with the spacing varying according to back conditions and the size of the opening. Mine openings will be twelve feet wide in the drifts but may be wider in the stopes. Metal mats and mine-grade wire will be installed in the back and diagonally on the ribs when additional ground support is required.

Material storage areas and stationary equipment will also be located underground. Roof bolts, mats, vent tubing, hoses, lubricants, and the smaller and more commonly used equipment parts will be stored underground near the working faces. These locations will change as the mine workings are advanced. Stationary underground equipment will include air compressors, transformers, and ventilation fans.

3. Surface Facilities

The proposed surface facilities are shown on Maps C-2 and C-3 for the main Whirlwind Mine area and Maps C-4 and C-5 for the Packrat Mine area. Minor changes may be made to the proposed layouts during construction; however, construction activities will be confined to the permit area and outside of surface drainages. The majority of the ore and waste rock (i.e., over 90 percent) will be brought to the surface from the Whirlwind portal. Any ore or waste brought through the Packrat portal will be transferred to bins where the material can be loaded into highway haul trucks for transfer to the Whirlwind or, in the case of ore, hauled directly to the mill.

A surface equipment list is presented in the lower portion of Section 4. There will be no processing activities on site as all the ore will be transported to the White Mesa Mill or another existing uranium mill in the region. Should a new mill be built by Energy Fuels, the ore would be transported to that process facility.
The surface facilities at the Whirlwind Project include the following.

- waste rock embankment
- ore stockpile area
- topsoil stockpile areas
- water treatment plant and tanks
- fuel and oil storage areas
- maintenance shops and warehouse
- mine offices and shower locker room (dry)
- designated parking and storage areas
- mine access roads and pads
- utilities
- solid waste storage (trash, scrap metal, batteries)
- ventilation shafts (existing and proposed)
- power drops and associated pad areas
- ore and waste bins at the Packrat portal
- retaining walls at Packrat portal
- drainage collection and diversion ditches with culverts
- mine sediment pond at Whirlwind portal
- powder magazine at Whirlwind portal
- magnesium chloride tank at Whirlwind portal
- ventilation fan at Whirlwind portal
- cyclone fences and gates at Whirlwind portal
- portable watchman’s trailer
- portable generators

Approximately one quarter of the proposed surface disturbance at the Whirlwind Project will be on land that was previously disturbed and reclaimed by previous mine operations. The remaining areas to be disturbed have also been impacted, but to a lesser extent, by historic exploration activities consisting primarily of road and pad construction. Surface disturbance on previously undisturbed ground is largely confined to the waste pile expansion on the east end of the Whirlwind portal site.
The proposed Packrat portal area disturbance is on land that has been completely disturbed in the past, as seen on Map C-1A. The former waste embankment was previously reclaimed by regrading, placing imported topsoil, and creating depressions on the land surface to provide pockets where seed could more readily germinate. The majority of the reclaimed waste embankment will not be re-disturbed. Only the upper portion of the waste embankment will be disturbed to allow for a portal bench with some minor facilities.

Table 5-1 below shows a breakdown of proposed surface disturbance between previously impacted areas and areas that were not impacted extensively by historic operations.

As mentioned in Section 1, some of these surface facilities, such as the reopening of mine access roads, pads, and portals, were approved under previously submitted prospect applications. This mine permit application encompasses these disturbances and is intended to supersede and replace those exploration permits.
Table 5-1 Proposed Surface Disturbance

<table>
<thead>
<tr>
<th>Area</th>
<th>Previously Disturbed Acreage</th>
<th>Total Disturbed Acreage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whirlwind Portal Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portal Bench</td>
<td>2.10</td>
<td>2.35</td>
</tr>
<tr>
<td>Access and Facilities</td>
<td>1.00</td>
<td>1.33</td>
</tr>
<tr>
<td>Portal Bench Slope</td>
<td>0.70</td>
<td>1.00</td>
</tr>
<tr>
<td>Fill Stockpile</td>
<td>0.00</td>
<td>0.27</td>
</tr>
<tr>
<td>Expanded Waste Embankment</td>
<td>0.00</td>
<td>9.98</td>
</tr>
<tr>
<td>Topsoil Stockpile #1</td>
<td>0.50</td>
<td>1.70</td>
</tr>
<tr>
<td>Water Treatment Area</td>
<td>0.00</td>
<td>1.54</td>
</tr>
<tr>
<td>Existing 5/10 Road &amp; Shoulder</td>
<td>0.73</td>
<td>0.73</td>
</tr>
<tr>
<td>Misc Ditches, etc.</td>
<td>0.00</td>
<td>0.34</td>
</tr>
<tr>
<td>Narrow strip north of 5/10 Road</td>
<td>0.04</td>
<td>0.19</td>
</tr>
<tr>
<td>Topsoil Stockpile #2</td>
<td>0.00</td>
<td>0.32</td>
</tr>
<tr>
<td><strong>Subtotals</strong></td>
<td><strong>5.07</strong></td>
<td><strong>19.75</strong></td>
</tr>
</tbody>
</table>

| Packrat Portal Area          |                              |                         |
| New Upper Bench              | 0.62                         | 0.62                    |
| New Lower Bench              | 0.37                         | 0.37                    |
| Packrat Road                 | 0.76                         | 0.76                    |
| **Subtotals**                | **1.75**                     | **1.75**                |

| Vent Shafts (Colorado)       | 0.23                         | 0.46                    |
| Power Drop Areas             | 0.64                         | 0.64                    |

**Total Disturbed Area (Colorado)** | 7.69 | 22.60

| Additional Shafts in Utah    | 0.00                         | 1.38                    |

**Total Disturbance (CO and UT)** | 7.69 | 23.98

Note: The acreages in Table 5-1 are approximate.
4. Surface and Underground Mine Equipment

The following equipment may be used at the mine operation.

<table>
<thead>
<tr>
<th>Underground Equipment</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel Skid-Steer Loaders, 2 cy capacity</td>
<td>2 – 3</td>
</tr>
<tr>
<td>Diesel Trucks (Buggies), 5 and 10 ton capacity</td>
<td>8 – 10</td>
</tr>
<tr>
<td>Development Drill, Jumbo</td>
<td>1</td>
</tr>
<tr>
<td>Production Drills, Jacklegs</td>
<td>8 – 10</td>
</tr>
<tr>
<td>Exploration Drills, Longhole</td>
<td>1 – 2</td>
</tr>
<tr>
<td>Diesel Boss Buggies and Utility Vehicles</td>
<td>2 – 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Surface Equipment (c)</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow Plow</td>
<td>1</td>
</tr>
<tr>
<td>Front End Loader, 2 – 3 cy capacity</td>
<td>1</td>
</tr>
<tr>
<td>Backhoe/Skid Loader or Excavator, 80-hp(^{(a)})</td>
<td>1</td>
</tr>
<tr>
<td>Highway Haul Trucks, 22 to 24-ton capacity (^{(b)})</td>
<td>2 - 8</td>
</tr>
<tr>
<td>Bulldozer, 200-hp</td>
<td>1</td>
</tr>
<tr>
<td>Motor Grader, 140-hp</td>
<td>1</td>
</tr>
<tr>
<td>Flat-Bed Truck, 1-ton</td>
<td>1</td>
</tr>
<tr>
<td>Pick-up Truck, ¾-ton (4wd)</td>
<td>2</td>
</tr>
</tbody>
</table>

Notes:

(a) A backhoe and/or hydraulic excavator will be brought on site as needed to perform maintenance activities.
(b) Highway haul trucks will be provided by a contractor. Trucks used for transportation will consist of 14-ton, end-dump trucks with 10-ton pups pulled behind or 23-ton end or side dump haul trucks. The number of trucks listed is based on two trips per day.
(c) Miscellaneous rental and contract equipment will be brought to the mine site as needed. These could include fuel trucks, propane trucks, boom trucks, maintenance vehicles including welders, pipe equipment, electrical man lifts for working on power lines, contract vent hole drilling equipment, exploration drilling equipment, material delivery trucks, and concrete and gravel trucks.
5. Waste Rock Handling Plan

The existing bench at the Whirlwind portal was made from waste rock excavated from the driving of the decline and the two short developmental drifts at the base of the decline. The slope of this bench was reclaimed previously but will be re-disturbed since the bench will be expanded using waste rock produced from underground mining operations. See Map C-1A for the configuration of the current bench. See Map C-2 for the plan view of the expanded waste rock embankment.

The waste rock pile will be expanded to the east and gradually raised in height. Map C-3 shows the cross sections of the existing and the expanded waste rock embankment. The waste rock will be hauled to the pile by low-profile trucks or “buggies” and dumped near the edge of the pile. A dozer will then level and push the material over the edge of the pile. The pile will have two levels; the lower level at the portal and an upper level to the east that will gradually increase in height and move further to the east as more waste is placed. Travel over the pile by the loaded rubber-tired buggies will compact the material creating a low-permeable surface. The waste rock pile will have a capacity of 900,000 tons, which will contain most of the waste rock generated during the projected ten-year mine life. The remaining waste rock will be disposed of underground in mined out areas.

The area east of the existing waste rock pile consists of pinyon and sagebrush crisscrossed by historic drill roads and pads (see Map C-1A). Prior to expansion of the waste rock embankment to the east, the vegetation will be stripped and approximately 12 to 18 inches of topsoil will be removed and stockpiled in Stockpile #1 shown on Map C-2 on the north side of County Road 5/10. Another small stockpile area exists on the expanded bench (Temporary Topsoil Stockpile). Downed trees and all other wood material will be placed in separate piles that will be placed on top of the topsoil during reclamation, either as mulch or in whole pieces. The area around the Whirlwind and Packrat portals has been checked for springs and seeps. None exist within the area of the waste rock embankment expansion.

The waste material will be generated from above and below the ore-bearing material by blasting (i.e., split-shooting). The material will be primarily sandstone that loses a large portion of its cementation upon exposure to air and water. The blasted rock ranges in size from fine-grained sand particles to a
maximum of 2 feet in diameter. As the waste rock is brought outside in the buggies, it will be dumped into the expansion area and graded to a maximum final slope of 3 horizontal to 1 vertical (3H:1V). Any waste rock hauled out of the Packrat Portal will be dumped into bins at the Packrat Portal and then hauled to the Whirlwind waste embankment using larger highway haul trucks.

As shown on Map C-2, two ten-foot wide benches will be placed on the final slope of the waste embankment as it is constructed, to prevent vertical drops of more than thirty feet. In addition, a haul road with a six percent positive slope will be constructed as the embankment expands. This road will be treated with magnesium chloride to minimize the generation of fugitive dust. Water will be channeled away from the slope using a ditch on the inside of this road. The road and top of the embankment will have a 3-foot high berm as required by MSHA for safety of the vehicle traffic on the road. This berm will be made of waste rock.

Expansion of the waste rock pile will occur in increments of approximately three to four acres so that a large portion of the area will not be disturbed at once. As permanent waste rock slopes are created, topsoil from new disturbance areas will be placed on the regraded slopes and seeded to allow for contemporaneous reclamation of a portion of the pile. This work will be completed during the fall seeding window (August 15 to October 15). All reclaimed slopes will be covered with a minimum of twelve inches of topsoil prior to reseeding and mulching. Based on soil samples taken in April of 2007, the average replacement thickness is 14 inches, which is used for all earthwork and reclamation calculations.

Permanent diversions will keep undisturbed runoff from entering the waste rock embankment from the uphill areas to the south. Drainage of the waste rock embankment is discussed in Section 18.

Recent samples of the ore and waste from newly exposed underground faces were taken by Energy Fuels. These samples were analyzed for chemical content and then tested using the Synthetic Precipitation Leaching Procedure (SPLP), which is the Division’s recommended procedure for determining whether mine waste has the potential to environmentally impact ground or surface water.
The sampling procedures, locations and results of these tests are presented in Appendix A. The results show that the ore has the potential to generate leachate and surface water runoff containing elevated levels of uranium, radium, and trace metals (see Section 6). The waste rock, however, did not produce leachate that exceeded state water quality standards. The following Best Management Practices (BMPs) for disposal and reclamation of waste rock will also minimize the potential for impacting surface or ground water resources.

**Waste Embankment BMP’s**

1) In the SPLP test, the ore is ground to a minute size (i.e., smaller than 9.5 millimeters) prior to leaching with a pH 5 solution, while the actual waste rock embankment site will have larger sized rocks from one inch to twenty-four inches in diameter, that will not leach as readily. The permeability of the waste rock (and susceptibility to leaching) will also be reduced by the compaction that occurs as loaded haulage buggies and other equipment travel over the top of the waste pile.

2) Undisturbed runoff from the south hillside will be permanently diverted away from the waste rock embankment, utilizing diversion ditches designed for the 100-year, 24-hour storm event.

3) The waste rock embankment will be covered with a minimum of twelve inches of topsoil and planted with a stable mix of grasses and forbs well suited to this location. The vegetation will utilize most of the direct precipitation and surface water runoff that occurs on the reclaimed embankment. This will minimize the amount of water that can percolate into the reclaimed waste material.

4) The gradual slopes and revegetated surface of the waste rock embankment will minimize erosion of topsoil and prevent exposure of the underlying waste rock.

Based on the apparent stability of the existing reclaimed and older, unreclaimed waste rock pile slopes in the area, a detailed slope stability analysis was not performed. Many of these older mines have slopes as steep as 1.4H:1V compared to the 3H:1V proposed minimum slope of the Whirlwind waste rock embankment. The spring and seep survey of the site conducted by Greg Lewicki, P.E. in April of 2007 revealed no springs or seeps; therefore, there is no water that could enter the waste from below
and potentially compromise the stability of the embankment. Exhibit U presents a slope stability analysis using commonly accepted basic equations and material parameters. The analysis indicates that the waste embankment has a calculated safety factor above 2, which is well above the minimum safety requirements for permanent slopes.

Runoff from the waste rock pile and other disturbed areas will be collected in the sediment pond shown on Map C-2. The sediment pond will allow suspended solids to settle out of solution before the water enters the natural drainage. As an added precaution, the sediment pond water will be tested quarterly for radium-226 and uranium, as well as other parameters (see Exhibit 8 for monitoring details). The sediment pond is designed to fully contain the ten-year, twenty-four-hour precipitation event for the site. It is also designed to safely pass the 100-year, 24-hour storm event through the principal spillway pipe (see Section 18 below).

6. Ore Stockpile Area

Ore will be end dumped directly onto the ore stockpile pad located north of the Whirlwind portal by the buggies. The stockpile pad has been sized to contain up to 15,000 tons of ore, which represents three to four months of full production. As shown on Map C-2, the ore pad covers approximately 0.5 acre and drains to a collection sump. The ore pad will consist of a geosynthetic clay liner (GCL) covered by a 2.5-foot thick cushion layer of finer-grained material and 1 foot of compacted run-of-mine (ROM) waste rock. The lined pad will drain to a concrete sump. The sump will be equipped with an overflow that drains directly to the lined tank that feeds into the water treatment plant. This overflow will utilize a six-inch diameter HDPE pipe that will be buried at least eighteen inches below the surface from the sump to the Untreated Water Tank. The entrance to this pipe will be screened to prevent large pieces of rock or debris from entering and clogging the pipe. The ore pad design is presented in detail in Appendix J.

The ore pad will be sloped toward the concrete sump described above. As shown on Map C-2, the ore pad area will be surrounded by a gradual sloping berm that will direct all runoff from the ore pad area to the sump. These provisions are designed to capture and allow for treatment of surface water runoff that may have contacted the uranium ore. As shown in Appendix A, leaching of the ore has the
potential to generate elevated levels of uranium, radium, and trace metals. The ore will be stored only temporarily on site and all ore will be removed prior to site reclamation as discussed in Exhibit 6. In addition, the 3.5 feet of total liner cover material and the liner will be removed and placed in a dry portion of the mine prior to reclamation of the pad.

A front-end loader will load the ore into haul trucks. Fugitive dust will be minimal because the ore will have a high moisture content and the loading area will be treated with magnesium chloride to seal the pad surface. The truck beds will be covered with tarps prior to leaving the mine site to prevent the generation of fugitive dust during haulage. Initially, approximately twenty trucks per week will be loaded and sent to the mill. As production increases to 200 tons per day, truck traffic will increase to an average of about forty roundtrips per week. Weather conditions, haul truck availability, mill demands, and other factors may result in periods of increased haulage of up to eighty roundtrips per week (i.e., sixteen trips per workday). The primary haulage route will be via Mesa County roads to Colorado Highway 141 just south of Gateway. Three secondary routes via Grand County, Utah roads to Utah highways may also be used, especially in the summer when weather conditions are more favorable (see Section 19).

Ore haulage will be performed by contractors who will be required to: obtain all necessary permits and clearances, follow Department of Transportation regulations including establishment of spill control plans, and obey Colorado and Utah traffic laws.

7. Water Treatment Area

A portable water treatment plant and associated tanks were installed on site as part of BLM-approved prospecting activities. Energy Fuels proposes to use these existing facilities during mining operations to treat mine water and ore pad runoff. Water treatment and discharge is expected to be intermittent, as most of the mine water will be used for drilling, dust suppression, and other mining activities. The water treatment facilities are located north of 5/10 Road as shown on Map C-2. Topsoil was removed from this area and the subsoil was graded and compacted prior to installing the water treatment system. Environmental protection measures for the treatment facilities are described in detail in Exhibit 8 and Appendix H. A description of the treatment components follow.
Untreated Water Tank

Three-inch diameter high density polyethylene (HDPE) pipe extends from the mine sump to the Untreated Water Tank. A 2-inch return line extends from the tank back to the mine. These water lines are buried from the portal to the tank to prevent freezing. A third, 6-inch diameter HDPE buried pipe will be installed from the ore pad sump to the Untreated Water Tank when the ore pad is constructed.

The Untreated Water Tank has dimensions of 68 feet by 68 feet by 4.75 feet high and is constructed of interlocking metal wall panels. The tank is lined with two 30-mil, reinforced synthetic liners. Leak detection is provided by an 8-oz. geotextile fabric that is located between the two liners and connected to a dip tube leak detector. Tertiary containment is provided by a GCL liner that is installed at the base of the tank between the wall panels. The tank has approximately 22,000 cubic feet of storage capacity (equivalent to 164,000 gallons of untreated water). Freeboard requirements are described in Section 18 below.

Water Treatment Plant

The treatment plant is mounted in a 47-foot-long truck trailer. There are three mix tanks of 370, 300, and 230 gallons containing dilute solutions of barium chloride, ferric sulfate, and other chemicals as needed (see Exhibit 8 and Appendix H). These chemicals are fed into the untreated waterline via metering pumps. After chemical dosing, the water flows through in-line static mixers to two 335-gallon reaction tanks. These reaction tanks are equipped with mixers that provide additional contact time between the treatment chemicals and the natural contaminants in the water (i.e., radionuclides, selenium and other trace metals). The water then flows by gravity into a Settling Tank located outside the trailer.

Settling and Polishing Tanks

The Settling Tank and Polishing Tank are of the same size with dimensions of 8 feet by 26.75 feet by 4.75 feet high with total capacities of 1,000 cubic feet or 7,500 gallons each. The tanks are constructed
in the same manner as the Untreated Water Tank and are equipped with double liners and leak detection. The treated water flows initially into the Settling Tank where the insoluble precipitate formed by the addition of barium chloride and ferric sulfate settles into the bottom of the tank. To insure complete separation of the solids from the treated water, the water gravity flows into the Polishing Tank before being discharged.

8. Topsoil Stockpile Areas and Sediment Pond Excavation

Topsoil Stripping
Topsoil will be stripped from all areas prior to conducting mining or construction activities. This includes both previously reclaimed areas and previously undisturbed areas. Pinyon pine, juniper, scrub oak, and any other small trees will be removed from previously undisturbed areas prior to stripping the topsoil. These trees and other woody material will be placed in separate piles. During reclamation, these materials will be placed on top of topsoiled areas, either as mulch or in whole pieces.

The Packrat Mine was reclaimed by importing alluvial soil from the Gateway area. The material was used to cover the backfilled portal, regraded waste embankment area, and access road. This material will be stripped to the extent possible, but it is expected that only 4 to 6 inches of material will be salvaged over an area of approximately 1.0 acre. This is a volume of 672 cubic yards, assuming an average soil depth of 5 inches. Since there is no room at the Packrat portal area for storing this material, the material will be used for the creation of the MSHA berm along the Packrat pad area and access road. These berms will be seeded with the mix described in the reclamation plan to minimize erosion.

The following areas of topsoil stripping correspond to the areas shown on map C-1A.

Area 1: Most of the Whirlwind portal area was previously reclaimed without placing topsoil; accordingly, there is only a limited amount of topsoil that can be salvaged from the previously reclaimed area. Almost all of the salvageable topsoil in this area occurs on the slope of the reclaimed waste pile, which covers about 1.6 acres. This material will be stripped to a depth of 6 inches and will
be placed in the Whirlwind stockpile on the north side of 5/10 Road (Stockpile #1). This represents about 1,300 cubic yards of topsoil. The existing growth media on top of the waste pile pad will also be salvaged and placed into the Temporary Topsoil Stockpile on top of the waste pile.

**Area 2:** The waste embankment will expand east over Area 2, which is relatively flat with gentle slopes. Most of the soil borings were completed in this area, where topsoil ranges from 1.2 feet to 2.3 feet in thickness. There are a number of rock outcrops in the area where no topsoil is available. Based on the collected soil samples, the average topsoil thickness in this area is 1.78 feet. When the rock outcrops are subtracted, the average thickness is estimated to be 1.6 feet. Since the area is 8.42 acres in size, the volume available for stripping is 21,700 cubic yards. Initially, only about 5,900 cubic yards will be stripped and placed in Stockpile #1, located north of 5/10 Road, for use in final reclamation. The stockpile will have 3H:1V sideslopes. A smaller stockpile will exist on the portal bench as shown on Map C-2 (Temporary Topsoil Stockpile, a.k.a., Stockpile #3). This area will have the same 3H:1V sideslopes and will contain approximately 3,900 cubic yards of topsoil stripped prior to future advances of the waste embankment. Subsequent topsoil stripping will be used to contemporaneously reclaim previously regraded areas of the waste embankment.

**Area 3:** Area 3 comprises the steeper slopes along the south edge of the waste embankment expansion. Soil boring 5 with a topsoil thickness of 1.2 feet was completed at the base of this slope. No borings were completed higher up on the slope, but based on a visual inspection, it is apparent that this area has a thinner soil cover than Area 2. For estimating purposes, a soil thickness of 0.8 feet is assumed, which results in an estimated topsoil volume of 3,000 cubic yards over the 2.36 acre area.

**Area 4:** This area is north of 5/10 Road and will contain the treatment plant, various tanks, and the Sediment Pond. No soil borings were completed in this area, but the area is similar in grade and landform to Area 2. An average topsoil thickness of 1.6 feet is assumed for Area 4. Since the area is 1.71 acres, the topsoil volume available for stripping is estimated to be 4,400 cubic yards. The majority of this topsoil (4,200 cy) will be placed in stockpiles east of the water treatment area (Topsoil Stockpiles #2 and #2A) and the subsoil stockpile (see Sediment Pond Excavation below). Some of the topsoil (200 cy) will be placed as a 6-inch cover over the sideslopes of the sedimentation pond and the fill stockpile that will be excavated from the pond area. The placed topsoil will seeded to produce a stable,
vegetated cover during active mining operations. During reclamation, the topsoil will be stripped from the subsoil stockpile and the sedimentation pond prior to regrading the area. After the area has been regraded to the approximate original contours, the topsoil will be placed on top.

The total estimated volume of topsoil available from the four areas is approximately 30,400 cubic yards. It is believed that this estimated volume is accurate to plus or minus 20 percent. The reclamation design and cost estimate are based salvaging and placing 30,400 cubic yards of topsoil.

A summary of the topsoil stockpile areas is given below:

1. Stockpile #1: Main Stockpile located north of County Road containing 5,900 cy from the initial stripping of Area 2 plus 1,300 cy from Area 1 for a total estimated volume of 7,200 cy. The stockpile area shown on Map C-2 is larger than necessary to store 7,200 cy, so there is extra storage space available in case the average stripping depth is greater.
2. Stockpiles #2 and #2A: Located at Water Treatment Area with an estimated volume of 4,200 cy.

Total estimated topsoil storage required: 15,300 cy

Temporary topsoil stockpiles will be created in front (i.e., east) of the waste rock pile as it expands. This material will be used to concurrently reclaim the north facing waste rock pile slopes next to County Road 5/10 after they are regraded to a 3H:1V configuration.

Each topsoil stockpile will have a small, one-foot high berm along the perimeter to isolate it from the surrounding area runoff and to trap runoff from the stockpile itself within the ditch created by the berm. All stockpiles that will be in place for more than one year will be seeded using the prescribed mix shown in the Reclamation Plan.
Sediment Pond Excavation

After topsoil is removed to an average depth of 16 inches over the sediment pond area, the pond will be excavated. The subsoil will be placed in a fill stockpile located east of the water treatment area and leach field as shown on Map C-2. An estimated volume of 4,608 cy of subsoil will be stockpiled.

9. Fuel and Oil Storage Areas

Diesel fuel and various oils for use in mobile equipment and generators will be stored and used on site. Secondary containment will be provided for all petroleum products. In most cases, secondary tank containment will consist of an oversized livestock water tank within which the fuel or oil tank will be placed.

The utility company will supply electrical power to the site; however, small generators may be used initially to supply power to the main facilities, remote ventilation fans, and to the water treatment trailer. These generators will be located within their respective trailers for secondary containment and security purposes. Fuel tanks will be located in the base of the generator or as separate tanks contained within larger livestock tanks for spill containment purposes. Once electrical power is available on site, the generators will be removed and/or used for emergency backup.

A Spill Control, Containment, and Contingency (SPCC) Plan for storing and using petroleum products will be prepared and implemented for the site in accordance with federal and state regulations, as the total aboveground storage of fuel and oil in containers of 55 gallons or more will exceed 1,320 gallons. A current plan has been included in Appendix F. A summary of fuel and oil storage at the site follows.

1. A skid-mounted oil storage shed with nominal dimensions of eight feet by ten feet will be located adjacent to the maintenance shop. Up to 500 gallons total of the listed products will be stored in the skid-mounted shed. Container size will range from 5 gallons to 55 gallons. This shed will drain to the Sediment Pond. The listed products are: Antifreeze, motor oil, gear oil, hydraulic oil, ATF, rock drill oil, and gasoline. Secondary containment will consist of the walls of the shed and shop.
2. *Used Oil drums* will be placed on a concrete pad equipped with secondary containment walls and a roof (to prevent contamination of rainwater). Used oil will be transferred to the drums using manual methods.

3. Up to four 500-gallon *diesel fuel tanks* will be installed on the Whirlwind Pad area (referred to as the fuel station on Map C-2) immediately west of the ore pad. These tanks will be installed within larger livestock tanks (approx. 700-gallons each). This area will be isolated within a low depression on the pad area so that any releases or spills will be contained within the immediate area.

4. There will be 100 to 500-gallon *diesel fuel tanks* outside the generator trailers at the Whirlwind and Packrat Portals, water treatment plant, and possibly one of the remote ventilation shafts. Secondary containment will be provided by livestock tanks large enough to hold a minimum of 110 percent of the diesel tank volume.

5. Small containers of oil and lubricants (less than 100 gallons total) will be stored and used in the two maintenance shops (i.e., Whirlwind and Packrat shops). Secondary containment will be provided by the shop walls and floor.

10. **Warehouse and Maintenance Shops**

A mobile trailer and a temporary prefabricated structure will be used initially as the warehouse and maintenance area, respectively, at the Whirlwind portal area. As the mine develops, these structures will be replaced by a one bay service area and warehouse constructed on top of the existing forty-foot by fifty-foot concrete pad of 6” thickness. This structure will be a prefabricated metal building that is painted a BLM-approved color to better blend in with the surrounding natural features. Maintenance activities will be limited to routine service and minor repairs.

A second maintenance shop is located in a short drift just north of the main Packrat portal. This underground shop will be blocked in and equipped with a garage door.
11. Mine Offices and Shower Facilities

A four-inch thick concrete pad with nominal dimensions of twenty feet by fifty feet will be constructed immediately north of the warehouse and maintenance shop. A prefabricated metal building consisting of mine offices and change/shower facilities (i.e., dry) will be constructed on this concrete pad. This building will be contiguous with the shop and warehouse and will be painted the same color. This area will have a chain link fence and gate to prevent unauthorized access when the mine is idle. Signs will be posted stating that visitors must check in at the mine office.

A portable watchman’s trailer will also be located on site as shown on Map C-2. This trailer will be approximately 10 feet x 30 feet and may be used as sleeping quarters for a security person at night or when the mine is not operating. A septic system will be installed for the shower and bathroom facilities as described under utilities below.

12. Designated Parking and Storage Areas

A gravel parking area will be provided for employees and visitors just north of and adjacent to the mine offices.

One or more material storage areas will be established on top of the Whirlwind waste rock pad. A small storage area will also be available at the north end of the Packrat waste rock pad next to the maintenance shop. These storage areas will contain supplies used underground such as roof bolts, mats, pipe, power cable, ventilation tubing, hoses, timbers, and parts for large equipment.

A 1,000 gallon tank containing a dilute solution of magnesium chloride will be installed on top of the pad near the Whirlwind portal as shown on Map C-2. This tank will be surrounded with a soil berm to contain any releases or spills. The magnesium chloride will be sprayed on the mine haulage roads to create a sealed surface that minimizes the generation of fugitive dust.
13. Mine Access Roads and Pads

Primary Access Roads

The Whirlwind Mine portal is located in the north central part of the claim block. It is accessed by driving 0.8 mile on Colorado Highway 141 south of the Gateway Post Office to Mesa County Road 4 4/10 (a.k.a., John Brown Road); then 7.4 miles southwest to the intersection with Mesa County Road 5 5/10; and, then proceeding west and north on Road 5 5/10 for 3.2 miles to the mine site. Energy Fuels has Surface Alteration Permits with Mesa County that allow the company to assist the County in road maintenance activities. Permitted maintenance activities include snow removal, minor repairs, and application of magnesium chloride on both roads. Installation of culverts and additional road improvements (i.e., construction of ditches, placement of road base, and periodic road grading) are also allowed on 5/10 Road.

Maintenance activities on John Brown Road and 5/10 Road are expected to result in year-round access to the mine. However, there will be time periods when the steeper sections of the road are not safe for ore haulage. The Whirlwind Mine Superintendent and the ore haulage contractor will make the decision whether to temporarily suspend ore haulage operations on a case-by-case basis. Normally this would occur after a heavy precipitation event. The County Conditional Use Permit also places restrictions on the times and days when ore haulage may occur to minimize impacts to other users of the road. At the present time, these restrictions include hauling only during three posted time periods on weekdays and no weekend haulage from April 15 to December 15.

Secondary Access Roads

The two short access roads to the Whirlwind off of 5/10 Road will remain in their current configuration as shown on Map C-1A. The Packrat portal will be accessed by reopening a previously reclaimed mine access road off of 5/10 Road (see Map C-2). Reopening of this road was completed in May 2007 during the exploration phase of the project. The 10-Straight vent shaft will be accessed by an existing secondary road and two-track road off of 5/10 Road. The proposed vent shafts are located next to existing roads and the access roads are included within the proposed 100-foot by 100-foot pad area (see Map C-1B).
The access roads to the portal areas within the mine permit will be dirt and/or gravel and bermed in accordance with MSHA regulations. The roads into the Whirlwind and Packrat will have swinging metal gates. Gates will be locked during weekends, holidays, and other down times. The short access roads to ventilation shafts and power drops will typically be two-track overland roads that will only be used for periodic inspections and maintenance. No fencing or gates will be required at these sites.

Mine Pad Areas

The Whirlwind pad, as previously discussed, will have two levels. The lower level will be at approximately the same elevation as the portal while the upper level will gradually move up the side of the hill to the east. This upper level will be built from waste rock hauled from the mine.

The Packrat pad will be relatively small (approximately 1.0 acre in disturbed area) and terraced to provide two levels as shown on Maps C-4 and C-5. The cut and fill for the portal area is an approximate balance of 3,200 cubic yards. Two 30-ton metal bins for storage of waste rock and ore will be installed so that the buggies can dump into the bins at the top level and haul trucks can pull under the bins on the lower level and be loaded. An additional pair of bins may also be installed at a later date if needed. See Map C-4 for a plan view of the mine layout. The upper pad will have a ramp that allows the mine buggies to reach the top of the bins to dump. Map C-5 shows the cross sections of the Pack Rat Mine. These cross sections show the existing terrain, the mining configuration and the reclaimed terrain. The existing reclaimed Packrat waste pile is located on steep terrain and is not suitable for disposal of waste rock. Accordingly, all waste rock and ore hauled out of the Packrat Portal will be dumped into the bins. The waste will be hauled from the waste bin to the Whirlwind waste rock pile while the ore will be hauled to either the Whirlwind ore stockpile or directly to the mill.

14. Utilities

The local power company will supply electricity to the site using the existing power poles and lines for the most part. Some additional poles and transformers will be needed and temporary generators may be used in some areas until the power is completely established. Installation of the new power poles and
lines and acquisition of the required right of ways will be the responsibility of San Miguel Power Company.

Power drops to the Whirlwind and Packrat portal areas, Whirlwind and Packrat underground workings, and vent shafts will be installed. The approximate locations of the two pad areas for the power drops to the Whirlwind and Packrat underground workings are shown on Figure C-1B. The power drops for the Whirlwind portal, Packrat portal, and the vent shafts will probably be from a power pole transformer to a breaker box at the ground surface within the proposed surface disturbance for these areas, although some vent shafts could be powered from an underground feed. For more detail on the power drop locations, see Section 17 of this Exhibit.

As shown on map C-1, several existing telephone poles are located within the proposed waste embankment expansion. A solar-powered radio is located on one of these poles, which provides telephone service to the mine. The poles are not owned by a utility company. Energy Fuels will remove the poles and relocate the radio receiver prior to the waste pile expansion into these areas. This will not occur for at least two years after mine startup.

Water for bathrooms, showers, and other general uses will be hauled to the site from nearby, privately owned springs or wells. The mine will supply bottled water for drinking purposes. A septic system will be installed in accordance with state and county requirements near the mine offices and dry change facilities.

The main building, which includes the maintenance shop, warehouse, mine offices, and dry change facilities will be heated using propane; the propane tank will be located near the building. The water treatment trailer will be equipped with an electrical heater for use during the colder months. A portable propane heating system may also be used at the Packrat maintenance shop during the winter.

15. Solid Waste Storage

A roll off container for disposal of trash will be located next to the maintenance shop and warehouse. A second roll off may be located on top of the Whirlwind pad near the storage area and smaller trash
barrels will be located in the shop areas. The trash will be picked up on a routine basis by a service company and disposed of at an approved landfill. No landfills will be constructed on site. Scrap metal will be stored in a bin and/or on pallets near the shop until it can be picked up for recycling. Used batteries and tires will be stored in the same area and will be picked up and recycled by vendors.

16. Ventilation Shafts

The existing 10-Straight Vent Shaft that accesses the southern portion of the Packrat Mine will be rehabilitated and used for ventilation purposes. As the mine expands, seven ventilation shafts will be added as shown on Map C-1B for a total of eight ventilation shafts. The location of these vent shafts may change by several hundred feet depending on the ultimate location of the drift and ventilation needs. The ventilation shafts will typically be 72 inches in diameter and cased. The steel casing will be grouted where it passes through aquifers to prevent intermixing of waters between formations.

A concrete pad up to 200 square feet in size and a thickness of 6” will be constructed at each new vent shaft to provide a level platform for drilling equipment during installation. Once the shafts are completed and cased, a single-vane axial fan with a diffuser will be mounted on top of each hole. These units are typically about three to five feet high and have metal grates on top. Taller diffusers may be installed if additional noise reduction is required. The diffusers will be painted a BLM-approved color to blend in with the surroundings.

The fans will be powered by electricity from nearby power poles and each unit will have locked breaker boxes at the power drop. Some additional poles and transformers will be needed to access some locations and temporary generators may used in some areas until the power is completely established. The vent shafts have been located adjacent to existing access roads. Surface disturbance at each vent shaft is estimated to be 0.23 acres consisting of a small pad area (typically 100 feet by 100 feet) that includes a 15-foot-wide, two-track access road. The vent shafts will be inspected periodically during operation (i.e., average of once per day) by Energy Fuels personnel.
17. Maps and Conceptual Design

Map B-1 – General Location Map (located in Exhibit 2)

The following Maps and Figures are included in Appendix I of this application:
Map C-1A - Base Map - Main Mine Area (with soils and vegetation)
Map C-1B - Base Map - Claims and Mine Area Map
Map C-2 - Mine Plan Map - Shows the mine operation with full extent of the ore waste embankment.
Map C-3 - Shows the cross sections of the Whirlwind Mine area.
Map C-4 - Shows the plan view of the Packrat Mine Area.
Map C-5 - Shows the cross sections of the Packrat Mine Area
Map C-6 – Mine Surface Hydrology Designs
Map F - Shows the final contours of the reclaimed area as well as the final land use.
Map G-1 – Regional Hydrology of Beaver Mesa to Dolores River
Map G-2 – Hydrogeologic Map of the Whirlwind Area
Map G-3 – Mapped Extent of Standing Water – 1994 Whirlwind Mine
Map M-1 – Mesa County Roads – Shows primary access roads in Mesa County
Map M-2 – Ore Transportation Routes – Shows various haul routes
Map N-1 – Claims Map – Shows the BLM mining claims.
Figure G1 – Simplified Geologic Map of the Uravan Mineral Belt
Figure G2 – Stratigraphic Column
Figure G3 – Geologic Cross Section of Beaver Mesa
Figure G4 – Section A-A’ Showing Recharge Areas on Beaver Mesa
Figure G5 – Geologic Log of BM00-1 Drill Hole
Figure G6 – Trilinear Diagram
18. Water Management

Surface drainage control is divided into the following three main categories:

1. Surface drainage from undisturbed areas uphill from both portal areas will be permanently diverted around the mine area via constructed ditches and culverts. This water will be diverted directly to nearby natural drainages. All such diversion ditches and culverts are designed for the NOAA year round 100-year, 24-hour storm event of 2.9 inches. This is more conservative than the lower rainfall presented in TR-55, which is more widely used in Colorado for determining peak flows. All ditches have a maximum slope of 2H:1V and 0.3 feet of freeboard. Any ditch with a design flow greater than 5.0 feet per second is designated for a rip-rap lining, which is also designed to withstand the peak flow from the 100-year 24-hour event.

2. Surface drainage from the Whirlwind waste rock pile and all other surface facilities will be diverted through ditches and culverts to the mine sediment pond that, in turn, discharges to an ephemeral drainage in Lumsden Canyon. The sediment pond will fully contain the 10-year, 24-hour event and will safely pass the 100-year, 24-hour event. A principal spillway pipe is used to drain the pond for storm events up to the 100-year event. Larger flows will be handled through a trapezoidal emergency spillway that also leads to the ephemeral drainage. The sediment pond is completely incised in the flat area at the low point of the Whirlwind disturbed area and will have excavated slopes of 2H:1V that will be topsoiled and revegetated. It has a surface area of 0.46 acres and a volume of 4,608 cubic yards.

3. Surface drainage from the ore stockpile pad will be directed to a sump that will overflow into a synthetically lined tank (Untreated Water Tank) that feeds the water treatment system. Water pumped from underground will also enter this system. The Untreated Water Tank is designed to utilize 40,000 gallons of capacity for daily operation of the mine dewatering and treatment system. The tank will also have 75,000 gallons of emergency capacity for continued mine pumping during planned or unplanned plant maintenance activities, and 49,000 gallons for inflow from the ore pad and the tank surface for a 100-year storm event. Therefore, the total design volume of the tank is 164,000 gallons. The tank will have 2H:1V sideslopes and a
minimum freeboard of 1.5 feet. This tank is also described as part of the Water Treatment System designed by Lyntek in Appendix H.

18.1 Whirlwind Surface Drainage

Surface drainage in the Whirlwind portal area will include installation of long-term drainage controls in the facility areas (i.e., buildings and water treatment system) and phased drainage controls at the ore pad and waste pile areas. The proposed drainage ditches and culverts are illustrated on Map C-6. Collection ditches within the site are shown in light blue and diversion ditches around the site are shown in purple. All collection ditches drain to the sediment pond while diversion ditches divert surface water runoff from undisturbed areas around the site. The sediment pond is sized to safely pass the 100-year storm event with a discharge rate of less than 3 cfs. The 10-year, 24-hour runoff is fully contained in the pond. The pond will remain throughout the life of mine and during the initial period after reclamation until vegetation has been adequately reestablished over the mine area.

Surface Facilities
As shown in Phase 1 of Map C-6, drainage from the buildings (i.e., shop, dry, and administrative offices), mine access road, and parking area will be collected in a ditch along County Road 5/10 and diverted to the sediment pond via two 24-inch culverts installed under the road. The water treatment area will be gradually sloped at a grade of about 2 percent toward the sediment pond. Therefore, stormwater runoff and any spills from the treatment area will be captured in the sediment pond. Surface drainage in the facilities areas will remain the same through phase 2 and 3 of the project as shown on Map C-6.

Ore Pad
Initially, the ore pad at the site will be located within a fully bermed area that will contain all direct precipitation. As the lower pad area is expanded to its full size, a new ore pad will be constructed using a GCL liner and 2.5 feet of cover material consisting of compacted fine-grained and run-of-mine waste rock covered with an additional 1.0 feet of compacted run of mine waste rock (see Appendix J). This pad will be contained within a berm and all drainage will be routed to a concrete sump. The
containment berm will be approximately a foot high and will have gradually-sloped sides that will allow for haulage buggies, trucks, and loaders to access the ore stockpile. The sump will be equipped with an overflow that will drain excess water through a 6-inch HDPE pipe into the Untreated Water Tank. As shown on Map C-6, these drainage controls will remain in place through Phase 2 and 3.

Waste Pile
Surface drainage controls for the waste pile will be implemented in three phases during mine operations; initial (phase 1), interim (phase 2), and final (phase 3). These three phases are illustrated on Map C-6.

During the initial phase, the existing lower pad will be expanded northward to its final design stage. An initial collection ditch G1a will be constructed along the east toe of the waste pile that will carry runoff from the pile to the sediment pond. This temporary collection ditch will be utilized until such time the interim phase 2 starts. An existing East Diversion Ditch (Tc-1) along the south perimeter of the waste pile will divert surface water runoff around the pile to a small natural channel located east of the waste pile. A second Diversion Ditch (Tde-1) located along County Road 5/10 will capture runoff from the areas further east of the waste pile. This phase is expected to last two years.

The interim phase 2 includes the expansion of the waste pile into Temporary Basins Tc and Tde at a flat grade up to the level of the interim East Diversion Ditch. The interim diversion will be constructed along the hillside contour above the expanding waste pile and will discharge into a culvert that runs under County Road 5/10 just east of the primary topsoil stockpile. The diversion ditch on the south edge of the lower pad area will be reconstructed so that it drains to the ephemeral drainage located west of the site. A culvert will be installed at the portal so that this water will not be impacted by mobile equipment passing through the portal. A collection ditch, Tn-1, will be installed between the expanding waste pile and the county road. Temporary collection ditches will also be installed around the east edge of the expanding waste pile as topsoil is stripped. These temporary ditches will be at the edge of the stripped area and will flow into collection ditch Tn-1. This phase of the operation is expected to last 3 to 4 years.
The final phase 3 of the project will consist of gradually raising the east portion of the waste pile. As the pile is raised, the west diversion channel will be extended further to the east and will become permanent. A permanent diversion channel will also be constructed around the east side of the pile. Internal collection ditches will remain at the waste pile downslope perimeter and new ditches will be installed along the haul road to the upper waste pile pad area. Phase 3 is expected to extend through the life of the mine.

The maximum projected flow through culverts during any phase determined the ultimate size of each culvert. A minimum culvert size of 24 inches was used for all installations to minimize the potential for plugging and to facilitate cleaning. Culverts will be installed at the initial phase of the project or as needed for the next phase to continue.

18.2 Packrat Surface Drainage

As the Packrat portal area is very small (i.e., about an acre), installation of an unlined collection sump is considered sufficient to control runoff and sediment from the disturbed area. This sump will handle the runoff from the 100-year, 24-hour storm event. As shown on Map C-6, the sump will be located at the bottom of the bin area. Surface water runoff will flow directly into the sump from the lower pad. Water runoff from the upper bench will be transferred to the bin level sump by a 6-inch diameter HDPE vertical pipe, which is shown on Map C-4.

Surface water runoff from above the Packrat will be diverted around the site by diversion channels located along the west perimeter of the pad. The channels will be directed into culverts where they pass under portal areas. All diversions, collection ditches, and culverts were designed using the 100-year peak flows.

18.3 Design Method

The hydrology designs, including ditches, culverts, drainage basins, peak flows, sediment pond, etc. are shown on Map C-6 Mine Surface Hydrology Designs. All calculations for the designs are shown in Appendix B.
For both the Whirlwind and Packrat sites, the 100-full-year type 2 storm event was chosen for designs. Information for the 2.90 inch event was obtained from the NOAA Atlas 2, Volume III for Colorado.

The hydrologic soils group for the Sili, Sedgran, and Bodot soils is “C”, although for conservative design purposes, a “D” hydrologic soil group was used.

The Curve Number Method was developed to allow calculation of the overall time of concentration (Tc) under a wide range of conditions. The method is designed for areas of 2,000 acres or less. The calculations require a proper understanding of the input requirements.

The HYDROCAD computer modeling program was used which uses the SCS Unit Hydrograph Method for watershed runoff modeling.

**SCS Unit Hydrograph Method**

The SCS unit hydrograph procedure (also known as the TR-20 runoff method) generates a runoff hydrograph by the following basic steps: (For brevity, this is a simplified description.)

1. A rainfall distribution is selected which indicates how the storm depth will be distributed over time. This is usually a standardized distribution, such as the SCS Type II storm, and often has a standardized duration of 24 hours.

2. The design storm depth is determined from rainfall maps, based on the return period being modeled. Combined with the rainfall distribution, this specifies the cumulative rainfall depth at all times during the storm.

3. Based on the Time-of-Concentration, the storm is divided into “bursts” of equal duration. For each burst, the SCS runoff equation and the average Curve Number are used to determine the portion of that burst that will appear as runoff.
4. A Unit Hydro-graph, in conjunction with the Time-of-Concentration, is used to determine how the runoff from a single burst is distributed over time. The result is a complete runoff hydrograph for a single burst.

5. Individual hydrographs are added together for all bursts in the storm, yielding the complete runoff hydrograph for the storm.

For a $T_c$ of 7.5 minutes, the burst duration is 1 minute, so a 24-hour storm will consist of 1440 bursts. If each burst involves a unit hydrograph of 100 coordinates, then 140,000 coordinates must be summed to produce the composite hydrograph.

Because of the computational requirements of the unit hydrograph procedure, the SCS derived a simplified tabular method as published in Technical Release 55 JR-55).

**Storage-Indication + Translation Method**

The basic storage-indication method accounts for only the storage effects of a reach. Other techniques must be used to account for the kinematic effects of long reaches. HydroCAD provides the option of adding a time lag or translation to the normal storage-indication routing.

**Time Translation**

The "Stor-Ind+Trans' routing method first performs a storage-indication routing, and then translates the resulting hydrograph by the travel time. A close examination of the resulting hydrograph will reveal that the peak discharge no longer corresponds to a point on the inflow curve, but is translated (delayed) by the prescribed amount.

$$T_c = \frac{L}{0.6}$$

where

$$L = \frac{I^{0.8} \times (S + 1)^{0.7}}{1900 \times Y^{0.5}}$$

*Whirlwind Mine 07 – rev. 3/08* 5-34
and \[ S = \frac{1000}{CN} - 10 \]

where:
- \( T_c \) = Time of Concentration [hours]
- \( L \) = Lag time [hours]
- \( L \) = Hydraulic length of the watershed [feet]
- \( Y \) = Average land slope [percent]
- \( S \) = Potential maximum retention [inches]
- \( CN \) = Weighted Curve Number

Note the use of the average land slope, and not the slope of the hydraulic path. Although some care is required to determine this value, the Curve Number method has the advantage of using a small number of fairly objective parameters. This provides more consistent results than some other approaches.

### 18.4 Water Treatment Plant and Tanks

Excess water from the underground workings will be pumped into the lined Untreated Water Tank via a buried, six-inch diameter HDPE pipe. The lined tank will be located just north of 5/10 Road and south of the sedimentation pond. Surface drainage overflow from the ore pad area will also be directed to this tank. A portable, trailer-mounted water treatment plant will be installed immediately west of the collection tank. See Map C-2. The plant will pump water from the synthetically lined collection tank and treat the water with barium chloride and ferric sulfate to precipitate out radium and uranium.

The treated water will be discharged into one of two synthetically lined tanks located immediately north of the treatment plant. Precipitated metals and radionuclides will settle out in the first tank and the second tank will collect the treated water prior to gravity discharge into the ephemeral drainage located immediately west of the tank. The treatment plant and tanks will be fenced and equipped with a locked gate to prevent unauthorized access.

Sampling and analysis of treated water will be conducted in accordance with Colorado Discharge Permit System (CDPS) Permit Number CO-0047562 with the Colorado Division of Water Quality Control (see Appendix N).

Details of the water treatment process are discussed in Exhibit 8 and Appendix H.
18.5 Construction QA/QC

The BLM and DRMS will be notified in writing at least 10 working days prior to the beginning of construction of stormwater control features, the ore pad, and any additional structures. This will allow the agencies the opportunity to conduct inspections prior to and during construction activities. A detailed preconstruction report will be prepared by a licensed professional engineer and submitted within 30 days of completion of the work or prior to commencing use, whichever date is less.

19. Mining Schedule

Mine life is estimated at approximately 10 years. **Table 5-3** shows the approximate schedule of mining operations at Whirlwind. Details of each task are covered in Section 2 – Underground Operations.

**Table 5-3**

<table>
<thead>
<tr>
<th>Task #</th>
<th>Description</th>
<th>Time Needed (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rehabilitation of existing workings in both the Urantah Decline and Packrat Mine. Construction of surface facilities.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Development of several nine-foot by twelve-foot drifts through known ore-bearing zones to provide access for production mining.</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Mine uranium. Addition of seven ventilation shafts (72 inch dia.)</td>
<td>102</td>
</tr>
<tr>
<td>4</td>
<td>Post-mining reclamation of operation. (Details in Table 6-1: Reclamation Timetable)</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Total months</td>
<td>144</td>
</tr>
<tr>
<td></td>
<td>Total years</td>
<td>12</td>
</tr>
</tbody>
</table>

20. General Area Road Use and Maintenance

Energy Fuels commits to maintain the primary access road of County Road 5/10 from where the road branches off of John Brown Canyon Road at Station 38+800 as indicated on Map M-1 to the Whirlwind mine portal area. This maintenance will be to County standards for road maintenance, and
will include magnesium chloride treatment, snow plowing, blading, and additional gravel as needed. Energy Fuels will also install new culverts and maintain the existing culverts. These new and existing culverts are also indicated on Map M-1.

Kimley Horn & Associates performed a traffic analysis for Energy Fuels. Their report, which follows, indicates that auxiliary turn lanes are not needed at the intersection of John Brown Canyon Road and Highway 141.
June 18, 2007

Mesa County Regional Transportation Planning
PO Box 20000-5093
Grand Junction, Colorado 81502

Attn: Ken Simms
Re: Whirlwind Mine Reopening
   Level I Traffic Study, Mesa County, Colorado

Dear Mr. Simms:

This letter presents the results of a Level I Traffic Engineering Evaluation per Mesa County guidelines for trip generation assessment for the reopening of the Whirlwind Mine. A Mesa County Level I traffic study is required for all projects that generate less than 10 trips during the peak hour and is intended to document the project trip generation and to confirm that auxiliary turn lanes are not required at the proposed access point.

The Whirlwind Mine portal is located north of Mesa County Road 4 4/10 (John Brown Canyon Road), approximately 11.4 miles southwest of the town of Gateway, Colorado. The Whirlwind Mine site consists of approximately 19.7 acres, much of which was previously disturbed and reclaimed by the former mine operators. The mine is accessed by driving approximately 0.8 miles on State Highway 141 (SH-141) south of the Gateway Post Office to Mesa County Road 4 4/10/John Brown Canyon Road and then 7.4 miles southwest to the intersection with Mesa County Road 5/10 and proceeding west and north on Mesa County Road 5/10 for 3.2 miles to the mine site. These county roads are mostly graded dirt with short gravel sections.

The primary haulage route will be via Mesa County roads to SH-141 just south of Gateway. Three secondary routes via Grand County, Utah roads to Utah highways may also be used, especially in the summer when weather conditions are more favorable. The attached map illustrated the primary haulage route, Route A, as well as the three secondary haulage routes, Routes B, C, and D.

Site-generated traffic estimates are determined through a process known as trip generation. For this study, Kimley-Horn used information provided by the client to determine the number of vehicles anticipated to enter and exit the site during the AM and PM peak hours, as well as the number of vehicles anticipated to access the site per day.
Initially, approximately twenty trucks per week will be loaded and sent to the mill. As production increases to 200 tons per day, truck traffic will increase to an average of about forty roundtrips per week. Weather conditions, haul truck availability, mill demands, and other factors may result in periods of increased haulage of up to eighty roundtrips per week (i.e., sixteen trips per workday). Therefore, it is anticipated that the total number of trucks that will access the site during a typical day would range from 4 to 16 trucks. To provide a conservative assessment of project generated traffic, it was assumed that 10 percent of the maximum 16 trucks per day would be entering and exiting the site during both the morning and afternoon peak hours. The morning and afternoon peak hours of adjacent street traffic typically occur between 7 and 9 AM and between 4 and 6 PM, respectively. The following table identifies the anticipated trip generation for the project.

### Whirlwind Mine Daily and Peak Hour Traffic Generation

<table>
<thead>
<tr>
<th></th>
<th>AM Peak Hour</th>
<th>PM Peak Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In</td>
<td>Out</td>
</tr>
<tr>
<td>Daily</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

The Whirlwind Mine is anticipated to generate a maximum of 16 trips per day. Of these 16 trips, it is estimated that a maximum of 2 trips will occur during the morning peak hour and 2 trips will occur during the afternoon peak hour. Therefore, since the Whirlwind Mine is anticipated to generate less than ten trips in the peak hour, auxiliary turn lanes are not required based on Mesa County guidelines. If you have any questions relating to this analysis, please feel free to give me a call at (303) 228-2308.

Sincerely,

KIMLEY-HORN AND ASSOCIATES, INC.

Elizabeth Goodremont, P.E.
Project Manager
The four possible haul routes from the mine to major highways are shown on Map M-2. Of the four routes, Route A is the only all-weather road available and will likely be the primary route used by the company contracted to haul the ore. The ore will be hauled to an off-site uranium mill for processing. The most likely destination is the White Mesa Mill in Blanding, Utah; however, the Cotter Mill in Canyon City, Colorado and the Uranium One Mill in Ticaboo, Utah are also possibilities. If Energy Fuels should construct a mill, the ore would be hauled to and processed at that mill. With the exception of the Ticaboo Mill, ore haulage on Route A would require a right turn (i.e., turn to the south) at Highway 141 thus avoiding truck traffic through the town of Gateway.

Ore haulage will not be performed by Energy Fuels, but rather contracted to one or more trucking companies. Ore haulage will be performed in accordance with Energy Fuels’ Ore Transportation Plan, which is included as Appendix K. The trucking company will be responsible for developing and implementing emergency response plans in the event of an accident, obtaining required road-use permits, and obeying all traffic rules. Energy Fuels will incorporate any road-use constraints mandated by the counties or the BLM into the ore haulage contract. Energy Fuels may also provide emergency cleanup services in the event of an accident provided that the ore haulage contractor requests this service as part of the contractual arrangements.
Section 1 – General Reclamation Plan
Section 2 – Reclamation Timetable
Section 3 – Seal Decline and Other Areas of Ground Water Inflow
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Section 20 – Weed Control
Section 21 – Revegetation Success Criteria
Section 22 – Monitoring Reclamation Success
Section 23 – Reclamation of Drill Holes
Section 24 – Reclamation Cost Estimate
1. **General Reclamation Plan**

The total disturbed area for this permit consists of the following areas:

- 19.75 acres in the main Whirlwind portal area,
- 0.99 acres in the Packrat portal area.
- 0.76 acres of Packrat access road.
- 0.64 acres at two power drop pad areas.
- An additional 0.23 acres at each of two ventilation shafts in Colorado and an additional 6 ventilation shafts in Grand County, Utah for a total shaft disturbance of 1.84 acres.

This is a total disturbed area of 23.98 acres in Utah and Colorado.

All disturbed areas will be reclaimed to dry rangeland for wildlife habitat, which is the primary post mining land use. Bat gates will be provided at the main Packrat portal to enhance bat habitat, which is a desire of the Colorado Division of Wildlife and the BLM. Current plans are to backfill the Whirlwind Portal during reclamation; however, a bat gate could also be installed at that portal if requested by the BLM. Map F show the final configuration of the two portal areas. Map C-3 shows cross sections of the Whirlwind site for current mining and reclamation cases and Map C-5 shows the same for the Packrat portal site.

As discussed in the mine plan (see Exhibit 5), the site will be partially reclaimed as the waste embankment is constructed over the 10-year mine life. Initially, the outer slope of the existing waste pile will be reclaimed, after it is expanded to its northern limit as shown in Cross section A-A’ on Map C-3. As the waste embankment of the pile expands to the east, the north face will be reclaimed concurrently. Topsoil replacement will be performed by dozers spreading the material over the slope, followed by seeding in the fall. The seed mix is presented later in this section. Final reclamation will commence at the end of the mine life of approximately 10 years.

The worst-case reclamation scenario (i.e., largest reclamation liability) occurs at the conclusion of mining, since most of the Whirlwind bench and a portion of the waste embankment will need to be
reclaimed. The entire 0.99-acre area at the Packrat portal will need to be reclaimed. The ventilation shafts will also be reclaimed at the conclusion of mining. Each portion of the reclamation is discussed in the sections that follow.

The reclamation timetable is shown in Section 2 in Table 6-1 and the costs for the worst-case scenario are calculated in Section 24 - Reclamation Costs.

2. Reclamation Timetable

The reclamation timetable below is based on the projections for the mine and the amount of reclamation that is needed after mine shutdown. Once the mine is permanently shut down, the reclamation is expected to take approximately 24 months. The initial 18 months of reclamation will consist of sealing the Whirlwind decline and monitoring the water pool that will form above the seal.
# Table 6-1  Reclamation Timetable

<table>
<thead>
<tr>
<th>Task #</th>
<th>Description</th>
<th>Time Needed (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Open Mine and create mine waste disposal areas prior to initial reclamation</td>
<td>36.0</td>
</tr>
<tr>
<td>2</td>
<td>Strip topsoil from expanding east portions of waste embankment to reclaim west portions.</td>
<td>84.0</td>
</tr>
<tr>
<td>3</td>
<td>This task is the start of the final reclamation process. Place a bulkhead seal in the lower portion of Whirlwind decline and monitor water pool. Also, seal off other areas of ground water inflow.</td>
<td>18.0</td>
</tr>
<tr>
<td>4</td>
<td>Pump sludge from the Treated Water Settling Tank into upper portion of decline using existing waterline. Add cement at pump to stabilize sludge. Excavate ore pad liner and cover material and place in the upper portion of the decline.</td>
<td>1.0</td>
</tr>
<tr>
<td>5</td>
<td>Remove fans and concrete foundations at all ventilation portals and seal shafts. Remove or cut power cable at power drops and seal cased holes. Replace topsoil and seed/mulch associated pad areas.</td>
<td>0.5</td>
</tr>
<tr>
<td>6</td>
<td>Dismantle and remove shop, warehouse, tanks, water treatment plant and tanks, fence, other site structures at Whirlwind and bins, retaining wall, shop door, and supply storage area at Packrat.</td>
<td>2.0</td>
</tr>
<tr>
<td>7</td>
<td>Remove foundations at Whirlwind portal and Packrat portal.</td>
<td>0.2</td>
</tr>
<tr>
<td>8</td>
<td>Install bat gate at Packrat and seal off shop area with blocks.</td>
<td>0.15</td>
</tr>
<tr>
<td>9</td>
<td>Conduct backfilling and grading at the 2 portal areas, waste embankment and mine benches.</td>
<td>0.50</td>
</tr>
<tr>
<td>10</td>
<td>Use MSHA berm on the Packrat Road to re-topsoil the Packrat portal area.</td>
<td>0.20</td>
</tr>
<tr>
<td>11</td>
<td>Re-seed and mulch the Packrat portal area.</td>
<td>0.10</td>
</tr>
<tr>
<td>12</td>
<td>Use hydraulic excavator to conduct partial backfilling and grading of Packrat road.</td>
<td>0.5</td>
</tr>
<tr>
<td>13</td>
<td>Seed and mulch Packrat road and block access.</td>
<td>0.10</td>
</tr>
<tr>
<td>14</td>
<td>Rip compacted areas of Whirlwind prior to topsoil replacement</td>
<td>0.10</td>
</tr>
<tr>
<td>15</td>
<td>Replace topsoil on remaining areas of Whirlwind mine.</td>
<td>0.40</td>
</tr>
<tr>
<td>16</td>
<td>Harrow topsoil at Whirlwind mine</td>
<td>0.10</td>
</tr>
<tr>
<td>17</td>
<td>Seed and mulch Whirlwind area and block access.</td>
<td>0.10</td>
</tr>
<tr>
<td>18</td>
<td>Backfill Sediment Pond* and Collection Ditches.</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td><strong>Total months</strong></td>
<td><strong>144</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Total years</strong></td>
<td><strong>12.0</strong></td>
</tr>
</tbody>
</table>

* Note: The sediment pond will be reclaimed after the reclaimed areas support adequate vegetation.
3. Seal Decline and Other Areas of Ground Water Inflow

The Whirlwind Mine will require the installation of a bulkhead seal in the lower portion of the decline to ensure that the water seeping into the decline from the lower Brushy Basin aquifer is not allowed to enter the mine workings. The lower bulkhead will be constructed near the base of the decline within a zone of competent sandstone of high compressive strength. The hydraulic loading on this seal is expected to be relatively low i.e., about 38 feet of hydraulic head based on a maximum of 630 feet of Brushy Basin intercept on a 6 % grade. Design details and the estimated cost of the seal are presented in Appendix L.

Energy Fuels will also attempt to seal off other ground water inflows into the mine that may still exist at the time of closure. This will likely consist of grouting and/or sealing of areas where water may be seeping into the mine through natural fractures or more permeable zones. The cost of a contingency seal in the Packrat workings has been included in the reclamation bond as described in Appendix L. The estimated costs of the Whirlwind decline seal and the contingency seal are $111,450 and $115,257, respectively. Energy Fuels and the Division of Reclamation, Mining and Safety believe that the likelihood of a seal in the Packrat workings is low, however, the Division requested the additional bond so that its potential cost is covered for a worst case scenario.

The ground water-bearing zone above the Whirlwind seal is perched and present only at the base of the channel sandstone unit; therefore, the water level behind the seal is expected to stabilize at or near the ground water inflow point within the decline. Energy Fuels will monitor the water elevation above the lower seal until it reaches equilibrium plus an additional 5 quarters (i.e., 1.25 years). Once the monitoring period is completed, the remainder of the mine site can be reclaimed.

4. Place Ore Pad Liner, Pad Cover Material, and Treatment Sludge in Mine

Over the life of the mine, percolation of rain water through the ore stockpile may result in radionuclides leaching into the compacted pad immediately below it; therefore, the 3.5 feet of cover material and the ore pad liner will be excavated over the 0.5-acre stockpile area shown on Map C-2. This material will be disposed of inside the mine above the seal and water pool. This area of the
decline is dry and the material will not be in contact with ground or meteoric water. The calculated volume of pad material is 2,820 cubic yards. The cost of this excavation, haulage and placement is $5 per cubic yard resulting in an estimated cost of $14,100. The liner consists of overlapping strips of GCL. These strips will be dragged into the mine with a chain and buggy and left in the upper part of the decline. The estimated unit cost of hauling the liner is $1,600.

The sludge collected in the Treated Water Settling Pond will be disposed of in either one of two ways: 1) mixed into a cement grout on site and disposed of in the mine in a designated area or 2) taken to the uranium mill with ore to be processed. The later disposal method is preferred as it allows for maximum utilization of the resource; however, this option may not always be available. For reclamation costing purposes, disposal in the mine is assumed. As discussed in Appendix H, the sludge is expected to contain low levels of radionuclides and metals that do not require disposal as a radioactive or hazardous waste.

The sludge volume is estimated to be approximately 19 cubic yards as discussed in Appendix H. The sludge will be slurried into a grout pump where cement will be added to form a cement grout that will be pumped into the upper portion of the decline using the existing waterline. The grout will be placed on top of or next to the ore pad material. The volume of slurried grout is expected to be about 40 cubic yards. The addition of cement and pumping of this material is expected to be $200 per cubic yard placed, resulting in an estimated cost of $8,000.

The total estimated cost for this task is $23,700.

5. Reclaim Ventilation Shafts and Power Drops

As explained in Section 15 of Exhibit 5 – Mine Plan, two ventilation shafts will be located in Colorado. Up to six other shafts may be present in Utah, which will be permitted under a NOI to Commence Small Mining Operations (i.e., 5 acres or less disturbance) with the Utah Division of Oil, Gas and Mining. All new shafts will be grouted where they intercept aquifers so that they do not provide a conduit for ground water flow.
There are a number of methods available for sealing a vent shaft at the surface including the use of foam, concrete, metal, and/or combination thereof. Seal designs will be provided to the DRMS and BLM at the time of closure for their review and approval. For reclamation costing purposes, the following traditional reinforced metal and concrete design is assumed.

The first step in reclaiming the vent holes will consist of digging down four to six feet deep around each hole and cutting the casing off from three to four feet below the ground surface. It is assumed that an 80-horsepower tracked hydraulic excavator will require about 20 minutes at 3 to 4 miles per hour (mph) to tram between the two Colorado locations and that the trench around each casing could be excavated in 45 minutes. Based on this scenario, 2 hours were allotted toward excavating around the 2 vent holes plus an additional 1 hour for traveling from the portal area to the initial excavation.

After the casing is cut off, a steel plate will be welded over the opening and structural steel (i.e., small I-beams and rebar) will be welded over the top of the steel plate to form a six-inch-thick, reinforced square cover. Concrete will be poured between the I-beams and around the rebar to complete the installation. A minimum of three feet of soil will be placed over the cover. The cost estimate assumes that a welder and laborer can cut the casing and weld together a cover in six hours and that two laborers can hand mix and pour the concrete for each cover in four hours. Materials are based on average cover dimensions of six feet by six feet. The total cost for each ventilation shaft is $5,500. Two shafts result in a total cost of $11,000 for Colorado.

Each shaft area is assumed to have a maximum disturbance of 100 feet wide x 100 feet long or 10,000 square feet. This includes any short two-track roads built to access the shaft area. After shaft sealing, the topsoil which was previously stockpiled at each shaft location will be replaced and graded. The area will then be seeded and mulched. Assuming an average topsoil depth of 12 inches, approximately 370 cubic yards of topsoil will be placed. This earthwork will be done at an estimated cost of $1.50 per cubic yard, therefore the cost per shaft is $555. Seeding and mulching costs are estimated to be $1,500 per acre, allowing for a 50% reseeding rate. Therefore, reseeding costs per shaft are $150. The cost for regrading and seeding is $705 per shaft resulting in a total estimated cost of $1,410 for the two shafts in Colorado.
As explained in Section 13 of Exhibit 5 – Mine Plan, two cased holes will serve as power drops into the mine workings. The power cable will be removed from these holes and then the casing will be cut off at a depth of three to four feet below the surface using an acetylene torch. The cased opening will be sealed with an expansion foam plug and the excavated soil will be placed back over the sealed hole. Plugging costs are estimated at $500 per hole or $1,000 total.

The proposed pad areas for the Whirlwind and Packrat power drops encompass 0.23 acre and 0.41 acres respectively, for a total acreage of 0.64 acres. Using the same cost assumptions as specified above for the vent shaft pads, this will require regrading of $370 + 659 cubic yards = 1029 cubic yards of topsoil at a cost of $1,543 and seeding of 0.64 acres at a cost of $960. Total estimated costs for regrading and seeding the two power drops is $2,503.

The total estimated cost for reclaiming the Colorado vent shafts and power drops is $11,000 + $1,410 + $1,000 + 2,503 = $15,913.

The additional costs for the 6 shafts in Utah are as follows:

- plug and seal: $5,500/ea
- retopsoil and regrade: $555/ea
- Reseeding: $150/ea

Subtotal: $6,205/ea

6 Utah shafts x $6,205 = $37,230.
Therefore, the total cost for this task is $15,913 + $37,230 = $53,143.

6. Dismantle Buildings and Structures at Both Portal Areas

Reclamation will include the removal of all buildings and other structures. The following structures will be removed at the Whirlwind Portal area:
- Powder magazines - 2 (skid mounted portable)
- Water Treatment Trailer (portable)
Water Treatment Tanks (3 tanks that must be disassembled and hauled off site) Removal cost: $1,200

Shop and office building, 60 feet x 43 feet size, One story (fixed building which must be dismantled) Removal cost: $6,000

Dry change facility, 50’ x 20’, One story (fixed building which must be dismantled) Removal cost: $2,500

Storage Trailer (portable) 12 feet x 40 feet

Generator Trailer (portable) 12 feet x 40 feet, assumes that it is still on site even though power is expected to be delivered to the mine at an early stage.

A skid-mounted oil storage shed with nominal dimensions of eight feet by ten feet located adjacent to the maintenance shop (portable).

Helipad (20 feet x 20 feet) Removal cost: $1,000

Four 500-gallon diesel fuel tanks on the Whirlwind Pad area as shown on Map C-2, called the fuel station, immediately west of the ore pad. These tanks will be installed within larger livestock tanks (approx. 700-gallons each). Removal cost: $2,200

Magnesium Chloride Tank located near the portal. The tank size is 1,000 gallons and it will be contained within a soil berm. Removal cost: $500

Propane tank (portable), 500 gallons.

Fence around water treatment area and mine entrance. Removal cost: $1,500

Concrete sump (6 feet x 6 feet) which drains from the ore pad area to a pipe (the HDPE pipe will remain buried in the backfill) Removal cost: $1,000

2 powder magazines: Removal cost $1,000.

Watchman’s trailer: (portable)

Subtotal of removal costs: $16,900.

The following structures will be removed at the Packrat Portal area:

- Retaining wall, approximately 300 feet in length, with an average height of 8 feet and a maximum height of 22 feet. This wall will be made of steel supports with wood beams. Removal cost: $10,000.
Concrete jersey barriers of 100 feet total length, which will be hauled off site and re-used.
Removal cost $2,500.

- Up to four steel bins for the loading of ore and waste. These bins will be 22 feet high for truck loading underneath, and an upper bin storage area of 12 feet x 12 feet. Removal cost for 4 bins: $10,000
- Shop door, approximately 12 feet wide by 8 feet high. This door will be removed and the opening blocked in prior to regrading. Removal cost: $300

Subtotal of removal costs: $22,800.

No other structures will require removal at the Packrat portal.
Total Removal costs of structures: $39,700.

7. Remove Foundations at Whirlwind and Packrat Portals

The shop and dry/admin building rest on concrete foundations that are 60 feet x 43 feet and 20 feet x 50 feet. The foundations are 6 inch thick with rebar. This is a volume of 66 cubic yards of concrete. The material will be removed with a Cat D-7 dozer equipped with a hydraulic concrete breaker or equivalent. The material will be loaded in trucks and hauled underground or off site. The cost of this removal is $24 per cubic yard and the disposal is $7 per cubic yard. Therefore, the total estimated cost is $2,046.

The Packrat bins will have up to 16 concrete footers of 3-foot depth and 2-foot diameter. These will cost $150 each to remove x 16 footers = $2,400.

The total cost for this task is estimated to be $4,446.

8. Install Bat Gate at Packrat Portal and Seal Shop Area

A steel bat gate will be welded into place at the main Packrat portal. The gate will cost an estimated $2,400 to fabricate and install. An 8-foot by 12-foot block wall will be constructed over the door
opening into the underground shop at an estimated cost of $500. The total cost for the Packrat portal area is $2,900.

9. Backfilling and Grading at Portal Areas

Whirlwind

The Whirlwind decline was originally equipped with a bat gate; however, no bats were found in the mine during inspections conducted by the BLM and the Colorado Division of Wildlife (DOW). For cost estimating purposes, it is assumed that the Whirlwind portal will be backfilled; however, the decision as to whether it will be backfilled or reclaimed with a bat gate will be made at the time of closure in consultation with the BLM. A bat gate was previously installed over the smaller portal at the Packrat Mine while the larger portal was backfilled. Generally, a larger opening is preferred by the bats and the reclamation cost estimate assumes that the larger portal will be reclaimed with a bat gate while the smaller portal will be backfilled.

Backfilling of the Whirlwind portal will consist of pushing material from the portal pad into the mine opening for a distance of 20 feet. Then additional material from the pad will be backfilled to a height of 10 feet above the top of the portal opening to the existing bench at a slope of 3H:1V. This backfill volume is 820 cubic yards. The cost of this backfilling and grading is $1.20 per cy, therefore the estimated cost for this work is $984.

The waste embankment final configuration will be created on an ongoing basis during mine operations; therefore, less earthwork will be required at the end of the mine life to achieve the final contours. Map C-3 shows that the grading at the end of the mine life is minimal. Final grading of the waste embankment will include grading the remaining angle of repose slopes to 3H:1V or less steep, placing fill against the backfilled portal area to create slopes of 3H:1V, and providing proper drainage for all areas. It is expected that approximately 4,000 cubic yards of waste rock will be regraded with a Cat D-7 dozer, or equivalent, at a cost of $0.75 per cubic yard. Therefore a total cost of $3,000 is estimated. The final contours are shown on Map F and the cross sections are shown on Map C-3 (see Appendix I).
No pocking of the surface at Whirlwind is specified since topsoil that is salvaged will provide a good medium for plant growth and the recontoured slopes will not be as prone to erosion as the longer and steeper slopes observed at the Packrat waste pile (see Packrat below).

Therefore, the estimated subtotal for backfilling and grading at Whirlwind is $984 + $3,000 = $3,984.

Packrat

The Packrat portal will require grading after the retaining wall is removed. The portal bench will be regraded to blend with the surrounding hillside except for a small flat area to be left at the base of the main portal. The final contours are shown on Map F and the cross sections are shown on Map C-5. The backfilling and grading will require dozing of approximately 3,200 cubic yards. The material will require a short uphill push with a D-7 dozer, at a grade of 33% and a length of approximately 240 feet. This represents a unit cost of about $1.00 per cubic yard; therefore, a total cost of $3,200 is estimated.

Pocking of the regraded surface will be required at the Packrat because the topsoil available for this site is poor (imported alluvium from lower elevation) and the slopes are relatively steep. Pocking consists of using the bucket of a hydraulic excavator to create a series of depressions in the slope surface where runoff can be retained so as to promote plant germination and reduce erosion. Pocking of the area of approximately 0.99 acres using depressions of approximately 10 feet x 10 feet and 2 feet deep will cost approximately $2,800. If additional soil is available from stripping and reclamation at the Whirlwind waste embankment area, additional soil may be brought to the Packrat portal for reclamation. The Whirlwind reclamation, however, will have no less than 12 inches of topsoil replacement.

The estimated subtotal for backfilling and grading at Packrat is $3,200 + $2,800 = $5,000.

Therefore, the total cost for backfilling and grading both portal areas and the waste embankment is estimated to be $8,984.
10. Use MSHA Berm to Re-topsoil Packrat Portal Area

All previous substitute topsoil used to reclaim the Packrat Portal area was stripped and placed along the perimeter of the Packrat Pad and Road to create the 3-foot high safety berm required by MSHA. During reclamation, this material will be removed and replaced on the pocked surface of the Packrat Portal area of approximately 0.99 acre. This material was previously calculated as having a volume of 672 cubic yards, assuming a soil depth of 5 inches. It will be placed carefully into the pockmarks at a unit cost of $3.50 per cubic yard. This represents an estimated total cost of $2,352.

11. Re-Seed and Mulch the Packrat Portal Area

Once re-topsoiling is complete, the area must be immediately seeded and mulched because the Packrat Road will be removed, preventing future access to the site by vehicle. Seeding and mulching will be done by broadcast methods using the seed mix described below in Table 6-2:

Table 6-2 Reclamation Seed Mix:

<table>
<thead>
<tr>
<th>Species</th>
<th>Lbs Pure Live Seed per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rincon or Native Four Wing Saltbush</td>
<td>2.0</td>
</tr>
<tr>
<td>Lutana Cicer Milkvetch</td>
<td>0.2</td>
</tr>
<tr>
<td>Cedar Palmer Penstemon</td>
<td>0.1</td>
</tr>
<tr>
<td>Lewis Flax</td>
<td>0.5</td>
</tr>
<tr>
<td>Hachita Blue Grama</td>
<td>0.3</td>
</tr>
<tr>
<td>Needle and Threadgrass</td>
<td>1.6</td>
</tr>
<tr>
<td>Paloma Indian Ricegrass</td>
<td>1.4</td>
</tr>
<tr>
<td>Nordan Crested Wheatgrass</td>
<td>1.0</td>
</tr>
<tr>
<td>Luna Pubescent Wheatgrass</td>
<td>2.0</td>
</tr>
<tr>
<td>Primar Slender Wheatgrass</td>
<td>1.3</td>
</tr>
<tr>
<td>Arriba Western Wheatgrass</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>12.2</strong></td>
</tr>
</tbody>
</table>

The rates above are for dill seeding. Seed application rates will be doubled when using broadcast methods.
Certified weed free hay or straw mulch will be applied after seeding at the rate of 2,000 lbs per acre. This mulch will be applied manually given the restricted access to this site and the undulating surface created by pocking.

The unit cost of seeding and mulching the Packrat Portal area is estimated to be $1,000 per acre. Accounting for reseeding at 50% success, this is a total unit cost of $1,500 per acre. The area of 0.99 acres therefore results in a total estimated cost of $1,485.

12. Partial Backfilling and Grading of Packrat Road

The Packrat Road is a pre-existing road that was cut from the hillside in order to provide access to the early operation of the Pack Rat Mine, which started decades ago. During construction of the road, rock and soil excavated from the road cut were side cast downslope to create the full width of the road. The road was previously reclaimed by ripping and seeding the road surface and installing water bars. Previous reclamation did not include recontouring of the road cut. Energy Fuels will utilize this road to access the Packrat portal and will reclaim the road after the work at the portal area is complete. Reclamation will include partial backfilling and recontouring of the road cut so that the reclaimed surface better blends with the surrounding area. Water bars will also be installed in their approximate former locations to divert water off the reclaimed road into the natural drainage below.

Pulling up all the material from the outside edge of the road is not practical or environmentally sound since the original slope was steeper than 2H:1V in many places. Replacement of the loose material at this slope angle would likely produce a slope with a low safety factor (i.e., less than 1.3) that is prone to accelerated erosion. In addition, almost all of the material placed on the outside edge of the road during original road construction has revegetated in the intervening years. Pulling this material back up the hill will result in more disturbance and potential erosion in an area that will not be easily accessible after reclamation is completed. It is proposed that only the top 2.5 vertical feet of the outside edge of the road be removed and placed on the inside edge to achieve partial backfilling. This will lessen the erosion impacts compared to more extensive recontouring and the material placed on the road cut slope (west edge) can be placed to achieve an angle of approximately 4H:1V, which is more stable, easier to
revegetate, and less prone to erosion. The cross sectional area to be cut and filled is approximately 25 square feet, as shown in Figure E-1 below.

Since the length of road is 1,660 feet, the volume needed to cut and fill is 1,537 cubic yards. Four large water bars will also be installed in approximately the same location as those installed during previous reclamation activities. This will require about 15 cubic yards of additional cut and fill per water bar bringing the total cut and fill quantity to 1,597 cubic yards. Using a small, track-mounted hydraulic excavator, this work can be done for approximately $2.00 per cy, therefore, the total estimated cost is $3,194.

Much of the road fill is well vegetated and contains the original topsoil from the road excavation; therefore no topsoiling of the fill is needed. It will be left in a rough loose condition to enhance
revegetation. Boulders will be used to construct berms in the narrower portions of the Packrat Road where a soil berm would be too wide. During reclamation, these boulders will be salvaged and later used to block the entrance to both the Packrat and Whirlwind access roads. Costs for placement of these boulders are addressed below under seeding and mulching.

13. Seeding, Mulching, and Blocking of Packrat Road

The backfilled surface will be reseeded as segments of road are reclaimed, since there will be no future access. The methods are the same as that described for the Packrat Portal area in Section 11 of this Exhibit. As measured from Figure E-1, the width of area to be reseeded is 25 feet times the road length of 1,660 feet = 41,500 square feet (sf) or 0.95 acres. The unit cost is $1,500 per acre, which includes 50% reseeding resulting in an estimated cost of $1,425.

Boulders salvaged from the road berm will be placed across the road entrance to discourage access by recreational vehicles. This work will be done with a front end loader at an estimated cost of $300. Total estimated cost for seeding, mulching, and blocking the road is $1,725.

14. Rip Compacted Traffic Areas of Whirlwind Mine Prior to Topsoiling

The Whirlwind portal bench, access roads, facility areas and top of waste embankments will be ripped to a depth of 2.5 feet prior to topsoiling to relieve compaction from vehicle traffic. The total area to be ripped is 7.41 acres and the estimated unit price is $300 per acre resulting in a total cost of $2,223.

15. Topsoil Replacement on Remaining Areas of Whirlwind Mine

As shown on Map F, the remaining areas that will require topsoiling at the end of the mine life are the water treatment area, called Area #2, which is 2.35 acres in size. The Whirlwind portal bench, and the eastern portion of the waste embankment are called area #1, which is 5.72 acres in size. The total area for re-topsoiling is 8.07 acres. The replacement thickness is from 12 to 16 inches with an expected average of 14 inches, therefore, the volume to be spread and graded is 15,189 cubic yards.
The required topsoil will be obtained from the following stockpiles:

Main Stockpile north of County Road: 7,182 cy.
Stockpile near Water Treatment Area: 4,214 cy.
Stockpile at portal bench: 3,928 cy.

Total available: 15,324 cy

The topsoil from the Water Treatment area will be used to reclaim that area. Similarly, the portal bench stockpile will be used to reclaim the bench itself. These piles can be easily moved a short distance by a D-7 dozer and spread over the desired area. The cost for this work is $0.75 per cubic yard x 8,142 cy = $6,106. This cost includes final grading by the dozer.

The main stockpile of 7,182 cy will be moved by loader and truck and spread with a D-7 dozer. The estimated unit cost is $1.55 per cy resulting in a total cost of $11,132.

Therefore, the total cost of topsoil replacement at the end of the mine life is estimated to be: $6,106 + $11,132 = $17,238.

16. Harrow Topsoil at the Whirlwind Portal Area

Harrowing topsoil at a grade of 3H:1V requires a tractor and disc. The area to be harrowed is 8.07 acres of topsoil replacement area + 1.82 acres of original stockpile area = 9.89 acres. Assuming a unit price of $220 per acre, results in a total estimated cost of $2,176.

17. Re-Seed, Mulch, and Block the Whirlwind Portal Area

The area of seeding and mulching is the same as that for harrowing topsoil: 9.89 acres. The seed mix is the same as that for the Packrat Portal. Hydromulching and hydroteeding methods will be used at this location since it has areas of 3H:1V slopes and the area is large enough to justify the mobilization of the hydroteeding truck. Wood fiber mulch will be included at the rate of 3,000 pounds (lbs) per acre.
Tackifier will also be applied. The cost for this work, including mobilization is $1,200 per acre, for an estimated cost of $11,868.

Assuming 50% reseeding will add $5,934, resulting in a total revegetation cost of $17,802.

Blocking access to the reclaimed Whirlwind portal area will be more difficult than the Packrat road because the area is open and the slopes are relatively gentle. It may be preferable to leave the fence and gate along the road in place until the area has achieved revegetation standards and then remove them at the same time as the sedimentation pond. For reclamation costing purposes, construction of a berm and ditch over a 200-foot linear distance is assumed in this area along with the strategic placement of boulders salvaged from the Packrat road berm. This work would be done with a D-7 dozer or equivalent at an estimated cost of $2,500. The total cost for revegetation and blocking site access is estimated to be $20,302.

18. Backfill Sediment Pond and Collection Ditches

The sediment pond must be backfilled. The estimated fill volume is 4,608 cubic yards (cy). The material will be obtained by regrading the treatment pad area and from the adjacent fill stockpile shown on Map C-2. Using a D-7 dozer, a unit cost of $0.50 per cubic yard and a total cost of $2,304 are estimated.

The Whirlwind Sediment Pond will not be backfilled until the vegetation is adequate to control erosion from the site. At that time, the ditches that drain to the Sediment Pond will be allowed to drain to the ephemeral branch of Lumsden Creek. See Map F in Appendix I. These ditches are designed for the 100-year, 24-hour event and they are meant to carry runoff off the site in a controlled manner. Any associated culverts under the county road will remain. The culvert within the waste rock area will be removed and replaced with a low-water crossing that will allow future access for reclamation monitoring and maintenance. This minor earthwork will be done with a D-7 dozer or smaller, at a cost of $1,000. Therefore, the total cost for pond and ditch removal is $3,304.
19. Post-Reclamation Site Drainage

The entire Packrat permit area will drain to the ephemeral drainage to the east, as in the past prior to mining. The reclamation of the Packrat Road will restore the natural drainage to a configuration that more closely approximates pre-mining conditions than that which currently exists. The Whirlwind area will be altered slightly since the permanent diversions around the reclaimed waste rock pile will remain to keep as much water off the waste as possible. The final layout of these permanent ditches is shown on Map F.

20. Weed Control

Appropriate measures will be employed to minimize the occurrence and spread of noxious weed species. The Weed Control Plan for the site will include:

1. A weed survey will be made of the permit area each spring in April or May.
2. If noxious weeds are identified, they will be sprayed using a backpack sprayer or 4-wheeler with chemicals approved for use by the weed control staff of Mesa County.
3. After reclamation, weed surveys and spraying will continue until the perennial cover and production of the site have met State and BLM requirements and bond release has been obtained.

The BLM and Mesa County weed control staff will be consulted regarding any identified weed infestation areas and appropriate control measures will be agreed upon prior to their initiation. The plan does not contemplate total weed removal in reclaimed areas on the property. Past experience shows that some initial weed cover in the first year following retopsoiling is beneficial to the reclamation effort at dry range sites. Weeds tend to provide shade for new grasses, are a means of holding snow on the seedbed longer and protect it from wind and water erosion until the planted species have taken hold.
21. Revegetation Success Criteria

The pre-mine site is basically Pinyon Juniper community with an understory of grasses and forbs. The post-mining revegetation will emphasize grasses, forbs and shrubs that can be utilized by wildlife as forage. Based on pre-disturbance reconnaissance of the Whirlwind waste embankment area, it is estimated that the live perennial cover below the tree canopy is 20%. The BLM will consider disturbed areas to be satisfactorily revegetated when the percent vegetative cover at least equals the cover percent prior to disturbance and the plant species composition is at least as desirable as the present prior to disturbance.

22. Monitoring Reclamation Success

Monitoring of reclaimed areas on an ongoing basis during mining operations and during the post-closure period will help to assure successful reclamation. The operator plans to consult with the local NRCS office in Mesa County and the BLM prior to and after reclamation to determine preferred methods for minimizing erosion and enhancing revegetation. If minor changes or modifications are needed to the seeding and reclamation plan, revision plans will be submitted to the BLM and DRMS, if required. It is hoped that the agencies will provide assistance in evaluating the success of the ongoing reclamation process. A summary of the areas disturbed and reclaimed and any other important items regarding site monitoring and reclamation will be submitted to the BLM and DRMS in annual reports.

24. Reclamation Cost Estimate

The reclamation scenario resulting in the highest cost occurs at the conclusion of mining, since most of the Whirlwind bench, vent shafts, and a portion of the waste embankment will need to be reclaimed. The entire Packrat portal, road, and power drop area will need to be reclaimed. Each portion of the reclamation is discussed in detail in Exhibit 6. The following Table shows a summary of the final tasks and the associated costs. These costs are being provided for reference purposes. The reclamation bonds will be calculated by DRMS and DOGM in consultation with the BLM.
### Table 6-3: Worst Case Reclamation Cost Summary

<table>
<thead>
<tr>
<th>Task #</th>
<th>Description</th>
<th>Cost</th>
<th>Time Needed (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Open Mine and create mine waste areas prior to initial reclamation</td>
<td>$0</td>
<td>36</td>
</tr>
<tr>
<td>2</td>
<td>Strip topsoil from progressive eastern portions of waste embankment to reclaim western portions.</td>
<td>$0</td>
<td>84</td>
</tr>
<tr>
<td>3</td>
<td>After mine is closed, place seal in Whirlwind decline and monitor water.</td>
<td>$111,450</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>Pump sludge from the Treated Water Settling Tank into upper portion of decline using existing waterline. Add cement at pump to stablilize sludge. Excavate ore pad liner and cover material and place in the upper portion of the decline.</td>
<td>$23,700</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Remove fans and concrete foundations at all ventilation portals, seal shafts and replace topsoil and seed/mulch. Remove or cut power cable at power drops and seal cased holes. Reclaim power drop areas.</td>
<td>$53,143</td>
<td>0.5</td>
</tr>
<tr>
<td>6</td>
<td>Dismantle shop, warehouse, tanks, water treatment plant, fence, other site structures at Whirlwind and bins, retaining wall, shop door and supply storage area at Packrat.</td>
<td>$39,700</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Remove foundations at Whirlwind portal and Packrat portal.</td>
<td>$4,446</td>
<td>0.2</td>
</tr>
<tr>
<td>8</td>
<td>Install bat gate at Packrat and seal off shop area with blocks.</td>
<td>$2,900</td>
<td>0.15</td>
</tr>
<tr>
<td>9</td>
<td>Conduct backfilling and grading at the 2 portal areas, waste embankment and mine benches.</td>
<td>$8,984</td>
<td>0.5</td>
</tr>
<tr>
<td>10</td>
<td>Use MSHA berm on the Packrat Road to re-topsoil the Packrat portal area.</td>
<td>$2,352</td>
<td>0.2</td>
</tr>
<tr>
<td>11</td>
<td>Re-seed and mulch the Packrat portal area.</td>
<td>$1,485</td>
<td>0.1</td>
</tr>
<tr>
<td>12</td>
<td>Use Back hoe to conduct partial backfilling and grading of Packrat road.</td>
<td>$3,194</td>
<td>0.5</td>
</tr>
<tr>
<td>13</td>
<td>Seed and mulch Packrat road. Block road with boulders.</td>
<td>$1,725</td>
<td>0.1</td>
</tr>
<tr>
<td>14</td>
<td>Rip compacted areas of Whirlwind prior to topsoil replacement</td>
<td>$2,223</td>
<td>0.1</td>
</tr>
<tr>
<td>15</td>
<td>Replace topsoil on remaining areas of Whirlwind mine.</td>
<td>$17,238</td>
<td>0.4</td>
</tr>
<tr>
<td>16</td>
<td>Harrow topsoil at Whirlwind mine.</td>
<td>$2,176</td>
<td>0.1</td>
</tr>
<tr>
<td>17</td>
<td>Seed and mulch Whirlwind area.</td>
<td>$20,302</td>
<td>0.1</td>
</tr>
<tr>
<td>18</td>
<td>Backfill sediment pond* and collection ditches.</td>
<td>$3,304</td>
<td>0.05</td>
</tr>
<tr>
<td>19</td>
<td>Mobilization.</td>
<td>$7,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal Direct Costs</strong></td>
<td><strong>$305,322</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>DRMS/Utah Overhead 21%</strong></td>
<td><strong>$64,118</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total Bond Estimate (Colorado and Utah)</strong></td>
<td><strong>$369,440</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**  
* The Sediment Pond will be reclaimed after the reclaimed areas support adequate vegetation.
Energy Fuels proposes to have a watchman on site during off shift hours and weekends. A chain link fence will also be installed around the main facilities and water treatment areas for security purposes. These fences and associated gates will discourage trespass onto the mine property but will not impede access to other BLM managed lands.

The watchman and fencing are permitted under Section 3715.2-1 of Title 43 of the Code of Federal Regulations (CRR). Specifically, this occupancy involves (a) protecting exposed, concentrated, or otherwise accessible minerals from theft or loss; and, (b) protecting from theft or loss appropriate, operable equipment which is regularly used, is not readily portable, and cannot be protected by means other than occupancy.

A detailed map that identifies the site and the placement of the items specified in paragraphs (c), (d), and (e) below is provided in this plan of operations as Map C-2, Mine Facilities Map. In conformance with Section 3715.3.2, the following written description of the proposed occupancy is provided.

a) How the proposed occupancy is reasonably incident: Energy Fuels proposes to have a watchman on site during the off-shifts and weekends. The watchman may have a spouse and one or two dogs. A watchman is necessary to safeguard expensive mining equipment, explosives, and the uranium ore that is stockpiled near the mine portal. The site is relatively remote (about 11 miles or 30 minutes from Gateway) and there are no nearby residences. The county sheriff could not reach the site quickly enough to prevent a robbery if a security alarm system is employed.

b) How the proposed occupancy meets the conditions specified in Section 3715.2 and Section 3715.2-1: The watchmen occupancy on site is solely for the purpose of allowing Energy Fuels to extract minerals without loss of valuable equipment or product.

c) Where you will place temporary or permanent structures for occupancy: The watchman will reside in a small mobile trailer or RV parked at the west side of the employee parking lot. The temporary
living quarters could also be set up within the fenced water treatment area if the parking area is too noisy or otherwise unsuitable.

d) The location of and reason you need enclosures, fences, gates, and signs intended to exclude the general public. Chain link fencing will be constructed around the water treatment area and the main facilities area. Gates will be located at the entrances to both the Packrat and Whirlwind facility areas as shown on Map C-2. Signs with the name of the mine will be posted near the access points warning the general public that mine operations are in progress and that all visitors should check in at the mine office. The fences, gates, and signs are designed to exclude the general public from accessing the mine area where heavy equipment is in use and radioactive materials are stored. They all serve to provide security during those hours when the mine is not in operation. If necessary, Energy Fuels may install additional barb-wire fencing and signage around other portions of the Whirlwind site at a later date to further discourage unauthorized access by the general public. The BLM would be consulted prior to erecting any additional fence or signs.

e) The location of reasonable public passage or access routes through or around the area to adjacent public lands: County Road 5/10 crosses between the Whirlwind and Packrat facilities. This road, which will not be fenced or gated, provides access to adjacent public lands.

f) The estimated period of use of the structures, enclosures, fences, gates, and signs, as well as the schedule for removal and reclamation when operations end. The mine life is estimated to be 10 years. After mining is completed, the project will be reclaimed including removal of all structures, fences, and signage. A detailed reclamation schedule is provided in Exhibit 5, Reclamation Plan.
ENVIRONMENTAL PROTECTION AND MONITORING PLAN

- Section 1 – General Plan
- Section 2 – Maps
- Section 3 – Other Agency Environmental Protection Measures
- Section 4 – Other Agency Permits
- Section 5 – Designated Chemical Evaluation
- Section 6 – Designated Chemical and Material Handling
- Section 7 – Facilities Evaluation
- Section 8 – Ground and Surface Water Information
- Section 9 – Ground Water Quality Data
- Section 10 – Ground Water Control and Monitoring
- Section 11 – Surface Water Quality Data
- Section 12 – Surface Water Control and Monitoring
- Section 13 – Climate Data
- Section 14 – Geochemical Data and Analysis
- Section 15 – Construction Schedule Information
- Section 16 – Quality Assurance and Quality Control Program and Measures
- Section 17 – Plant Growth Medium (Soils)
- Section 18 – Wildlife Protection
- Section 19 – Disposal of Ore Pad Material and Sludge in Mine Workings
1. General Plan

An Environmental Protection and Monitoring Plan is being submitted because the project is classified as a Designated Mining Operation by the Colorado Division of Reclamation, Mining and Safety (DRMS). This classification results from the current DRMS definition of Designated Mining Operations that includes a “mining operation at which toxic or acid-forming materials will be exposed or disturbed as a result of mining operations.” The Whirlwind Project falls into this category because mine water will be pumped to the surface intermittently where it will be treated and discharged. The mine water contains elevated levels of radionuclides, uranium, and trace metals that could be considered chronically toxic if ingested over an extended period of time. Additionally, some of the water treatment chemicals are strongly acidic and, in their undiluted form, could present a potential threat to human health or the environment.

In preparing this Environmental Protection and Monitoring Plan, the proposed mine plan was evaluated to determine what portions of the project could potentially generate “toxic” materials that would require implementation of additional environmental controls. The following three aspects of the mine plan were identified as having the greatest potential to impact the surrounding environment, especially ground and surface water.

1) Mine Waste Disposal: Surface water runoff from the waste pile and infiltration of precipitation through the waste material could potentially liberate radium, uranium, and other metals resulting in impacts to ground water and/or surface water. Synthetic Precipitation Leaching Procedure (SPLP) tests were conducted on representative waste rock samples to determine the waste’s potential for leaching radionuclides and metals. The test results, which are presented in Appendix A, indicate that the waste rock has low leaching potential. The activity and concentration levels of all the constituents in the leachate generated from the tests were below maximum state water quality limits. Based on these results, the waste pile was designed in accordance with standard mine methods in which surface runoff is diverted around the waste pile while surface runoff within the pile is directed to a sediment pond. Discharges from the sediment pond will be sampled and analyzed periodically to verify that any water being discharged meets state water quality standards. The waste rock embankment is discussed in detail in Section 5 of Exhibit 5.
2) Ore Storage: SPLP testing of representative ore samples generated a leachate containing elevated levels of radium, uranium, arsenic, and selenium (see Appendix A). To ensure that the temporary stockpiles of uranium ore will not impact ground or surface water, the ore pad will be limited to 0.5 acre and a berm will be maintained around the pad that directs all runoff to a small concrete sump. The overflow from the sump will connect to a waterline that will deliver the water to the lined Untreated Water Tank (see Exhibit 5, Section 6). From there, the water will be pumped to the treatment plant for removal of radionuclides and trace metals prior to discharge. The ore pad will be underlain by a geosynthetic clay liner (GCL) on a prepared subgrade. The liner will be protected by 2.5 feet of compacted cushion material and 1 foot of run of mine (ROM) waste rock. Details regarding the construction of the ore pad are presented in Golder Associates design report, which has been included as Appendix J. The liner is designed to prevent downward migration of leachate that could potentially impact ground water. At the end of mining, the liner and cover material will be excavated and placed in the Whirlwind Mine in an appropriate (i.e., dry) area prior to sealing. This is discussed in more detail in Exhibit 6 – Reclamation Plan.

3) Mine Water Treatment and Discharge: Excess water will need to be removed from the mine on an intermittent basis. As discussed in Exhibit 14, ground water inflow into the mine is attributed primarily to seepage from water-bearing zones above the mine workings. This ground water is of poor quality and degrades further when in contact with the ore zone resulting in mine drainage that requires treatment prior to discharge into the local ephemeral drainage.

Mine water management and treatment are the focus of this Environmental Protection and Monitoring Plan because it is these activities that place the mine project into the Designated Mining Operation permit category and, the environmental controls for waste rock disposal and ore storage are already described in detail in Exhibits 5 and 6.

The mine water will be pumped on an intermittent, or as necessary, basis from a sump inside the Whirlwind Mine to the surface for treatment. A 3-inch high density polyethylene (HDPE) pipe will be buried from the portal through the bench area, down the bench slope, under County Road 5/10 and to the Untreated Water Tank shown on Map C-2. The pipe will be buried below the frost line to prevent
freezing. A 2-inch HDPE pipe will be buried along side the 3-inch pipe to allow pumping of water from the tank back to the mine’s head tank, which is located in the decline.

Direct precipitation runoff from the ore stockpile pad will be directed to a sump that will overflow into a 6-inch diameter HDPE pipe, or equivalent, that will also drain to the Untreated Water Tank. This pipe will be buried alongside the water pipes from the mine. As can be seen from Map C-2, the ore pad area and surrounding loading area is approximately 0.5 acre.

The Untreated Water Tank has a capacity of 164,000 gallons. It is designed to contain up to 50,000 gallons of water during normal treatment operations. The tank has 65,000 gallons of additional capacity for scheduled and unscheduled periods of treatment plant downtime and 49,000 gallons of additional reserve storage capacity for the surface water runoff from the ore pad and direct precipitation on the tank surface from a 100-year storm event. The Untreated Water Tank is lined with two 30 mil, reinforced synthetic liners. Leak detection is provided by an 8-oz. geotextile fabric that is located between the two liners and that is connected to dip tube leak detector. The entire tank area is also underlain by a GCL on a prepared subbase. This liner provides a third level of containment in the event of a leak.

Water from the Untreated Water Tank will be pumped to the water treatment trailer, where barium chloride and ferric sulfate will be added to remove radium, uranium, and trace metals. The treated water will flow by gravity into a Settling Tank and then to a Polish Tank prior to discharge. Both tanks have a nominal capacity of 7,500 gallons and were constructed with multiple liners in the same manner as the untreated water tank. Radionuclides and metals will coprecipitate out of solution as chemical compounds formed by adding water treatment reagents in the Settling Tank. A minor amount of additional settling may also occur in the Polish Tank; however, the main purpose of this tank is to allow sampling of the treated water prior to discharge. The treated water will discharge by gravity flow to the ephemeral tributary of Lumsden Creek located immediately west of the treatment area, as shown on Map C-2.
Lyntek Incorporated, which specializes in designing treatment plants of this type, has prepared a
detailed design of the treatment plant and water tank system. The plant design is included as Appendix H.

2. Maps

In Appendix H, the following maps are enclosed:

Flow Sheet, Water Treatment Plant
General Trailer Layout

In addition, Map C-2 - Mine Plan, which is included in Appendix I, shows the layout of all surface
facilities for the Whirlwind and Packrat sites.

3. Other Agency Environmental Protection Measures

Local Agencies
A Conditional Use Permit for the mine was approved by Mesa County. The Conditional Use Permit
included many of the same environmental protection measures described in this Plan of Operations.
This permit also included more detailed analyses of road maintenance on County Road 5/10, traffic
volume, and noise generation. Road maintenance included installing road warning signs, additional
culverts for storm water control, and graveling sections of the road to allow safe access to the mine
during inclement weather. The anticipated traffic volume at the intersection of John Brown Canyon
Road and Highway 141 is less than 4 trips per day during peak traffic hours; therefore, auxiliary turn
lanes will not be required at this intersection. Noise reduction measures will include mufflers or
silencers on the generators and fans used at the site.

Energy Fuels has obtained an individual sewage disposal system permit from Mesa County for
construction and operation of a septic system as the site. The proposed location of the leach field is
north of 5/10 Road next to the treatment plant as shown on Map C-2. Energy Fuels will also apply for
building permits from the County prior to building more permanent structures on site. Currently,
temporary structures and self contained porta-bathrooms are present on site during exploration activities. The required permits will be obtained prior to replacing the temporary structures with more permanent facilities. The septic system will be installed in accordance with applicable state and county regulations. Bottled water will be supplied for drinking purposes and water needed for other uses such as showering will be transported to the site from a potable source. A permit is not required for this type of system because the number of employees will be less than 25, which is the current permitting threshold for these types of water systems.

At the present time, no Grand County permits have been identified as being necessary for proposed mining activities.

Federal Agencies
A Spill Prevention, Control and Countermeasure (SPCC) Plan will be prepared and maintained in conformance with the U.S. Environmental Protection Agency’s (EPA’s) regulations for aboveground storage of more than 1,320 gallons of petroleum products. This plan will provide measures for properly storing and handling petroleum products and responding to, and reporting, spills. The SPCC Plan will also include notification to the BLM hazardous material coordinator in the event of a spill of a reportable quantity of a petroleum product. A copy of the most SPCC Plan for the site is included in Appendix F.

A 404 dredge and fill permit is not required from the U.S. Army Corp of Engineers because no drainages or wetlands will be impacted by surface disturbing activities. If this should change in the future, Energy Fuels would request a jurisdictional determination from the Corp for the drainage that would be impacted. If the affected drainage was determined to be a water of the United States, Energy Fuels would obtain a permit from the Corp and approval from the BLM prior to construction. For example, installation of a culvert to access a remote ventilation shaft could trigger the need for a Nationwide Permit Application to the Corp if the drainage is considered jurisdictional. The BLM would be copied on all such correspondence.

Ore transportation will be conducted by independent trucking contractors. These contractors will be required to follow all U.S. Department of Transportation rules for hauling uranium ore. Energy Fuels’
Ore Transportation Plan, which is included Appendix K, summarizes these rules and provides emergency response guidelines in the event of an accident.

**Colorado State Agencies**

The DRMS is the lead Colorado State agency for mine permitting. A 112d Permit Application was approved by the DRMS in February 2008. The 112d Permit Application was formatted differently from this Plan of Operations, but was otherwise virtually identical with respect to mine design, reclamation, and environmental protection measures. The DRMS, with BLM input, will be responsible for determining the reclamation bond amount for the Colorado lands impacted by the proposed mining operation.

The Colorado Discharge Permit System (CDPS) permit issued by the Water Quality Control Division (WQCD) established the limits for all chemical constituents that must be controlled in the discharge of treated water. A copy of this permit, which was issued in July 2007 and later amended in December 2007, is included as Appendix N. The treated mine water will be discharged into an ephemeral tributary to Lumsden Creek, which when flowing, discharges into the Dolores River. The permit requires sampling and analysis for selected radionuclides and metals on a weekly and monthly basis at the discharge point. The permit standards are based on the water quality criteria established by the state for Stream Segment 3a of the Dolores River. A Material Containment Plan will also be developed that provides guidance for the storage, use, cleanup, training, and reporting associated with the use of water treatment chemicals on site. The most current Material Containment Plan for the site is presented in Appendix F. The plan includes notification to the BLM in the event of a spill of a reportable quantity.

A Stormwater Management Plan (SWMP) is currently in place and implemented for exploration activities on site. The plan was recently expanded to include the proposed mine and reclamation activities described in this Plan of Operations. This plan, which is required by WQCD, addresses both permanent and temporary best management practices as well as stormwater monitoring. A copy of the plan has been provided to both the BLM and DRMS.

Energy Fuels submitted and received approval from the Colorado Air Pollution Control Division (APCD) for three Air Pollution Emission Notices (APENs). These APENs quantify potential air
pollutants from fugitive dust, generator emissions, and mine ventilation emissions. All three sources are considered to be minor sources by the APCD. Fugitive dust controls include applying magnesium chloride and water to mine haul roads and county access roads, maintaining a high moisture content in the ore stockpile, and prompt revegetation of topsoil stockpiles and reclaimed areas. The generators used on site will be modern units with relatively low emissions and noise levels. Ventilation emissions will be recorded continuously and the results will be modeled annually using an EPA approved method to determine radiation levels at the nearest receptor.

A solvent-cleaning station may be installed in one or both of the maintenance shops. These stations generally consist of a cleaning sink mounted on a small drum of solvent. The solvent is pumped into and used in the sink and then recycled back to the drum via a gravity drain. The drums of solvent are periodically replaced by a vendor that recycles the solvent. If these stations are installed, Energy Fuels will acquire the necessary permit(s) from the Colorado Hazardous Materials and Waste Management Division (HMWMD). The electrical transformers to be used on site will not contain Polychlorinated Biphenyls (PCBs). As addressed in Section 4.5 of Appendix H and Section 6 of this exhibit, sludge produced from the water treatment system will be disposed of in accordance with HMWMD’s Radiation Management Program’s regulations for Technologically-Enhanced Naturally Occurring Radioactive Materials (TENORM).

Utah State Agencies

A small mine permit has been approved by the Utah Division of Oil, Gas and Mining (DOGM) for the installation and eventual reclamation of the vent shafts proposed in Utah. This application had similar content to Section 15 of Exhibit 5 and Section 5 of Exhibit 6. DOGM, with BLM input, will be responsible for determining the reclamation bond amount for proposed surface disturbances in Utah.

4. Other Agency Permits

Other permits and plans required for this operation that will include environmental protection measures are listed below. All of these permits and plans, with the exception of the Mesa County building permit, are in place.
5. Designated Chemical Evaluation

The water treatment chemicals commonly used on site include barium chloride and ferric sulfate. Sulfuric acid and sodium metabisulfite have also been used in the system to reduce pH and oxygen levels, respectively. The ferric sulfate, sulfuric acid, and sodium metabisulfite are low pH chemicals in their undiluted state and, in that form, meet the definition of a “designated chemical.” After mixing, the chemicals will be added to the untreated water in dilute concentrations that present minimal risk to human health or the environment. The chemical mixing will be performed within the treatment plant using appropriate personal protection equipment (PPE), with adequate ventilation, and under the supervision of a certified wastewater treatment operator.

The water treatment chemicals are designed to help remove potentially harmful constituents from the mine discharge water during the water treatment process. Barium chloride and ferric sulfate will be added to the untreated water to precipitate radionuclides and metals. These chemicals will be premixed in reagent tanks of about 300 gallons each. A spare reagent tank has also been included in the plant design as a contingency measure should an additional water treatment chemical be added to the...
treatment process. During the initial shakedown period for the treatment plant, both sulfuric acid and sodium metabisulfite have been added in this spare tank to treat selenium. The sulfuric acid lowers the water pH, which helps precipitate selenium. Metabisulfite reduces the oxygen levels in the water, which changes selenium from its selenate form to selenite, which is more easily adsorbed in the chemical precipitant. It is unknown at this time whether sulfuric acid and metabisulfate will continue to be used; it is unlikely that both would be necessary. Addition of a flocculant could also be beneficial to the treatment process. Flocculants are typically non-toxic chemicals that cause the fine particles in solution to agglomerate into flocs, which settle much more rapidly than would the individual dispersed particles.

The chemical precipitate produced from the treatment will settle out in the Settling Tank as a sludge. This sludge will contain low levels of radionuclides and metals. Based on testing performed at a similar facility, the metal concentrations and radioactivity levels are expected to be well below the regulatory thresholds that would require disposal of the sludge as a hazardous waste (see Section 4.5 of Appendix H).

Magnesium chloride or a similar non-hazardous chemical will be used to treat haul roads within the mine and waste pile area. The chemical will be added in a dilute solution to the road surface where it will bind with the road material. The hard surface created by this treatment will minimize the amount of fugitive dust generated by mine haulage activities. The road treatment solution will be stored in a tank near the mine portal entrance. The tank will be bermed to contain any spills or other releases to the environment.

Diesel fuel, oils, and antifreeze will be used in the mine equipment. Storage and use of these products is discussed in Exhibit D, the SPCC Plan, and the Material Containment Plan. The current SPCC and Material Containment Plans for the site are provided in Appendix F.
6. Designated Chemical and Materials Handling

Pallets of dry chemicals, up to 1000 lbs. each, and 55-gallon drums of chemical solution will be stored in the treatment plant trailer. Drums containing chemical solutions will be stored on spill-containment pallets or in secondary containment basins. As discussed below, the trailer is also equipped with a secondary containment tank that is connected to the floor drain. The water treatment chemicals will be stored in quantities that are less than their reportable quantities. Petroleum products and antifreeze will be stored in above-ground storage tanks, drums, and smaller containers. All storage areas will have secondary containment that will capture the products in the event of a spill or leak.

The complete description of how the water treatment chemicals will be used and stored is explained in Appendix H. The Environmental and Operator Safety Plan is presented in Section 4.0 of the same appendix and the MSDS sheets for the primary chemicals are also attached to the same. The expected use rate of barium chloride is 1.3 tons per year and the expected rate of ferric sulfate use is 0.2 tons per year. MSDS sheets for all chemicals are maintained in a binder at the mine site.

With the addition of barium chloride and ferric sulfate to the mine water, a sludge precipitate will form that contains radium, uranium, arsenic and other metals. The Settling Tank has been designed to contain the full amount of sludge produced for the currently projected mine life of 10 years. As described in the reclamation plan, the sludge will be shipped to a mill for uranium recovery, disposed of in an appropriate off-site landfill, or mixed with concrete and disposed of in a dry location within the upper portion of the Whirlwind decline.

If the rate of sludge production is more than anticipated due to an increased solids load from the mining operation or the mine life exceeds 10 years, than a one time sludge removal would be needed in the latter part of the mine life. This material would be removed from the Settling Tank and either 1) dried and disposed of at a off-site facility approved to handle such material, according to the TENORM regulations of the CDPHE or 2) mixed with ore and transported to a uranium mill for recovery.
Spills and leaks from the treatment system will be contained as described in Section 4.5 and 5.0 of Appendix H, and will not result in a release to the environment. Liquid spills will be contained in the treatment trailer or be directed to the floor drain that discharges into a 400-gallon secondary-containment tank located immediately outside the trailer. This solution will be evaluated for content and then either recycled for plant use, pumped to the Settling Tank, or disposed of off site at an approved facility. If a significant spill should occur from one of the 300-gallon reagent tanks, the plant will automatically shut down to prevent a situation where water could flow through the system without proper chemical dosing.

Sections 4.0, 5.0 and 6.0 of Appendix H provide chemical information, a material handling plan, and a monitoring plan respectively. Appendix F presents the current SPCC and Material Containment plans for the mine. These plans will be updated whenever the storage or use of chemicals and petroleum products changes. The procedures and controls discussed in Appendices F and H are designed to minimize the potential that an upset condition within the plant could adversely impact the surrounding environment.

If it is necessary to temporarily shut down the mine, dewatering operations will continue on an intermittent basis. If the plant is not needed because mine operations are consuming all of the ground water inflow, the plant will be shut down until needed. Temporary shutdown will include minimizing the volume of water contained in the water tanks, draining liquid reagents from the mix tanks, and locking the trailer and gates to prevent unauthorized access.

7. Facilities Evaluation

Maps and drawings describing the facility layout are included in Appendix H. Map C-2 in Appendix I shows the relative location of the treatment facility, tanks, and point of discharge. The proposed portable treatment plant with its secondary containment features is a proven design that has been used successfully at other locations. The plan takes into account site conditions by locating the treatment plant and water tanks in a relatively flat area that provides sufficient space to allow for the extra tank storage capacity that may be needed in the event of a plant outage or large storm event. The plant area is located downslope and separate from the main mine area with its own separate access off County
Road 5/10. It is surrounded by a chain link fence so that access is controlled and limited to authorized personnel. The use of fabricated tanks and a portable trailer to house the treatment plant will facilitate future closure and reclamation of the site.

7.1 Water Balance

As discussed in Exhibit 14, the upper Salt Wash ore zone is relatively dry. The majority of the ground water found in this unit originates from the Burro Canyon and Brushy Basin aquifers above. This water enters the mine workings through the Whirlwind decline, the existing Ten-Straight Shaft, historic exploration drill holes, and natural fractures and faulting. Based on records kept by Pioneer Uravan and Umetco, Energy Fuels believes that the water inflow into the Whirlwind and Packrat mine workings averages about 7 gpm. Historically, the ground water entering the mine workings collected in sumps and was used in mining operations for drilling and dust suppression purposes. Because the ground water inflow rate was relatively low, mine operations consumed most of this water when the mines were active.

After the mines shut down, ground water accumulated in the low areas of the mine workings until equilibrium was established between the water source and the ore formation. This accumulated ground water will need to be pumped out, treated, and discharged prior to starting full-scale mining operations. The water treatment system is designed to treat 20 gpm. During initial dewatering, the system will be operate 24 hours per day to remove the water collected in the lower portions of the mine plus the additional ground water inflow during this period. Once the mine is dewatered, the plant operation can be reduced to one shift per day.

Most, if not all, of the ground water inflow into the Whirlwind Mine will be consumed by mining activities when the mine is put into production. A water right to consume this water has been approved by the district water court. During mining operations, the ground water inflow will be directed to mine sumps where it will be used for drilling and dust suppression. Most of the water used during drilling flows back out of the drill holes and into the nearest mine sump, where it is then circulated back to the drilling equipment. However, some of the water remains in the rock, which is blasted and mucked out with small loaders. Some water is also lost to evaporation as dry air from the surface is circulated.
through the mine for ventilation purposes. The anticipated water balance during production is shown on Figure T-1 and described in the narrative below.

The mining plan calls for an initial mining rate of 100 tons of ore with an average of 275 tons of waste rock generated per workday. Assuming that the broken material averages eight to nine percent moisture content, an average of about 7,700 gallons of water will be removed in the mined material per workday. As the mine develops, production is expected to increase along with water use and consumption. As shown in the calculation below, this means that most, if not all of the projected ground water inflow will be consumed by mining.

Ground Water Inflow = 7 gpm x 60 minutes x 24 hours x 7 days/week = 70,560 gals/week
Water Consumed = (7,680 gal/day x 5 days/wk) = 38,400 gals/week

The added moisture in the ore and waste is beneficial in reducing fugitive dust emissions from the ore stockpile and waste rock pile. The moisture also promotes higher densities in the waste rock material, which is compacted by the loaded buggies and other mobile equipment used on top of the waste rock pile.

Water will also be evaporated by the mine’s ventilation circuit. Approximately 100,000 cubic feet per minute of air will be circulated through the mine during the initial stages of development and
production. The water saturation level in the air will likely increase by an average of 30% or more while the air is circulated through 1 to 2 miles of drift. At an approximate elevation of 7,000 feet, a 30 percent increase in saturation is equivalent to 0.0002 pounds per cubic foot (pcf) of air.

Water Evaporated = 100,000 cfm x 0.0002 pcf x 1gal/8.3 lb = 2.4 gpm or about 24,000 gals/wk

As the mine expands, Energy Fuels expects that pumping, treatment, and discharge of water will be needed only intermittently. This may include pumping in the spring when ground water inflows may increase due to snowmelt, after weekends and holidays, and in the event that open exploration holes are mined into (which is not uncommon in historic mine areas). As discussed in Section 10, Energy Fuels will plug point sources of ground water inflow as they are encountered during the normal course of mining. This is expected to further reduce the need for future water treatment at the site.

7.2 Treatment System Safety Features

The safety features of the treatment system components consisting of the Untreated Water Tank, Settling and Polish Tanks, and the Treatment Plant are described in more detail below.

Untreated Water Tank Safety Features

The Untreated Water Tank was installed in the fall of 2007 and consists of interlocking fabricated panels that support a multiple liner containment system. Prior to tank construction, topsoil was removed from the treatment area and the area was graded and compacted. Fine-grained squeegee material was then placed and compacted to create a smooth and level surface for tank installation. The interlocking panels were installed first and were anchored with blocks to prevent movement. Next, a geosynthetic clay liner (GCL) was installed on the prepared subbase between the panels as an extra precaution against seepage. The tank installation was completed by installing two 30-mil synthetic liners within the panel support system. A geotextile was also installed between the two liners and then connected to a monitoring dip stick to provide leak detection. This system provides both multiple containment and leak detection in the event that the upper liner is punctured.
The Untreated Water Tank has a total capacity of 164,000 gallons. To provide adequate settling of suspended particles in the mine water, the tank will be maintained at a nominal operating level of 50,000 gallons. The tank is designed with an additional 65,000 gallons of storage capacity for 6.5 days of mine pumping at an inflow rate of 7 gpm. The 7 gpm inflow is the expected rate of mine dewatering that would be required to keep the Whirlwind/Packrat mine workings dry when the mine is idle. When the mine is operating, most of this water will be consumed by drilling and other mining activities and the volume of water requiring treatment will decrease proportionately.

The Untreated Water Tank is also designed to contain the calculated 49,000 gallon direct precipitation and runoff volume generated during a 100-year, 24-hour storm event on the ore pad area and tank surface. Runoff from the ore pad will flow to a sump in the corner of the pad and then overflow through a pipe to the Untreated Water Tank. The incremental design volume for the 100-year storm event is 49,000 gallons, which also includes direct precipitation on the tank.

The expected volume of runoff from the ore pad area was calculated using the SURVCADD program and shown below:

Runoff Curve Number and Runoff

Project: Whirlwind Mine       By: GL
Location: Ore Pad Storm Volume       Checked: GL
Developed Watershed

1. Runoff curve number (Cn)

   Cover description   CN  Soil Type  Area
   Pad compacted      92  disturbed  0.720 Acres (This is the total area draining to the sump)

   CN (weighted): 92

2. Runoff

   Frequency ................ : 100 yr
Rainfall, P (24-hour) .. : 2.90 in
Runoff, Q .............. : 2.0668 in
Runoff Volume .......... : 0.1395 Acre-Ft = 40,600

Volume of Direct Precipitation on Tank = (2.9 in./12) x 68 ft x 68 ft/(7.48 gal/ft³) = 8,400 gal.
Total Extra Volume Required for 100-yr storm event = 40,600 gal. + 8,400 gal. = 49,000 gal.

Treated Water Tank Safety Features

The two Treated Water Tanks (a.k.a., Settling Tank and Polish Tank) were installed in identical fashion to the Untreated Water tank. The Settling Tank is designed to handle the full amount of precipitated sludge produced from the water treatment process over the life of the mine (see Section 3.3 of Appendix H). The level of sludge will be monitored on an ongoing basis during operation. The treated water from the Settling Tank could be directly discharged; however, a Polish Tank has been included in the design to provide additional holding capacity and the opportunity to sample the water prior to discharge.

Treatment Plant Safety Features

Safety procedures for daily plant operation, with redundancies and backups are summarized below:

1) All plant personnel will be fully trained and supervised in the operation of the plant by a state certified industrial wastewater operator. Annual refresher training and additional training for any facility alterations will be provided. Training records will be maintained at Energy Fuels’ Nucla office.

2) Once the ore pad is constructed, the Untreated Water Tank will have a float valve installed at the 115,000-gallon level, which corresponds to a freeboard level of 1.5 feet. If the water reaches this level, the float valve will trigger the mine pump to shut down and/or sound an alarm. The 1.5 feet of freeboard will provide 52,000 gallons of additional storage capacity, which is sufficient to contain the 100-year, 24 hour storm event runoff from the ore pad area plus direct precipitation on the tank.

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3) Plant personnel will be required to inspect the plant at the start and periodically during each shift.

4) Any liquid chemical spills in the trailer will be collected in a floor drain and diverted to a 400-gallon, secondary-containment tank located immediately outside the trailer.

5) Any shutdown of the generator will shut down the entire plant, including the reagent feed equipment and the pump from the Untreated Water Tank to the plant.

6) Level controls in the reagent feed tanks will shut down the entire plant if any tank reaches a volume of less than or equal to 5% of its capacity.

7) The ongoing monitoring and sampling procedures are outlined in Appendix H – Section 6.0.

8) An Emergency Response Plan has been prepared as is included with the Material Containment and SPCC Plans in Appendix F. The Emergency Response Plan provides direction on how to respond to an upset condition at the plant that presents a threat to worker safety and/or the environment.

8. Ground and Surface Water Information

Map G-1 shows the regional hydrology of the Beaver Mesa area and all the nearby springs, streams, ditches, wells and other water features from the mesa to the confluence of Lumsden Creek with the Dolores River. The River is 5.1 miles downstream from the mine discharge point. The strata and aquifers within 2 miles of the site are comprised of the following in the order of their occurrence:

- Sandstones of the Burro Canyon Formation, (known discharge at DP Spring at Lumsden Fault)
- Sandstones of the Brushy Basin member of the Morrison Formation (closest known discharge is Willow Creek located southeast of Beaver Mesa)
- Sandstones of the Salt Wash member of the Morrison Formation (known discharge at PR Spring)
- Sandy shale and mudstone of the Summerville Formation (aquitard with no aquifers)
- Slick Rock member of the Entrada Sandstone (possible aquifer but no known springs)
- Dewey Bridge member of Entrada Sandstone (no known aquifer on Beaver Mesa)
- Sandstones of the Navajo Sandstone (possible aquifer but no known springs)
- Sandstones of the Kayenta Formation (possible aquifer but no known springs)
- Wingate Sandstone (possible aquifer but no known springs)
- Sandstones of the Chinle Formation (possible spring in Lumsden Canyon)

Figure G2 shows a stratigraphic section of the geologic formations for the area. Map G-2 shows the formation outcrop areas, old mine workings, wells, springs, mine portals, mine shafts, and other features in relationship to the planned Whirlwind Mine. Surface topography is also shown on this map.

Exhibit 14 provides detailed information on the formations, springs, ground water and surface water found on Beaver Mesa and downstream in Lumsden Canyon.

Overall, there is very little groundwater in the area. Although numerous perforations exist from the Burro Canyon and Brushy Basin aquifers into the old mine workings, the discharges from the portals were minimal in the past and have since ceased. The only exception was the Rajah 30 portal, which was sealed. This is discussed in detail in Exhibit 14.

There are no known wells or other uses in Lumsden Creek within 2 miles downstream of the planned discharge location. The treatment plant will discharge in the middle fork of Lumsden Creek, which is an ephemeral stream. It flows only in response to spring thaw and large runoff events. Over the distance of approximately 5.15 miles from the planned discharge point to the Dolores River, Lumsden Creek drops 2,515 feet from an initial elevation of 7,050 feet to an elevation of 4,535 feet. This is an average grade of 9.2%. The approximate distances from the mine discharge point to key locations are presented in Table T-1 below.
Table T-1 Lumsden Canyon Drainage from Whirlwind Mine to Dolores River

<table>
<thead>
<tr>
<th>Segment #</th>
<th>From</th>
<th>To</th>
<th>Length Ft</th>
<th>Cumulative Ft</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mine Discharge</td>
<td>Packrat Mine</td>
<td>2,040</td>
<td>2,040</td>
<td>Steep Canyon</td>
</tr>
<tr>
<td>2</td>
<td>Packrat Mine</td>
<td>Junction of North fork from Dutchman Mine and DP Spring</td>
<td>3,791</td>
<td>5,831</td>
<td>Steep Canyon</td>
</tr>
<tr>
<td>3</td>
<td>Junction N Fork</td>
<td>Junction with East Fork From Raja 49</td>
<td>1,330</td>
<td>7,161</td>
<td>Steep Canyon</td>
</tr>
<tr>
<td>4</td>
<td>Junction from East Fork</td>
<td>Lumsden Spring</td>
<td>8,300</td>
<td>15,461</td>
<td>Steep Canyon</td>
</tr>
<tr>
<td>5</td>
<td>Lumsden Spring Mouth of Canyon</td>
<td>Dolores River</td>
<td>8,410</td>
<td>27,198</td>
<td>Mild Slopes</td>
</tr>
</tbody>
</table>

The nearest recorded occurrence of any usable water downstream in the Lumsden Creek drainage is PR Spring, located 2,040 feet downstream of the discharge point. This spring flows at approximately 4-10 gallons per minute and feeds a stock tank, which then overflows into a minor drainage. The water flows from the base of the Top Rim sandstone in the Salt Wash and reportedly infiltrates into the soils prior to reaching Lumsden Creek. The spring water is of poor quality, as it contains elevated levels of radium, uranium, arsenic and selenium.

The next closest downstream water occurrence is Lumsden Spring. There is an upper and lower contact for the spring, as recorded by the BLM in 1993. This spring is 2.93 miles downstream of the discharge point for treated water. When the spring was sampled by Energy Fuels in April 2007, it was flowing at 7 gpm. The water contained elevated concentrations of uranium and selenium, but was of better quality than PR Spring. The 1993 samples of this water collected by the BLM exhibited elevated levels of radium 226 and uranium. See Appendix E for a summary of the water data collected for the general area.

The only major fracture system in the area is the Lumsden Fault (see Map G-2), which has a vertical displacement of slightly less than 100 feet. It is located north of the Packrat portal and trends SW – NE. DP Spring, which is located upstream in the west tributary of Lumsden Creek, occurs at or near the fault. It appears that Burro Canyon ground water flowing to the northeast along the known dip of
1.75 degrees encounters the fault and is forced to the surface at this point. The water quality of this spring is relatively good but it degrades significantly as it flows through the toe of the old Dutchman mine dump, which is located in the northwest drainage channel of Lumsden Canyon.

The Whirlwind Mine waste pile, treatment tanks and other facilities are located in the Brushy Basin member of the Morrison Formation, as shown on Map G-2. There are no known fractures in the immediate vicinity. Although the Brushy Basin member is known to have some minor aquifers, it primarily contains shales and mudstones which prevent downward migration of water. There are no known springs in the area of the mine pile or the other surface facilities of both portals.

9. Ground Water Quality Data

Ground water quality data is available for all the major geologic formations in the Whirlwind Project area. Representative samples have been collected from the Burro Canyon Formation at the BLM Well and DP Spring. Upper Brushy Basin sample data has been collected from the two shallow wells known as the Cherokee Wells and Willow Spring, which are located east of the mine site. Middle and Lower Brushy Basin samples have been collected from drill holes completed as part of past uranium exploration and environmental investigation projects. Two water samples were also recently collected from where the Lower Brushy Basin unit intersects the Whirlwind Decline. The Salt Wash has a discharge at PR Spring that has been sampled extensively. Ground water data is also available from past mine discharges in the area (Packrat Mine, Lumsden #2, and Rajah 49) and from the current water pools in the Whirlwind decline and Packrat drifts. Water quality data for the springs, groundwater, surface water and mine water are presented in Appendix E.

The water quality data and other information collected from the Beaver Mesa aquifers indicate that:
1) the aquifers located immediately above and below the mine workings are limited in extent, thickness, and potential recharge;
2) the water quality deteriorates with depth on the mesa. The Burro Canyon and the Upper and Middle Brushy Basin aquifers are of relatively good quality while the Lower Brushy Basin and Salt Wash aquifers contain high levels of salts, metals, and radionuclides;
3) the mine workings, which are located at the very top of the Top Rim Salt Wash unit is a tight formation containing very little in-situ ground water;
4) most of the water in the mine workings is entering the mine from above through natural fractures and pre-existing exploration holes, vent shafts, and declines; and,
5) the water quality of the ground water flowing into the Salt Wash deteriorates further because of contact with the uranium-bearing sandstone that contains elevated levels of salts, metals, and radionuclides.

The conclusions presented above are based on the water information presented in Exhibit 14.

10. Ground Water Control and Monitoring

Reduction of ground water inflows into the mine during mining operations and after mine closure will minimize the potential impacts to ground and surface water in the area. It will also provide cost savings for Energy Fuels by limiting the volume of water that will need to be pumped and treated. Monitoring and ground water characterization will be conducted during and after mine operations, both within the mine and in the two closest aquifers, to create a model of the local ground water system and identify any impacts to ground water that may occur as a result of mining activities.

10.1 Ground Water Control Measures

Reduction of ground water flows will be accomplished by: (1) implementing an inflow source control program at the start of and during mining operations, and (2) constructing hydraulic seals during closure and reclamation to further reduce ground water inflow from point sources and non-point sources. Details of the proposed ground water control program follow.

Point Source Control

During mining operations, Energy Fuels will identify those locations where ground water is entering the mine. This will include both point sources and area where seepage occurs over a broader area. Potential point sources consist primarily of historic mining features such as open exploration holes and un-grouted vent shafts and declines. Non-point sources include seepage from fracture systems and
more permeable sandstone lenses. The locations and estimated flow rates where ground water is entering the mine workings will be identified and plotted on a map, where possible.

Each of the ground water inflow locations will be evaluated to determine whether the inflow can be prevented or reduced in volume as part of active operations or at time of mine closure. Point sources can be plugged or partially plugged by installing packers in the opening and then grouting the opening above the packer through the packer mandrel or by drilling from the side and injecting a concrete grout. Packers are inflatable and/or mechanical devices that can be wedged tightly in an opening. Larger openings, such as around the outside of a vent shaft, may require the installation of forms that can then be filled hydraulically with a cement grout. Sprayed structural (e.g., polyurethane) foam can also be used at times to create temporary support for the subsequent installation of permanent seals.

It may also be possible to grout or otherwise plug some point sources from the surface. In most cases, this will be limited to larger features such as vent shafts that can be readily located on the surface. Surface plugging of cased vent shafts would, in most cases, consist of drilling around the opening and sealing the opening off from shallow aquifers by injecting grout. Surface exploration drill holes drilled by Energy Fuels Resources are plugged in accordance with existing regulatory and specific exploration permit requirements. Most historic surface exploration drill holes cannot be located and plugged on the surface because the collar area of the holes has typically caved and been filled in over time.

After identifying those areas where immediate action can be taken, Energy Fuels will conduct sealing operations. This may require the assistance of a grouting contractor with specialized equipment. The sealing operations and observed reductions in ground water inflow rates will be documented. Those seepage areas that cannot be sealed during mining operations will be evaluated for sealing at the time of mine closure as discussed below under Closure Source Control.

As the mine is developed, point source control will continue to be implemented. New vent shafts will be grouted where they pass through aquifers so that there is no conduit available for ground water inflow. Historic exploration holes and other points of ground water inflow encountered during mine development will be evaluated and, where practicable, sealed using packers and injected grout.
Closure Source Control

Point Source Control is expected to reduce the ground water inflow rate into the mine and the volume of water that will need to be pumped and treated during active operations. However, there will be other areas where ground water inflow cannot be controlled during mining. The Whirlwind decline is a good example of this type of situation. The decline passes through the lower Brushy Basin aquifer over a distance of about 200 feet. The seepage along this contact is barely detectable but the overall inflow is significant (i.e., as high as 2 gpm). There does not appear to be a reliable method for sealing off this inflow during active mining operations and some, if not all, of this water will still be needed to support drilling and dust suppression activities in the mine.

Energy Fuels proposes to seal off the portion of the decline that is making water during final reclamation by installing a hydraulic seal downgradient of the seeping sandstone lenses. The aquifer is perched and present only at the base of the channel sandstone unit; therefore, the water level behind the bulkhead seal is expected to stabilize at or near the ground water inflow point within the decline. Energy Fuels will monitor the water elevation above the lower seal until it reaches equilibrium plus an additional 5 quarters (i.e., 1.25 years). This will be done by manual measurement since the upper seal will not be installed.

The pool is not expected to migrate significantly because it will be contained within low-permeable Brushy Basin mudstones and shales. A schedule for taking water level measurements and water quality samples will be proposed to DRMS and the BLM prior to sealing based on the inflow rates measured at that time. Once the pool reaches and maintains equilibrium for 5 quarters, the portal will be backfilled and reclamation of the site can be completed.

Exhibit 6 – Reclamation Plan provides additional details for the bulkhead seal in the decline. Other areas of low, generalized seepage will also be evaluated as part of closure activities for possible implementation of inflow reduction measures. Energy Fuels has also agreed to include a contingency bulkhead seal in the reclamation bond for the site (see Exhibit 6).
10.2 Ground Water Monitoring and Characterization

Ground water will be monitored (1) within the mine, (2) in a monitoring well completed in the lower Brushy Basin, and (3) at PR Springs. This information will be used to establish baseline conditions, verify compliance with regulations, and construct a model of ground water flow and quality for the site. Proposed water quality parameters and test methods are presented in Table T-2 below.

**Table T-2 Water Monitoring Parameters at Whirlwind Mine**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Method</th>
<th>Det. Limit</th>
<th>Unit</th>
<th>Monitoring Well W-1</th>
<th>Mine Water</th>
<th>PR Springs</th>
<th>Storm Water</th>
<th>Treated Water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major Ions (See Note 1)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alkalinity, Total as CaCO3</td>
<td>E310.1/A2320 B</td>
<td>1</td>
<td>mg/L</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Bicarbonate as HCO3</td>
<td>E310.1/A2320 B</td>
<td>1</td>
<td>mg/L</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Calcium</td>
<td>E200.7/E200.8/ E215.1</td>
<td>1</td>
<td>mg/L</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Chloride</td>
<td>E500.0/A4500-Cl B</td>
<td>1</td>
<td>mg/L</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Fluoride</td>
<td>A4500-F C/Technicon 380-7WE</td>
<td>0.1</td>
<td>mg/L</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Magnesium</td>
<td>E200.7/E200.8/ E242.1</td>
<td>1</td>
<td>mg/L</td>
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<td>X</td>
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<td>Phosphorus</td>
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<td>X</td>
<td>X</td>
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<td>Potassium</td>
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<td>1</td>
<td>mg/L</td>
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<td>X</td>
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<tr>
<td>Sodium</td>
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<td>1</td>
<td>mg/L</td>
<td>X</td>
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<td>Sulfate</td>
<td>A4500-SO4 E/E300.0</td>
<td>1</td>
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<td>X</td>
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<td>Nitrate as N</td>
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<td><strong>Physical Properties (See Note 2)</strong></td>
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<tr>
<td>Chemical Oxygen Demand (COD)</td>
<td>HACH 8000</td>
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<td>mg/L</td>
<td></td>
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<tr>
<td>pH</td>
<td>A4500-H B/E150.1</td>
<td>0.1</td>
<td>s.u.</td>
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<td>X</td>
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<tr>
<td>Total Dissolved Solids (TDS)</td>
<td>A2540 C/E160.1</td>
<td>10</td>
<td>mg/L</td>
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<td>X</td>
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<td>Total Suspended Solids (TSS)</td>
<td>A2540 D/E160.2</td>
<td>10</td>
<td>mg/L</td>
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<tr>
<td><strong>Metals (See Note 3)</strong></td>
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<tr>
<td>Arsenic</td>
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<td>X</td>
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<td>X</td>
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<td>Beryllium</td>
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<td>X</td>
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<td>Boron</td>
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<td>X</td>
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<tr>
<td>Cadmium</td>
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<td>X</td>
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<tr>
<td>Chromium</td>
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<td>mg/L</td>
<td>X</td>
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### Parameter Method

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Method</th>
<th>Det. Limit</th>
<th>Unit</th>
<th>Monitoring Well W-1</th>
<th>Mine Water</th>
<th>PR Springs</th>
<th>Storm Water</th>
<th>Treated Water</th>
</tr>
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<tbody>
<tr>
<td>Iron</td>
<td>E200.7/E200.8/E200.9/E236.1/E200.2</td>
<td>0.03</td>
<td>mg/L</td>
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<tr>
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<td>mg/L</td>
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</tr>
<tr>
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<td>mg/L</td>
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<td>X</td>
<td>X</td>
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<td>Molybdenum</td>
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<td>X</td>
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<tr>
<td>Nickel</td>
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<td>0.01</td>
<td>mg/L</td>
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<td>X</td>
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<td>Selenium</td>
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<td>X</td>
<td>X</td>
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<tr>
<td>Uranium</td>
<td>E200.8/E908.0/E200.9/E286.2</td>
<td>0.01</td>
<td>mg/L</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Vanadium</td>
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<td>mg/L</td>
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<td>X</td>
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</tr>
<tr>
<td>Zinc</td>
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<td>0.01</td>
<td>mg/L</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tr>
</tbody>
</table>

**Non-Metals**

- Cyanide, Weak Acid Dissociable: ASTM D2036, 0.005 mg/L

**Radionuclides - Total**

- Radium 226: E903.0, 0.2 pCi/L
- Radium 228: E904.0/RA-05, 1.0 pCi/L

**Radionuclides - Dissolved**

- Radium 226: E903.0/E200.2, 1.0 pCi/L

### Notes:

1. SAR (sodium adsorption ratio) and ionic balance calculations will be provided for all samples except treated water.
2. Physical parameters including dissolved oxygen, specific conductivity, pH, and temperature will be measured at the time of sample collection of all samples.
3. All metals will be analyzed for total metals with two exceptions:
   - treated water samples will be analyzed for dissolved iron; and
   - groundwater samples collected from monitoring well W-1 will be analyzed for dissolved metals only.

### Mine Water Monitoring and Reporting

Energy Fuels will document existing water conditions within the Whirlwind Mine complex (i.e., Packrat workings and the Whirlwind Decline) as safe access is gained to the various areas. This information will be collected and reported quarterly to DRMS and the BLM. The quarterly hydrological report will include:

1. Mapped inflow locations and flow rates (quarterly measurement)
2. Description of each inflow and possible source reduction measures (initial report)
3. Proposed point source and closure source control measures (initial report)
4) Results of any source control measures implemented during mine rehabilitation (as completed)
5) Water sampling and analytical results for each inflow greater than 1 gpm (minimum of two sampling events per inflow taken over the first two quarters)
6) Documentation of any new inflow locations, flow rates, and water quality
7) Mapped locations and depth of standing water and any associated flow rates within the mine drifts (quarterly measurement).
8) Sampling and analytical results of representative pools of standing water (minimum of two sampling events at up to three locations)
9) Records of mine water volumes pumped, treated, and discharged as well as the volume of water that is used during mining (i.e., hauled out of the mine in the produced ore and waste and exhausted to the atmosphere by the mine ventilation system).

PR Spring Monitoring and Reporting

The monitoring program will also include recording of the flow rate and sampling and analysis of PR Spring on a quarterly basis for the first 5 quarters of the project. After 5 quarters of baseline monitoring, the spring will be checked quarterly for flow rate and sampled and analyzed on an annual basis. PR Spring flows from the base of the Top Rim sandstone and represents the closest downgradient sampling point (from the mining zone) for ground water. The spring seeps from an area that supports tree and shrub growth, as opposed to the relatively sparse vegetation in surrounding areas. The point for sample collection and flow measurements will be an existing PVC pipe from which water flows into a stock tank before overflowing into the drainage below. Quarterly flow rates and water quality analyses will be reported in the quarterly hydrological report to DRMS and the BLM. Any changes in flow rate and/or water quality will be discussed and evaluated.

In conjunction with monitoring activities at PR Spring, monitoring personnel will also perform a pedestrian survey of the Top Rim sandstone within Lumsden Canyon. This survey will be performed over a distance of about 1,000 feet to the south of PR Spring and 1,500 feet to the northwest of PR Spring. Any seeps or wet spots encountered in this area will be plotted on a map, measured for approximate flow rate, and sampled and analyzed if the flow rate is sufficient to collect a sample. This
seep survey will be performed in late spring of each year after the snow has melted. In addition, the flow rate at upgradient DP Spring will be measured and reported quarterly.

**Lower Brushy Basin Monitoring and Reporting**

Energy Fuels will install a monitoring well (Well W-1) just north of County Road 5/10 as shown on Map C-2. This monitoring well is located downgradient of the Whirlwind surface facilities and the bulkhead seal in the decline. The monitoring well will consist of threaded 2-inch polyvinylchloride (PVC) pipe screened in the lower water-bearing zone of the Brushy Basin (approximately 150 feet below ground surface). If the well produces water, it will be sampled 8 times in the first 15 months after completion (i.e., immediately after completion and every two months thereafter) to establish baseline conditions. If the well does not produce sufficient water for sampling or is dry, water levels will be recorded during the 8 baseline sampling events. After baseline conditions have been established, a monitoring schedule will be developed in consultation with DRMS.

A boring log, well completion details, water levels, and an initial water quality analysis will be submitted to DRMS within 90 days after well completion as part of the quarterly hydrologic report. Subsequent monitoring data will be included in later quarterly reports for the facility. Energy Fuels will notify DRMS and the BLM within 30 days of receiving sample results if the analyses indicate deterioration in water quality compared to the established baseline data. If this were to happen, Energy Fuels would evaluate ground water conditions and propose suitable mitigation measures if the compiled information indicate an impact from mining activities.

Energy Fuels will also monitor water inflows into the Whirlwind Decline from the lower Brushy Basin. Flow rates will be reported quarterly and any changes in flow rates will be described.

**Ground Water Characterization**

An environmental consulting company experienced in hydrogeologic investigations will review the existing geology and hydrology database plus the information collected from the underground mine, springs, and Monitoring Well W-1 over the first 5 quarters of mine operation. Staff from this company
will then inspect the mine workings and prepare a preliminary ground water characterization of the site. The preliminary ground water characterization will identify any data gaps that may exist and propose measures for collecting additional data to complete the characterization. This report will be submitted to DRMS for review and comment prior to implementing additional field work.

Additional field and laboratory information needed to address data gaps may include one or more of the following.

1) Hydraulic conductivity test results for rock samples from representative mine strata.
2) Placement of tracer or dye packs in mine pools coupled with monitoring of springs and seeps.
3) Installation, sampling, and testing of additional temporary or permanent water wells.
4) Geologic and structural mapping of the mine workings.
5) Inventory and sampling of outlying springs or seeps in similar geologic terrain and hydrogeologic conditions.

Once the additional data is collected, the final ground water characterization report will be prepared and submitted to DRMS for review and comment. The report will characterize the upgradient and downgradient aquifers, the ground water flowing into the mine, the water flowing out of the mine, the eventual fate of the water flowing from the mine, and any ground water impacts from mining operations. Potential environmental impacts that are found as a result of the investigation will be evaluated in the report and, if necessary, mitigation measures will be proposed.

11. Surface Water Quality Data

Surface water quality data is discussed in Exhibit 14 and presented in Appendix E. Surface water in Lumsden Creek occurs only intermittently after precipitation events and during spring snow melt. Several small ponds have been placed in the three tributaries upstream from the mine for use as stock watering ponds. These ponds further reduce downstream flows. The creek water does not have any known domestic or agricultural uses downstream of the mine site. With the exception of wildlife use, it is unlikely that there will be any future downstream uses of the water due to the prevailing dry conditions and intermittent nature of the surface flows. As shown in Table T-1, Lumsden Creek is in a
steep canyon for the first 3.55 miles downstream from the treatment plant discharge location. The steep terrain and remote location on public land make it even more unlikely that the water could be used beneficially for domestic or agricultural purposes in the future.

The surface water quality data indicate that natural erosional processes and historic mining activity has resulted in the accumulation of uranium-bearing sands within the Lumsden Creek streambed. Limited downstream sampling of the creek by the BLM in 1996 and 1997 indicate that the environmental effect of this material is low during storm events when flow rates are significant. However, lower surface water flows from springs, snow melt, and small precipitation events can become more concentrated in radionuclides and metals when exposed to these uranium-bearing materials. This is most apparent in the west tributary of Lumsden Creek where DP Spring flows through the toe of the historic Dutchman waste dump. The spring water degrades in quality with increases in radium, uranium, and arsenic levels as it flows through the toe area and gradually infiltrates into the streambed. The middle tributary to Lumsden Creek, where Energy Fuels proposes to discharge treated water, is less impacted by historic mining activities.

12. Surface Water Control and Monitoring

Potential contaminants in surface water will be controlled by diverting surface waters away from material storage areas, containing and treating surface water runoff originating in ore storage areas, and by both preventing exposure to surface water and providing for secondary containment of the various chemicals used on site.

Containment and use of chemicals on site for water treatment, dust suppression, and equipment fueling and maintenance is addressed earlier in Section 6 of this Exhibit and in more detail in Appendices F and H. There will be no acid mine drainage or acid-forming material on site. The uranium ore, as previously discussed, has the potential to contribute radionuclides and metals to surface water runoff. Accordingly, runoff from the ore pad will be contained and treated prior to discharge. All ore stockpiles will be removed prior to performing reclamation.
Detailed designs have been developed to divert all undisturbed runoff away from the site for the 100-year, 24-hour storm event. The diversions around the waste embankment will be permanent. Detailed designs have also been developed for the collection of all surface runoff from the disturbed area. This is done through a series of collection ditches, culverts and a sediment pond at the Whirlwind site. The Packrat portal area is relatively small and contains a sump that will contain the runoff from the 100-year event with no discharge.

These drainage designs are discussed in Exhibit 5 – Mine Plan, Section 17. The actual design calculations are presented in Appendix B and on Map C-6.

As described in Section 17 of Exhibit 5, the sediment pond that will receive surface water runoff from the disturbed area around the Whirlwind portal was designed to contain all the runoff from the 10-year, 24-hour storm event. Storm events larger than this size will be discharged through the pond’s emergency overflow. The water collected in and discharged from the sediment pond will be sampled and analyzed on a quarterly basis for a full suite of DRMS water quality parameters including radium-226 and uranium (see stormwater column in Table T-2).

In the event that a sediment pond sample fails to meet surface water quality discharge parameters, Energy Fuels will investigate the system of collection ditches to determine the likely source or sources of the elevated constituents. If this should occur, the most likely cause would be the placement of low-grade proto-ore in or next to a collection ditch. Identification of the potential source would include visual reconnaissance, sampling of soil materials, and follow-up sampling and analysis of subsequent surface water runoff events. A full report of any exceedances and corrective action taken will be provided in the quarterly report to the DRMS with copies to the BLM. Should surface water discharge from the sediment pond continue to exceed state standards, additional mitigation measures would be adopted in consultation with DRMS and the BLM. This could include diverting the pond water to the water treatment system for treatment prior to discharge.

Energy Fuels has obtained a discharge permit from the Water Quality Control Division of CDPHE for treating and discharging excess mine water. The permit requires that the treated water be sampled and analyzed on a weekly and monthly basis during active discharge operations. The monitoring
parameters and frequency are summarized on Table T-2. The permit limits for each constituent are based on the state water quality standards for the Dolores River at Gateway (i.e., Segment 3a of the river). The permit limits are provided in the CDPS Permit that is included as Appendix N.

13. Climate Data

The available climate data for the location has been included in Exhibit 13. Evaporation data is included. Interpolation between weather stations was required, since no one station was representative of the actual mine site. Site-specific wind data is not available but the prevailing winds are generally from west to east. Site-specific precipitation data from nearby Cave Canyon has also been included in Exhibit 13. This data, which was provided by the BLM, corresponds closely with the precipitation data that was generated through interpolation methods.

14. Geochemical Data and Analysis

Recent samples of the ore and waste from newly exposed underground faces were taken by Energy Fuels. These samples were analyzed for chemical content and then tested using the Synthetic Precipitation Leaching Procedure (SPLP), which is the Division’s recommended procedure for determining whether mine waste and ore has the potential to environmentally impact ground or surface water.

The sampling procedures, locations and results of these tests are presented in Appendix A. The results show that the ore has the potential to generate leachate or surface water runoff containing elevated levels of uranium, radium, and trace metals. Accordingly, runoff from the ore stockpile area will be contained and treated prior to discharge.

The waste rock, however, did not produce leachate that exceeded state water quality standards. The following Best Management Practices (BMPs) will also help insure that the waste material does not impact surface or ground water resources.
Waste Rock Pile BMPs

1) In the SPLP test, the ore is ground to a minute size (i.e., smaller than 9.5 millimeters) prior to leaching with a pH 5 solution, while the actual waste rock pile will consist primarily of larger sized rocks from one inch to twenty-four inches in diameter, that will not leach as readily. The permeability of the waste rock (and susceptibility to leaching) will also be reduced by the compaction that occurs as loaded haulage buggies and other equipment travel over the top of the waste pile.

2) Blending of low grade ore with high grade ore will be standard practice at the mine, thereby minimizing the amount of sub-ore-grade material that would otherwise be disposed of as waste.

3) Undisturbed runoff from the hillside south of the waste rock pile will be permanently diverted away from the waste rock embankment, utilizing diversion ditches designed for the 100-year, 24-hour storm event.

3) The waste rock embankment will be covered with a minimum of twelve inches of topsoil cover material and planted with a stable mix of grasses and forbs well suited to this location. The vegetation will utilize most of the direct precipitation and surface water runoff that occurs on the reclaimed embankment. This will prevent most of this water from ever entering the waste material.

4) The gradual slopes and revegetated surface of the waste rock embankment will minimize erosion of the topsoil and make any subsequent exposure of waste rock unlikely.

15. Construction Schedule Information

The water treatment plant and tanks were installed as part of prospecting activities. Required construction and estimated completion times for the remaining environmental protection facilities are listed below. The goal is to have all of these facilities in place by early fall.

1) Construct diversion ditches, collection ditches, and sediment pond (3 months)
2) Enlarge top of waste pile and construct lined ore pad, sump, and overflow pipe to the Untreated Water Tank (6 months)
3) Install septic system (1 month)
4) Move and reinstall the fueling station, oil storage enclosure, and generator stations, as needed, with appropriate secondary containment for all petroleum products (6 months).

16. Quality Assurance and Quality Control Program and Measures

Energy Fuels will notify the BLM and DRMS at least 10 working days in advance of any major construction activities on site. This will allow the agencies the opportunity to conduct inspections prior to, during, and after construction. A licensed professional engineer experienced in construction of ponds, embankments, liners, etc. will be on site during the construction of the ore pad and sediment pond to verify that these facilities are properly constructed. The engineer will prepare a detailed post-construction report that will be submitted to the agencies within 30 days of completion of the work.

Operation and monitoring of the treatment system will be directly supervised by a state certified wastewater operator. This person will be responsible for making adjustments in the plant equipment to meet discharge standards and for implementing a water discharge monitoring program that meets all the requirements of the site’s CDPS Permit. A copy of this permit is included as Appendix N.

17. Plant Growth Medium (Soils)

The soil types and boundaries for the area are shown on Map C-1A. All soil information for these types is presented in Exhibit I. All of these soils support vegetation and no unsuitable or problematic soils have been identified.

All topsoil from previously reclaimed areas and newly disturbed areas will be salvaged and used for reclamation. The plans for this stockpiling are explained in Exhibit 5. The Packrat power drop pad area currently has an infestation of Russian knapweed and field bindweed. This power drop area may need to be pretreated for the weeds prior to doing any topsoil stripping at this location.
All topsoil stockpiles will be seeded with the mix described in the Reclamation Plan once the piles are established. The process of spreading, grading, and harrowing the topsoil prior to reseeding has been described in Exhibit 6 – Reclamation Plan. The topsoil will be tested to determine if any amendments are needed should the stockpiles exhibit poor revegetation.

It is expected that approximately 12 inches to 18 inches of topsoil will be salvaged from the previously undisturbed areas at the Whirlwind portal area. Based on recent test hole data presented in Exhibit 11, the estimated average thickness of topsoil replacement at the Whirlwind portal area and waste embankment is 14 inches. All calculations and reclamation costs have been based on this amount of topsoil fill over the Whirlwind area. Approximately 12 inches of topsoil will be salvaged from vent shaft and power drop areas and another 4-6 inches of imported topsoil will be salvaged from the outer slope of the existing Whirlwind pad and from the Packrat portal area. This material will all be stockpiled and used for reclamation.

18. Wildlife Protection

The Untreated Water Tank and all other tanks in the water treatment facility will be fully enclosed by a chain link fence (see Map C-2) to preclude domestic livestock and most wildlife. The Untreated Water Tank surface is only 0.1 acre in size. The small pond footprint, mining activity in the immediate area, and the presence of other water sources nearby is expected to deter waterfowl from using the untreated water pond on a frequent basis. Bird and bat escape structures will be installed on all the water tanks during the warm weather months when wildlife may use the tanks more frequently as a water source.

As described in the reclamation plan, the site will be fully reclaimed to wildlife habitat once the mine is closed. One portal at the Packrat bench will be left open for bat habitat.

19. Disposal of Ore Pad Material and Sludge in Mine Workings

Over the life of the mine, percolation of rainwater through the ore may result in radionuclides leaching into the compacted ore pad. A geosynthetic clay liner (GCL) will be installed beneath the pad area to confine this potential contamination to the upper 3.5 feet of compacted pad area. During reclamation,
the compacted soil cover and the liner will be excavated and placed in a dry area within the upper portion of the Whirlwind decline.

The accumulated sludge from the Settling Tank will be disposed of in either one of three ways: 1) mixed into concrete on site and disposed of in the upper decline in a designated (i.e., dry) area above the water table, 2) transported to a uranium mill with ore to be processed, or 3) transported to a suitable off-site landfill for disposal. For reclamation costing purposes, the first alternative is assumed. The sludge volume is estimated to be approximately 19 cubic yards (see Appendix H). The concrete grout produced is expected to be about 40 cubic yards. The grout would be pumped into the mine and placed over or next to the ore pad material.
Section 1 - Reasons and Causes of Temporary Closure
Section 2 - Measures to Stabilize Excavations and Workings
Section 3 - Measures to Isolate or Control Toxic or Deleterious Materials
Section 4 - Provisions for the Storage or Removal of Equipment, Supplies and Structures
Section 5 - Measures to Maintain the Project Area in a Safe and Clean Condition
Section 6 - Plans for Monitoring Site Conditions During Periods of Non-Operation
Section 7 - Closure Schedule and Reporting
This Interim Management Plan was developed in accordance with Section 3809.401 of Title 43 of the Code of Federal Regulations (CFR). It addresses management of the Whirlwind Project area during periods of temporary closure (including periods of seasonal closure) to prevent unnecessary or undue degradation.

1. Reasons and Causes of Temporary Closure

The Whirlwind Project has an estimated mine life of 10 years; however, this may be extended as the mine expands and additional ore reserves are delineated. During the mine life, there may be periods when the project has to be temporarily closed for various reasons including, but not limited to:

1) Decrease in the price of uranium ore or an increase in mining costs resulting in uneconomic mining conditions.
2) Lack of adequate manpower to operate the mine efficiently.
3) Road closures due to weather or other causes.
4) Inadequate ore reserves or grade resulting in the need to conduct additional exploration activities prior to further mine development.
5) Loss of contract for selling ore.
6) Poor ground conditions, flooding, or other physical changes in the mine that may require reevaluation and modification of the mining method.

In the event that the mine has to be temporarily closed, the following procedures will be implemented.

2. Measures to Stabilize Excavations and Workings

The underground workings will be stabilized in accordance with Mine Safety and Health Administration (MSHA) regulations and periodically inspected during temporary closure. Roof bolts, mats, wire mesh, cribbing and other types of support will be installed, as needed, to stabilize the back and ribs. Equipment will be removed from immediate working faces and from lower areas of the mine where ground water may collect. The portal gates will be double locked to prevent unauthorized access.
For closure periods of six months or less, ground water will be pumped out of the mine on an intermittent basis, treated, and discharged in accordance with the project’s Colorado Discharge Permit System (CDPS) discharge permit. This will prevent water from building up in the lower areas of the mine, which could result in deterioration of the existing back and rib support. If closure should extend longer than six months, dewatering and water treatment may be suspended (see additional details below).

The surface area will be maintained in accordance with the project’s Storm Water Management Plan (SWMP). Areas exhibiting erosion will be repaired and runoff will be monitored periodically in accordance with the approved Plan of Operations and SWMP. Ditches, culverts and other surface drainage features will be inspected periodically and cleaned out as needed. Concurrent reclamation of the waste pile will be conducted in the fall if a portion of the waste embankment is ready for reclamation.

3. Measures to Isolate or Control Toxic or Deleterious Materials

Potentially toxic materials on site are limited to mine water drainage, stormwater runoff from ore stockpiles, fuel and oil, water treatment chemicals, and possibly a solvent cleaning station in one or both maintenance shops. Measures for isolating or controlling each of these materials during temporary closure are described below.

As discussed above, mine water will continue to be treated and discharged during a short-term closure. If closure should extend beyond six months, the mine dewatering and treatment system may be shut down. Based on previous experience at this, mine water would accumulate in the lower portion of the mine, but would not be expected to rise to the point where water was flowing out of the Packrat portal. If this should occur, then the treatment system would be restarted before water was allowed to discharge from the portal and Energy Fuels would evaluate other potential control measures including mine seals in the lower portals.
Prior to shutting down the treatment plant, the solution in the reagent tanks will be consumed and the water in all tanks will be lowered to the minimum practical level. This will provide ample storage capacity for precipitation events in excess of the 100-year, 24-hour storm. Within the mine, the pumps and other equipment will be moved back beyond the expected high-water level.

Leach testing of the uranium ore indicates that precipitation runoff from the ore stockpiles may contain elevated levels of radionuclides and metals. For this reason, the stockpile area has been designed to drain to the lined, Untreated Water Tank. This system will remain in place as long as ore is stockpiled on site. Adequate tank capacity will be maintained at all times to completely contain the direct precipitation and runoff generated by the 100-year, 24-hour storm event.

Energy Fuels will attempt to transport all stockpiled ore off site for processing within six months of temporary closure. In the event that this cannot be done, the company will consult with the BLM and the DRMS and develop a plan for long-term storage of this material. This plan may include implementation of additional controls or monitoring measures or placement of the ore back underground in a location above the water table. If all ore is removed from the stockpile area, Energy Fuels may request permission from the agencies to temporarily divert runoff from the stockpile pad to the sedimentation pond rather than the Untreated Water Tank.

During a short-term temporary closure, fuel tanks, oils and other petroleum products will be kept in locked, secured areas and any solvents will be picked up and recycled by the licensed vendor. Secondary containment features will be periodically inspected and maintained. If mine operations are suspended over a longer time period, the fuels and oils will be removed from the site.

4. Provisions for the Storage or Removal of Equipment, Supplies and Structures

Equipment and supplies will be maintained on site in secure areas during a short-term closure period. Mining equipment will be parked underground and the portals gates will be locked. Some supplies may also be moved underground, but most will remain stockpiled in the yard area or under lock and key in the maintenance shops, warehouse, and water treatment trailer. A security guard will be present on site full time or periodically as needed to deter theft and vandalism.
If the temporary closure period extends beyond six months, Energy Fuels may gradually remove some or all equipment, supplies, and both mobile and modular structures from the site to minimize the potential for theft and vandalism and reduce the need for full-time security. The equipment and supplies would be moved to other mine sites or to Energy Fuels’ main facilities in Nucla.

5. Measures to Maintain the Project Area in a Safe and Clean Condition

All areas of the site will be kept clean and free of litter and debris. Trash, used tires, old equipment parts, empty barrels, and other miscellaneous materials will be removed from the site and either recycled or disposed of properly.

Site safety will be maintained by discouraging unauthorized access through the use of locked gates, fences, warning signs, and security personnel. All buildings and trailers will be kept locked when not in use. The gates to the main facilities area, water treatment area, and Packrat area will also be locked. Both the Whirlwind and Packrat portal gates will be kept double locked. A security guard may be present on site on either a part or full time basis.

6. Plans for Monitoring Site Conditions During Periods of Non-Operation

During temporary closure, Energy Fuels will continue to perform environmental monitoring as required by its various permits. This will include monitoring of:

1) Discharges of treated water;
2) Monitoring wells;
3) Nearby springs;
4) Ground water inflow into the mine; and,
5) Stormwater.
All surface areas will be inspected at least weekly during a closure of six months or less. If the site remains relatively stable and the closure period extends beyond six months, Energy Fuels may reduce the frequency of surface inspections.

7. Closure Schedule and Reporting

No seasonal or maintenance shutdowns of the project are anticipated at this time. In the event that market conditions or other circumstances require a temporary shutdown of mine operations, Energy Fuels will provide notice to the BLM within 30 days after such suspension in conformance with Part 3802.4-7 of Title 43 of the CFR. This notice will include:

1) verification of intent to maintain structures, equipment, and other facilities;
2) the expected reopening date;
3) current mine contact information; and,
4) any revisions to this Interim Management Plan.
WILDLIFE INFORMATION

EXHIBIT 10

- Section 1 - Significant Game Resources on the Affected Lands
- Section 2 - Significant Non-Game Resources on the Affected Lands
- Section 3 - Seasonal Use of Affected Lands
- Section 4 - Presence and Estimated Population of Threatened or Endangered Species in the Area
- Section 5 - Fish Resources
- Section 6 - General Effects of the Operation on the Existing Wildlife of the Area
1. Significant Game Resources on the Affected Lands

Mule deer and elk are found in the Whirlwind project area. Evidence indicates that elk use the area in the spring and fall, while mule deer are probably present spring through autumn. The area is not designated winter range.

2. Significant Non-Game Resources on the Affected Lands

Bald eagles and red-tailed hawks are known to be in the area although no nests have been seen within the vicinity of the permit area. Cotton Tail Rabbits, Squirrels, Mourning Doves, Badgers, Raccoons, and Red Fox use areas such as this (pinyon-juniper) for habitat. Birds use the area but since there is no water on site, the use is limited. Bats are known to use the Packrat/Hubbard mine complex, mostly during winter.

3. Seasonal Use of Affected Lands

Most wildlife use the site year around, although deer and elk may move to lower elevations during periods of heavy snow.

4. Presence and Estimated Population of Threatened or Endangered Species in the Area

None are present in any portion of the permit area.

5. Fish Resources

None, since there are no water bodies on site or in the immediate area.
6. General Effects of the Operation on the Existing Wildlife of the Area

A small amount of habitat for deer and elk will be temporarily disturbed (24 acres) by the operation, although the amount disturbed at any one time would be less due to ongoing reclamation during the life of the mine. A portion of this acreage (7.69 acres) was previously disturbed and reclaimed.

The mine sediment pond will trap sediment and minimize siltation of waters downstream during the mining operation. See Mining Plan for details. The mine will be fully reclaimed to wildlife habitat. The main Packrat portal will have a bat gate welded at the entrance to prevent human entrance but allow bats to enter the workings, thus potentially improving post-mining bat habitat.

A chain link fence will be maintained at the water treatment plant at all times to prevent wildlife from entering the site. Birds and bats will still be able to enter the site but the only water area that could be potentially harmful to drink is the Untreated Water Tank and this tank will only have a surface area of 0.10 acre during normal operation. The untreated water from the Whirlwind is of relatively good quality; however, the water in the Packrat Mine is expected to contain higher levels of radium and trace metals. The three treatment tanks will be equipped with bird escape structures so that birds and bats can safely exit the tanks after landing on the water.

The following information was extracted from the Westwater biological survey conducted within the project area during June of 2007. Figures are attached. Photographs are included in Exhibit 12 - Vegetation. Table 3 provides additional detail regarding items 1 through 6 above.
### Endangered, Threatened, Sensitive Species

There is no habitat in the project area for any federally listed species. The following BLM sensitive species (Grand Junction Resource Area) are known to occur at 7,000 feet or above, and in habitats found in the project area:

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bat, Townsend's big-eared</td>
<td>Corynorhinus townsendii</td>
</tr>
<tr>
<td>Bat, spotted</td>
<td>Euderma maculatum</td>
</tr>
<tr>
<td>Bat, Allen's (Mexican) big-eared</td>
<td>Idionycteris phyllotis</td>
</tr>
<tr>
<td>Myotis, fringed</td>
<td>Myotis thysanodes</td>
</tr>
<tr>
<td>Myotis, Yuma</td>
<td>Myotis yumanensis</td>
</tr>
<tr>
<td>Bat, big free-tailed</td>
<td>Nyctinomops macrotis</td>
</tr>
<tr>
<td>Goshawk, northern</td>
<td>Accipiter gentilis</td>
</tr>
<tr>
<td>Frog, northern leopard</td>
<td>Rana pipiens</td>
</tr>
<tr>
<td>Butterfly, Great Basin silverspot</td>
<td>Speyeria nokomis nokomis</td>
</tr>
</tbody>
</table>

The bat species are all known to roost in mines. Townsend’s big-eared bat also hibernates in mines. The BLM Bats/Inactive Mines Project (Navo et al 2001) identified the Packrat/Hubbard complex as a hibernaculum for Townsend’s big-eared bat, and a roost for several other species of bat. Project coordinator Kirk Navo, (CDOW personal communication, 6/21/07) suggested conducting mine re-opening activities during the months of April through September to avoid possible disturbance of hibernating bats.

Northern goshawk usually nests above 8,000 feet in aspen or aspen/conifer forest, but there are records of this species nesting at lower elevations and in other habitats. For example, there are historic nests south of Piceance Creek in piñon-juniper woodland, and near Dinosaur National Park in cottonwoods. Both habitat types are present in the project area, but disturbance as a result of the project would be minimal.

Northern leopard frog is found to 11,000 feet in suitable habitats. The two springs in the project area could possibly provide suitable habitat, but no individuals were found during field work. Activity around the Whirlwind Portal and proposed vent shafts should have no effect on this habitat.

The Great Basin silverspot is known to be present in Unaweep Seep northeast of Gateway. The two springs in the project area could possibly provide suitable habitat. Activity around the Whirlwind Portal and proposed vent shafts should have no effect on this habitat.

**Observations**

No BLM sensitive species were observed during field work.
Recommendations
Scheduling mine re-opening activities for the summer months will avoid disturbing hibernating bats.

Raptors, Birds of Conservation Concern (BOCC)
Raptor surveys focused on piñon and ponderosa pine woodlands and sandstone bluffs in the project area. Thirteen species of raptors may potentially occur in the project area (Table 2). Five of the raptors that may potentially occur are also on the FWS Birds of Conservation Concern (BOCC) list.

Table 2. Raptor species that may be present in the project area

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>BOCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Harrier</td>
<td>Circus cyaneus</td>
<td>Yes</td>
</tr>
<tr>
<td>Cooper’s Hawk</td>
<td>Accipiter cooperii</td>
<td>No</td>
</tr>
<tr>
<td>Sharp-shinned Hawk</td>
<td>Accipiter striatus</td>
<td>No</td>
</tr>
<tr>
<td>Northern Goshawk</td>
<td>Accipiter gentiles</td>
<td>No</td>
</tr>
<tr>
<td>Red-tailed Hawk</td>
<td>Buteo jamaicensis</td>
<td>No</td>
</tr>
<tr>
<td>Swainson’s Hawk</td>
<td>Buteo swainsoni</td>
<td>Yes</td>
</tr>
<tr>
<td>Golden Eagle</td>
<td>Aquila chrysaetos</td>
<td>Yes</td>
</tr>
<tr>
<td>American Kestrel</td>
<td>Falco sparverius</td>
<td>No</td>
</tr>
<tr>
<td>Peregrine Falcon</td>
<td>Falco peregrinus</td>
<td>Yes</td>
</tr>
<tr>
<td>Prairie Falcon</td>
<td>Falco mexicanus</td>
<td>Yes</td>
</tr>
<tr>
<td>Great Horned Owl</td>
<td>Bubo virginianus</td>
<td>No</td>
</tr>
<tr>
<td>Northern Saw-whet Owl</td>
<td>Aegolius acadicus</td>
<td>No</td>
</tr>
<tr>
<td>Long-eared Owl</td>
<td>Asio otus</td>
<td>No</td>
</tr>
</tbody>
</table>

Observations
In this portion of Colorado, the raptor nesting season is generally considered to occur between mid-February and mid-August. Typically, owls and eagles are the first raptors to begin the annual nesting cycle followed by members of the Genus Accipiter, Buteo, Circus and Falco. Usually, by mid-August all young birds have fledged and left the nest.

Suitable raptor nesting habitat occurs in much of the survey area but no active or inactive nests were found. During the two days of the survey one red-tailed hawk was seen briefly soaring over the Whirlwind Portal area and one Cooper’s hawk was flushed from a piñon pine on Beaver Mesa. Neither bird was seen again and no evidence of nesting was found. In addition one feather, presumably from a great horned owl, was found on Beaver Mesa but no great horned owls themselves were either heard or seen.

Two BOCC birds were observed during the survey. Black-throated gray warblers (Dendroica nigrescens) were found throughout the project area but were most often encountered on Beaver Mesa. In one instance (at UTM 12S 668492mE, 4278672mN) a black-throated gray warbler exhibited
territorial behavior but a subsequent nest search produced no results. Virginia’s warblers (*Virmivora virginiae*) were also found throughout the survey area but were most commonly heard on the brushy slopes to the south of Whirlwind Portal. Visual sightings of Virginia’s warblers were difficult because of the dense brush but some males did respond to a recorded call of the species.

Pinyon jays (*Gymnorhinus cyanocephalus*), another BOCC species, were expected in the survey area but none were seen or heard.

**Recommendations**

It is unlikely that any nesting raptor species will be affected by operations around Whirlwind Portal or the proposed vent shafts.

In Colorado black-throated gray warblers start to build nests in early May and their chicks are fledged by the first week in August. In the project area black-throated gray warblers nest primarily among the piñons on Beaver Mesa. Virginia’s warblers, on the other hand, prefer nesting in the lower elevation oakbrush. They begin nesting in early June and their chicks are fledged by mid-August. Construction should be avoided between the time of nest building and chick fledging. If construction does occur between those times then additional nesting surveys should be performed and a 300 foot radius buffer placed around any active nests.

**Other Wildlife Species**

Wildlife species found in the area are common to piñon-juniper communities in western Colorado. During the field examination, evidence indicating the following species utilize the area was observed: American elk, mule deer, coyote, gray and/or kit fox, black bear, desert cottontail, and wild turkey. This evidence represents only a small percentage of the wildlife species that may use this site at some time during the year. Evidence indicates elk use the area in spring and fall, while mule deer are probably present spring through autumn. The area is not designated winter range.

A wide variety of birds species were noted during field work, including broad-tailed hummingbird, northern flicker, white-throated swift, mourning dove, western kingbird, ash-throated flycatcher, western wood pewee, dusky flycatcher, warbling vireo, common raven, Steller’s jay, scrub jay, black-billed magpie, black-capped chickadee, juniper titmouse, bushtit, white-breasted nuthatch, house wren, canyon wren, ruby-crowned kinglet, blue-gray gnatcatcher, American robin, mountain bluebird, hermit thrush, yellow warbler, yellow-rumped warbler, western tanager, black-headed grosbeak, spotted towhee, green-tailed towhee, chipping sparrow, Brewer’s sparrow, vesper sparrow, lark sparrow, song sparrow, western meadowlark, Brewer’s blackbird, brown-headed cowbird, and house finch.

Wildlife resources of the site are summarized in Table 3.
### Table 3. DRMS Effects Summary

<table>
<thead>
<tr>
<th>1. Significant Game Resources on the Affected Lands</th>
<th>Is in CDOW GMU 60, and is used for seasonal deer and elk hunting.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Significant Non-Game Resources on the Affected Lands</td>
<td>Raptor nesting and neotropical migratory bird habitat is present, but no active nests were observed during the June 13-15, 2007 site survey. Application of recommendations is expected to avoid and minimize effects on these species. Bats are known to use the Packrat/Hubbard mine complex, mostly during winter. Avoiding human disturbance during the hibernation season should minimize effects on bats.</td>
</tr>
<tr>
<td>3. Seasonal Use of Affected Lands</td>
<td>The area is used by deer and elk from spring through fall, but is not considered to be winter range (NDIS 2007).</td>
</tr>
<tr>
<td>4. Presence and Estimated Population of Threatened or Endangered species in the area.</td>
<td>No species included on the Endangered Species List have been documented as present within the project area, and suitable habitat for such species is not present.</td>
</tr>
<tr>
<td>5. Fish Resources</td>
<td>The project area does not include any perennial waters that support fish populations.</td>
</tr>
<tr>
<td>6. General Effects of the Operation on the Existing Wildlife of the Area</td>
<td>Available habitat for foraging and hiding/thermal cover for deer and elk would be reduced for the life of the mining operation and through the time needed to restore vegetation to the site. During the operation of the mine, resident wildlife would be displaced from the immediate vicinity of the human activity. Some direct mortality, especially of less mobile terrestrial species, would be expected, especially related to traffic on the access roads during the mining operation. Due to the abundance of very similar wildlife habitat in the general vicinity, and limited amount of similar activity at the present time, the project is unlikely to have any long-term detrimental effects on wildlife of the area. Based on information from the project proponent, water quality of the water to be pumped from the mine and stored onsite is not expected to be harmful to wildlife species.</td>
</tr>
</tbody>
</table>
REFERENCES


There are two naturally-occurring soil types within the Whirlwind and Packrat Mine permit area. The Whirlwind has only Type 66—Bodot-Sili-Rock outcrop complex and the Packrat has only Type 6 – Rock Outcrop Sedgran. The areas of the Whirlwind and Packrat that were previously reclaimed are covered with a combination of subsoils, sandy waste, salvaged topsoil, and imported alluvial soil from the lower part of John Brown Canyon. The proposed surface disturbance at the Packrat portal will occur entirely on previously disturbed and reclaimed land. All soil type boundaries are shown on Map C-1A for both mine portal areas.

Topsoil from the original Packrat portal area was not salvaged. Alluvial material was brought in for previous reclamation efforts and placed to a depth of 4-6 inches. Some vegetation has been successful on this material. As described in the mine plan, this material will be salvaged and placed in the required MSHA berms at the Packrat portal area and the Packrat road. The material will be re-used for reclamation of the Packrat portal area.

Topsoil borings were completed within the proposed Whirlwind disturbance area on May 3, 2007. The boring locations are shown on Map C-1A. The topsoil was determined to be a clay loam. Analyses of two topsoil samples by Colorado State University are attached.

The area of topsoil salvage is divided among four areas which are described below:

**Area 1:** The existing slopes of the Whirlwind portal bench, which were previously reclaimed with original topsoil to an approximate depth of 0.5 feet. This material will be stripped and re-used in reclamation. As shown on Map C-1A, this area is 1.6 acres in size, therefore, the volume available for stripping is approximately 1,300 cubic yards.

**Area 2:** The east expansion area of the waste embankment will be located on relatively gentle slopes. Most of the soil borings were completed in this area, where topsoil ranges from 1.2 feet to 2.3 feet in thickness. There are a number of rock outcrops in the area where no topsoil is available. From the following table, it is seen that the average topsoil thickness in this area is 1.78 feet. When the rock
outcrops are subtracted, the average thickness is estimated to be 1.6 feet. Since the area is 8.4 acres in size, the topsoil volume available for salvage is estimated to be 21,700 cubic yards.

**Area 3:** Area 3 comprises the steeper slopes along the south portion of the waste expansion area. This area has less topsoil available for stripping. Boring 5, which was completed at the base of this area, contained only 1.2 feet of topsoil. An average thickness of approximately 0.8 feet is assumed for this area. Since the area is 2.36 acres, the topsoil volume available for stripping is estimated to be 3,000 cubic yards.

**Area 4:** This area is north of 5/10 Road and will contain the treatment plant, water tanks, and sediment pond. No borings are in this area, but visual inspections and the similarities to Area 2 suggest that the topsoil thickness will be similar to Area 2. Assuming a soil depth of 1.6 feet over an area of 1.71 acres results in an estimated salvage volume of 4,400 cubic yards.

The total estimated volume of topsoil available from the four areas is approximately 30,400 cubic yards. It is believed this calculated volume is accurate to plus or minus 20%. Reclamation calculations are based on 30,400 cubic yards of salvageable topsoil.

Results from the borings are shown below:
Table 11-1 Whirlwind Topsoil Samples

<table>
<thead>
<tr>
<th>Area</th>
<th>Sample #</th>
<th>Topsoil Depth (ft)</th>
<th>Description</th>
<th>Material Below Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>Dark brown clay loam</td>
<td>Clay</td>
</tr>
<tr>
<td></td>
<td>Avg Area 1</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1.8</td>
<td>Dark brown clay loam</td>
<td>Tannish Green Clay</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>1.7</td>
<td>Dark brown clay loam</td>
<td>Brown Grey Clay Loam</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>1.8</td>
<td>Dark brown clay loam</td>
<td>Dark Brown Clay</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>1.3</td>
<td>Dark brown clay loam</td>
<td>Brown Clay with Red Sand</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>2.3</td>
<td>Dark brown clay loam</td>
<td>Brown Clay</td>
</tr>
<tr>
<td></td>
<td>Avg Area 2</td>
<td>1.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>1.2</td>
<td>Dark brown clay loam</td>
<td>Tan Clay with White Streaks</td>
</tr>
<tr>
<td></td>
<td>Avg Area 3</td>
<td>1.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following information was extracted from the Westwater biological survey conducted in the project area in June of 2007. Figure 3 showing the soils of the entire area is attached. Photos are included in Exhibit 12.

The Whirlwind Portal and proposed vent shafts lay within four soil mapping unit boundaries. The disturbed area of two vent shafts, VS-1 and VS-2, each contain two soil mapping units (15 and 102) as does the two-track road accessing them. See Figure 3. Soil descriptions for this report were obtained from the USDA, Natural Resources Conservation Service.

15 - Bond - Windwhistle complex, 2-15% slopes. Three proposed vent shafts in Utah (VS-1, VS-2, VS-3), Section 9, T25S, R26E, lie in this complex. Bond loam comprises 45% of this unit. It has loam to sandy clay loam subsurface textures; is well drained; medium runoff; moderately permeable; and shallow to sandstone bedrock (10 - 20 inches). Windwhistle very fine sandy loam comprises 35% of this unit. It has very fine sandy loam or loamy very fine sand subsurface textures; is well drained; slow runoff; moderately rapid permeability; and moderately deep to sandstone bedrock (20 - 40 inches). Various inclusions make up the remainder of this unit.

102 - Waas very fine sandy loam, 2-8% slopes. Four proposed vent shafts in Utah (VS-1, VS-2, VS-4, VS-5), Section 9, T25S, R26E, are in this soil mapping unit. Waas very fine sandy loam comprises 72% of this unit. It has loam subsurface texture; is well drained; slow runoff; moderate permeability; and is deep to bedrock (greater than 80 inches). Various inclusions make up the remainder of this unit.
66 - Bodot - Sili - Rock outcrop complex, 5-25% slopes. The Whirlwind Portal lies within this soil mapping unit. Bodot clay loam comprises 45% of this unit. It has clay subsurface textures; is well drained; high or very high runoff; slow or very slow permeability; and is moderately deep to clayey shale bedrock (20 - 40 inches). Sili clay loam comprises 25% of this unit. It has clay subsurface textures; is well drained; high or very high runoff; slow or very slow permeability; and is moderately deep to clayey shale bedrock (20 - 40 inches). Rock outcrop comprises 20% of this unit and other inclusions make up the remainder. Stones and boulders cover 1.5% of the surface.

111 - Maudlin - Beje complex, 3-12% slopes. The proposed vent shaft in Colorado (VS-6), Section 2, T50S, R20W, lies in this soil mapping unit. Maudlin fine sandy loam comprises 50% of this unit. It has sandy clay loam subsurface textures; is well drained; low runoff; moderate permeability; and is moderately deep to sandstone bedrock (20 - 40 inches). Beje fine sandy loam comprises 35% of this unit. It has sandy clay loam subsurface textures; is well drained; low to high runoff; moderate or moderately rapid permeability; and is shallow to bedrock (10 - 20 inches). Other inclusions make up the remainder of this unit.
Map Unit Description
Mesa County Area, Colorado

6 Rock outcrop-Sedgran, 40 to 99 percent slopes, very stony

Setting
Elevation: 5500 to 8000 feet
Mean annual precipitation: 10 to 13 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 100 to 135 days

Composition
Rock outcrop: 60 percent
Sedgran and similar soils: 25 percent
Minor components: 15 percent

Description of Rock outcrop

Properties and Qualities
Slope: 50 to 99 percent
Depth to restrictive feature: 0 to 0 inches to Bedrock (lithic)
Capacity of the most limiting layer to transmit water (Ksat): Very low or low (0.00 to 0.00 in/hr)
Frequency of flooding: None

Interpretive Groups
Land capability (non irrigated): 8s

Typical Profile
0 to 60 inches: unwethered bedrock

Description of Sedgran

Setting
Landform: Mesas
Landform position (two-dimensional): Backslope
Parent material: Colluvium over residuum weathered from sandstone

Properties and Qualities
Slope: 40 to 65 percent
Surface area covered with stones and boulders: 1.5 percent
Depth to restrictive feature: 10 to 20 inches to Bedrock (lithic)
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low or moderately high (0.06 to 0.20 in/hr)
Frequency of flooding: None
Calcium carbonate maximum: 10 percent
Gypsum maximum: 0 percent
Available water capacity: Very low (about 1.7 inches)

Interpretive Groups
Land capability (non irrigated): 7e

Typical Profile
0 to 9 inches: fine sandy loam
9 to 12 inches: chalky loamy fine sand
12 to 19 inches: very chalky loamy fine sand
19 to 23 inches: unwethered bedrock

Minor Components
Soils with more silt and clay and are >20' deep to sandstone
Percent of map unit: 8 percent
Soils that are more than 20 inches deep to sandstone
Percent of map unit: 7 percent
Map Unit Description

Mesa County Area, Colorado

66 Bodot-Sili-Rock outcrop complex, 5 to 25 percent slopes, very bouldery

Setting

Elevation: 5500 to 8100 feet
Mean annual precipitation: 10 to 13 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 100 to 135 days

Composition

Bodot and similar soils: 45 percent
Sili and similar soils: 25 percent
Rook outcrop: 20 percent
Minor components: 10 percent

Description of Bodot

Setting
Landform: Benches
Landform position (two-dimensional): Footslope
Parent material: Colluvium derived from sandstone and shale over residuum weathered from clayey shale

Properties and Qualities
Slope: 6 to 25 percent
Surface area covered with stones and boulders: 1.5 percent
Depth to restrictive feature: 20 to 40 inches to Bedrock (paralithic)
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low or moderately high (0.06 to 0.20 in/hr)
Frequency of flooding: None
Calcium carbonate maximum: 16 percent
Gypsum maximum: 0 percent
Available water capacity: Low (about 4.9 inches)

Interpretive Groups
Land capability (non irrigated): 6e

Typical Profile
0 to 5 inches: clay loam
5 to 32 inches: clay
32 to 56 inches: weathered bedrock

Description of Sili

Setting
Landform: Benches
Landform position (two-dimensional): Footslope
Parent material: Colluvium derived from sandstone and shale over residuum weathered from clayey shale

Properties and Qualities
Slope: 5 to 25 percent
Surface area covered with stones and boulders: 1.5 percent
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low or moderately high (0.06 to 0.20 in/hr)
Frequency of flooding: None
Calcium carbonate maximum: 15 percent
Gypsum maximum: 0 percent
Available water capacity: High (about 9.3 inches)

Interpretive Groups
Land capability (non irrigated): 6e
Ecological site: Clayey Foothills (R034XY289CO)

Typical Profile
0 to 3 inches: clay loam
3 to 9 inches: gravelly clay loam
9 to 15 inches: clay loam
15 to 39 inches: clay
Map Unit Description

Mesa County Area, Colorado

39 to 60 inches: clay

Description of Rock outcrop

Properties and Qualities
Slope: 5 to 25 percent
Depth to restrictive feature: 0 to 0 inches to Bedrock (lithic)
Capacity of the most limiting layer to transmit water (Ksat): Very low or low (0.00 to 0.00 in/hr)
Frequency of flooding: None

Interpretive Groups
Land capability (non irrigated): 8s

Typical Profile
0 to 60 inches: unweathered bedrock

Minor Components
Soils with bedrock above 20 inches
Percent of map unit: 4 percent

Soils with less clay and silt
Percent of map unit: 3 percent

Soils with more than 35 percent rock fragments
Percent of map unit: 3 percent
### Physical Soil Properties

Mesa County Area, Colorado

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USDA Natural Resources Conservation Service

Tabular Data Version: 3
Tabular Data Version Date: 01/01/2007

Page 4 of 9
### RUSLE2 Related Attributes

Mesa County Area, Colorado

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## RESEARCH SOIL ANALYSIS

### WHIRLWIND SAMPLES

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<th>P</th>
<th>K</th>
<th>Zn</th>
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### Soil Texture

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<td>21</td>
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<td>Clay Loam</td>
<td>6.34x10⁶</td>
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Existing Plant Communities

See Map C-1A for an aerial image of the current Whirlwind and Packrat portal areas showing trees and grass areas. The entire site is classified as piñon juniper community, although there are some patches of grassy areas with native forbs and some ponderosa trees.

The pictures below show the vegetation in the area of the Whirlwind waste expansion and the reclaimed Packrat waste embankment.

Figure J-1 Looking west from proposed waste embankment area looking at existing Whirlwind bench
Figure J- 2 Looking east from proposed waste embankment area showing various communities.
Figure J-3 Looking southeast from northern edge of proposed waste embankment along 5/10 Road.
Figure J-4 Looking south toward north facing hillside in waste embankment area.
General Habitat Description

The Whirlwind Portal is located in the moderately steep upper portion of Lumsden Canyon near the middle fork of Lumsden Creek (Photo 1). There are small areas of very steep sandstone cliffs near the Whirlwind Portal. The six proposed vent shaft holes are located on Beaver Mesa which consists of mildly sloping terrain bisected by intermittent drainages. Elevations in the project area range from approximately 7,500 ft. on Beaver Mesa to 6,800 ft. in Lumsden Canyon.

Exposed bedrock in the area is from the Jurassic Morrison Formation and the Cretaceous Burro Canyon and Dakota Formations.

The vegetation in the project area varies depending on slope, aspect, elevation and soils. Generally, the composition of vegetation is piñon (*Pinus edulis*) woodlands and mixed bunch grass and sagebrush shrublands (Photo 2). A few Utah junipers (*Juniperus osteosperma*) can sometimes be found among the piñons. Ponderosa pines (*Pinus ponderosa*) are sparsely scattered around the area although a few
denser stands do exist, notably just south of the Whirlwind Portal and along the drainages of Lumsden Creek on Beaver Mesa.

On the north facing slope just south of the Whirlwind Portal shrubs consist of Utah serviceberry (*Amelanchier utahensis*) and oakbrush (*Quercus gambelii*). The south fork of Lumsden Creek, to the east of the Whirlwind Portal, includes small moist pockets supporting rocky mountain maple (*Acer glabrum*) and western poison ivy (*Toxicodendron rydbergii*). No riparian vegetation was observed.

Remnants of a homestead can be found near an abandoned mine (UTM 12S 670179mE, 4278490mN). Vegetation in that area includes Siberian elm (*Ulmus pumila*), lilac (*Syringa* spp.), smooth brome (*Bromus inermis*), orchardgrass (*Dactylis glomerata*), and alfalfa (*Medicago sativa*).

A list of common plant species found in the project area is included in Table 1.

### Threatened, Endangered and Sensitive Plant Species (TESS)

The TESS plants that may potentially occur within the project area are dependent on specific geology, soil types, elevations, and terrain. The determination of presence/absence of suitable habitat for these species was based on previous WestWater Engineering observations of sites occupied by BLM sensitive plants, the Colorado Natural Heritage Program (CNHP) Rare Plant Field Guide (Spackman et al. 1997), and locations of species documented in the CNHP statewide database. A list of BLM sensitive species may be found at this website: [http://www.blm.gov/co/st/en/BLM_Programs/botany/Sensitive_Species_List_.print.html](http://www.blm.gov/co/st/en/BLM_Programs/botany/Sensitive_Species_List_.print.html)
### Table 1. Common plant species observed in the project area

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
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<tr>
<td>Piñon pine</td>
<td><em>Pinus edulis</em></td>
</tr>
<tr>
<td>Ponderosa pine</td>
<td><em>Pinus ponderosa</em></td>
</tr>
<tr>
<td>Utah juniper</td>
<td><em>Juniperus osteosperma</em></td>
</tr>
<tr>
<td>Alderleaf mountain mahogany</td>
<td><em>Cercocarpus montanus</em></td>
</tr>
<tr>
<td>Gambel oak</td>
<td><em>Quercus gambeli</em></td>
</tr>
<tr>
<td>Utah serviceberry</td>
<td><em>Amelanchier utahensis</em></td>
</tr>
<tr>
<td>Wyoming sagebrush</td>
<td><em>Artemisia tridentata wyomingensis</em></td>
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<tr>
<td>Arrowleaf balsamroot</td>
<td><em>Balsamorhiza sagittata</em></td>
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<tr>
<td>Yellow rabbitbrush</td>
<td><em>Chrysothamnus viscidiflorus</em></td>
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<tr>
<td>Onion</td>
<td><em>Allium spp.</em></td>
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<tr>
<td>Prickleypear cactus</td>
<td><em>Opuntia spp.</em></td>
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<tr>
<td>Tracy’s thistle</td>
<td><em>Cirsium undulatum var. tracy</em></td>
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<tr>
<td>Bottlebrush squirreltail</td>
<td><em>Sitanion hystrix</em></td>
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<tr>
<td>Crested wheatgrass</td>
<td><em>Agropyron cristatum</em></td>
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<tr>
<td>Idaho fescue</td>
<td><em>Festuca idahoensis</em></td>
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<tr>
<td>Indian rice grass</td>
<td><em>Oryzopsis hymenoides</em></td>
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<tr>
<td>Junegrass</td>
<td><em>Koeleria macrantha</em></td>
</tr>
<tr>
<td>Western wheatgrass</td>
<td><em>Pascopyrum smithii</em></td>
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</tbody>
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### Observations

The survey area has potential habitat for Montrose bladder pod (*Lesquerella vicina*) and possibly Grand Junction milkvetch (*Astragalus linifolius*), neither of which was found. There is a small amount of suitable habitat for Naturita milkvetch (*Astragalus naturitensis*) but it was not observed. Other possible rare plants in the survey area require seep habitat but no seeps were found. The DP and PR springs do not support TESS plants.

### Recommendations

It is not likely that operations in the Whirlwind Mine Area will impact any TESS plants.

### Noxious Weeds

#### Observations

The Whirlwind Mine project area is not widely affected by many noxious weeds. Most are in the immediate vicinity of the Whirlwind Portal and Packrat power drop (Fig. 2 and Photos 3 and 4) but downy brome (cheatgrass) was noted throughout the survey area, especially in disturbed areas. The types of noxious weeds and their locations are in Table 2.
Recommendations

Soil disturbance associated with mining/construction activities may promote the spread of invasive noxious weeds. The application of an aggressive weed management plan near the Whirlwind Portal and Packrat power drop is recommended to: 1) prevent the invasion and expansion of noxious weeds and 2) ensure the establishment of desirable plant communities upon rehabilitation of the site. Table 2 lists recommended noxious weed control measures.

Table 2. Weed locations and control recommendations

<table>
<thead>
<tr>
<th>Common Name*</th>
<th>Scientific Name</th>
<th>Infestation Location</th>
<th>Control Methods</th>
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</thead>
<tbody>
<tr>
<td>Downy Bromec</td>
<td>Bromus tectorum</td>
<td>Occurs throughout the area. Concentration near Whirlwind Portal reclaimed area 150 x 500 feet.</td>
<td>Plant competitive grasses, limit grazing.</td>
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<tr>
<td>Common Burdock</td>
<td>Arctium minus</td>
<td>Six plants at Whirlwind Portal: One - 12S 669788mE, 4278833mN One - 12S 669810mE, 4278832mN Four - 12S 669929mE 4278826mN</td>
<td>The small number of plants lends itself to cutting and digging of rosettes and bolting plants; re-seed with aggressive grasses. Herbicides if needed.</td>
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<tr>
<td>Field Bindweed</td>
<td>Convolvulus arvensis</td>
<td>Both sides of 5/10 Road north of Whirlwind Portal. 4 x 500 feet.</td>
<td>Herbicides in fall; plant competitive grasses.</td>
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<tr>
<td>Hoary Cress</td>
<td>Cardaria draba</td>
<td>Whirlwind Portal area: 50 x 150 feet at 12S 669820mE, 4278868mN 20 x 20 feet at 12S 669786 mE, 4278844mN 10 x 30 feet at 12S 669811mE, 4278837mN Six - 12S 669829mE 4278826mN</td>
<td>Herbicides during flowering stage, multiple treatments. Plant competitive grasses. Digging or grubbing, unless done biweekly over the course of a few years, is not effective and may only serve to spread the infestation via root sprouts.</td>
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<tr>
<td>Russian knapweed</td>
<td>Acroptilon repens</td>
<td>20 x 20 feet at 12S 669418mE, 4279306mN</td>
<td>Herbicides in bloom or early seed stage; plant competitive grasses.</td>
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* Government weed listing:  U-Utah    G-Grand County, Utah    C-Colorado    M-Mesa County, Colorado

Whirlwind Mine 07 – rev. 3/08  12-8
COE - Potential Waters of the United States

Areas of COE jurisdiction under Section 404 of the Clean Water Act consist of Waters of the United States. Waters of the US includes wetlands and drainage courses (streams, ephemeral drainages that connect to streams via surface flow or subsurface connection), ponds, lakes and springs. In general, ephemeral washes with evidence of flow (detritus accumulation, erosional features, and lack of vegetation) may be considered jurisdictional by COE. COE jurisdiction in ephemeral drainages is considered to be areas below the Ordinary High Water mark (OHW) as indicated by evidence of flow.

Areas of potential Army Corps of Engineers (COE) jurisdiction under Section 404 of the Clean Water Act in the vicinity of the proposed activity include 2 springs and related drainages, and 2 ephemeral drainages. Locations of these features are shown on Figure 2.

Observations

Springs: The springs include the PR Spring and DP Spring. PR Spring is located near the Packrat Mine Portal, and DP Spring is located approximately 0.5 miles northwest of the Whirlwind site. Any disturbance within 100 feet of either spring is likely to involve a COE Individual Permit as lands within 100 feet of springs have been withdrawn from Nationwide Permits.

Ephemeral Washes: The ephemeral washes likely to be within COE jurisdiction (COE 1 and COE 2) are associated with vent shaft access.

COE 1 is located on a two-track trail in Utah, Section 9, T25S, R26E that provides access for two proposed vent shafts (VS-1 and VS-2). This trail crosses a small ephemeral wash (12S 668357mE, 4279033mN). Potential COE jurisdictional area below Ordinary High Water (OHW) is estimated at 18 inches wide by 2 inches deep. Water erosion has exposed shallow sandstone bedrock just north of the two-track (Photos 5 and 6).

COE 2 is located on a two-track trail accessing a proposed vent shaft in Colorado (VS-6) (Photo 7), Section 2, T51N, R20W (UTM 12S 668970mE, 4277860mN). OHW is estimated at 12 inches wide by 2 inches deep.

Any fill of these washes is likely to be permitted under COE Nationwide Permit #14.

Recommendations

Avoid construction during seasonal runoff. Keep traffic to the necessary minimum. Most soils are shallow so prompt revegetation with a protective mulch covering is recommended following disturbance to avoid erosion to bedrock. Consult with COE regarding possible permit actions.
REFERENCES


Photo 1. Looking southeast towards Whirlwind Portal

Photo 2. Sagebrush, piñon pine. Ponderosa pine on ridge
Photo 3. Hoary cress and downy brome. Whirlwind air duct (yellow) in background

Photo 4. Field bindweed along road edge at Whirlwind Portal
Photo 5. COE 1 looking north. Exposed bedrock in drainage (middle of photo)

Photo 6. COE 1 looking south. Two-track in foreground
Photo 7. COE 2 near proposed vent shaft
The following climate information is presented for the Whirlwind Mine. The data was interpolated from local Remote Animated Weather Stations from the Western Regional Climate Center. The Little Dolores Colorado (RAWS) and the Carpenter Ridge Colorado (RAWS) are the sites that were used, since no one site represents the actual weather that occurs at the mine site. The Little Dolores station is located in the NW1/4 SE1/4 Sec 31 T12S R103W at an elevation of 6796 ft above sea level. This location is approximately 23 miles NNW of the mine. The Carpenter Ridge station is located in the NE1/4 NW1/4 Sec 2 T48N R20W at an elevation of 8088 ft above sea level. This is approximately 13 miles south of the mine. The temperature data for the Whirlwind Mine was averaged from the two sites because the elevation of the mine (7050 ft) is between the two stations along with being located approximately between them north to south.

The annual precipitation of 16” per year was gathered from a map produced by the U.S. Department of Agriculture Fig K-1. The average monthly precipitation was calculated by multiplying the ratio of the average annual precipitation (16” per year) at the Whirlwind Mine to the average annual precipitation (17.29” per year) of the Carpenter Ridge station by the average monthly precipitation for the Carpenter Ridge station. The average monthly and annual precipitation for the mine site using this method coincides closely with precipitation data collected by the BLM for Cave Canyon. Cave Canyon is located 3 miles southwest of the Whirlwind Mine at a similar elevation. The Cave Canyon data covers the period from 1981 to 2007 and is attached at the end of this exhibit.
**AVE Monthly Precipitation**

\[ \text{AVE Monthly Precipitation at Whirlwind} = \text{AVE Monthly Precipitation at Carpenter Ridge} \times \left( \frac{16'' \text{/year}}{17.29'' \text{/year}} \right) \]

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![Mine Location](image)

**Figure K-1**

*Whirlwind Mine 07 – rev. 3/08*
Fig K-2 Location of Weather Stations
The average evaporation for the Whirlwind Mine is approximately 46 inches per year. (See Figure K-3)
### Cave Canyon Monthly and Annual Precipitation

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Average: 1.62, Maximum: 4.11, Minimum: 0.05, Std. Dev.: 1.01
1. Introduction

Umetco Minerals Corporation (Umetco) and the U.S. Bureau of Land Management (BLM) extensively monitored the ground and surface water in the project area in the 1990s and early 2000s as part of mine closure and reclamation activities. Energy Fuels has conducted additional monitoring since acquiring the mineral rights in fourth quarter 2006. Both the current and historic data have been compiled into four tables (Tables E-1 through E-4), which are presented in Appendix E. State and federal regulatory standards for various ground and surface water uses are listed at the bottom of each of these tables and those analytical results that are above a standard are shaded for reference purposes. Shading indicates that the water in question may not be suitable for one or more regulated uses such as domestic drinking water. The laboratory reports and field information used in compiling the ground and surface water quality tables are also provided in Appendix E.

Much of the hydrogeologic background information presented in this exhibit was obtained from a series of Umetco reports that were submitted to the State and BLM during the aforementioned closure and reclamation period. Two of these reports have been included in their entirety as Appendix C. Exploration activities conducted by Cotter in 1996 and Energy Fuels in 2007 also provide insight into the local geology and ground water systems. Reports describing the 1996 and 2007 drilling results are provided in Appendix D. Supporting figures and maps referenced in this exhibit are included in Appendix I, Maps and Figures.
2. General Area Discussion

The area where the mining will take place is known as Beaver Mesa. The regional area is characterized by mesas cut by deep canyons. There are narrow benches on the mesa shoulders in some areas and near-vertical, 500-foot cliffs elsewhere. Elevations within the claim group range from 7,800 feet in the southwestern part to 6,800 feet near the canyon rim in the northeast part. The area is semiarid. All elevations support moderate growths of juniper and piñon in rocky soils along with sage and other brush, forbs, and grasses. Where soils are rich in the higher elevations and northern slopes, there are stands of ponderosa pine and oak brush.

The northern portion of the mesa where the mine is located drains into Lumsden Creek, an intermittent drainage that flows in the spring and after large precipitation events. Lumsden Creek flows into the Dolores River north of Gateway as shown on Map G-1. The elevation drops to 4,550 feet at the Dolores River. Lumsden Creek is fed by three small springs: DP Spring, PR Spring, and Lumsden Spring (see Map G-1). These springs occur at or near where sandstone aquifers intersect the Lumsden Fault (see Map G-2), which bisects the canyon.

The closest water wells to the mine are the Shallow and Deep Cherokee Wells located about 2,000 feet east to southeast of the Whirlwind portal. These wells are both completed in the upper Brushy Basin Member of the Morrison Formation, which is above the Salt Wash Member where the mine workings are located. The Cherokee Wells, which produce only small amounts of water, are currently capped and not in use. They were used historically as water sources for the Cherokee Mine Camp. There is also an agricultural well (BLM Well) located on top of the mesa about 1 mile due west of the Whirlwind portal on the Utah side of the state line. This well is completed in the Burro Canyon Formation, which is also located above the mine workings. It is used by a local rancher for watering livestock. The closest downstream water well to the mine within the Lumsden Creek Watershed is the Lonie Ranch Well located about 5 miles from the mine area near the Dolores River. This well is probably completed in the river alluvium.
3. Regional Geology

The Whirlwind Mine lies in the central and east-central part of the Colorado Plateau in Utah and Colorado as shown on Figure G1. The Plateau’s basement rocks are mostly Proterozoic metamorphics and igneous intrusions. The area was relatively stable throughout the Paleozoic and Mesozoic Eras with minor uplifts, subsidence, and tilting resulting in fairly flat-lying sedimentary rocks ranging from evaporites, limestones, and marine clastic sediments, through eolian sandstones, to detritus of fluvial systems. The Uncompahgre Uplift, seven miles northeast of the Whirlwind claims, was active during the late Paleozoic so that Pennsylvanian through early Jurassic sedimentary rocks wedge out against the pre-Cambrian crystalline rocks. This thick stratigraphic sequence to the southwest is interrupted locally by salt-cored anticlines in the Paradox Basin area, basement fault-related monoclines, and Tertiary/Late Cretaceous laccolith intrusions (see Figure G1). The salt anticlines are elongated in a northwest direction, as is the Uncompahgre Uplift. Flowage of the salt was erratically active from Permian through late Jurassic, thereby affecting deposition of the Triassic and early Jurassic sediments, including the flow of the streams that deposited the Morrison Formation in which the uranium resource is located. The Uncompahgre Plateau was again faulted upward in Tertiary time and deep canyon cutting occurred, continuing through the Pleistocene. Some twelve miles to the southwest of the Whirlwind Mine area lay the La Sal Mountains. These consist of Tertiary laccoliths intruded into several different horizons of Mesozoic sedimentary rocks.

The uranium deposits in the Beaver Mesa Mining District occur in the late Jurassic Morrison Formation. As shown on Figure G2, the Morrison Formation has two geologic members in the Gateway, Colorado area. The lower member, the Salt Wash, is the main uranium host. The upper part of the Morrison is the Brushy Basin Member. The Salt Wash consists of about equal amounts of fluvial sandstones and mudstones deposited by meandering river systems. The Brushy Basin was deposited mostly as a large mud flat probably with many lakes and streams. Much of the material deposited to form the Brushy Basin originated from volcanic activity to the west. The majority of the uranium production has come from the upper sandstones of the Salt Wash Member known as the Top Rim. In addition to uranium, many of the deposits contain considerable amounts of vanadium. The primary uranium mineral is uraninite (pitchblende) (UO₂) with minor amounts of coffinite (U SiO₄ OH). Montroseite (VO OH) is the primary vanadium mineral, along with vanadium clays and hydromica.
4. Site Geology

Map G-2 shows the outcrop geology of the area around the Whirlwind and Packrat mines. The structural contours on this map show the base of the Summerville Formation, immediately below the Salt Wash. Also shown on this map are major faults, workings of the old mines, the extent of the Whirlwind decline, and the wells and springs in the area.

4.1 Lithology

Figure G3 shows a geologic cross section through the Whirlwind and Packrat area from the southwest (top of mesa) to the northeast (Lumsden Canyon). Each of the geologic units, starting at the top of the mesa is described below (Umetco, 1995b). A more detailed stratigraphic column for the area is provided on Figure G2.

_Dakota Sandstone (Kd)_

Erosional remnants of the Dakota Sandstone Formation cover about ten percent of the top of Beaver Mesa above the Whirlwind Mine area. The Dakota Sandstone Formation is only a few tens of feet thick in this area and consists of yellowish-brown and gray friable to quartzitic sandstone and conglomeratic sandstone with interbedded gray to black carbonaceous shale.

_Burro Canyon (Kbc)_

The Burro Canyon Formation is the primary surface outcrop on top of Beaver Mesa and is approximately 100-210 feet thick on the mesa. The Burro Canyon Formation consists of white, gray and light-brown fluvial sandstone and conglomerate interbedded with green and purple lacustrine siltstone, shale and mudstone and thin impure limestone beds. It forms cliffs, often about 100 feet high. The sands and conglomerate occur in lenticular, very thick beds that display crossbedding. The conglomerates contain generally well-rounded chert pebbles.

_Brushy Basin (Jmb)_

Much of the Brushy Basin Member of the Morrison Formation (90%) is mudstone, claystone, and siltstone composed of bentonitic clays derived from detrital glassy volcanic debris from volcanic activity to the southwest. This material settled on a large floodplain and deposited fine-grained clastic material interbedded with a few channel sandstones and conglomerates. Occasional beds of lenticular
Coarse-grained sandstone are fairly common in the lower part of the formation. The Brushy Basin also contains a few thin fresh-water limestone beds, some of which have been silicified. Devitrification of the volcanic ash may have been a major source of the uranium that leached downward into the Top Rim sandstones of the Salt Wash (see below). The total thickness of the Brushy Basin Member, estimated from several drill holes, is 370 to 410 feet.

**Salt Wash (Jms)**
The Salt Wash Member of the Morrison Formation consists of lenticular sandstone beds (about 60%) and lesser amounts of red mudstone and shale (about 40%). The lenticular and cross-bedded sandstones, which are usually very fine-to-fine grained, indicate deposition in a fluvial environment. The member is exposed as a series of strong ledges and slopes containing white to light gray or light brown to rusty red and fine- to medium-grained sandstone. The sandstone units crop out as cliffs or rims while the mudstones form slopes. In the upper part of the Salt Wash, the numerous channel sandstones have coalesced into a relatively thick unit referred to as the Top Rim, which hosts the ore deposits in the Beaver Mesa area. Similarly, there is a thick sequence of channel sandstones at the base of the member called the Bottom Rim. Usually there are several thinner sequences or individual channel sandstones in the central part of the member, which are termed Middle Rim sands. Both the Middle and Bottom Rim sands also locally host uranium/vanadium deposits. The Salt Wash is in excess of 300 feet in thickness within the Whirlwind claim block.

**Summerville Formation (Js)**
This is a remarkably even-beded, thin-beded unit that forms slopes. It is primarily reddish-brown sandy or silty shales, but some beds are greenish-gray. Thin beds of red and green chert are widespread. In this area the formation is about 90 feet thick (Cater, 1955). The top is often channeled by the sandstones at the base of the Salt Wash Member, but it may be difficult to locate if Salt Wash mudstones rest directly on the Summerville shales. This formation is an aquiclude (Blanchard, 1990) separating the occasional aquifers of the Morrison Formation from the Entrada aquifer.

**Colluvial and Landslide Deposits**
Slopes below the Burro Canyon rim contain landslide deposits that often cover all of the Brushy Basin and parts of the Salt Wash Member. As shown on Figure G4, colluvial and landslide deposits are
present locally along the canyon walls. These deposits consist of sandstone fragments in a matrix of reddish-brown and light green mudstone and clay.

4.2 Geologic Structure
The Whirlwind area lies in the northwest-trending Sagers Wash Syncline formed between the Uncompahgre Uplift and the La Sal Mountain intrusion. The Beaver Mesa mining area is structurally simple compared with much of the surrounding region. The rocks dip gently (160 feet per mile, 1° 45', Eicher, Hedland, & Miller, 1957) to the northeast near the axis of the Nucla-Sagers Wash Syncline at a saddle between northwest and southeast plunging synclinal axes (Umetco, 1995b).

This area was little affected by the Uncompahgre- or La Sal-related faulting. The Lumsden fault is the only fault identified within the area. It trends N70°E through the center of Lumsden Canyon (see Map G-2) and dips steeply to the south (Umetco, 1995b). The displacement is estimated to be about 65 feet between the Lost Dutchman and Hubbard portals. To the west, drill data plots suggest that the vertical displacement is on the order of 100 feet. Eicher, et al (1957) show a similar range of displacements of 70 to 90 feet on their cross sections. Lateral displacement, if any, has not been determined. The Lumsden fault was reportedly encountered in at least two headings in the Bonanza Mine. Water flow was not observed and thus the Lumsden fault does not appear to be a water pathway (Umetco, 1995b).

5. Ground Water and Surface Water Systems
The upper 1,000 feet of Beaver Mesa from the Summerville aquiclude up through the Burro Canyon and lower sandstones of the Dakota Sandstone is an isolated ground water regime consisting of small sandstone aquifers with limited recharge areas (Umetco, 1995b). Figures G3 and G4 show the recharge areas for the mesa in cross-sectional view and plan view, respectively. The Burro Canyon and Dakota hydrologic unit has a recharge area of 5.7 square miles, which is very small but still greater than the total recharge area of the Brushy Basin and Salt Wash combined. These units outcrop in steep areas and have a relatively narrow recharge area due to steep slopes. Because of the small recharge areas, ground water occurrence is limited in extent and size. When considering that the area receives an average of only 20 inches of total precipitation per year, and much of this is lost to evaporation, surface water runoff, and soil and plant retention; there is not much left for recharge into aquifers.
Surface water is also limited in extent and volume with Lumsden Creek flowing only intermittently in response to snow melt and major storms (Wright Water Engineers, Inc. (WWE) 1999). There are a number of small stock ponds on Beaver Mesa above the mines (see Map G-1) that are fed by stormwater runoff. The three small springs located in the area (i.e., DP, PR and Lumsden Springs) discharge water into the creek; however, these flows infiltrate into the streambed downstream within a short distance (typically about ¼-mile or less) (BLM, 1993). DP Spring, with an average flow of about 10 gallons per minute (gpm) is located above the mine workings along the Lumsden Fault. The spring originates from a Burro Canyon aquifer that abuts less permeable Brushy Basin mudstones along the fault (WWE, 1999). PR Spring, which produces between 4 and 10 gpm depending on the season, originates from the Salt Wash formation just below the mining level (WWE, 1999). The spring is located about 800 feet from the fault and may also be a product of displacement and/or fracturing caused by the fault. Lumsden Spring is located in the lower portion of the canyon about midway between the mines and the Dolores River (see Map G-1). This spring was flowing at 4 gpm when sampled in August 1993 (BLM, 1993) and about 7 gpm when sampled by Energy Fuels in April 2007.

6. Ground Water

Much of our knowledge regarding ground water on Beaver Mesa is derived from Boring BM00-1, which was drilled and tested in October 2000 by Umetco. This boring was located on top of the mesa at an elevation of about 7,440 feet. It is located in close proximity to the Whirlwind and Packrat mine workings as shown on Map G-1. Umetco conducted packer tests at different intervals to determine ground water inflow rates. They also collected water samples from three separate water-bearing zones within the Brushy Basin unit. A water sample was not collected from the Salt Wash due to lack of water. Figure G5 presents the well log for this boring. Umetco’s report dated October 2000 (U.S. Environmental Services, Inc. (USES), 2000) is presented it its entirety as part 1 of Appendix C.

Cotter Corporation (Cotter) previously conducted exploration drilling on top of the mesa in the immediate vicinity of the Whirlwind and older Packrat mine workings in 1996. The seven drill holes completed in this area (JB-96-1 through 7) are 400 to 500 feet east and north of Boring BM00-1 as shown on Map G-2. Although the primary purpose of Cotter’s drilling program was uranium exploration, some information regarding ground water was collected. This information (Cotter, 1996),
which supports Umetco’s findings and provides additional site-specific data, is included in Appendix D.

The ground water data for Beaver Mesa shows that the water quality changes markedly with depth. This change in water quality is graphically presented in Figure G6, which is referenced throughout the subsequent discussions on ground water quality. Figure G6 is a Piper Plot, which is a type of trilinear diagram. Trilinear diagrams are used to show the ratios of the major ions in each type of water. The compositions of most natural waters can be closely approximated in terms of three cationic species (calcium, magnesium, and sodium plus potassium) and three anionic species (sulfate, bicarbonate, and chloride). By converting the concentrations from milligrams per liter (mg/L) to milliequivalents per liter (meq/L) and then expressing the individual values as percentages of the total meq/L of cations and of anions, the composition of water can be represented conveniently in a trilinear diagram.

6.1 Burro Canyon Aquifers

The Burro Canyon Formation is the primary surface outcrop on Beaver Mesa and is approximately 100-210 feet thick on the mesa (Cater, 1955). Figure G5 shows the stratigraphy of the lower 105 feet of the Burro Canyon Formation from Boring BM-001. The log shows that the formation is mostly sandstone with one mudstone bed located approximately 50 feet from the base of the formation. The upper portion of the underlying Brushy Basin consists primarily of mudstone, which forms an aquitard to the downward flow of ground water.

The BLM Well that is located approximately one mile west of the Whirlwind Portal in Utah is completed in the Burro Canyon Formation. This well, also known as the Dolores Point Well, was drilled in 1981 and has been producing a reported 15 gallons per minute for livestock use on an intermittent basis. The well, which is at a surface elevation of approximately 7,450 feet, was completed to a depth of 150 feet with the main water source and pump located between 100 and 115 feet below ground surface (bgs) in a coarse sandstone aquifer. The deepest portion of the well from 120 to 150 feet bgs consists entirely of Brushy Basin shales and mudstones. A smaller aquifer is located in a five-foot-thick limestone bed at 75 to 80 feet bgs. The static water level in the well is 75 feet bgs according to the well driller’s report.
The BLM Well was sampled by Energy Fuels on April 26, 2007. The sample was collected after the well was pumped for 30 minutes at approximately 12.5 gpm. The laboratory analysis, presented in Table E-1, indicates that the water is of good quality with a total dissolved solid (TDS) concentration of 344 mg/L, low metal concentrations, and radium activity levels below detection limits. As shown on Figure G6, the BLM Well water is predominantly a calcium bicarbonate water. The water quality and chemical fingerprint of the well water are virtually identical with the DP Spring water (see Section 8.2), which also originates in the Burro Canyon Formation.

It is interesting to note that only one of the seven exploration holes drilled by Cotter in 1996 near the Whirlwind Mine encountered water in the Burro Canyon Formation. A flow of less than 2 gpm was reported in Drill Hole JB-96-1 at a depth of 94 feet (see Appendix D). The lack of Burro Canyon water in 6 of the 7 drill holes indicates that the Burro Canyon aquifer may be discontinuous over this portion of the mesa. This could be due to limited recharge and natural edge effects along the perimeter of the mesa or impacts from historic mining activities. As discussed in Section 7, there is an existing vent shaft and historic drill holes in this area that may have drained portions of the Burro Canyon and Brushy Basin aquifers into the underlying mines.
6.2 Brushy Basin Aquifers

Three water-bearing sandstone units were encountered in the Brushy Basin member during the drilling and testing of Boring BM00-1. These units, herein referred to as the Upper, Middle, and Lower Sandstones were encountered at depths of 121 to 135 feet bgs, 242 to 264 feet bgs, and from 360 to 428 feet bgs (see Figure G5). These sandstone units are separated by thick sequences of mudstone.

As discussed in Dick White’s January 8, 2008 memorandum titled “Geological Interpretation of Beaver Mesa Water-Bearing Zones Based on Exploration Drilling Results”, the sandstone lenses within the Brushy Basin member of the Morrison Formation were formed by ancient stream and river channels flowing across a slowly subsiding plain. This resulted in the creation of isolated sandstone lenses within the massive mudstone deposits of the Brushy Basin. These lenses are irregular in shape and size and seldom continuous over a large area because the stream locations usually shifted over time. Ground water, if encountered, is typically found along the base of the sandstone lenses and is unconfined (under no pressure). In these cases, ground water recharge is very limited because the overlying mudstones and shales prevent ground water from percolating downward to the sandstone lenses. Mr. White’s memorandum and supporting information is included in its entirety as Part 2 of Appendix D.

Water analyses of the samples collected from BM00-1 and from other available sources indicate that the water quality in the Brushy Basin changes with depth. The Upper Sandstone ground water is similar in quality to the Burro Canyon aquifers with a calcium-bicarbonate chemical signature (see Trilinear Diagram or Piper Plot in Figure G6) and low levels of radionuclides. The Middle sandstone ground water also has low levels of radionuclides; however, calcium has been partially replaced by sodium and potassium as shown on the Piper Plot. The ground water in the lowest sandstone unit, in contrast, contains some radionuclides above regulatory standards and is a sodium and potassium-bicarbonate water with almost no calcium.

The change in water quality with depth is attributable to the formation’s origin and chemical characteristics. Much of the Brushy Basin is mudstone, claystone, and siltstone composed of clays derived from detrital glassy volcanic debris. Devitrification of this volcanic ash is believed to be the source of the uranium and other radionuclides that leached downward into the lower Brushy Basin and
Salt Wash sandstones. This leaching of the mudstones would also have resulted in calcium gradually being replaced by sodium and potassium, which are abundant in these rocks.

Each of the water-bearing zones within the Brushy Basin is examined in more detail below.

**Upper Brushy Basin Sandstone**

The Upper Sandstone is located near the Burro Canyon/Brushy Basin contact in a transition zone from the Burro Canyon sandstones to the massive mudstones of the Brushy Basin. In many places on the mesa, the lower Burro Canyon Aquifer and the Brushy Basin Sandstone comprise a single sandstone aquifer with only minor shale parting between the geologic units. However, the parting between the sandstone units was greater at Boring BM00-1 and they are treated herein as separate water-bearing zones.

An open-hole pumping test in BM00-1 from 93 to 140 feet bgs confirmed that the Upper Sandstone was capable of producing water. A water sample from this well was not analyzed; however, data is available for this aquifer from two wells that are located near the Cherokee shaft, approximately 2,000 feet east to southeast of the Whirlwind portal (see Maps G-1 and G-2). These wells, which are located at a surface elevation of about 7,240 feet, supplied domestic water to the mine camps that were located near the Cherokee shaft. The shallower well is uncased and approximately 40 feet deep. The deep well is cased and 110 feet deep.

Both wells were sampled by the BLM. The shallow well, which had a static water level of 37 feet bgs, was sampled in 1999. The deeper well had a static water level of 77 feet bgs and was sampled in 2000. The sample analyses showed that the ground water was similar in both wells with a calcium-bicarbonate signature and low levels of radionuclides. This water had slightly more sodium and less calcium than the Burro Canyon water, but otherwise was very similar in quality. The analytical results for both wells are presented in Table E-1. The major ion chemistry of the deeper well sample is plotted on Figure G6 for comparison purposes. Willow Spring, which is located southeast of Beaver Mesa in John Brown Canyon, has similar ion chemistry to the Cherokee Wells and appears to originate from the lower Burro Canyon and Upper Brushy Basin contact zone. Additional information regarding Willow Spring is provided in Section 8.3.
The two Cherokee Wells appear to have limited productivity. The shallow well is approximately two-feet in diameter and was probably installed using a churn drill. This well contained only two to three feet of water when sampled in 1999 and required one-half hour to recover from hand bailing. The deeper well, when sampled in 2000, did not fully recover from hand bailing after 70 minutes and the sampler noted that the sound of dripping water could be heard inside the casing. Cotter’s exploration drilling in 1996 did not report any water in the upper Brushy Basin Member, although damp conditions were reported over a five foot interval (110 to 115 feet) in Drill Hole JB-96-3. The limited occurrence of water and low productivity of this zone is consistent with the fact that the sandstone lenses that comprise this aquifer are thin and interbedded with mudstone.

**Middle Brushy Basin Sandstone**

A second water-bearing sandstone lens was encountered in Boring BM00-1 at about 137 feet below the Burro Canyon/Brushy Basin contact. This sandstone zone occurred at a depth of 242 to 264 feet bgs. A packer test was conducted over an interval from 250 feet to 280 feet bgs with 60 gallons of water being pumped prior to taking a sample. The sample results, plotted on Figure G6, show that the meq ratio of calcium to sodium plus potassium is about midway between the Burro Canyon Water and the Lower Brushy Basin. Radionuclide levels were found to be at low to nondetect values. Analytical data for this sample are presented in Table E-1. As discussed in Section 8.3, there are no known springs in the area associated with this aquifer.

The Middle Brushy Basin Sandstone appears to have relatively high productivity compared to the other water-bearing zones within the Brushy Basin Member. Cotter’s exploration program in 1996 reported from 10 to 30 gpm inflow on six of the seven wells at depths between 255 and 290 feet bgs. As discussed in Section 7.2 below, this aquifer also appears to have been the major source of ground water inflow into the Rajah 30 Mine shaft.

**Lower Brushy Basin Sandstone**

Several thick sequences of sandstone were encountered in Boring BM00-1 near the base of the Brushy Basin at depths of 360 to 371 feet bgs and 388 to 437 feet bgs. This is 70 to 150 feet above the Brushy Basin/Salt Wash contact at 510 feet bgs. Packer tests were conducted over intervals of 355 to 400 feet and 395 to 440 feet. Sixty gallons of water were pumped from each interval before Samples BM00-1-2 and 3 were collected. Both samples were sodium-bicarbonate waters with increasing levels of sulfate.
and total dissolved solids when compared to samples collected higher up in the Brushy Basin. As shown in Table E-1, radionuclides were present in both samples and elevated above regulatory standards for combined radium-226 and 228 in the upper sample (i.e., 41 picoCuries per liter (pCi/L) compared to a standard of 5 pCi/L). The elevated radionuclide levels in the upper packer test are also evident on the hole’s gamma log, which is shown on the left-hand side of Figure G5. The meq ratios for major ions from the two samples are plotted on Figure G6.

Cotter’s 1996 exploration program could not identify ground water inflow rates in the Lower Brushy Basin Sandstone because the holes were not cased during drilling and occurrences of ground water below the initial intercept (i.e., Middle Brushy Basin Sandstone) could not be determined. However, the Whirlwind Decline intercepts the Lower Brushy Basin Sandstone starting at an approximate elevation of 6,848 feet. Accounting for formation dip, this corresponds well with the initial drilling intercept reported above for the Lower Brushy Basin Sandstone. Historic information collected by Pioneer Nuclear Inc. indicated that an average of 5.3 gpm of ground water flowed into the nominal 9-foot high by 12-foot wide decline over a five month period from late November 1981 through early May 1982 after mining operations shutdown. More recent monitoring by Energy Fuels shows that current inflows are at about 1 to 2 gpm over about 100 feet of tunnel length. The sandstone lens continues above the seep area for several hundred more feet; however, this upper portion of the sandstone lens does not appear to contain any ground water.

6.3 Salt Wash Aquifers
A thick sequence of sandstone was encountered in Boring BM00-1 at the top of the Salt Wash from 510 feet bgs to 555 feet bgs. A packer test was conducted over the interval from 500 to 560 feet in an effort to collect a background sample of ground water from the Salt Wash in advance of mining operations. The test interval was pumped for 40 minutes at which time the pump ran dry. The interval then failed to produce any water after it was allowed to recharge for three hours. This procedure was repeated a second time with the same results. These results indicate that the upper portion of the Salt Wash is very tight and contains little water. This is even more apparent considering that BM00-1 was located only 500 feet from the flooded lower portion of the Whirlwind mine.

Most of the water that is in the very upper portion of the Salt Wash appears to have been introduced into this sandstone unit by historic mining activities such as the Whirlwind decline discussed above.
Historic drill holes and vent shafts are also probable conduits for ground water inflow. The ground water entering the formation appears to pond in lower areas of the mine and then gradually infiltrate into the sandstone and move both downward and laterally. Downward movement is, however, limited by a 1 to 10-foot thick mudstone aquitard that is located below the mine workings. Lateral movement is believed to be predominantly along the northeast trending dip toward Lumsden Fault. Additional details regarding the local hydrogeology are presented in a 2001 memorandum by Frederick Peel of U.S. Environmental Services Inc. (USES, 2001) that is included in its entirety as Part 2 of Appendix C. Water quality issues associated with this introduced water are discussed in detail in Section 7 below.

There is also some ground water present lower in the Salt Wash as evidenced by PR Spring, which flows from the lower portion of the Top Rim sandstone unit. The spring water is a sodium-bicarbonate water of poor quality (i.e., elevated levels of radium, uranium, arsenic and selenium) as is discussed in Section 8.4, Surface Water. The Top Rim sandstone unit sits on a thick mudstone unit that effectively isolates it from the Middle Rim sandstone unit below.

7. Mine Water

The majority of the ground water found in the Top Rim mines on Beaver Mesa appears to be seeping into the underground workings from above through open drill holes, shafts, declines, and natural fractures. This conclusion is based on the packer tests performed by Umetco in 2000, inspections of the Whirlwind and Packrat Mines by Energy Fuels personnel, and anecdotal remarks from miners that previously worked in the area.

The ground water inflow rate appears to be very low for all of the mines located in the Lumsden Canyon area because there is currently no flow out of the many mine portals that daylight into the canyon. Since the mine drifts (i.e., tunnels) follow the ore zone and the ore zone dips toward the canyon, these mines are essentially self draining. As discussed below, the combined inflow into the Whirlwind and Packrat workings is estimated to be 10 gpm or less. During previous mining operations, this water was used to support drilling and other mining activities. Currently, the water appears to collect and infiltrate into the sandstone formation in the lower portions of the mine.
Most of the ground water inflow probably originates from the lower Brushy Basin sandstone units since they are located closest to the mine workings. If the lower Brushy Basin water were subject to Colorado water quality regulations, such as a discharge from a mine, it would probably need to be treated to reduce radium to less than the 5 pCi/L water quality standard. Once this water enters the mine workings, its quality deteriorates further due to contact with the ore zone, which contains elevated levels of uranium, radium, and trace metals. This is evident from water quality sampling conducted by Umetco and the BLM of the Packrat and other nearby mines during the 1990s and more recent sampling of standing water within the Packrat Mine by Energy Fuels. Water quality data for the various mine waters are compiled in Table E-2.

7.1 Current Mine Conditions

Most of the water that has accumulated in the lower portion of the Whirlwind Mine appears to be seeping from the decline where it intersects the lower portion of the Brushy Basin. Ground water can be clearly seen seeping into the decline and then flowing down to the bottom of the Whirlwind workings. The flow was estimated to be 1 to 2 gpm during a recent inspection.

Analytical data for two water samples collected from the decline within the Brushy Basin intercept area in early May 2007 are presented in Table E-2. The first sample, called the Whirlwind Seep, had levels of selenium (0.023 mg/L), uranium (0.0814 mg/L), and radium-226 (6.5 pCi/L) above some regulatory standards plus an elevated arsenic concentration (0.024 mg/L). The second sample from the Upper Whirlwind Sump in the Brushy Basin unit had similar concentrations of selenium (0.038 mg/L), uranium (0.0993 mg/L), and arsenic (0.029 mg/L). Radium-226 was not tested in this sample. These analytical results confirm the previous findings from Boring BM00-1 that the natural background ground water entering the mine from the lower Brushy Basin unit is of poor quality.

Analysis of water samples collected in the lower Whirlwind sump or pool, which is within the Salt Wash unit, show that the sump water has the same water quality as the water seeping into the mine from the decline above. Piper Plots of the decline water and the Whirlwind Pool, as shown on Figure G6, are similar in water quality chemistry to the two water samples collected from Boring BM00-1 in the lower Brushy Basin Sandstone.
Energy Fuels’ inspections of those areas of the Packrat Mine that are currently accessible have encountered standing water (typically boot high) in some portions of the drifts. One open exploration drill hole was also observed that was producing about 1 gpm of water. Historically, drillers were not required to plug their exploration holes and these holes can provide an open conduit for ground water flow. Based on historic data, there are probably hundreds of open drill holes on Beaver Mesa that were drilled from the late 1940s through the 1970s by uranium companies and federal agencies. It is also known that the 10-Straight Shaft in the older portion of the Packrat Mine is delivering some water from either Burro Canyon or Brushy Basin (or both) into the mine. This area of the mine is currently not accessible but water can be heard cascading in the shaft from the surface above. Umetco maps from the early 1990s indicate that approximately 3 gpm was flowing into the mine from this shaft.

Energy Fuels collected samples of standing water in the Packrat Mine in October 2006 and January and April 2007. This water has the same major ion profile as the Whirlwind sump water and the lower Brushy Basin water; however, the levels of uranium, vanadium, radium, arsenic, and selenium are substantially higher in the Packrat water as shown in Table E-2. These increases in concentration and activity levels are attributable to the water being in contact with the uranium-bearing sandstone for a considerable period of time. Similar water quality will probably exist during mining operations because the mine water will be used for drilling operations in the ore zone.
7.2 Historic Mine Water Information

Data gathered between 1993 and 1997 by Umetco and the BLM shows that approximately 1 gpm of water discharged from the Packrat portal up until the end of 1995 when the flow ceased. Small flows of similar magnitude were also reported from the Lumsden #2 and Lumsden #5 (also known as the Rajah 49) portals, which have also ceased. This cessation of flows from the portals was probably due to decreasing ground water inflows into the mine workings over time as a result of aquifer depletion and implementation of source control measures by Umetco. No discharges were reported from the other portals in Lumsden Canyon including the Bonanza, Dutchman, Hubbard, La Sal, La Salle #1 and #2, Lumsden #1 and #3, and Austin #4 even though they are all located at the downdip edge (northeast edge) of the mesa. Map G-3 shows the mapped extent of standing water in the Packrat Mine, Whirlwind Decline, and Lumsden #2 Mine in 1994. At that time, the Packrat and Lumsden #2 still had small portal discharges.

Water quality analyses of the Packrat discharge during the early 1990s are presented in Table E-2. The data shows that this water is of similar quality to the standing water recently sampled in the Packrat Mine. This is not surprising because the discharge water would have flowed along the floor of the main drifts for some distance prior to exiting the mine portal. This would have created a prolonged contact time between the water and the uranium-bearing sandstone similar to that observed with the standing water.

The Rajah 30 Mine is the only mine on Beaver Mesa that historically had a ground water problem. This mine, which is now flooded, discharged approximately 15 gpm into John Brown Canyon during the 1990s when it was still open. Most of the water entering the mine originated from the shaft where it intersected the mid-portion of the Brushy Basin unit. The ground water inflow into the mine decreased substantially when the shaft was sealed with concrete as part of Umetco’s reclamation activities (Bates, 2007). The mine discharge ceased completely when Umetco sealed the main portal with a concrete bulkhead in 2001 (Fowler, 2007a).
7.3 Water Treatment and Source Reduction

Most of the ground water inflow into the mine during active operations is expected to be consumed by mining activities. Energy Fuels will treat any mine water that needs to be discharged so that it meets Colorado water quality discharge standards for radium and other constituents. The company will also plug point sources of groundwater inflow during mining operations (e.g., open drill holes, seepage around vent shafts) where feasible and install a series of underground sumps to minimize the uncontrolled flow of water in the drifts. Plugging of point sources is expected to reduce the volume of water entering the mine and that would otherwise need to be treated and discharged. Additional source reduction will be performed at the time of mine closure and reclamation including sealing of the portion of the decline that intersects the Lower Brushy Basin Sandstone. Over the long-term, source control is expected to minimize future ground water impacts in the Salt Wash and depletion of water from the Brushy Basin and Burro Canyon aquifers located above the mine. Source reduction is described in more detail in Exhibit 8.

8. Surface Water

The surface water in Lumsden Canyon has been extensively characterized by Umetco and the BLM as part of past mine closure and reclamation activities in the area. Much of the information presented in this section and in the Appendix E water quality tables was provided by the Grand Junction BLM Field Office; its receipt is gratefully acknowledged.

As shown on Map G-1, the Whirlwind Mine area is located within the Lumsden Canyon drainage, which discharges into the Dolores River immediately north of Gateway. All of the proposed surface disturbance is outside of the 100-year flood boundary for Lumsden Creek. Lumsden Creek is an intermittent stream that flows only in response to sizable rain events and snowmelt (WWE 1999). There are three springs that feed into Lumsden Creek: DP Spring, PR Spring, and Lumsden Spring (see Map G-1). However, these springs are relatively small and the flows dissipate within a short distance downstream of their source (BLM, 1993 and Fowler, 2001).

8.1 Lumsden Creek

From the Whirlwind Mine, Lumsden Creek is in a relatively steep gully for the initial 1-1/4 mile. In this area, the creek runs along the east side of the Packrat access road and reclaimed waste pile.
Approximately 1,200 feet of this section crosses through reclaimed waste rock from the Lumsden #2 Mine. Some waste rock has also washed downstream of the reclaimed areas. After one mile, the creek joins with the west tributary that comes from the DP Spring and Dutchman Mine area. Another one-quarter-mile downstream, the east tributary from the Rajah 49 (a.k.a., Lumsden #5) Mine area flows into the creek. From this point, the creek slope becomes progressively less steep with the elevation decreasing approximately 1,000 feet over the next two miles. At the mouth of the canyon, the area flattens out and the elevation falls only about 300 to 400 feet before reaching the Dolores River located approximately two miles away. Overall, the total distance from the main Whirlwind disturbed area to the River is 5.15 miles and the total elevation drop is approximately 2,500 feet.

Because of its ephemeral nature and remote location, very few surface water samples have been collected of Lumsden Creek other than those taken of the three springs that discharge into the streambed. In 1996 and 1997, Wright Water Engineers set up a series of monitoring stations in Lumsden Creek to sample water. Numerous visits were made to the monitoring stations, but water flow was not recorded in the creek except for those areas immediately downstream of the springs. WestWater Engineering, Inc. studied the stream biology in 1997 and indicated that Lumsden Creek does not support aquatic life due to limited flow in the stream.

The only know samples of the creek were collected by the BLM in 1996 and 1997 at the mouth of Lumsden Canyon (see Map G-1) about 1.5 miles from the Dolores River (Fowler, 2001). A sample station consisting of containers buried in the streambed with a series of surface intakes was installed in 1996. Two samples were collected of stormwater in 1996 when creek flow was believed to be about 5 cubic feet per second (cfs). The analytical results showed that radium-226 and uranium were present (2 pCi/L and 0.025 mg/L, respectively) in the water but at levels below regulatory standards. The sampler failed to collect water in 1997; however, three grab samples of creek water were collected during minor storm events when the creek flow was reported to be intermittent. These samples, collected during low flow conditions, contained noticeably higher levels of radium-226 (5.2 to 6.0 pCi/L) and uranium (0.185 to 0.448 mg/L). The data for all five sampling events is presented in Table E-3.

Although there is very little water sampling data for the creek, inferences can be made regarding the creek’s water quality based on the sampling and analytical data collected for the creek and associated springs. Waters from both the DP Spring and Lumsden Spring flow within the creek for a short
distance before infiltrating into the creek bed. In both cases, the water quality degrades somewhat (i.e., radionuclide and metal levels increase) due to contact with historic mine waste (BLM, 1993 and Fowler, 2001). The most significant impact to the creek is the Dutchman waste dump. A large portion of this dump was placed in the upper west tributary of Lumsden Creek in the area just below DP Spring. Over the years, storm events have carried this material down the creek.

Surface Drainage Through the Lost Dutchman Waste Dump, West Tributary of Lumsden Canyon

The BLM performed an informal background survey of Lumsden Creek a number of years ago using a scintillator and found that radioactivity was elevated above background levels through the entire length of the creek (Fowler, 2007b). Accordingly, low flows such as those produced by melting snow in the spring would be expected to have increased levels of radionuclides and metals. The historic waste material would likely have less effect on water quality during large storm events when the water flows are substantially higher and of shorter duration.

The only known uses of Lumsden Creek are the small stock ponds located above the mining area in the creek’s upper watershed. There are no known uses of the creek from the mines down to the Dolores
River, although a water right has been filed on Lumsden Spring. A residence (Lonie Ranch House) and a new sewage treatment plant for the town of Gateway are located on County Road 4 1/10 near where Lumsden Creek discharges into the Dolores River. Mesa County has also approached the BLM about acquiring land in this area near the river to construct a transfer station and county shop (B. Fowler, 2007b). The remainder of Lumsden Creek between the mines and the mouth of the canyon is relatively remote with no road access.

A sample of the Lonie residential well water was collected and analyzed in 1994. The depth of the well was not recorded, but it is likely a shallow well completed in the alluvium. The results show that the water was very hard (332 mg/L CaCO₃) and slightly elevated in total dissolved solids (693 mg/L), but otherwise of good quality. Radium was not detected and uranium and vanadium were detected, but at very low concentrations. A water sample was also collected from the Dolores River below where Lumsden Creek outlets in the river on September 1, 1994. The sample was collected just below the gaging station when the river was flowing at 113 cubic feet per second (cfs). The water was very hard (460 mg/L CaCO₃) and had a high sediment load as evidenced by a turbidity of 150 nephelometric turbidity units (NTUs); otherwise, the water chemistry appeared normal. Neither radium nor uranium was detected in the water sample from the river. The analytical results for the Lonie Well and Dolores River samples are presented in Table E-3.

8.2 Burro Canyon Springs

DP Spring, as shown on Map G-2 is located next to Lumsden Fault along the Burro Canyon/Brushy Basin contact. It is situated where the vertical displacement along the fault resulted in the Burro Canyon aquifer abutting against impermeable Brushy Basin claystones. This barrier terminates local ground water regimes and forces Burro Canyon water to the surface at the DP Spring. DP Spring flows at approximately 4-14 gpm (average of about 10 to 11 gpm) depending upon the season. The highest flows are recorded in the spring and the lowest flows in late summer. The spring water is a calcium-bicarbonate water of good quality, as shown in Table G-4, with no reported exceedance of water quality standards. The DP Spring was used intermittently in the past as a source of domestic water; however, current water uses appear to be limited to ranching and wildlife.

The spring is channeled into a pipe that discharges into a stock tank. From that point, the water overflows and flows downstream approximately 700 feet to the historic Dutchman Mine. The water
flows through the mine dump resulting in infiltration of water and water quality degradation. The water seeps into the streambed at the toe of the dump and Lumsden Creek is normally dry from this point all the way down to the Lumsden Spring location. Sampling and analysis of the residual water before it completely infiltrated into the streambed showed significant increases in radium, uranium, and arsenic levels as can be seen for the Dutchman Mine (Toe of Dump) analytical results presented in Table E-4.

Stock Tank at DP Spring

8.3 Brushy Basin Springs
Willow Spring is located approximately two miles south of DP Spring in John Brown Canyon. It is situated near the Burro Canyon/Brushy Basin contact and appears to be flowing from two locations, one at the base of the Burro Canyon Formation and one at a lower elevation in the upper portion of the Brushy Basin. The water chemistry is similar to DP Spring, as shown on Figure G6, but with a higher ratio of sodium and higher levels of dissolved solids (see Table G-4). This spring has an average flow of approximately 6 gpm but shows similar seasonal fluctuations as DP Spring.

There are no known springs in the middle and lower Brushy Basin anywhere on Beaver Mesa, in spite of the fact that aquifers have been encountered at these formation levels in drill holes, shafts and declines. This lack of Brushy Basin springs may be attributable to the following hydrologic conditions:
1) The recharge area for the Brushy Basin on Beaver Mesa is very limited.
2) The lenticular and discontinuous nature of the sands prevent steady flow over a great distance, resulting in pods of water bearing strata that cannot migrate.
3) The perforations from drill holes, shafts, natural fractures, faults, etc. are allowing the Brushy Basin water to enter existing mine workings along the edge of the mesa where water would normally seep.

8.4 Salt Wash Springs

PR Spring is located 400 feet north and 44 feet lower than the Packrat portal and about 800 feet from the Lumsden Fault. The spring occurs at the base of the Top Rim sandstone unit where it contacts a thick red mudstone unit (USES, 1991). It flows at approximately 4-10 gpm depending upon the season. The water flows into a stock tank and then overflows into a natural drainage below. The water flow from the PR Spring normally does not reach Lumsden Creek, but rather infiltrates into the soil within about one-quarter mile of the stock tank (BLM, 1993).

The PR Spring water is of poor quality with elevated levels of radium, uranium, arsenic, and selenium. Water quality data for this spring, both historic and more recent, are presented in Table E-4. The spring’s ion chemistry is also plotted on the trilinear diagram presented in Figure G6. The figure shows that the spring water is higher in calcium and sulfate when compared to the Lower Brushy Basin ground water.
At the request of the Colorado Water Quality Control Division, the spring was previously evaluated to determine if its occurrence near the Packrat Mine and its poor quality were associated with mining activities at the Packrat Mine. The investigation determined that there was no connection between the mine and the spring because:

1) PR Spring existed in its present form before the Pack Rat Mine was started in the 1950s. This conclusion was based on interviews with original residents of Beaver Mesa (Umetco, 1995a).
2) The Packrat Mine was separated from PR Spring by a 1 to 10-foot thick gray mudstone unit of low permeability that prevents mine water from percolating into the lower strata where the spring is located.
3) The water chemistry of the Packrat Mine water was different from the PR Spring water with respect to some key constituents (magnesium, bicarbonate, uranium and radium).

A March 15, 2001 technical memorandum by Frederick Peel of U.S. Environmental Services, Inc. (USES, 2001) that addressed items 2 and 3 above is presented in its entirety in Part 2 of Appendix C.
The high level of radium, uranium, arsenic and selenium seen in the PR Spring water is apparently a natural phenomenon due to the geochemistry of the rock formation. The lower portion of the Top Rim sandstone where the spring occurs contains elevated levels of radionuclides and metals, although they are not as concentrated as in the uranium ore deposit found in the upper portion of the Top Rim sandstone.

Energy Fuels believes that hydraulic connections between the Lumsden Canyon mines and the PR Spring strata cannot be totally ruled out. Some water from the mines is probably entering the lower sandstone unit (albeit at a relatively low rate) because:

1) Open drill holes from historic exploration activities are probably present throughout the area and would have extended through the full extent of the Top Rim sandstone.
2) The gray mudstone unit beneath the ore zone may not be present throughout the entire mesa.
3) Natural fracturing and faulting in the area provide conduits for ground water flow between strata.
4) The older mine workings in Lumsden Canyon may extend through the entire Top Rim sandstone in localized areas.

Accordingly, source control of water entering the mines, both during operations and subsequent reclamation, is an important best management practice for the mine so as to minimize the potential for future infiltration into the lower sandstone unit.

8.5 Springs Below the Summerville Formation
Lumsden Spring is located about 3 miles below the Whirlwind Mine within Lumsden Creek. It can be easily spotted from the county road below by the cottonwood trees growing in the immediate area. The spring flows from the alluvium that has collected in the stream bed. The alluvial material, although well rounded from stream action, probably contains some mine waste rock from the Lost Dutchman and other upstream mines because mining-related debris is also present. It is not certain whether the spring results from shallow alluvial ground water flow that daylights at this location or if the spring emanates from the underlying sandstones in the lower Chinle Formation or upper Moenkopi Formation.
When Lumsden Spring was sampled in August 1993, approximately 4 gpm of water was reported as flowing out of the stream bed and then flowing approximately 1,500 feet before infiltrating back into the streambed (BLM, 1993). When inspected on April 25, 2007 by Energy Fuels, the spring was flowing at approximately 7 gpm and surface flows were observed further downstream.

As shown on Table E-4, the spring is a calcium-magnesium bicarbonate water, very similar to DP Spring in terms of ion chemistry. Water samples were collected in 1993 at the point where the spring first appeared and then just before it infiltrated into the streambed. The upper contact sample contained detectable levels of uranium, arsenic, and selenium below water quality standards and radium-226 activity levels of 16.7 picoCuries per liter (pCi/L), which is above the regulatory standard of 5 pCi/L for combined radium-226 and 228. The lower contact sample contained higher concentrations of uranium, arsenic, and selenium with both uranium and arsenic exceeding drinking water standards. The radium activity level also increased to 33 pCi/L (BLM, 1993). Analysis of the water sample collected in 2007 near the mid-point of the spring flow indicated that arsenic (0.004 mg/L) and radium-226 (1.3 pCi/L) levels were relatively low and within drinking water standards. However, selenium (0.086 mg/L) and uranium (0.216 mg/L) concentrations were elevated. The results from the 1993 and 2007 sampling events are presented in Table E-4.
Upstream deposition of historic mine waste in the creek has likely impacted the water quality in Lumsden Spring. Natural erosion of the uranium-bearing sandstones in both the Salt Wash member of the Morrison Formation and the Chinle Formation (which is also mined for uranium on the Colorado Plateau) may also be contributing to the elevated levels of radionuclides and metals observed in the spring water.

A water right has been filed on the spring; however, the location is relatively remote and there is no roaded access to the spring. No apparent use is being made of the water at the present time. The water from this spring infiltrates into the streambed and evaporates under normal (i.e., dry) conditions before it reaches the Dolores River.

8.6 Water Containment, Treatment and Discharge
The analytical data for the existing mine water and previous discharges of mine water presented in Table E-2 indicate that the mine water will require treatment for radionuclides and metals prior to discharge. The proposed water treatment system is described in detail in Appendix H. Energy Fuels proposes to discharge the treated water into the middle tributary of Lumsden Canyon at Outfall 001. As shown below and on the next page, this drainage has been impacted by waste rock from the
Lumsden No.2 and Packrat waste dumps; however, the impacts have been significantly less than those observed in the west tributary (see photographs on next page).

Energy Fuels conducted leach testing of both its waste and ore materials to characterize their geochemical properties. This testing indicated that the ore material was capable of generating elevated levels of radionuclides and metals if placed in an uncontrolled environment but that the waste rock was relatively inert. Based on this information, the exploration and mine plans were designed to contain precipitation runoff from ore stockpiles and minimize the runoff from waste rock piles as described in Exhibit 5.

*Middle Tributary Below Reclaimed Waste Dump*
9. Sanitation Facilities

Portable sanitation facilities will be provided at the mine site during exploration and the initial phase of mine operation. The waste will be taken off site for treatment at an approved facility. A leach field will be constructed to dispose of wastewater when a new dry and shop are constructed during the production phase of mine operation. The leach field will be designed in accordance with state and county regulations and will be permitted with the Mesa County Health Department. The preliminary location of the leach field is shown on Map C-2 near the water treatment area north of County Road 5/10.
REFERENCES


Blanchard, P.J., 1990. Ground-Water conditions in the Grand County area, Utah, with emphasis on the Mill Creek-Spanish Valley area. Utah Department of Natural Resources Technical Publication No. 100, 69p.


Fowler, Bruce, 2007b. Personal Communication with Bruce Fowler (BLM) and Frank Filas (Energy Fuels). Denver, Colorado, April 12, 2007


Currently, the smaller Packrat portal is unsealed and covered by a bat gate to allow bat ingress/egress.

The BLM Bats/Inactive Mines Project identified the Packrat/Hubbard complex as a hibernaculum during the winter for Townsend’s big-eared (*Corynorhinus townsendii*) bat, and a roost for several other species of bat. The Townsend’s big-eared bat is a BLM sensitive species. The Packrat mine is reported to be too cold for summer bat habitat. The BLM has recommended that mine re-openings in the area take place during the summer months in order to minimize impact on the bat population.

Reclamation of the Packrat portal will include backfilling of the smaller Packrat portal and the installation of a bat gate on the larger portal, allowing for improved bat access.
The Whirlwind project is located on Beaver Mesa about 5 miles southwest of Gateway. The area is rural and relatively remote. To maintain good air quality in the area, Energy Fuels Resources will monitor and control fugitive and point source emissions of criteria and hazardous air pollutants at the mine site and monitor and model radon gas emissions from the active underground mine workings. Criteria pollutants include carbon monoxide, nitrogen oxides, particulate matter less than 10 micrometers in size (PM-10), total suspended particles (TSP), volatile organic compounds (VOCs), sulfur dioxide, and lead. Hazardous air pollutants include many other gases generally emitted in much smaller quantities. A discussion of the emission control program is provided below followed by a review of the radon gas monitoring program.

Currently, the primary source of fugitive emissions is PM-10, TSP, and nitrogen oxide generated by occasional traffic on the unpaved county roads in the area. Fugitive emissions may also be generated by ranching activities (i.e., plowing and disking) and wildfires. No significant sources of other criteria or hazardous air pollutants are currently associated with the Whirlwind Mine area.

Energy Fuels has submitted Air Pollutant Emission Notices (APENs) to the Colorado Air Pollution Control Division for fugitive emissions associated with mining activities, emissions associated with mine ventilation, and emissions associated with internal combustion engines (generators). These APENs have been issued and Preliminary Construction Permits have been issued for each APEN. Final permits will be approved following the self-certification process, to be conducted within 180 days of the start of mining activities. Energy Fuels calculated the maximum anticipated emissions from the above sources based on conservatively estimated maximum production rates, stockpile volumes, cumulative haulage distances, generator emission rates, electrical needs, mine ventilation needs, and emission controls to be implemented at the site. Energy Fuels used EPA’s “AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources” to calculate anticipated emissions. The issued permit numbers are 07ME1051F (mining activities), 07ME1052 (ventilation), and 07ME1053 (generators). As a condition of these permits, Energy Fuels will calculate emissions on a monthly basis to ensure that none of the above sources are exceeding the permit limits. Mining activities are considered a minor source of fugitive emissions.
Potential sources of fugitive emissions associated with mining activities at the Whirlwind project include:

1) Topsoil Stripping
2) Topsoil, waste rock, and ore stockpiles.
3) Waste rock and ore handling.
4) The haulage roads throughout the mine site.

Fugitive emissions will be monitored by observing opacity by EPA Method 9. In addition, fugitive emissions will be calculated on a monthly basis based on actual production rates. Emission control measures proposed by Energy Fuels at each of these areas are described below.

**Topsoil Stripping**

Topsoil will be stripped incrementally from areas as needed so that the total stripped area is minimized at any one time. In addition, topsoil will be moistened prior to stripping, as necessary.

**Topsoil, Waste Rock, and Ore Stockpiles**

Topsoil stockpiles will be seeded at the earliest appropriate season to establish a good vegetative cover. A good vegetative cover will minimize erosion and fugitive dust at the topsoil stockpiles. Every effort will be made to establish vegetative cover within one year of completion of the stockpile.

Waste rock will be moist or wet when brought out of the mine. Subsequently, the waste rock dump will be compacted with construction equipment on a regular basis. The slopes on the western portion of the waste rock dump will be reclaimed concurrently with mining as the waste rock dump expands to the east.

Ore, like waste rock, will be moist or wet when brought out of the mine. Ore will typically be stored for short periods of time on the ore pad while it awaits shipment to the mill. During extended periods of storage, the ore stockpile will be wetted as needed to maintain an adequate moisture content.
Waste Rock and Ore Handling

Waste rock will come out of the mine in a moist or wet condition, minimizing fugitive emissions when unloading onto the waste rock dump.

Ore, like waste rock, will come out of the mine in a moist or wet condition. Ore will be wetted during storage and prior to loading onto haul trucks, as necessary, to maintain moisture.

Haulage Roads Throughout the Mine Site

To minimize the amount of particulate emissions generated by haulage of ore and waste rock over dirt haul roads, Energy Fuels will treat the haul roads with magnesium chloride or a similar product, per the manufacturers’ recommendations. These chemical treatments bind the upper three to four inches of soil together creating a hard surface that generates minimal dust. If fugitive dust becomes a problem, a water truck may be used to wet down the haul roads and the top of the waste rock dump. This would likely occur during the summer when generation of dust is more common due to weather conditions (i.e., dry, hot, and windy).

In addition, Energy Fuels will work cooperatively with Mesa County under a surface alteration permit to employ dust control measures on County Road 5/10. This most likely would consist of one or two applications of magnesium chloride or equivalent product in late spring and mid-summer. The vent shafts on top of the mesa to the west of the mine portals will be visited only once per shift or less; accordingly, the county and side roads from the mines to the top of the mesa and these vent shafts will experience very little traffic. Fugitive particulate emissions are expected to be minimal and similar to the current emissions from the light traffic in this area.

Ventilation Emissions

Ventilation emissions were calculated based on the maximum allowable in-mine level of PM-10. Based on this level and conservatively estimated maximum emission levels, PM-10 emissions from
mine ventilation is minimal. The Whirlwind Mine ventilation emissions are considered a minor source. Ventilation emissions will be calculated on a monthly basis based on actual ventilation rates.

**Internal Combustion Engine (Generator) Emissions**

Emissions of criteria pollutants and hazardous air pollutants from generators are considered a minor source. Generator emissions are composed primarily of nitrogen oxides. The generators to be used on-site will meet strict New Source Performance Standards (NSPS). These generators incorporate modern, best-available control technology to limit emissions. In addition, Energy Fuels will use very low sulfur content diesel fuel, containing less than 15 parts per million of sulfur, in all its generators and equipment. Generator emissions will be calculated on a monthly basis based on actual fuel usage.

**Mine Radon Gas Emissions**

Energy Fuels will monitor and model the radon emissions from its vent shafts and portals. This information is collected and presented annually to the U.S. Environmental Protection Agency. The monitoring is performed with radon canisters and air velocity meters while the modeling is completed using EPA approved air pollutant concentration models. The maximum radon dose permitted at the closest receptor under the National Emission Standards for Hazardous Air Pollutants (NESHAP) is 10 millirems per year. This maximum dose rate is equivalent to a calculated increased lifetime cancer risk of about 2 in 10,000.
CULTURAL/ARCHAEOLOGICAL RESOURCES EXHIBIT 17

A cultural resource survey was conducted by Alpine Archaeological Consultants, Inc. (Alpine) in May of 2007 encompassing 144.17 acres – 109.81 acres in Mesa County, Colorado on lands administered by the Grand Junction Field Office of the Colorado BLM and 34.36 acres in Grand County, Utah on lands administered by the Moab Field Office of the Utah BLM. In Utah, 59.4 acres of the project area had previously been surveyed to current standards and were excluded from the current inventory. The acreage totals include 11.52 acres of access road survey in Colorado and 9.33 acres of access road survey in Utah.

Portions of the current project area had been previously inventoried in 1986 for the Dolores Point Fuelwood Sale (High 1986) and in 1997 for the Cotter Corporation Liberty Uranium Leases survey (Fuller 1997). The Dolores Point Fuelwood inventory areas were reexamined, whereas the Cotter Corporation inventory areas were not, because the Cotter Corporation inventory was conducted to current standards. Previously recorded sites from the Cotter Corporation inventory within the current project area were revisited and considered relative to proposed actions.

The inventory resulted in the recordation of one new site, re-recordation of nine previously recorded sites, and recordation of four new isolated finds (IF’s). The new site – 5ME15765 – is on land administered by the Grand Junction Field Office of the Colorado BLM. Three previously recorded sites - 5ME5116, 5ME5117, and 5ME5119 – were originally recorded during the Dolores Point Fuelwood Sale inventory; all three are on land administered by the Grand Junction Field Office. Five previously recorded sites are on land administered by the Moab Field Office of the Utah BLM. Site 42GR2095 was originally recorded during the Dolores Point Fuelwood Sale inventory. Sites 42GR2776, 42GR2777, and 42GR2778 were originally recorded in 1997 for the Cotter Corporation’ Liberty Uranium Lease survey (Fuller 1997). Site 42GR3188 was originally recorded in 2002 for the State land exchange. Table 17-1 displays the results in tabular form, including recommendations regarding eligibility for the National Register of Historic Places (NRHP).
Table 17-1 Summary of Alpine’s Recommendations.

<table>
<thead>
<tr>
<th>Site or IF Number</th>
<th>Land Ownership</th>
<th>NRHP Status</th>
<th>Management Recommendations</th>
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</thead>
<tbody>
<tr>
<td>5ME5116</td>
<td>Colorado BLM</td>
<td>Recommended not eligible</td>
<td>No further work</td>
</tr>
<tr>
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<td>Colorado BLM</td>
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<td>No further work</td>
</tr>
<tr>
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<td>Colorado BLM</td>
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<td>Officially eligible</td>
<td>Avoid</td>
</tr>
<tr>
<td>42GR2776</td>
<td>Utah BLM</td>
<td>Officially not eligible</td>
<td>No further work</td>
</tr>
<tr>
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<td>Utah BLM</td>
<td>Officially eligible</td>
<td>Avoid</td>
</tr>
<tr>
<td>42GR3188</td>
<td>Utah BLM</td>
<td>Officially eligible</td>
<td>Avoid</td>
</tr>
</tbody>
</table>

All sites recommended or determined to be eligible for inclusion on the NRHP will be avoided by proposed actions. In order to avoid impacts to these sites, mine ventilation shafts, power supply, and associated access roads will be constructed outside of the identified site boundaries. In the unlikely event that a significant site cannot be avoided, a treatment plan will be prepared and implemented in conjunction with the BLM prior to project impacts.
The Whirlwind Mine will not have a large economic impact on the area because it will only employ 10 to 12 people initially and a maximum of about 24 at peak production. The miners are expected to live in or near the nearby communities of Gateway, Nucla, Naturita, and Grand Junction. The mine workforce will consist of several experienced miners with the balance of the crews being made up of newly-trained personnel from the local workforce. The average miner’s salary will be between $40,000 and $50,000 per year. Service providers and vendors in these communities will also benefit from providing power, fuel, mine equipment and parts, drilling and facility construction services, and other services and products to the mine and mine personnel. Both Mesa County and Montrose County would benefit from the increased tax base.

Gateway is the closest community to the mine. It is located approximately 11 miles by road from the Whirlwind Project and approximately 30 minutes by automobile. Gateway is a small, unincorporated town of about 200 people. A modern resort, Gateway Canyons, was constructed several years ago at Gateway. This resort dramatically changed the socioeconomic base of the community and currently employs 80 to 90 staff members plus numerous construction workers. Most of the staff and construction workers commute to the resort from Grand Junction via vans and busses. Pricing for housing and other services has increased significantly in Gateway during the past several years. Trailer parks and the few rental homes in the area are fully occupied. The current high land prices in the area would make it difficult for a miner to find affordable lodging within the community; however, the mine may attract young existing residents interested in pursuing mining as an occupation.

Naturita and Nucla are sister cities of about 700 people each located about 1 hour south of Gateway and 1.5 hours from the Whirlwind Project by automobile. Historically, these communities relied heavily on uranium mining and milling for employment. When the price of uranium collapsed in the early 1980s, the local economy suffered and many miners relocated to other areas or changed occupations. Currently, the primary employers in these communities are a surface coal mine and power plant. Energy Fuels’ mine office is located in Nucla and the managers, engineers, and geologists that will support mining operations are based at this office. Housing and infrastructure at Naturita and
Nucla appears to be adequate to accommodate some additional influx of miners and their families to support the Whirlwind Project and other mines that may be restarting in the area.

Grand Junction is the largest city on the west slope of Colorado with a population of almost 50,000. The Grand Valley area around Grand Junction including Clifton, the Redlands, Palisade, and Fruita has a population in excess of 100,000. Grand Junction is located about 1 hour north of Gateway and about 1.5 hours from the Whirlwind Project. Although the natural resource industries (petroleum, mining, and logging) have been a key component of the local economy, commerce and industry has become much more diversified in the Grand Valley over the past 20 years. The economy is currently vibrant with the recent petroleum upswing. Because of its relatively large population, the socioeconomic impacts of the mine on the Grand Junction area are expected to be negligible.
BACKGROUND RADIATION

An increase in background radiation levels is expected near uranium mines and in mineralized zones containing uranium ores. Waste rock (or sub-ore grade material) is generated during mining operations and, because this material is uneconomical to process for its mineral content, it is either placed on the surface in a physically stable location or placed in unused underground areas of the mine when feasible. The waste rock contains low levels of radium-226, uranium, and other radioactive elements. These radioactive elements continue to decay and emit radiation in the form of gamma rays and alpha / beta particles or as a radioactive gas called radon. Placement of this rock on the surface may increase the overall radiation level above natural background conditions on the waste dump and in the area near the waste dump, although this is not always the case since mines are sited in mineralized zones where the natural background radiation is generally higher than non-mineralized zones.

Typically, the radiation level on waste dumps increases above non-mineralized natural background levels by approximately one order of magnitude. This increase in the overall radiation level may increase the risk level of contracting cancer in humans because radon gas could become more concentrated in a closed building and direct gamma radiation exposure would be greater if a person were to construct a house or other permanent building on top of the waste dump. A permanent or long term exposure to an increased level of radiation has been shown to increase the risk level for certain cancers (i.e. lung cancer).

As part of its leasing program, the Department of Energy (DOE) conducted a gamma, or direct, radiation exposure analysis of 37 reclaimed uranium mines on the Colorado Plateau in 2001 (DOE 2001). The geology and mineralization at the DOE study sites are similar to the Whirlwind area in that the mining occurred in the Salt Wash unit of the Morrison Formation and similar types of waste rock would have been generated. The DOE found that the gamma exposure rates at these sites ranged from 15 to 300 microroentgens per hour (µR/hr) with an average rate of 54 µR/hr. Natural background levels in adjacent non-mineralized areas ranged from 5 to 17 µR/hr, with an average of 10 µR/hr. The DOE determined that the level of exposure represented by the highest recorded exposure rate of 300 µR/hr would not significantly impact public health. Their evaluation concluded that:
“Public exposure to residual ore materials at abandoned uranium mine sites is not currently regulated. However, the Nuclear Regulatory Commission has established an exposure standard (100 milli-rem per year) for members of the general public that receive an exposure from regulated sites. For a member of the public to be exposed to levels above this standard at any of the aforementioned mine sites, the individual would have to remain at the site of greatest potential exposure (the 300 µR/hr location on Lease Tract C-G-26A) for an extended period of time (24 hours a day for approximately 14 days). This scenario is unlikely, given the remoteness of the property and BLM’s 14-day restriction on recreational camping.”

The EPA has also previously evaluated exposures from radon emissions for individuals located near underground uranium mines (EPA 1989). They found that radon concentrations for nearby individuals (within 0.33 to 33 miles) ranged from 2.0 x 10^-6 to 0.0031 working levels. Assuming that an individual was continuously exposed, this is equivalent to a probability of a latent cancer fatality of 5.5 x 10^-8 to 8.5 x 10^-5, or about 5 chances in 100 million to 8 chances in 100,000 (DOE 2006). Over 10 years, the probability of a latent cancer fatality would range from 5.5 x 10^-7 to 8.5 x 10^-4, or about 5 chances in 10 million to 8 chances in 10,000. For perspective, an individual has a lifetime probability of dying from cancer from all sources of about 220,000 in 1 million, or a risk of lung cancer of 60,000 in 1 million (DOE 2006).

In the case of the Whirlwind Mine, and most other uranium mines in the area, the site is located in a relatively remote area on public land. The closest private land to the waste rock embankment is located about 1,800 feet or 1/3rd of a mile to the northwest. This is the closest exposure point at which a house could be constructed in the future. Since construction of residential or commercial buildings is not allowed on public land managed by the BLM, public exposure after the site is reclaimed will likely be limited to occasional recreational uses such as camping, hiking and hunting.

Radiation exposure rates at the Whirlwind Mine site after reclamation are expected to be lower than the average levels documented by the DOE for the following two reasons.

1. The older mines studied by the DOE typically had a higher cut-off grade and placed more “proto-ore” (i.e. lower grade material) in their waste dumps compared to current operations. This proto-ore
raised the radioactivity levels of the waste dumps; in fact, the DOE mentioned that the 300 µR/hr site contained “small, residual pieces of ore-grade materials”.

2. Plans call for reclaiming the regraded Whirlwind waste embankment with an average of 14 inches of clay loam topsoil. The relatively thick clay-rich cover is expected to attenuate radiation better than the coarser-grained topsoil used at many sites.

Site-specific modeling conducted by Golder Associates of the waste rock and proposed soil cover support this conclusion. This evaluation, which is included as Appendix M, determined that the exposure level at the reclaimed waste rock pile would be only 10 mrem/yr for a person camping directly on top of the pile for 365 days in that year. In summary, the radiation levels of the reclaimed waste embankment are not expected to present a significant health risk to the general public or potential future residents in the private-land areas located nearby.

References

DOE, 2001. Letter report from the DOE to the BLM Colorado State Office regarding “Request to Relinquish Lands back to the BLM”.


The design of the waste embankment is evaluated in this Exhibit for its slope stability. Based on the apparent stability of the existing reclaimed and older, unreclaimed waste rock pile slopes in the area, a detailed slope stability analysis was not performed. Many of these older mines have slopes as steep as 1.4H:1V compared to the 3H:1V proposed minimum slope of the Whirlwind waste rock embankment. The spring and seep survey of the site conducted by Greg Lewicki, P.E. on May 3, 2007 revealed no springs or seeps in the vicinity of the proposed waste rock embankment. Therefore, there is no water that could enter the waste from below and potentially compromise the stability of the embankment.

The stability of the proposed slopes can be verified using observed material properties and the factor of safety calculation for cohesionless soils without seepage. When including the benches, as shown on Map C-3, the overall slope of the reclaimed Whirlwind waste embankment is 16.8 degrees. The material is primarily blasted sandstone that will have an internal angle of friction alone of over 34 degrees. This is based on standard data for material of this type. The material will likely have a small amount of cohesion, which will add to the strength, but it is ignored in calculating the factor of safety shown below.

The Safety factor = tangent of internal angle of friction / tangent of the actual angle of material.

Safety factor = tan 34 deg / tan 16.8 deg = .6745/.3019 = 2.23

The calculated safety factor of 2.23 is well above the 1.3 to 1.5 safety factor traditionally recommended for permanent slopes.