# NORTH MAIL TRAIL 3D SEISMIC SURVEY

# ENVIRONMENTAL ASSESSMENT CO-SJFO-01-081EA

**BUREAU OF LAND MANAGEMENT**

**SAN JUAN PUBLIC LANDS CENTER**

**CANYONS OF THE ANCIENTS NATIONAL MONUMENT**

**MAY 2002**

# TABLE OF CONTENTS

# ENVIRONMENTAL ASSESSMENT
# CO-SJFO-01-081EA

# NORTH MAIL TRAIL 3D SEISMIC SURVEY

ENVIRONMENTAL ASSESSMENT NUMBER: **CO-SJFO-01-081EA**

PROJECT NAME**:** North Mail Trail 3D Seismic Survey

PLANNING UNIT**:** Canyons of the Ancients National Monument

LEGAL DESCRIPTION: T. 35 N., R. 19W Sections 6, 7, 18, 19, 30
T. 35 N., R. 20W Sections 1 - 3, 10 - 15, 22 - 25
T. 36 N., R. 20W Sections 25 - 27, 34 - 36

APPLICANT: Western Geco

## I. INTRODUCTION

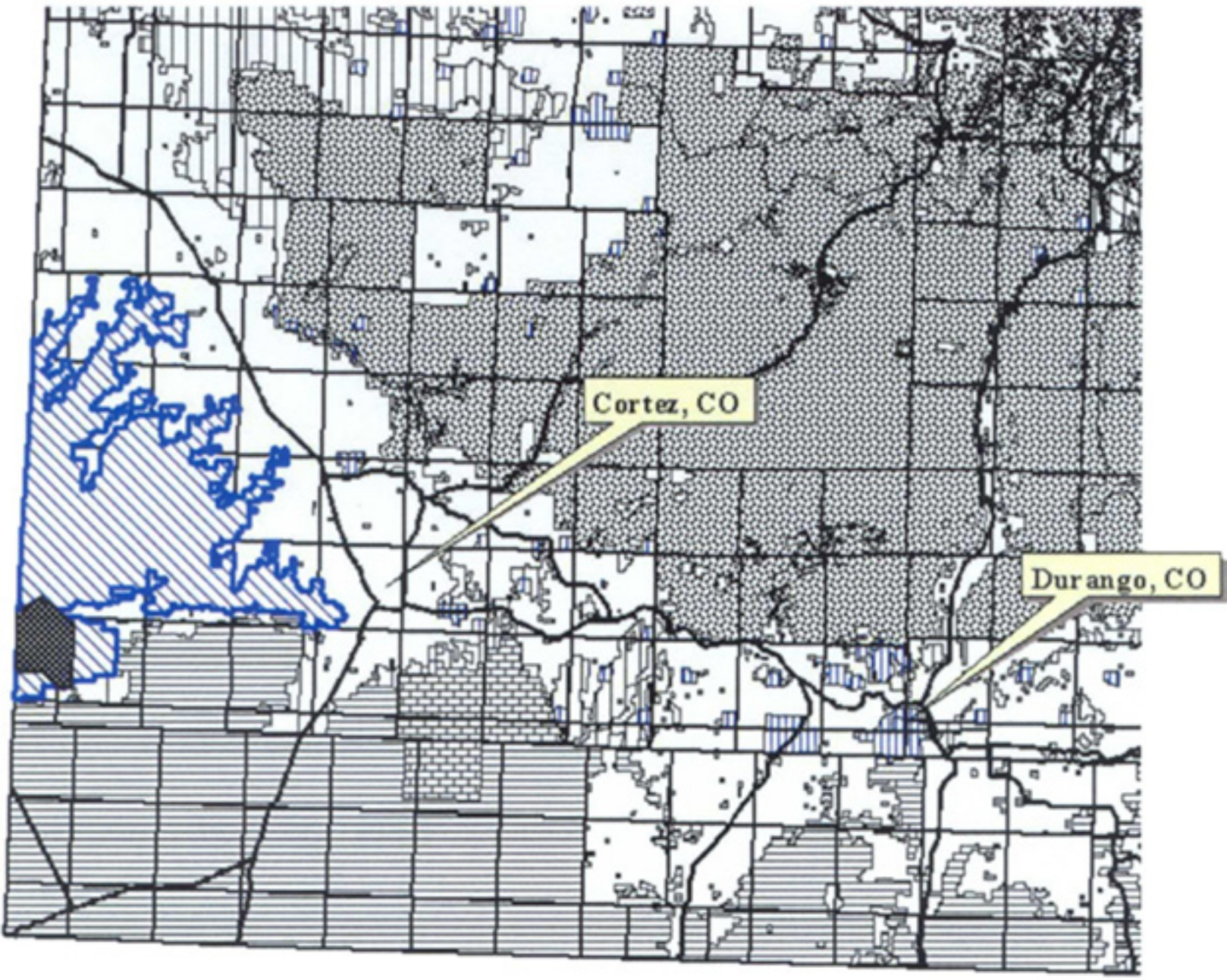
Western Geco has submitted to the Bureau of Land Management (BLM) a Notice of Intent to conduct 3-dimensional (3D) geophysical exploration. Western Geco is conducting the survey at the request of the lessee, Legacy Energy, to test the geologic Paradox Formation. The survey is proposed in the North Mail Trail Mesa area of the Canyons of the Ancients National Monument (refer to Figures 1 and 2 for location maps). This survey, hereafter referred to as North Mail Trail 3D, would be used to determine the extent of natural gas or oil reserves present in the subsurface and whether such resources may warrant development.

### A. PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of the proposed action is to identify geologic targets of oil or gas reservoirs. A survey of this type is needed to accurately identify those target areas where wells may be drilled in order to proceed with orderly development of oil/gas resources.

There are several 2D seismic lines (totaling about 42 miles of line) that already exist in the area of the proposal. These lines date from the 1970s and early 1980s. A 3D survey, conducted in 1995, overlaps the southern end of the Project Area (see Figure 3 for previous exploration areas). Through that project the applicant, Legacy Energy, demonstrated that 3D seismic technology improves the ability to identify target boundaries

# Figure 1
# North Mail Trail 3D Seismic Project Area and Canyons of the Ancients National Monument General Location



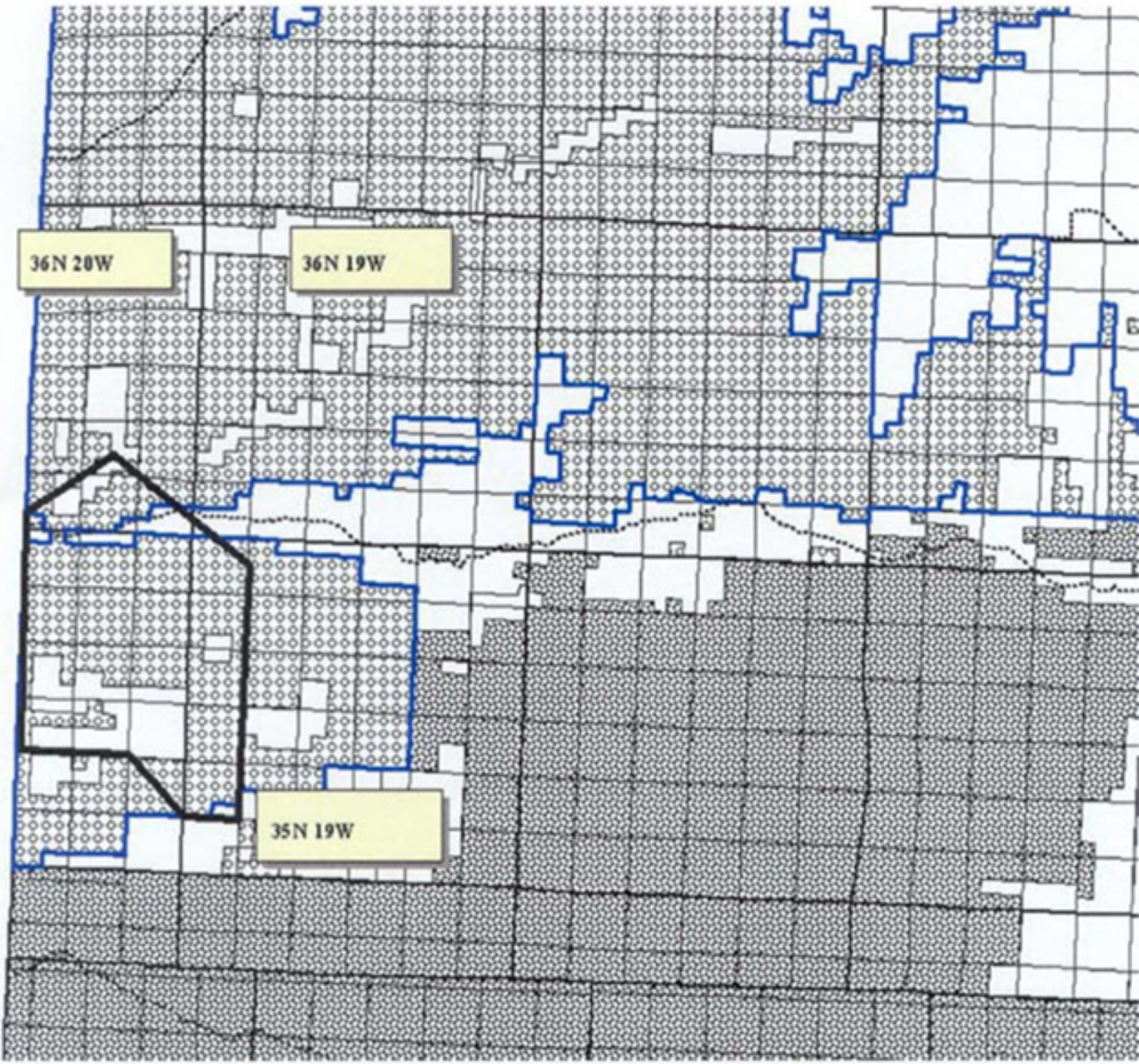

North Mail Trail 3D Project Area
Main Highways
Canyons of the Ancients National Monument
Township Lines

Ownerships

Ute Mountain Ute Tribe
BLM
COLORADO
NPS
PVT
USFS

9 0 9 18 Miles

# Figure 2
# North Mail Trail 3D Seismic Project
# Project Area



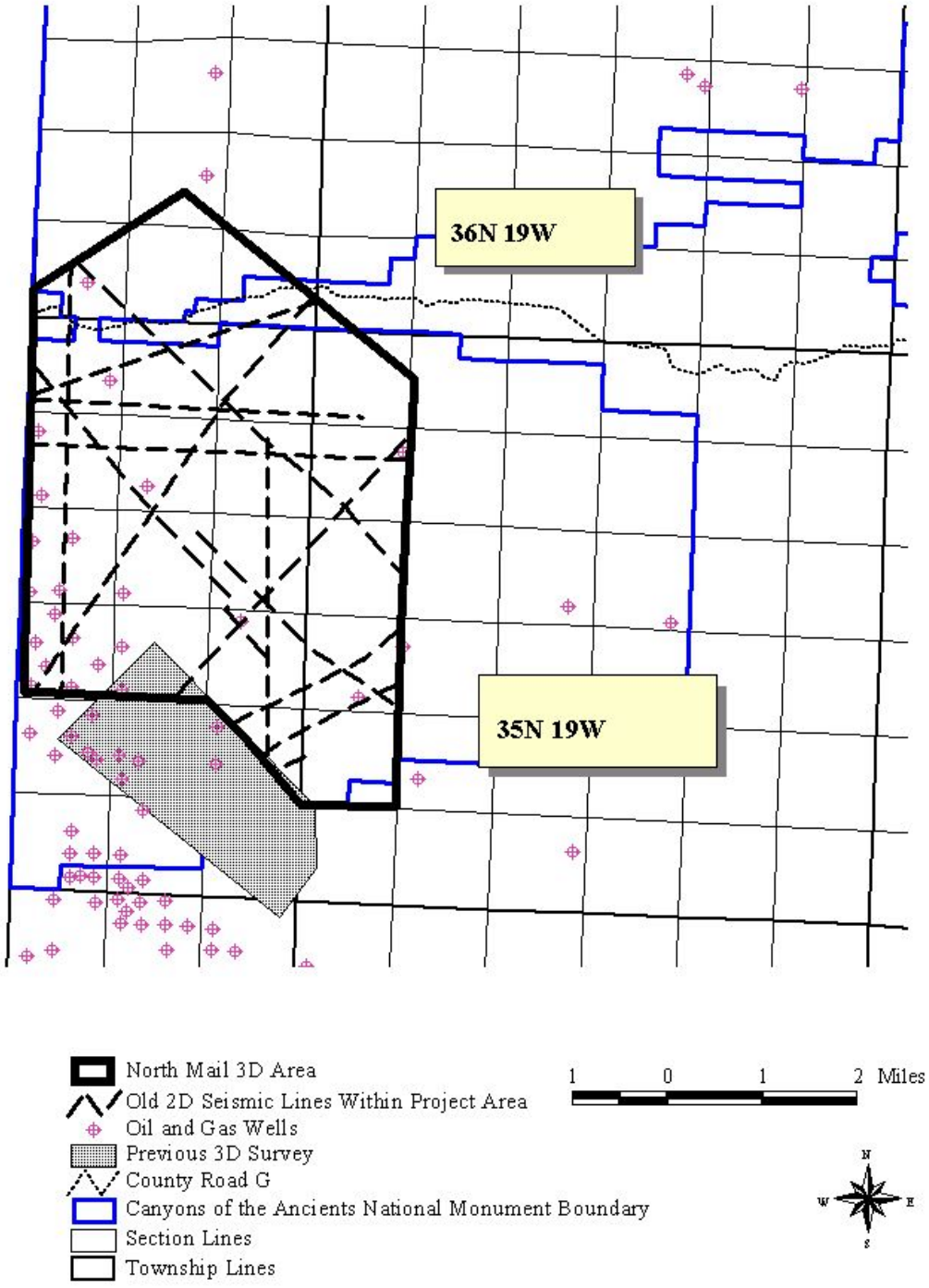

North Mail Trial 3D Project Area
County Road G
Canyons of the Ancients National Monument Boundary
Section Lines
Township Lines

Ownerships

Ute Mountain Ute Tribe
BLM
Private

2 0 2 4 Miles

**Figure 3**
**North Mail Trail 3D Seismic Project**
**Previous Oil and Gas Exploration and Development Activity**



better than 2D in the nearby oil field, Flodine East (C. Stewart, 1995, and information provided by the proponent).

Development of oil and gas resources is consistent with BLM's mission. The Mineral Leasing Act of 1920 (MLA), as amended, provides that exploration and development of domestic oil and gas is in the best interest of the United States. The intent of the MLA and its implementing regulations are to allow, and essentially encourage, lessees or potential lessees to explore for oil and gas or other mineral reserves on Federally controlled lands.

The BLM is responsible for administering rights associated with valid existing leases (MLA). Under the MLA, the lessee shall have the right to use so much of the leased lands as is necessary to explore and develop, and dispose of the leased resource (43 CFR § 3101.1-2). These rights must be permitted in a manner that assures adequate protection of other resource values (Federal Land Policy and Management Act of 1976).

## B. PLAN CONFORMANCE REVIEW

The proposed action has been reviewed for conformance with the Canyons of the Ancients National Monument (CANM) Proclamation (9 June 2000). The Monument was created to protect cultural, geologic, and biologic resources that make the area nationally significant, including one of the highest (if not the highest) known density of archaeological sites in the Nation, geology that is remarkable for its landforms, and crucial habitat for several unique reptiles (i.e. the Mesa Verde night snake, the long-nosed leopard lizard, and the twin-spotted spiny lizard).

The proclamation addresses oil and gas development as follows:

> "Because most of the Federal lands have already been leased for oil and gas, which includes carbon dioxide, and development is already occurring, the monument shall remain open to oil and gas leasing and development; provided the Secretary of the Interior shall manage the development, subject to valid existing rights, so as not to create any new impacts that interfere with the proper care and management of the objects protected by this proclamation; ...."

The Monument is initiating the preparation of a new Resource Management Plan (RMP). Until this new land use plan is adopted, management of the Monument is guided by the 1984 San Juan/San Miguel Resource Management Plan (1984 RMP) and the 1991 Oil and Gas Amendment to the RMP (1991 O+G Amendment). Additional guidance is provided in the Oct. 5, 2000, Colorado "State Director's Guidance – Canyons of the Ancients National Monument" memorandum and a Sept. 13, 2000, BLM Washington Office memorandum entitled "Interim Management Guidance for Oil and Gas Leasing

and Development of the Canyon of the Ancients National Monument". More information about the Interim Guidance can be found at the following web site: www.co.blm.gov/canm/canmoginterim.htm.

Relating to the present NEPA review, the Washington Office memorandum states:

> "... The analysis will recognize the short-term nature of oil and gas operations in the context of the long-term nature of the natural and cultural resources environment.
>
> - If the analysis indicates no impact to the Monument resources, or indicates impacts to resources, but determines that the impacts are consistent with the Proclamation, the proposed operation can proceed in accordance with applicable regulations, standards and stipulations.
>
> - If the analysis and documentation indicate that the proposal may have impacts that are not in conformance with the Proclamation, the BLM will work with the applicant to find alternatives or modifications to the proposal that will minimize such impacts through special permit conditions, consistent with the applicant's right under applicable laws, regulations, and stipulations."

The Proposed Action, as well as the other alternatives, is in conformance with the 1984 RMP, the 1991 O+G Amendment, and the above referenced Interim Guidance from the Colorado State Director and the Washington Office because oil and gas exploration and development is considered an appropriate management activity in this area.

## II. DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

### A. APPLICANT'S PROPOSED ACTION

#### 1. Summary of Proposed Action and Disturbance

WesternGeco proposes to conduct a vibroseis three-dimensional (3D) geophysical seismic survey over an area encompassing approximately 19.9 square miles (12,736 acres). The proposed project is located on the western edge of Montezuma County, Colorado, in Townships 35 and 36 North, Ranges 19 and 20 West. The survey would be located predominantly on the south side of County Road G and lies within the borders of the newly designated 164,000-acre Canyons of the Ancients National Monument. BLM lands would comprise approximately 15.0 square miles (9600 acres) of the proposed project area; whereas 4.9 square miles (3136 acres) would consist of private land. Refer to Figures 1 and 2 for a general location map and a map of the project area.

Appendix 1 contains a list of proposed mitigations. These mitigations would be implemented as project design features that would be accomplished by the BLM, or by the Applicant/Operator as a part of Conditions of Approval for the authorization of this project, or any of the action alternatives. These features provide a good method of mitigating potential impacts.

Driving of most support vehicles would be limited to existing roads and trails. Only vibroseis buggies and an one ATV (all terrain vehicle) would drive off-road. A vibroseis support truck might need to travel off-road if vibroseis equipment needed repair. Staging areas would be located on pre-existing disturbed areas, such as abandoned well pads, where possible. If no pre-existing disturbed areas exist where a staging area is required, a Class III archaeological survey would be conducted prior to staging activities to ensure avoidance of cultural sites.

Surface disturbance as a direct result of the seismic operation would total up to 243 acres on both public and private lands. Surface disturbance could range up to approximately 190 acres on BLM lands. This represents approximately 2% of public lands in the Project Area and about 0.1% of the National Monument. Surface disturbance on private lands could range up to approximately 56 acres (2% of private lands located within the Project Area).

A buffer of approximately 20% is included in these surface disturbance estimates, to account for slight weave driving pattern used by the equipment, and minor variations in general driving. Thus the actual surface disturbance may be less than the above estimate.

The Proposed Action would take up to three weeks to complete. It would consist of three phases: survey, recording, and reclamation.

**2. Phase I - Survey and Archaeological Inventory**

The initial phase of the project involves surveying the source and receiver locations. The survey crew consists of a five to ten person survey crew utilizing a global positioning system (GPS). The survey crew would walk down the lines locating the source and receiver points on foot. Pin flags and flagging would be utilized to indicate each source and receiver point. Orange pin flags indicate receiver points, pink pin flags for source points. Pink flagging indicates the access routes on the source lines.

An archaeologist would work with the survey crew identifying archaeological sites and flagging them for avoidance. In addition to new sites identified during this Class III inventory, the archaeologist would also flag for avoidance any previously recorded archaeological, historic or prehistoric sites identified during a Class I records search, conducted prior to commencement of the field inventory.

## 3. Phase II - Recording and Vibroseis Operations

a. Crew Communications

Prior to commencement of each phase of operations, Applicant employee briefings would be conducted for the purpose of informing project participants of critical elements of the Archaeological Resources Protection Act (ARPA) and the National Historic Preservation Act (NHPA), as well BLM policies and expectations concerning the protection of natural and cultural resources and how those laws and regulations affect his/her field duties. In addition, daily crew meetings would be conducted to facilitate communication at the crew level and to keep the crew informed of any special areas of concern in the vicinity of that day's operations. All supervisors, drivers and the recording truck observer would be provided detailed maps of the project area indicating the access routes approved for travel. Individual crewmembers and contractors would be held accountable for their personal performance with respect to these policies.

The crew would operate out of Cortez, Colorado, traveling to the project site via Hwy 789, County Road G and 407. Each company vehicle would have a copy of the BLM permit and an emergency response plan, which gives instructions on how to handle an emergency situation as well as supplying a list of emergency phone numbers. Every vehicle would also be equipped with a first aid kit, fire extinguisher and a radio to facilitate communication on the project site.

b. Recording Operations

During the recording phase, a minimum of 14 lines of recording equipment, with 60 geophone stations each, would be active at any given time. The spread (area occupied by live recording equipment) would encompass approximately 5 square miles. Additional recording equipment would be laid out beyond the spread, to be checked for equipment malfunctions in advance, thus expediting the recording process. The receiving lines would be parallel and oriented north south. Receiver lines would be 660 apart with 220-foot intervals between receiver points on the receiver line. At each receiver point a set of geophones would be laid out by hand.

Within the grid of receiver lines and geophones would run the source lines. These source lines would run parallel and be 2200 feet apart, with source points at 311-foot intervals along the lines. Source points are the locations where a pad on the buggy vibrator contacts the ground and transmits energy through pressure fluctuation. There would be a total of about 60 miles of source lines, with approximately 1151 source points. Approximately 20% (216) of the source points

would be located on or near existing roads to minimize surface disturbance. The design of a 3D survey requires that data be recorded in a sequential manner, usually beginning at one side of the project and working through to the opposite end. This may vary depending on the amount of equipment available. Source points would be offset to avoid rough terrain or archeological sites.

A staging area with a landing zone for the helicopter would be utilized to bag and prepare the recording equipment. Each staging area would be located on previously disturbed areas such as abandoned well pad locations and bladed areas when possible and would encompass an approximate 250 $ft.^2$ area. Crew vehicles, the helicopter fuel truck, and a Vibrator Technicians truck, as well as several trailers utilized to transport equipment to the site or for equipment support would be parked at the staging area. Any staging areas on BLM lands not located on previously disturbed areas would be surveyed by the archaeologist and cleared with the BLM. Although four or five staging areas would be identified, only one main staging area and two or three smaller staging zones located in more remote areas are likely to be utilized.

A helicopter would be used to transport recording equipment to the field. A line, 50-75 feet long, and carousel would be used to deliver equipment to the ground. At the staging area geophones, seismic cables, small solar batteries, and digitizing boxes would be included in each reinforced nylon cache bag. The helicopter would move approximately six cache bags at a time. Each bag would be lowered to the ground and released at predetermined locations on the receiver line.

During the initial lay-out phase, approximately 3 to 4 layout crews would walk down the receiver lines and lay out the recording equipment by hand. Each crew would consist of 5 to 6 people. As the project progressed, some of the layout crew would be utilized as pickup crews removing equipment, flagging, and pin flags.

A coordinator truck, usually at the staging area, would direct the helicopter to areas where equipment pickup or delivery is needed from the receiver lines. Additional support personnel would include supervisors, operators in the recording truck, landing zone coordinators, a vibrator technician, trouble-shooters who would locate and replace malfunctioning equipment, and the helicopter pilot and mechanic. One helicopter would be used for this project.

Ground crew members would be flown into remote areas or would walk to the receiver lines from nearby roads or trails. The recording equipment would be laid out by hand as crewmembers walk down the flagged line.

Cables, similar in size and appearance to an outdoor extension cord, would be laid out on the surface of the ground along the flagged receiver line. Each cable would cover six receiver stations. A small digitizing box and two solar-powered batteries (usually laid on top of the canvas bag and remaining in position until the recording process was completed) would be located at the end of each cable and connect the two cable heads together. At each flag one set of geophones (6 geophones) would be laid out in a 12-foot diameter circle and connected to the recording cable. The phones would usually be covered by loose dirt by foot action to reduce the noise and to insure the quality of the data.

The geophones are small sensors -- which are approximately 3 inches in diameter. On the bottom of the geophone (sensor) is a blunt spike approximately 2 to 3 inches long that is placed into the soil using foot pressure.

To accommodate receiver stations located in areas with rock, a small battery powered hand drill would be utilized to drill six 2-3 inch deep holes with a diameter of approximately $3/8^{th}$ to $3/16^{th}$ of an inch. These small holes would be located six feet apart in a 12-foot diameter array. This situation is only expected to affect a very small percentage of geophone locations and would be avoided if a slight modification of the receiver station is feasible.

A recording truck containing data collection equipment would be connected to the survey grid by a master cable (similar to the receiver cables with digitizing boxes and solar batteries), which relays data from the north-south receiver lines to the recorder. Usually two to three operators (called observers) would assist in recording the data. The recording truck would be parked at convenient locations along existing roads or two-track trails.

c. Vibroseis Operations

The vibroseis method would be utilized as the energy source to create sound waves. Four Pelton AHV IV buggy-mounted vibrators would be used. Buggies would be equipped with floatation tires 67 inches tall and 34 inches wide. Although the buggy vibrators weigh approximately 30 tons, because of the surface area of the tires, their ground pressure is only approximately 35 pounds per square inch (psi).

The buggy vibrators would access off-road source lines from roads or trails at an angle to prevent line-of-sight from vehicle traffic on BLM or county roads. In addition, a serpentine (slight weaving) pattern of driving would also be

implemented to further reduce the visibility of the tracks. Vibrator buggies would drive predominately in-line (vehicles driving in the tracks of the preceding vehicle). This procedure would not apply to buggy vibrators when following designated drive-arounds or designated access routes off the lines. The buggy vibrator's maneuverability allows tight corners and a variety of terrain to be negotiated. In areas with trees, they would weave between trees as much as possible. A Kawasaki Mule or Polaris Ranger (low impact vehicle weighing 1300 pounds with approximately 3.5 – 6.0 psi) would be utilized primarily to scout the flagged access ahead of the buggy vibrators in order to reduce unnecessary vibrator travel within the 100 foot archaeologically cleared area and expedite the completion of the project.

The formation of the buggy vibrators at the time of recording at a source point would be determined during start-up testing. The most common formation for the buggy vibrators is an in-line formation. Vibrator pads would be lowered to the ground and would vibrate for 10 –14 seconds. While at a source point, vibrators would either stay in place or move forward up to 9 times (for a total of 10 positions at a source point) and at a distance of 4 feet each time. They would vibrate at each stop. The number of stops would be determined at start-up testing. Upon completion, buggies would precede to the next source point.

Trucks would not be used on source lines to transport people or access the receiver lines. The vibrator technician's truck may need to drive to the buggy vibrators on the source line if problems with the buggy vibrators occur. In this event, the vibrator technician's truck would follow the footprint made by the vibrators and should not involve additional driving acreage. Any driving along source lines by vibrators, the technicians truck or mules would be kept to a minimum and precautions would be taken to avoid disturbance.

**4. Phase III - Reclamation and Equipment Removal**

Clean-up would occur concurrently with the completion of Phase II. All pin flags, flagging and lathe would be collected from the completed portions of the project area as the survey progressed. All paths of departure from roads and trails would be reclaimed to BLM specifications. Upon completion, a final inspection would be conducted to insure that cleanup was complete and in compliance with BLM guidelines. A notice of completion would be submitted with a post-plot of all final source and receiver locations.

## B. ALTERNATIVES CONSIDERED

### 1. Shot-Hole: Drill transported by Helicopter Alternative

The Shot-hole/Helicopter Alternative would require the operator to utilize explosives located in the ground to generate an energy signal instead of a vibroseis. A helicopter would be used to transport a drill to the site of each source point. A well pad would not be required. The process of laying down and picking up geophone lines would be similar to that of the Proposed Action.

The number of source points (1151) would be the same as that of the Applicant's Proposed Action. Approximately 20% (216) of the sites would be located on or near existing roads to minimize new surface disturbance. Surface disturbance around the source points in off-road areas is expected to be minimal. The estimated time to complete this alternative is about 9 weeks.

a. Explosives, Magazines, and Staging Areas

Two explosive magazines would be located at one of the staging areas. The magazines are approximately 8' x 6' x 10'. A temporary fenced area would be set up to hold empty explosive boxes and trash. Upon completion, the explosive boxes would be removed and disposed of by the explosives company.

Additional staging areas, accessible by existing roads, would be required throughout the Project Area for the heliportable operations. Vehicles, fuel trucks, and some supplies would be located at these sites. Previously disturbed or bladed areas would be utilized wherever possible.

b. Pre-Testing

Depth of hole, charge size, and type of explosives can affect the final quality of seismic data. Pre-testing would involve drilling a pattern of test holes with various depths, charge sizes, and types of explosives to determine the best combination of these three variables. Testing would need to be completed and analyzed prior to determining the parameters and commencement of the operation. One to three test locations may be necessary depending on subsurface variables. Approximately 120 to 240 stations of recording equipment (five miles or more) would be laid out. The array is usually linear and begins at the end of the test hole locations.

Test locations must be based subsurface geology. A road would be utilized, where available, for the recording equipment. This may not be feasible in all cases.

Drilling would be completed before recording crews arrived. This is to ensure that

recording crews did not stay on stand-by if drilling problems developed. Additional time would be needed for mobilization and demobilization of the helicopter and portable drills. It is assumed that three to four drills could average a total of 24 holes per day. Estimated total project time would be extended by approximately six weeks for a total of nine weeks in the field.

c. Heliportable Operations

A helicopter must move the drill parts, compressor, and supply basket to each new shot-hole site. Most heliportable drill models require three to five moves to transport all equipment. One helicopter could support four drills. The helicopter would move one drill while the other three were drilling.

The drill stand, compressor, and supply basket usually each have four feet with leveling legs on one side. In some cases of very uneven or steep ground, a 1' x 2' area may be leveled to create a small ledge to stabilize the back end of the stand.

An explosives truck would transport explosives from the primary staging area to the site of that day's heliportable operations in the mornings and return explosives to the primary staging area in the evenings. A temporary day-magazine would be stored at this site. The magazines and explosives truck would comply with the Federal Bureau of Alcohol, Tobacco and Firearms guidelines.

Drill holes are approximately 3 inches in diameter and up to 100 feet in depth. A hole is usually drilled and loaded. Upon completion of the hole, the helicopter will move the drill to the next hole site. The drill helper would remain at the site to complete hole plugging.

d. Plugging

Shot-holes would be plugged in accordance with the Colorado Oil and Gas Conservation Commission Rule 333. If no water is injected into the hole and no water is encountered when drilling the hole, cuttings generated from the drilling process and other native soils can be used to plug the hole. A non-metallic plug with the operator's identification code would be placed in the hole at a depth of three feet. The remaining hole would then be filled and tamped to the surface with cuttings and native soil. Cuttings around the hole would be raked and spread so that they are less than one inch in thickness. A sufficient mound of native soil shall be left over the hole to allow for settling.

Where water is encountered, bentonite would be used to plug the hole up to ten feet above the static water level or to a depth of three feet from the surface. If artesian flow is encountered, the hole will be plugged to the surface or at least 50 feet above

the static water level with either cement or bentonite. The Operator is required by Colorado Oil and Gas Conservation Commission to inspect the hole after several weeks to insure that the hole has not resumed flowing. Artesian flow is not expected to occur on this project.

e. Shot-Hole Blow-Outs

A shot-hole plug will occasionally not hold when the test hole is detonated. Additional plugging supplies would be brought to the site of the hole by helicopter.

f. Pit Holes

Areas with large amounts of subsurface water and/or gravel or cobbles may require drilling mud or other additives to be utilized during the drilling process. The purpose of the mud and/or additives would be to prevent collapse of the walls of the hole. A large metal container, slightly larger than a bathtub, would be used to mix mud. Upon completion of the hole, the mud would be emptied in the vicinity of the hole and spread to less than one inch thickness. The mud pit would be transported on the back of the drill. Some test holes may require this method. The number would not be expected to be substantial.

g. Operabilty comparison to Proposed Action

The Lessee has provided the following reasons why shot-hole is less preferable than vibroseis for an energy source:

- Shot hole depth, charge size, and type of explosive must be predetermined prior to the actual survey. None of these variables can be easily adjusted to improve data recovery. Vibrator settings can be adjusted in the field. Vibroseis field testing is easily conducted to determine optimum sweep frequencies and sweep lengths. These adjustments can greatly improve the results of a survey.

- If wind or traffic occurs during recording, data from the shot hole technique can be less useful or even lost. Vibroseis source points can easily be recorded again.

- The fieldwork cost for this type of survey is three to four times as expensive as the Proposed Action.

- Additional money and time would also be required to process the signals generated by the shot technique. The Lessee's existing data in the adjacent area consist of vibroseis source-type. The Lessee already has information regarding how vibroseis signals should be processed to best indicate subsurface geology in the area.

## 2. Shot-Hole/Buggy-Transported Drill Alternative

The Shot-Hole/Buggy Alternative is similar to that of the Shot-Hole/Helicopter Alternative. Geophone lines, source point numbers and locations, drilling, and plugging would be the same.

The main difference would be that the drill would be transported overland by buggy. One or two additional vehicles would accompany the drill overland depending on availability. Self-contained buggy drills have compressors and small water tanks mounted on the drill. The more common rig utilizes a second compressor or water buggy that works in conjunction with the drill. The remaining vehicle would consist of a hole-plugging vehicle (usually a pick-up truck).

Each buggy-drill may be able to complete an average of 15 to 20 holes per day. Progress is dependent on drilling conditions. Multiple trips may be required on a source line to provide additional explosives, pick up unused explosives, provide water or fuel, and to transport crewmembers and equipment back and forth if a line cannot be completed in a day. Unforeseen events such as poor drilling conditions would result in additional trips. The drill and water truck could be left on the source line each evening. The hole-plugging truck could be used to transport crewmembers.

New surface disturbance would be similar to that of the Proposed Action. It would be less intense in some areas and more intense in other areas, depending on the number of vehicle trips that would be required on any one line. It is anticipated that the total time to complete this alternative is about 6 weeks.

The Lessee has expressed similar concerns regarding this alternative:

- The quality of signal would be less than that of vibroseis.
- Additional time and money would be required to process signals generated by shot.
- The cost would be approximately twice as much as that of the Proposed Action and half that of the Shot-Hole/Helicopter-Transported Drill.

## 3. Vibroseis Survey Using Existing Roads and Trails Only Alternative

This alternative, called Existing Roads Alternative, would be similar to that of the Proposed Action; however all vehicular travel and source points would be restricted to existing roads and trails (refer to Figure 4 for a map showing existing roads and trails). No new surface disturbance would result from this alternative.

The Lessee has concerns regarding the loss of source points if activities are restricted to existing roads and trails for the following reasons:

- 3D seismic projects must cover a large percentage of the area to produce accurate information.
- The restriction of source lines to existing roads and trails would not provide adequate coverage over the area.
- The resulting information would have large gaps in it.

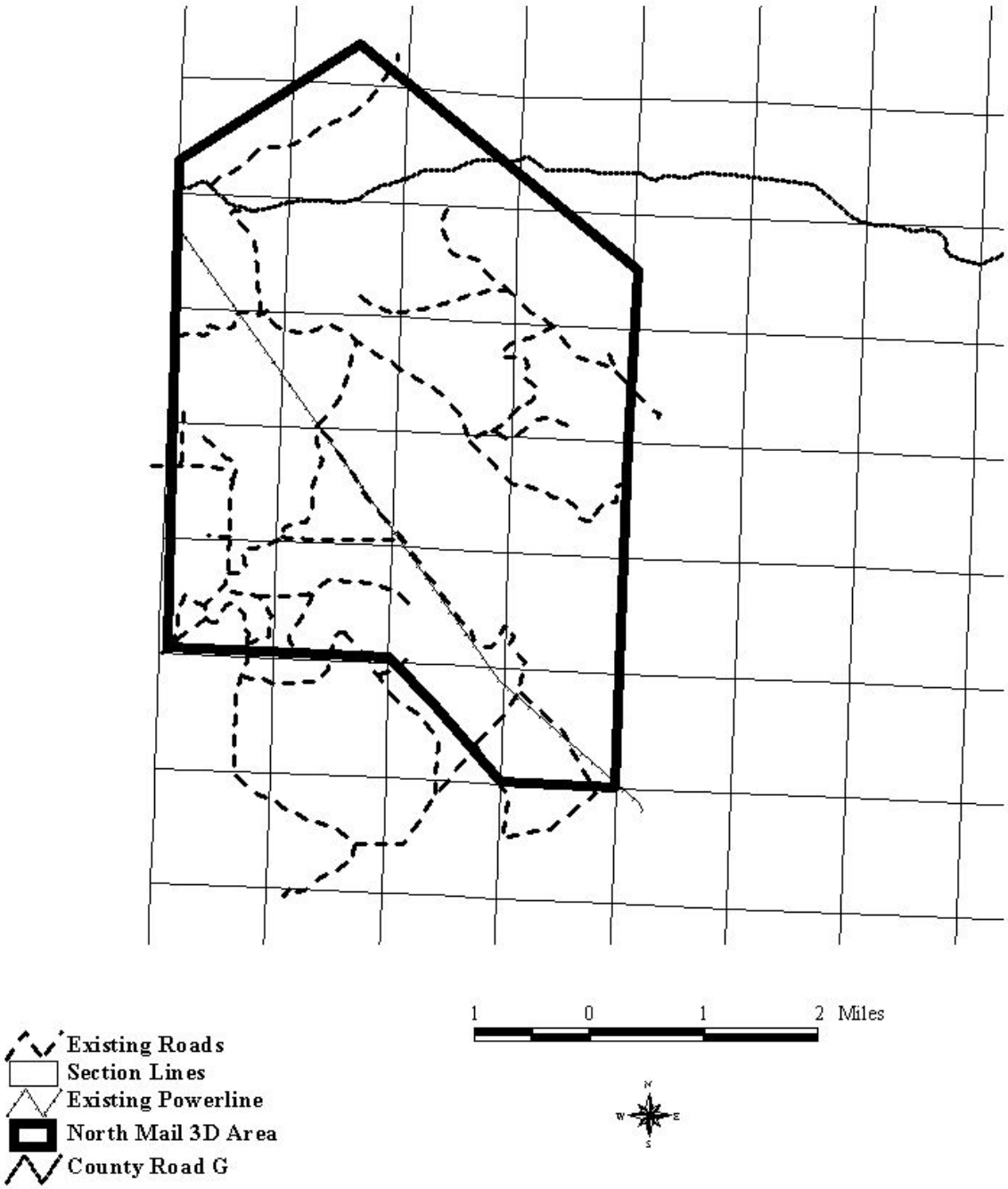
**4. No Action**

Under the No Action Alternative, the proposed geophysical exploration project would not be authorized on BLM-administered lands through this NEPA document. The applicant would have the options of submitting a new proposal modified to reflect environmental concerns raised in this document, requesting further consideration of this proposal through an Environmental Impact Statement (EIS), or canceling the project. Future geophysical projects in this area could be submitted for consideration by the BLM. Development of valid existing oil and gas leases would continue subject to existing regulations.

## C. ALTERNATIVES CONSIDERED BUT DROPPED FROM ANALYSIS

Exploratory drilling has also been used as a technique to determine underground geology. However, while this technique will give the most accurate information of the underground geology, it is only accurate for the diameter of the borehole (usually 6 inches or less). The further the distance from a particular borehole, the less accurate knowledge would be about the underground geology; so additional exploratory holes must be drilled. The default spacing for the Paradox Formation set by the Colorado Oil and Gas Commission is 1 well for every 40 acres, so theoretically there could be over 300 wells drilled (12,736 acres/40 acres per well); however, this scenario is extremely unlikely. One well for every 160 acres is possible and could result in about 80 wells over the project area. At an estimated acreage of disturbance per well of 10 acres (1991 O+G EIS, p. B-1, includes access roads), projected total disturbance could exceed 800 acres. Because this method has a projection of over 3 times greater surface than any of the above alternatives, the disturbance would likely result in more environmental impacts than seismic to attain a similar level of knowledge about where oil and gas reservoirs may be located, and the likelihood the Lessees would consider this technique impractical and

**Figure 4**
**North Mail Trail 3D Seismic Project**
**Existing Roads**



infeasible (potential costs could easily run into the tens of millions of dollars), this alternative will not be analyzed further in this document.

# III. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

## A. INTRODUCTION

The project area is located in the southwest corner of Colorado, 18 miles west of the town of Cortez. It lies within the Colorado Plateau physiographic province. It contains relatively flat-lying mesa tops ranging in elevation from 4900 to 5400 feet, and is dissected by deep broad canyons whose bottoms can be as much as 500 feet below the canyon rims.

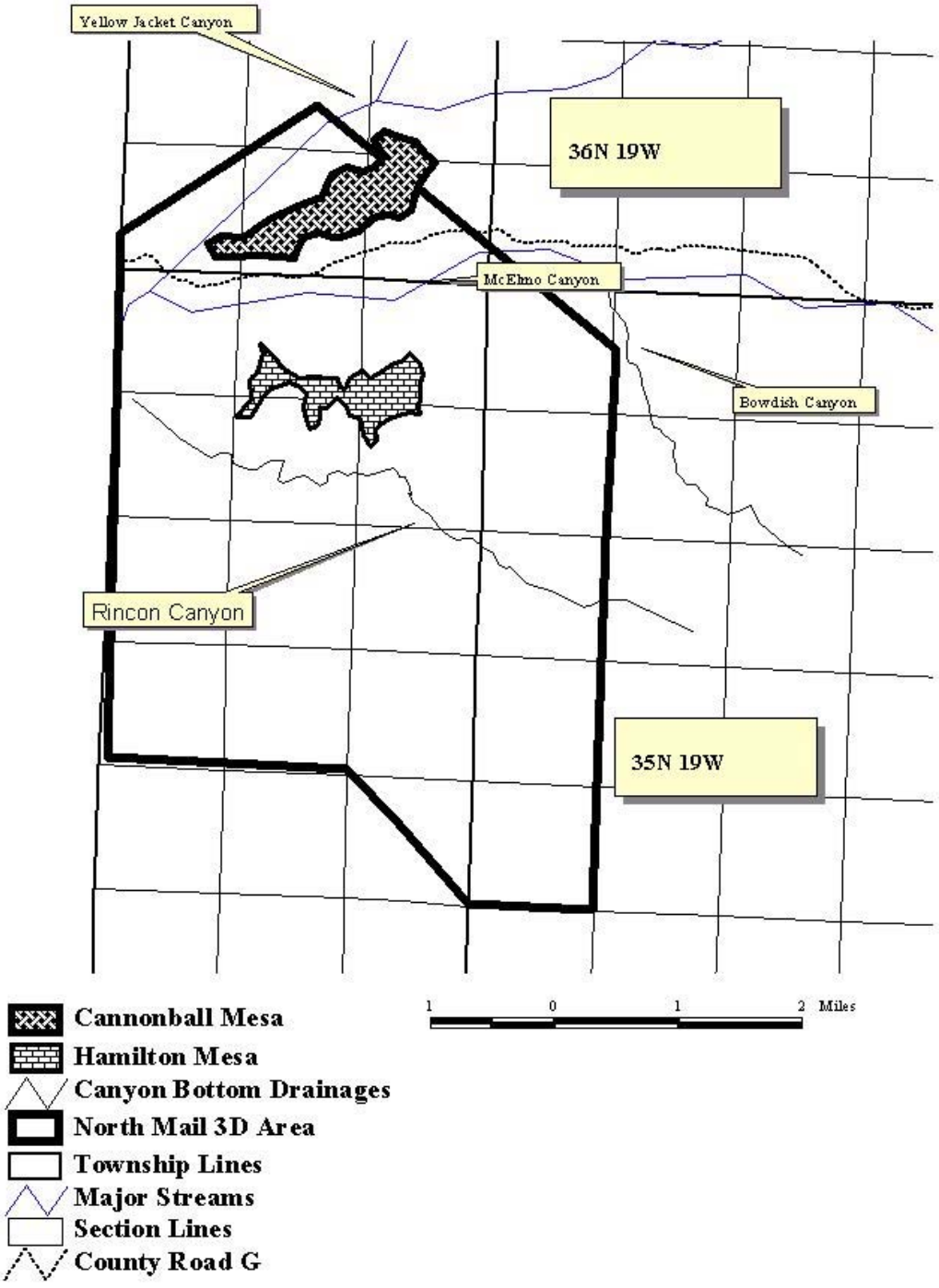
Average annual precipitation at Hovenweep National Monument, five miles to the north of the project area and at the same elevation, is 8 to 14 inches with about half of that occurring during the growing season (Western Regional Climate Center, NOAA).

The area consists of portions of several canyons, including Yellow Jacket and McElmo Creek Canyons. The canyons have been cut by fluvial stream erosion through uplifted sedimentary beds (typical of the Colorado Plateau). Numerous rock outcrops, ledges and cliffs are exposed in the canyons. In addition to the main canyons, there are smaller tributary canyons. The canyons have created isolated mesas such as Cannon Ball Mesa, Hamilton Mesa, Flodine Park, and Mail Trail Mesa. Refer to Figure 5 for a map showing most major geographic features.

The area lies within the Paradox Basin of the Colorado Plateau. The Paradox Basin is seen as nearly horizontal sedimentary formations that have been slightly tilted to the southwest. Sediments exposed throughout much of the project area date to Jurassic, Cretaceous, and Quaternary Period (Pratt, et al., 1976). Visibly exposed Cretaceous-age Dakota Sandstone and underlying Burro Canyon Formation comprise the uplands in the project area. These formations are highly visible along the upper cliffs, rimrock and eroded edges of the mesas bordering McElmo Creek and Rincon Canyon, and lie stratigraphically above the Morrison Formation. The mesas are capped by Quarternary silts of eolian (wind) origin.

Privately owned land on the mesa tops at the headwater of Yellow Jacket Canyon near Dove Creek, Colorado, has been extensively cultivated utilizing dry and irrigated farming techniques. Canyon bottoms and mesa tops in the project area serve as rangeland for cattle. In addition to BLM rangeland, this area has a significant amount of private land in the canyon bottoms that are used for orchards, hay fields, and pastureland. Yellow Jacket Creek, McElmo Creek, and small reservoirs near Rincon Canyon provide the primary sources of perennial water in this desert region. These water sources support wetland and

**Figure 5**
**North Mail Trail 3D Seismic Project**
**Geographic Features**



riparian vegetation and provide habitat for wildlife. Yellow Jacket Creek, north of McElmo Canyon Road, has one of the most developed and extensive riparian vegetation zones in the area, with stands of cottonwood and willow. Approximately 60% of the wetland/riparian zone in the project area is on private land.

The dominant vegetation consists of a salt desert shrub community. There are scattered piñon and juniper on the mesa tops. Riparian vegetation in McElmo and Yellow Jacket Canyons consists primarily of sandbar willow, tamarisk, Russian olive, and cottonwood.

Two oil fields, Flodine Park Field and Flodine Park East, overlap the southwest portion of the Project Area. There are thirteen valid oil and gas leases in the Project Area. There are about 7 producing oil and gas wells within the Project Area, all located in the southwestern corner of the Project Area. There are several 2D seismic lines crossing the area. In addition, there is one 3D survey that overlaps a small portion (approximately 200 acres) of the southeastern border. Most of the 2D lines project work was conducted in the 1970s and early 1980s (when lines were bulldozed). The 3D project was conducted in 1995.

The Hovenweep National Monument has several sites located within CANM, but the closest unit is about 5 miles from the Project Area.

## B. RESOURCES NOT AFFECTED

The following critical elements have not been identified in or near the Project Area or are not affected by the Proposed Action or alternatives and so are not addressed: Environmental Justice, Prime or Unique Farmlands, Wild and Scenic Rivers, and Wilderness. Table 1 lists resources elements considered in this document, designates which are critical elements (elements which must be either discussed or a no impact declaration made in the BLM NEPA document) and which are non-critical, and indicates whether or not the resource element would be potentially affected by the proposed action. All resource elements potentially affected by the Proposed Action or alternatives are discussed in the following sections.

## C. RESOURCES POTENTIALLY AFFECTED

### 1. Air Quality

a. Affected Environment

The geophysical survey project location is within a Class II air quality area. The project area is located approximately 25 miles west of Mesa Verde National Park. Air quality in Mesa Verde National Park qualifies as Class I, the highest standard in the Nation.

No long-term air quality monitoring data is available for the project area, although existing air quality is assumed to be similar to that of Mesa Verde National Park Class I area. The National Park Service began monitoring air quality parameters at Mesa Verde in 1981. Air quality is generally considered good and the major air quality related value currently impacted by pollution is visibility. Changes to atmospheric light extinction affecting visibility at the Park are primarily from sulfate, organic, and soot aerosols (Binkley et al., 1997).

| Critical Element | Potentially Affected? | | Non-Critical Element | Potentially Affected? | |
|---|---|---|---|---|---|
| | Yes | No | | Yes | No |
| Air Quality | X | | Forestry | X | |
| Areas of Critical Environmental Concern | | X | Soils | X | |
| Cultural Resources | X | | Lands and Rights of Ways | X | |
| Environmental Justice | | X | Migratory Birds | X | |
| Prime or Unique Farmlands | | X | Mineral Resources | X | |
| Floodplains | X | | Paleontologic Resources | X | |
| Invasive Non-Native Species | X | | Range | X | |
| Native American Religious Concerns | X | | Recreation | X | |
| Threatened and Endangered | X | | Socio-economic Values | X | |
| Wastes, Hazardous or Solid | X | | Special Status Species | X | |
| Water Quality (surface and ground | X | | Visual Resources | X | |
| Wetlands | X | | Wild Horses and Burros | | X |
| Wild and Scenic Rivers | | X | General Wildlife Species | X | |
| Wilderness | | X | Vegetation | X | |
| | | | Public Health and Safety | X | |

**Table 1: Critical and non-critical elements affected by the Alternatives.**

b. Environmental Consequences – all action alternatives

BLM and Forest Service air quality specialists were consulted regarding geophysical survey activities (S. Archer, pers. comm., 2002, M. Schmidt, pers. comm., 2002). Fugitive dust related to vibroseis equipment, shot hole explosions, helicopter operation, and transportation/scouting vehicles could have potential localized air quality impacts. Any impacts to air quality from dust would be very short term in nature and limited to operating hours for the duration of the survey activities (3-9 weeks depending on the alternative).

The disturbance of soils may lead to limited wind erosion in the area (refer to the soils resource section). This type of erosion could lead to airborne dust during windy conditions. The primary constituent of sensitive soils with biological crusts is sand. National and State health and visibility standards for particulate matter address particles 10 microns and 2.5 micron or less in diameter ($PM_{10}$ and $PM_{2.5}$). These are sizes that easily become airborne, contribute to increased light extinction, and can cause health problems. Sand particles are much larger than those addressed by air quality regulations (2000 microns in diameter) and are less likely to become airborne for extended periods of time. It is not anticipated that activities associated with the action alternatives would exceed any National or State air quality standards.

Air quality data for Mesa Verde National Park show the contributions of different pollutants affecting local air quality as indicated by aerosol monitors. Sulfate, organics, and soot are the primary aerosols impacting air quality. Dust is a very small component of the total extinction budget. Dust generated by wind erosion is not expected to affect air visibility in the Project Area due to the limited duration and extent of the activities. Dust is not the primary component affecting visibility at the closest Class I area, Mesa Verde National Park; therefore, no direct, indirect, or cumulative impacts are anticipated to Mesa Verde National Park.

## 2. Cultural Resources

a. Affected Environment

During October and November of 2001, an intensive (Class III) archaeological inventory was conducted along the 60 miles of proposed seismic source lines and off-line access routes associated with the proposed action. The report documenting this inventory was submitted to the BLM, CANM on January 3, 2002. The inventory was conducted on the federal lands and on the land of the one private landowner who granted permission for an inventory.

A Class III intensive inventory was not conducted along the proposed receiver lines because the activities conducted along these lines are considered to have minimal affect on cultural resources. The geophone lines will be placed by hand crews, and no vehicles will be driven along these lines. BLM Manual 3150 regarding Onshore Oil and Gas Geophysical Exploration Surface Management Requirements states that inventories are not needed for pedestrian operations such as the transport of hand carried geophones (3150.31B3).

The majority of the private land holdings within the area of the proposed action were not inventoried for cultural resources for this proposed project because the landowners chose not to participate in the comprehensive archaeological survey. Therefore, the exact nature and extent of the cultural resources on those lands is not known. However, previous inventories conducted on private lands in the area identified some significant cultural resources. Because the BLM is not permitting the proposed activities on the private lands included in the Proposed Action, it is not responsible for compliance with Section 106 of the National Historic Preservation Act for those lands.

Sixty-three sites were located during the 2001 inventory (33 previously recorded, 30 newly recorded). They include prehistoric and historic sites, as well as sites with both prehistoric and historic components. The prehistoric sites include lithic scatters, quarries, open camps, limited activity areas, field houses, and habitations. The historic sites include camps, limited activity areas, and a homestead. Thirty-five of the sites could not be assigned specific cultural and temporal affiliations. Of the sites that could be assigned cultural and temporal affiliations (either single or multiple occupations), three are Paleo Indian, nine are Archaic, 19 are Ancestral Puebloan, and three are historic Navajo.

Forty-two of the 63 sites are recommended as eligible for inclusion on the National Register of Historic Places. Ten sites require additional data before an eligibility determination can be made (hereafter called unevaluated sites). The unevaluated sites will be treated the same as eligible sites for the purposes of this project. Eleven sites are recommended as ineligible for inclusion on the National Register.

Approximately 2,240 acres, or 44.6 percent of the Hamilton Mesa Cultural Resource Emphasis Area is included within the Project Area. This cultural resource emphasis area was defined in the Anasazi Area of Critical Environmental Concern Management Plan (AACECMP) as a cultural resource emphasis area because it was considered to be of probable national importance. Hamilton Mesa contains Ancestral Puebloan habitations and Archaic period sites. The AACECMP states that this area is considered eligible to the National Register of Historic Places under criterion C and D, and that special protective stipulations may be necessary to

adequately protect the cultural sites. It also includes guidelines for cultural resource emphasis areas that are designed to reduce impacts to these resources and their setting. The Anasazi ACEC is now the CANM.

Portions of the Project Area are located within two areas designated in the 1984 RMP as No Surface Occupancy Areas (NSO) for the protection of cultural resources. The northeastern portion of the Project Area is located within the 1,000-acre Bowdish Canyon NSO, and the northwestern portion of the area of the proposed action overlaps with the 5,120-acre Yellow Jacket Canyon NSO area. These areas were designated as no surface occupancy for the protection of cultural resources from surface ground disturbing oil and gas development such as well pads, pipelines, and roads. Waivers for proposed activities within these NSO areas may be granted if it can be shown that there will be no effect to cultural resources from these types of projects.

b. Environmental Consequences

(1) Proposed Action Alternative

The predominate sources of potential impacts to cultural resources would be from ground vibration activities and public use of buggy tracks after the operation is completed.

Where Class III inventories have been conducted, source lines have been relocated to completely avoid, or provide limited controlled access through, sites. Archaeological monitoring would be conducted to ensure site integrity is maintained.

The proposed staging areas were not included in the earlier referred to Class III cultural resources inventory; however, prior to project approval, a Class III archeological survey would be required for all staging areas, regardless if there was any previous disturbance (see Appendix 1).

One method of measuring the intensity of ground vibrations at a particular location is through a determination of particle peak velocities (ppv). The BLM Manual, H-3150-1, recommends ppv of 75 or less to protect cultural structures. PPVs will vary dependent on distance from the source, drive levels, peak forces, sweep range, and ground conditions. A resource protection offset of 300 feet for vibroseis testing has been determined for standing structures and rock art (Illustration 10, p. 1, BLM Manual H-3150-1) that would protect these cultural sites from ground vibration disturbance. However, studies by Matheson Mining and Engineering (November

2001) demonstrate that vibration levels at 100 feet are well below the required safe threshold of 75.

Public use of roads in the Project Area is restricted to existing open roads. However, it is recognized that some public disregard this prohibition of off-road use. It is possible that the public would utilize any tracks that result from the Proposed Action. Cultural sites accessed by these tracks could become damaged by vehicular use and the sites could become susceptible to vandalism. However, the potential impacts to cultural resources from this indirect effect are considered minimal because of the requirement (see Appendix 1) that the vibroseis buggies travel in a weaving pattern and the requirement that the operator rapidly reclaim disturbances near existing roads. These measures would provide little enticement for illegal public off-road use.

There are some private lands where the archaeological inventory was not conducted. It is anticipated that without a Class III inventory and monitoring, there is a high potential for impacts to occur to cultural sites located on these uninventoried private lands due to vehicles driving over the surface, compression from the vibroseis pad on the surface, or vibrations resulting from the vibroseis testing. The BLM has attempted to obtain permission from these private landowners, but no response has been received. The BLM will document the fact that a good faith effort has been made to provide for an inventory of those lands, however, because the BLM is not permitting the Proposed Action on those private lands, no further action can be taken.

The AACECMP states that portable, off trail geophysical operations will be encouraged in cultural resources emphasis areas such as Hamilton Mesa. The Proposed Action is not a portable form of off trail geophysical operation because it requires the use of vehicles traveling off-road. However, impacts to this cultural resource emphasis area are anticipated to be minimal because sites will be avoided and the protective measures (see Appendix 1) placed on the operator.

As mentioned earlier, there are two areas designated as No Surface Occupancy in the 1984 RMP, the Bowdish and the Yellow Jacket Canyon No Surface Occupancy areas. The proposed source lines located within the NSO areas have been routed to avoid sites, and indirect impacts from public utilization of buggy tracks would be mitigated (see Appendix 1). Therefore, there would be no impact to sites within the NSO areas, and a waiver may be issued for activities within these areas.

***Summary of Proposed Action***. Impacts to cultural resources are anticipated to be slight to non-existent as a result of the Proposed Action. Cultural site-avoidance, monitoring, and other protective mitigations provided in Appendix 1 should minimize potential environmental impacts associated with the seismic operation.

(2) Shot Hole/Helicopter Alternative

This alternative would use the same source lines identified for the proposed action, with the same requirements to avoid identified cultural sites. The primary impacts to cultural resources from this alternative would be from drilling and explosives used in the shot holes, and from project staging and reclamation activities. The area around the shot holes could be disturbed and standing masonry structures and rock art panels could be damaged depending on the distance of the structure/rock art panel from the shot hole and the force of the shot. Resource protection offsets related to vibrations caused by explosives in shot holes have been established for cultural resources and other facilities and are listed in Table I and II of Illustration 10 of BLM Manual H-3150-1 and incorporates varying shot hole sizes and depths of the charge. The operator would submit proposed depths and charge weights for source points. The BLM will determine a buffer based on the distances recommended in the Manual.

Potential impacts from helicopter operations, i.e. soil compaction and damage to features such as standing walls, rubble mounds, upright slab features, and check dams, are considered negligible. The pressure exerted on the ground from a helicopter skid is estimated to be around only 5 pounds per square inch. This is approximately equivalent to an average sized person standing on one foot. The 300-foot avoidance buffer to standing features would protect the sites from wind activity associated with rotor wash.

As discussed under the Proposed Action, the staging areas on existing disturbed sites have not been inventoried. Similar to the Proposed Action, a Class III inventory would be conducted prior to authorization of the staging area.

The discussion of potential impacts on uninventoried private lands under the Proposed Action is applicable under this alternative.

The AACECMP states that portable, off trail geophysical operations will be encouraged in cultural resources emphasis areas such as Hamilton Mesa. This alternative would involve the use of portable methods that would be more appropriate for the Hamilton Mesa cultural resource emphasis area.

As mentioned earlier, there are two areas designated as No Surface Occupancy in the 1984 RMP, the Bowdish and the Yellow Jacket Canyon No Surface Occupancy areas. The proposed source lines located within the NSO areas have been routed to avoid sites. Therefore, there would be no impact to sites within the NSO areas, and a waiver may be issued for activities within these areas.

***Summary of the Shot Hole/Helicopter Alternative***. Impacts to cultural resources in the Shot Hole/Helicopter Transport alternative are anticipated to be less than impacts associated with the Proposed Action as mitigated. The potentially affected area would remain the same as the Proposed Action. Off-road use would be less compared to the Proposed Action. There would be less potential for vehicles to create noticeable tracks that the public might subsequently use. Sites located on the surface of the ground on proposed source lines located within the Yellow Jacket and Bowdish NSO areas would be avoided.

(3) Shot Hole/Buggy Alternative

The impacts to cultural resources from this alternative are primarily related to the use of vehicles along the source lines/roads and the drilling of and explosives used in shot holes. The potential effects of this alternative on cultural resources are very similar to the Proposed Action, with the exception that there would be greater ground vibration.

(4) Existing Roads Alternative

The impacts to cultural resources from this alternative would be negligible. Concerns over illegal public off-road use would be resolved.

(5) No Action Alternative

There would be no additional impacts to cultural resources as a result of this Alternative.

## 3. Native American Religious Concerns

a. Affected Environment

No traditional cultural properties or sacred sites were recorded during the Class III inventory. However, three sites with probable historic Navajo components were found. These components consist of sheep camps or temporary habitations. Native Americans are being consulted through the request for comments on this environmental assessment.

b. Environmental Consequences – all alternatives

It is anticipated that all of the action alternatives would have similar effects on any Native American Religious Concern site. Native Americans are being consulted through the request for comments on this environmental assessment. The

Authorized Officer, prior to reaching a decision on which alternative is chosen, will consider their comments. Any sites which are identified as qualifying as Native American Religious Concerns would be avoided.

**4. Paleontology**

Paleontological surveys were conducted at the same time as the archaeological surveys. No fossil resources were identified during these surveys.

**5. Soils**

a. Affected Environment

The project area is primarily associated with the Morrison, Dakota Sandstone, and Burro Canyon Geologic Formations. Eolian deposits are also present. Mesa tops, mesa side slopes, lowland plains and hills, and sand dunes are the prominent landforms.

The soils on the edges of the mesa tops formed from sandstone parent material, and are well-drained and shallow to bedrock (less than 20 inches). They occur on slopes of 0-10%, and predominantly classify into the Farb series (Lithic Torriorthents, loamy, mixed, calcareous, superactive). Surface soil texture of these soils is sandy loam, and the subsurface texture is sandy loam. Sandstone rock outcrop and surface rock fragments are associated with these soils, and help to buffer them from wind and water erosion.

Other soils of the mesa tops formed from sandstone parent material and from eolian material derived from sandstone, and are well-drained and deep (greater than 40 inches to bedrock). They occur on slopes of 0-10%, and predominantly classify into the Mack series (Typic Calciargids, fine-loamy, mixed, superactive, mesic). Surface soil texture of these soils is fine sandy loam, and subsurface texture is sandy clay loam.

Soil compaction potential for the soils on the mesa tops is slight due to the high sand content associated with their thick surface layers. Soil erosion potential from water is slight due to the gentle slopes and the high infiltration rate of these soils. Soil erosion potential from wind is slight for Farb soils and slight to moderate for Mack soils.

The soils of the mesa sideslopes formed from shale and sandstone parent materials. They occur on slopes ranging from about 15-80%. These sideslopes are mostly composed of sandstone and shale rock outcrop, boulders, and soils that predominantly classify as Typic Torriorthents. Soils are well-drained with variable

depths to bedrock (shallow to deep). Surface soil texture is sandy loam, while subsurface texture is clay loam and silty clay loam. Soil compaction potential for these soils is moderate. Soil erosion potential from water is moderate to severe due to the steep slopes and the instability of the Morrison geologic formation associated with these sideslopes. Soil erosion potential from wind is slight. These soils will not be disturbed from the proposed action since they do not contain source points and vehicles will not travel on them.

The soils of the plains and hills of the project area, which occur in low-lying landscape positions below the mesa tops and mesa sideslopes, are highly variable. They occur on slopes of about 0-15%, and mostly formed from shale of the Morrison Formation. They classify into the Uzacol, Zwicker, and Claysprings series. They are well-drained with variable depths to bedrock (shallow to deep). Surface soil texture for these soils is clay loam, while subsurface texture is clay. Surface rock fragments are common, and help to buffer soils from wind and water erosion. Soil compaction potential for these soils is moderate. Soil erosion potential from water is slight to moderate, with the latter occurring on the steeper slopes. Soil erosion potential from wind is slight.

The project area contains small sand dune features that, with one known exception, do not occur anywhere else in the CANM. These soils are mostly classified into the Sheppard series (Typic Torripsamments, mixed, mesic). While this soil series appears to only occur in this portion of the CANM, it is of large extent in southeastern Utah, northern New Mexico, northern Arizona, and southwest Colorado (National Cooperative Soil Survey, 2000). These soils occur on plains and hills of the project area, in low-lying landscape positions below the mesa tops and mesa sideslopes. The dunes appear as small knobs elevated above the surrounding lands. They occur on slopes of about 0-15%. Some of the dunes have a relatively smooth ground surface and tend to be more stable, while others have a hummocky micro-topography and tend to be more easily disturbed. The soils of these dunes formed from eolian material derived from sandstone. They are excessively-drained, deep to bedrock (greater than 60 inches), and composed of fine sand throughout the profile. These soils are very loose and easily displaced. Vegetation (including sand sagebrush and *Muhlenbergia pungens*) is loosely rooted into these soils and easily disturbed. Soil compaction potential is slight due to the high sand content. Soil erosion potential from water is slight due to the gentle slopes and high infiltration rate. Soil erosion potential from wind is severe due to the high amount of bare soil and the sand content.

b. Environmental Consequences

(1) Proposed Action

Proposed activities associated with this alternative would disturb the ground surface due to vehicle operation involved in the process. The large flotation tires of the vehicles would leave depressions (areas lower than the surrounding surface) or tracks in the soil surface. The Mack soils would be compressed about 2-5 inches due to their high sand content. The Farb soils would compress about 1-3 inches due to the higher silt and clay content of their surface soils, and due to surface rock fragments that would help to buffer the soils from the weight of the vehicles. The tracked soils would not be severely compacted due to their high sand content, and would not significantly affect the movement of plant roots. Soil displacement on these soils due to tire action would be minimal unless tires spin. The compressed soils just described would not be severely compacted due to their high sand content, and should not significantly affect the movement of plant roots. Vibrating pads placed on the soil surface at the source points would cause some slight depression and compaction of the surface soils, but no displacement is expected and impacts would be minimal.

The previous 3D vibroseis seismic project that occurred 7 years ago partially overlaps the southern portion of this Project Area and contains similar soils. Based on the recent observations of that project area, little, if any, signs of soil depression from vehicle tracks or vibrating pads were visible, with the exception of ruts and tracks present in a few areas where soil conditions may have been too wet. However, these tracks and ruts were very uncommon. Therefore, it is anticipated that the depressed soils anticipated under the Proposed Action would recover in 7 years or less.

Vehicle travel on the Sheppard soils of the sand dunes would leave depressions or tracks and displace the soils due to the soft incohesive nature of the sandy soils. Tire tracks up to a foot or more deep are likely to occur. Soils would be displaced within about 1 foot of their origin unless tires spin, in which case they could move farther. The loosely rooted vegetation on these soils is also likely to be uprooted by the tires. The tracked soils would not be severely compacted due to their high sand contents, and would not affect the movement of plant roots. Vibrating pads at the source points would also compress these soils up to a few inches, but this impact would be minimal. These soils are currently subject to significant wind erosion, which readily moves surface soils around within the dune area. Unless vehicles get stuck and dig deep trenches in the soil, tracks and pad marks created by vehicles in the Sheppard soils during proposed activities are likely to be filled in by blowing sand within 1 year and probably sooner.

There would be some disturbance to soils and biological soil crusts (refer to following section for discussion on biological soil crusts) from trampling by people at the geophone locations, but it would be minimal.

Vehicle travel in the project area would not result in an increase in soil erosion by water since that risk is slight on most sites where the vehicles would travel (vehicles would not travel on mesa sideslopes). The risk is slight because (1) slopes are not steep (less than 15%), (2) slope lengths are short, (3) we expect that most of the ground cover (vegetation, litter, rock) and topsoil would remain intact and in place, (4) the sandy soils have high infiltration rates and low water erodibility potential, and (5) because mitigation measures (see Appendix 1) designed to minimize the risk of water erosion on these soils would be implemented.

Since disturbed soils are more susceptible to wind erosion than undisturbed soils when dry (Belnap 2001), the soil disturbance from vehicles that would compress surface layers and disturb biological soil crusts may increase the chances for some wind erosion to occur particularly on the Mack soils. But it is expected to be minimal since the ground cover (vegetation, rock, litter) would not be significantly decreased and because the soils are not highly susceptible to wind erosion. Soil particles blown by wind would mostly be sand-sized and would stay close to the ground due to their weight. Wind erosion may increase slightly on the Sheppard soils since vehicles would disturb the soils and uproot some vegetation cover, but wind erosion is already occurring to a great extent on the Sheppard soils due to the high amount of bare soil and the inherently erodible nature of the sandy soils associated with them. Therefore, soil erosion from wind may increase slightly due to proposed activities, but it is not expected to significantly increase.

Soil compaction resulting from the weight of the vehicles would be minimal throughout the project area. The high sand contents of most soils make them very resistant to compaction whether they are wet or dry. Soils of the plains and hills of the project area that are more susceptible to compaction due to their higher clay contents would likely be compacted to some extent, but if those soils are adequately dry (soil moisture content below the plastic limit) when activities occur and vehicles minimize the number of times they drive across those soils, compaction should be minimal and soil productivity (as measured by a plants ability to grow) should not be noticeably affected. Thick and sandy soil surface horizons, vegetation cover, rock, and litter, all found to some degree in the project area, would help to buffer soils from compaction.

(2) Shot Hole/Helicopter Alternative

Effects to soils would be less than the Proposed Action or the Shot Hole/Buggy-Transport alternative, since there would not be soil disturbance from vehicles and the amount of acres disturbed would be much less. There would be some disturbance to soils and biological soil crusts from trampling by people and from the drilling equipment at the source points, but it would be minimal.

(3) Shot Hole/Buggy Alternative

Effects to soils would be similar to those described for the Proposed Action, since a similar amount of ground would be disturbed from the vehicles involved and the vehicles would have similar effects. The degree of effects would be less intense in some areas and more intense in others, depending on the number of vehicle trips that were required on each source line.

(4) Existing Roads Alternative

Effects to soils would be least of any of the action alternatives, since there would not be soil disturbance from vehicles and the amount of acres disturbed would be much less.

(5) No Action Alternative

As this alternative proposes no activities, there would be no effects to the soils of the project area.

## 6. Biological Soil Crusts

a. Affected Environment

Biological soil crusts are composed of multiple organisms including cyanobacteria, green algae, lichens, mosses, microfungi, and other bacteria (Belnap *et al*. 2001). They reduce wind and water erosion, fix atmospheric nitrogen, and contribute to soil organic matter (Eldridge and Greene 1994). They are a rough carpet on the ground surface, and their below ground components form a matrix that binds soil particles together (Belnap 1995).

Biological soil crust cover is poorly developed in most areas of the Project Area primarily due to extensive cattle grazing activities. The loam soils had an average crust cover of 5% ranging from 0 to 33% for 16 sample points taken in the Project Area. Cover was patchy and predominantly a weak cover of cyanobacteria with trace amounts of moss and lichen. The soils derived from shale had an average crust cover of 12% ranging from 1% to 30% for 6 sample points. Again, cover was patchy, often associated with hummocks or rocky patches in the terrain and dominated by a weak cover of cyanobacteria with smaller amounts of moss and trace amounts of lichen. However, cyanobacteria-dominated biological soil crusts that are in a very early successional stage are often present on or just below the soil surface, but are not readily visible (Belnap 2001, Belnap, pers. comm. 2002).

Therefore the extent of biological soil crusts may be underestimated. Biological soil crusts were essentially absent on the Sheppard soils of the sand dunes. (CANM Ecological Inventory 2001).

b. Environmental Consequences

(1) Proposed Action

Vehicular traffic can rapidly destroy cryptogrammic crusts (biological soil crusts) (Johansen and Rushforth 1985, Belnap *et al*. 1994). Where vehicles come in contact with such crusts, vehicle travel would disturb the biological soil crusts that occur on the soil surface of the project area. The weight of the vehicles and their tire action would crush the crusts and break them apart, overturn them, and bury them to various degrees (Belnap 2002, Belnap, pers. comm. 2002). Impacts to crusts would be greater the more times vehicles pass over the same crust. The severity of the disturbance to crusts from four vehicles proposed to be used in this alternative is expected to be severe based on a rating system that rates crusts that are only crushed as slight; crusts that are crushed, broken apart, and somewhat displaced (less than 50% overturned and buried) as moderate; and crusts that are crushed, broken apart, and greatly displaced (more than 50% overturned and buried) as severe. Impacts to crusts at the source points where vibrating pads are placed on the soil surface would be slight to moderate. Although impacts to biological soil crusts would occur as described above, these impacts would be realized on small amount of the ground surface of the project area (slightly less than two percent). The overall adverse ecological effects to biological soil crusts and the ecosystems they are a part of would be minimal, and should not affect the important ecological functions those crusts perform in the Project Area.

Recovery rates for biological soil crusts are dependent on many factors including disturbance type, severity, and extent; vascular plant community structure; adjoining substrate condition; inoculation material availability; and climate during and after disturbance (Belnap *et al*. 2001). Cyanobacteria-dominated crusts, the most common ones in the project area, are the most resistant to mechanical disturbance, are highly mobile, and can recolonize disturbed surfaces rapidly (Belnap *et al*. 2001, p. 49). A study on the Colorado Plateau reported recovery rates of 14 to 34 years after a severe disturbance (scalped plots) to cyanobacteria-dominated crusts (Belnap*, et. al*. 2001, p. 56). Research on biological soil crusts in the Moab, Utah area indicates recovery rates of soil crusts at an advanced successional stage after severe soil surface disturbance ranging from 50 to 300 years (Belnap, pers. comm. 2002). Considering that this project area occurs on the Colorado Plateau in a similar environmental setting (climate and soils) to the research sites, it is likely that the recovery rates for the projected moderate-severity disturbance to the biological

soil crusts in this project area following the proposed action would be less than 50 years, at least for the cyanobacteria-dominated crusts. Recovery rates for the other more complex biological soil crusts of the project area would likely be longer due to their higher susceptibility to mechanical disturbance and their more advanced successional stage (Belnap *et al*. 2001).

(2) Shot Hole/Helicopter Alternative

Effects to biological soil crusts would be minimal since vehicle activities take place on existing, closed, and tertiary roads. There would be some slight to moderate severity disturbance (crusts that are crushed, broken apart, and somewhat displaced) to biological soil crusts from trampling by people and from the drilling equipment at the source points, but it would be minimal. Impacts to crusts would be realized on a small amount of the ground surface of the project area (slightly less than one percent), so the overall adverse ecological effects to biological soil crusts and the ecosystems they are a part of would be minimal, and should not affect the important ecological functions those crusts perform in the project area.

(3) Shot Hole/Buggy Alternative

Effects to biological soil crusts would be similar to the Proposed Action.

(4) Existing Roads Alternative

Effects to biological soil crusts would be minimal since vehicle activities take place on existing, closed, and tertiary roads.

(5) No Action Alternative

This alternative proposes no activities, so there would be no effects to the biological soil crusts of the project area.

## 7. Groundwater

a. Affected Environment

Shallow groundwater aquifers occur throughout the Project Area. These aquifers support the wetland/riparian vegetation zones found in drainages in the area.

b. Environmental Consequences

(1) Proposed Action

This alternative would have no impact on local hydrology and water rights for the following reasons. The energy source from the vibroseis buggies does not impart sufficient energy to alter the shallow aquifers feeding local springs and seeps. Routes were selected to provide sufficient offset to known archaeological sites to avoid surface disturbance, and this offset would be sufficient to protect the springs and seeps near these sites. The setting of geophones would not affect the hydrology and water rights because this activity has no intrusive effect on surface water features. Setting geophones near springs and seeps or crossing streams on foot would have no impact on the environment.

(2) Shot Hole/Helicopter Alternative

The shot-hole methodology could locally affect hydrologic features such as springs and seeps. The near-surface shocks can cloud the spring water for several weeks, and drill holes can potentially affect the shallow groundwater flow near these features. Drill holes may penetrate underlying confining strata, which would allow groundwater to drain downward, not flow laterally to a spring or seep. Another potential impact to hydrology would be if the shot-holes penetrate artesian aquifers, providing a groundwater discharge point that may intercept the normal flow of groundwater.

Shot holes could also affect water rights, particularly if there are any changes in the shallow groundwater flow regime. By altering the groundwater flow regime, some shallow wells, seeps and springs may be affected. If these water sources have assigned water rights, then changes to groundwater flow may affect water rights.

The Colorado Oil and Gas Commission regulates the drilling of shot holes. When water is encountered, bentonite would be used to plug the hole up to ten feet above the static water level or to a depth of three feet from the ground surface. If artesian flow is encountered, the hole would be plugged to the surface or at least 50 feet above the static water level with either cement or bentonite. The operator is also required by the Colorado Oil and Gas Commission to inspect the hole after several weeks to ensure that the hole has not resumed flowing. With these requirements, only minimal impacts to groundwater are anticipated under this alternative.

(3) Shot Hole/Buggy Alternative

This alternative is anticipated to have similar impacts to groundwater hydrology compared to the other Shot Hole alternative.

(4) Existing Roads Alternative

Similar to the Proposed Action, this alternative is anticipated to have no impacts to groundwater.

(5) No Action Alternative

There would be no impacts to the groundwater resources if this alternative were selected.

**8. Surface Water, Floodplains, Wetland/Riparian Resources**

a. Affected Environment

McElmo Creek, Yellow Jacket Creek, and reservoirs located in sections 3, 12, 13 and 14 of T35N R20W are perennial water sources and support the only wetland/riparian vegetation zones in the project area. Reservoirs are used to water cattle grazing in Rincon Canyon. The floodplains along McElmo and Yellow Jacket Creeks are confined within dry benches formed by erosion in canyon bottoms by stream channels. Other surface water features in the project area consist of ephemeral washes such as Rincon Canyon, which only have surface water during storm events and support a minimal amount of wetland/riparian vegetation.

Wetland/riparian vegetation and floodplain zones in the project area were delineated using USGS digital orthophoto quads (DOQs). Analysis results show that 98% of the wetland/riparian zone falls within 350 feet of the perennial water sources. Source points and vehicle routes have been identified by the operator and have been reviewed by the BLM for vibroseis or shot hole activity depending on the alternative. There are 1,151 source points identified in the project area, approximately 40 source points are located within 350 feet of perennial water sources.

b. Environmental Consequences – Surface Water and Flood Plains

(1) All Actions Alternatives

For all alternatives, surface water quality impacts would be limited to the potential for small-localized erosion resulting in immeasurable increases in total suspended sediment in McElmo Creek. The potential for erosion would be small and localized because the vibroseis trucks and vehicles used for shot-hole activities are equipped with low impact tires and operations would be taking place in dry weather. Sediment delivery to water bodies would be low, since the operators would not travel on slopes greater than 40 percent, and would avoid perennial water features except in locations where an on-site impact analysis has been performed. Wind blown sediment from the disturbed vehicle routes and/or staging areas would be the

primary source of increased sediment in water bodies for all activities, but this would be very slight.

There are two perennial water crossings that would be used for all the action alternatives. One crossing is on an existing BLM road (McElmo Creek), and the second is on an old ranching road (Yellow Jacket Creek). Both crossings would have a limited impact on surface water quality due to the disturbance of the channel bottom by vehicle traffic. These crossings have an increasing potential for impacts with more vehicle use.

There would be no measurable change in surface water quantity since there is no proposed surface water use for any of the alternatives and Colorado Well Permits require sealing aquifers with bentonite when shot hole wells contact groundwater (see Groundwater section).

For all alternatives, impacts to floodplains would be limited to vegetation disturbance and compaction from vehicles traveling to source points. Many of the vehicle routes in floodplains follow existing ranching roads. There are approximately seven routes that would require vehicles to cross the main channel in Rincon Canyon and crossings in smaller washes throughout the project area. Four of these routes use existing roads and the other three do not have wetland vegetation present. Floodplains in ephemeral dry washes such as Rincon Canyon would not be impacted by vehicle travel since operations would be suspended during inclement weather and when water is present in channels.

c. Environmental Consequences - Wetlands/Riparian Vegetation Zones

(1) Proposed Action

The environmental consequences to wetland/riparian vegetation zones in the project area would be limited to short-term impacts to wetland/riparian vegetation along receiver lines and vehicle routes, soil compaction during vibroseis activity, and the potential for localized erosion from vehicles.

Based on an on-site impact analysis performed in February 2002 and the DOQ analysis mentioned previously, it was determined that a no-activity buffer of 350 feet is adequate to protect wetland/riparian vegetation in this project area (Note: for streams the buffer is measured from the center of the channel on both sides, i.e. 700 ft total width). Exceptions within this buffer have been addressed individually during site visits with consideration given to degree of slope, soils, vegetation and other resource values. Appendix 2 provides a table listing the source point locations in which exceptions to this 350-foot buffer would be allowed.

Most of the 40 source points and vehicle routes within the 350-foot buffer are on dry benches above the riparian vegetation zone. Out of 40 source points evaluated, four had vehicle access routes that were on steep slopes near the stream channel and/or were in the wetland/riparian zone. Based on the on-site impact analysis performed in February, one of the source points would have the access route changed from the original route proposed (61756043) and the other three (61956069, 61956070, 61956071) would be relocated or dropped from the survey (See Appendix 2).

The Yellow Jacket Creek crossing has a small area near the creek where willows cannot be avoided by vehicles. The presence of these willows is due to infrequent use of this ranch road. Along this same crossing there are a number of small cottonwoods that have been flagged and can be easily avoided by vehicles.

There would be a short-term impact to wetland and riparian vegetation along receiver lines laid by hand crews traveling through dense vegetation. These impacts would be similar to wildlife or livestock travel and would result in broken branches and trampled vegetation that should recover in at most two years. The crews would not be allowed to remove or thin vegetation and helicopter support for receiver lines would be limited to areas outside the 350-foot buffer. Equipment can be dropped within the buffer but outside the riparian zone with prior approval from the BLM.

(2) Shot Hole/Helicopter Alternative

Surface impacts to wetlands/riparian areas would be less under this alternative then they would be under the Proposed Action because of the reduction in vehicle traffic. However, impacts would be not substantially less since there is a potential for vehicle travel to support drilling operations, the receiver lines would be laid in the same method, and there are potential impacts from drilling wells.

There is a potential for limited subsidence around well locations and localized changes to subsurface water flow paths using the shot hole method. Since the alluvial aquifers supporting riparian vegetation are generally in unconsolidated material, drilling and explosives can cause temporary cavities to form. Colorado Well Permit regulations require the operator to plug the top of the well with native material and/ or well cuttings from 3 feet below the ground surface and to mound the fill on the soil surface to account for subsidence. These regulations should be adequate to protect most well locations.

Wetland/riparian vegetation is supported by water tables near the soil surface. There is the potential for impacts to subsurface water flow paths from well drilling. Colorado Well Permit Regulations require the operator to fill the well with bentonite to 10 feet above non-artesian aquifers and 50 feet for artesian aquifers. These regulations are designed to protect changes in subsurface water flow and should be adequate to protect water tables that support wetland/riparian vegetation.

(3) Shot Hole/Buggy Alternative

Impacts to wetlands/riparian areas would be similar to the Proposed Action with the addition of potential impacts including surface subsidence around wells and changes in subsurface flow paths from the shot hole method.

(4) Existing Roads Alternative

Impacts to wetlands/riparian areas would be the least under this action alternative. This alternative would include both stream crossings mentioned in the Surface Water section since they are on existing roads and trails, but would eliminate 30 of the 40 sites closest to perennial water features addressed in the Proposed Action.

(5) No Action Alternative

There would be no additional impacts to wetlands/riparian areas under this alternative.

## 9. Vegetation

a. Affected Environment

About half of the analysis area (5,401 acres BLM, 1,138 acres private ownership) has shallow soils derived from Morrison shale. Ecological sites are Saltdesert Breaks and Clayey Saltdesert (Cortez Soil Survey). At potential, these sites are dominated by a saltdesert shrub community of shadscale saltbush (*Atriplex confertifolia*), fourwing saltbush (*Atriplex canescens*), spiny hopsage (*Atriplex grayia*), greasewood (*Sarcobatus vermiculatus*), big sagebrush (*Seriphidium tridentatum*), alkali sacaton (*Sporobolus airoides*), galleta grass (*Hilaria jamesii*), Salina wildrye (*Leymus salina*) and Indian ricegrass (*Achnatherum hymenoides*). These sites are found predominantly in the large basin areas within the analysis area.

About 45% of the area (4,050 acres BLM, 1,852 acres private ownership) has deeper loam soils of eolian origin. The ecological sites are Alkali Flat, Alkali Bottom and Shallow Desert and at potential will support a grassland community with a light scattering of saltdesert shrub species. These sites have a higher productivity than the shale derived communities. They are found on the mesa tops and along the upper portions of Rincon canyon.

Existing vegetation conditions for these ecological sites is quite different than the potential. Site conditions are not achieving nor are they moving toward Public Land Health Standards for "upland soils" or for "healthy and productive plant and animal communities". Loam sites are dominated (over 75% of the vegetative cover composition) by annual grasses and forbs particularly cheatgrass (*Anisantha tectorum*), six-weeks fescue (*Vulpia octoflora*) and fillaree (*Erodium cicutarium*). Shale derived sites are similar with over 60% of the composition made up of weedy alien annuals. There are typically remnants of the native grasses galleta grass and alkali sacaton and a light cover of shadscale, spiny hopsage (*Atriplex grayi*), wolfberry (*Lycium pallidum*) and big sage.

Small, scattered sand dunes make up small portion (3%) of the area (126 acres BLM and 235 acres private ownership). These dunes support a vegetative community with species that are unusual to this area. Some of the dunes are stable with a moderately high cover of sand dropseed (*Sporobolus cryptandrus*) and cheatgrass, others are more unstable with patches of exposed sand intermixed with sand sage (*Oligosporus filifolius*) and Indian rice grass. The unstable dunes have patches of sandhills muhly (*Muhlenbergia pungens*), which until rangeland health surveys in 2001 was only documented in Colorado in Moffat County, and individuals of sanddune skyrocket (*Ipomopsis gunnisonii*), a species specific to sandy areas in the Four Corners.

Less than 3% (147 acres BLM, 315 acres private ownership) of the area is riparian.

The river bottom in McElmo Creek and Yellow Jacket Creek supports a Cottonwood community dominated by sandbar willow (*Salix exigua*), tamarisk (*Tamarix ramossisima*) and Russian olive (*Elaeagnus angustifolia*) with patches of cottonwood (*Populus deltoids*). The noxious weed Russian knapweed (*Acroptilon repens*) is common throughout the riparian areas.

Bare soil is typically high on all sites, averaging 45%. The shale sites often have a scattered covering of gravel, averaging about 20%, which provides cover to the bare soil. In 2001, production averaged 200 pounds per acre dry weight on the shale sites and 450 pounds per acre on the loam sites. This is about 70% of the potential for these sites in an average year.

A Rangeland Health Evaluation was conducted in the Project Area during the summer of 2001 (data available at the Dolores Field Office). Three attributes (soil and site stability, hydrologic function, and biotic function) were evaluated as to the degree of departure from expected site conditions. (Pellant et al, 2000). The two ecological sites (shale and eolian loam) were evaluated based on the degree of departure from expected site conditions as follows: "none", "slight to moderate", "moderate", "moderate to extreme" and "extreme". Within the Project Area, the attributes were rated as follows:

- Soil and Site Stability – On the soils derived from shale the ecological sites had a "moderate" degree of departure from expected conditions, soils derived from eolian loam had a "moderate to extreme" rating.

- Hydrologic Function – Both soil types rated "moderate".

- Biotic Function – Both soil types rated "moderate to extreme".

There are five long-term trend studies within the project area that were established to monitor changes in vegetative composition due to livestock grazing. Trend studies are typically monitored every five years. Rangeland trend studies in the project area show static to downward trend with a loss of cool season and native perennial grass species. (Wallace Permit Reissuance EA, on file Dolores Field Office). The integrity of these trend studies will need to be protected by avoiding surface disturbance in the areas where vegetation is measured.

b. Environmental Consequences

(1) Proposed Action

Shrub species such as spiny hopsage, four wing saltbush, greasewood, shadscale, and big sagebrush are one to four feet tall with brittle woody stems. With repeated vehicle passes and vibrator pad compaction such as would occur with this alternative, these shrubs would in most cases be damaged severely enough to cause mortality. Spiny hopsage, shadscale, greasewood, and big sagebrush are not sprouting species, so they would not sprout back and would only regenerate through seed. A field review of seismic activities completed in 1995 in the same area and vegetation types showed dead shrubs where the vehicle tires passed over them (Stewart field review 3/20/02). The dead shrubs are not obvious and over the last seven years the surrounding vegetation has filled in.

Vegetative types on soils derived from shale have a light shrub cover. The dominant shrubs are Gardner's saltbush (*Atriplex gardneri*) and mound saltbush (*Atriplex obovata*), which are shorter and more flexible and may be able to withstand one or two vehicle passes.

For perennial bunch grasses, some individuals may be impacted with repeated vehicle passes, which would disturb root masses. Overall these species would slightly decline in the analysis area. During the review of the 1995 activities, there were no obvious remaining impacts to vegetation on these sites. Perennial rhizomitous grass species would be impacted for one growing season, but would probably survive the impact because of their spreading root structure. Alien annuals such as cheatgrass and fillaree are invasive on these sites and after the project would probably increase in response to the disturbance.

The Sheppard soils that form the small sand dunes are easily disturbed. During the 1995 seismic project, one small dune was crossed. On this dune, vibroseis vehicles became stuck where they traversed a short steep slope. The tracks have not revegetated. Where vibroseis vehicles crossed flat and well vegetated sections the tracks were less noticeable, shrubs had been killed but herbaceous vegetation had recovered. (Stewart field review 3/20/02)

In this harsh environment with low and unpredictable precipitation, shrub re-establishment and growth is very slow. Considering the land health conditions in this area, shrub re-establishment would occur at an even slower rate.

Two of the standards for rangeland health, upland soils and healthy and productive plant and animal communities, are not being met nor are these indicators making

significant progress towards meeting the standards for a healthy watershed. Small portions of the project area would suffer a temporary decline in vegetative cover. Although the affected area is small, the widespread impacts associated with the Proposed Action would not contribute in a positive way to recovery of a higher standard of rangeland health.

Reseeding with native species in this environment has had limited success in the past. Competition with high densities of alien annual species such as cheatgrass and fillaree prevents the establishment of perennial grass seedlings (Rafferty and Young, 2002). Low, unpredictable precipitation and high winds also contribute to a low probability of success. The best chance for success and the greatest need for reseeding would be on the deeper loam soils of the mesa tops. Drilling or burying the seed with a small harrow would increase seeding success but should only be done if the disturbance is severe enough to merit the greater disturbance of harrowing, and introducing species from non-local genetic sources. Larger disturbance areas such as vehicle turn around locations would have greater need for rehabilitation. Smaller linear disturbance features would most likely reestablish in cheatgrass quickly due to seed sources closely surrounding the areas. These areas would have a lower priority for rehabilitation.

After the project is complete, off road vehicles may illegally travel on source lines, using some of the new routes and newly re-opened roads preventing the reestablishment of vegetation.

(2) Shot Hole/Helicopter Alternative

Impacts to vegetation would be less under this alternative than the Proposed Action because of the reduction of activities on off road routes.

Vehicle use of closed and tertiary roads would occur and would return conditions on these routes to an opened road condition. Sections of these routes where shrubs, grasses and biological soil crusts have begun to reestablish would be returned to bare conditions. Appearance of the routes would be similar to open routes and unauthorized vehicle use after the project may increase.

(3) Shot Hole/Buggy alternative

Impacts to vegetation would be similar to the Proposed Action. A single shot hole buggy would be used rather than four vibroseis vehicles but more vehicle pass would be necessary making the impacts similar.

(4) Existing Roads Alternative

Impacts to vegetation would be minor under this alternative, because vehicle traffic would be confined to existing disturbed areas.

Vehicle use of closed and tertiary roads would occur and would return conditions on these routes to an opened road condition. Sections of these routes where shrubs, grasses and microbiotic crusts have begun to reestablish would be returned to bare conditions. Appearance of the routes would be similar to open routes and unauthorized vehicle use after the project would increase.

(5) No Action Alternative

There would be no change to current vegetation conditions in the analysis area due to seismic activity.

## 10. Threatened, Endangered and Sensitive Plants

a. Affected Environment

There are no Threatened or Endangered plant species nor habitat for these species in the analysis area.

There are no known locations of BLM Sensitive plant species within the analysis area but there are locations nearby. Within a few miles, to the south of the analysis area, there are several locations of Cronquist milkvetch (*Astragalus cronquistii*). Within a few miles, to the east of the analysis area, there is a population of Jones blue star (*Amsonia jonesii*) and several populations of Naturita milkvetch (*Astragalus naturitensis*).

Potential habitat exists for the following sensitive species in the Project Area:

***Amsonia jonesii*, Jones blue star**

Found on runoff-fed draws on sandstone in pinyon-juniper, and desert shrub communities from 3,900 to 7,000 feet. This species flowers in late April through early May.

***Astragalus cronquistii*, Cronquist milkvetch**

Occurs on sandy and gravelly ridges on red sandstone. Also on Mancos Shale and

on substrates derived from the Morrison Formation in the eastern part of its range at elevations of 4800 to 5800 feet. This species flowers in late April through May and goes to fruit in May. Montezuma County, Colorado, San Juan County, Utah.

***Astragalus naturitensis*, Naturita milkvetch**

Occurs on sandstone mesas, ledges, crevices and slopes at elevations from 5,000 to 7,000 feet. Blooms in April through early June. New Mexico, Utah and in Mesa, Montezuma, Montrose and San Miguel Counties Colorado.

***Epipactis gigantea*, Giant helleborine**

Found in seeps on sandstone cliffs and hillsides at elevations of 4800 to 8000 feet. Flowers June through July. Found in Archuleta, Chaffee, Delta, Moffat, Montezuma, Montrose and Saquache Counties Colorado, and San Juan County, Utah.

***Erigeron kachinensis*, Kachina daisy**

Saline soils in alcove and seeps in canyon walls at elevation of 4800 to 5600 feet. Flowers May through July. Montrose County, Colorado, San Juan County, Utah

*Mimulus eastwoodiae*, **Eastwood monkey-flower**

Shallow caves and seeps on canyon walls at elevations of 4700 – 5800 feet. Blooms late July to early September. Found in Delta, Mesa, Montrose and San Miguel Counties, Colorado, and San Juan County, Utah.

b. Environmental Consequences

(1) Proposed Action

If there are occurrences of *Epipactis gigantea, Erigeron kachinensis,* or *Mimulus eastwoodiae* in the analysis area they are not likely to be impacted due to their habitats in seeps of canyon walls.

If there are occurrences of *Astragalus cronquistii*, *Astragalus naturitensis,* or *Amsonia jonesii* in the analysis area, any off-road activity is likely to impact individuals. These are perennial forbs that would resprout from the roots if surface disturbance is limited and roots are not disturbed. If roots are disturbed it is likely that the individual plants would be killed. Flowering and seed production would be disrupted for one growing season. The projected low percentage of ground disturbance (2% of the project area) coupled with the avoidance measures contained in Appendix 1 relating to sensitive plant species would result in minimal impacts to

these species.

(2) Shot Hole/Helicopter Alternative

The potential for impacts to *Astragalus cronquistii* would be lower under this alternative as compared to the Proposed Action. While there is still the potential that some individuals could be impacted due to the placement of geophones and drill holes, the overall likelihood of impact to the species or habitat is insignificant.

(3) Shot Hole/Buggy Alternative

Potential impacts to sensitive plant species would be similar to the Proposed Action.

(4) Existing Roads Alternative

Potential impacts to sensitive plant species would be the least under this action alternative because surface disturbance would be confined to existing roads and trails.

(5) No Action Alternative

There would be no additional impacts to sensitive plant species under this alternative

## 11. Threatened, Endangered and Sensitive Wildlife Species

a. Affected Environment

The Project Area falls within the range of several listed Threatened or Endangered Species. The Project Area does not provide suitable habitat for the following listed species: Mexican spotted owl, black-foot ferret, or Canada lynx. Bald eagles are occasionally seen foraging along McElmo Creek during the winter but are not known to nest within the vicinity of the project so there should be no effect on bald eagle. The black-footed ferret's historic distribution included southwest Colorado but there are no known ferrets currently occupying this area (Fitzgerald et al. 1994).

Habitat has been identified in McElmo and Yellowjacket Creeks as suitable and potential habitat for the threatened southwestern willow flycatcher habitat and surveys have been conducted in areas of both creeks. (Bob Ball, pers. comm). No southwestern willow flycatchers have been located to date.

Since no water depletions would occur, there would be no effect to listed Colorado River drainage fishes.

Three candidate species may occur in this area: yellow-billed cuckoo, Gunnison's sage grouse, and the boreal toad. The yellow-billed cuckoo and boreal toad are rare and not likely to be found in this ecosystem. There is no suitable habitat for these species within the project area. The project area falls within the historic range of the Gunnison's sage grouse. No grouse are known to occur and no suitable habitat is within the project area.

The ferruginous hawk, a BLM-listed sensitive species, is uncommon to fairly common during the winter in southwest Colorado (Andrews and Righter 1992). Foraging birds may be disturbed by this project if it occurs during the winter months.

The longnose leopard lizard is on the State Director's Sensitive Species List but was incorrectly omitted from the San Juan Resource Area. Until the list is corrected, it is being considered sensitive for this Resource Area. It was identified in the CANM proclamation. This lizard is known to occur in southwest Colorado and was observed in the Project Area on Hamilton Mesa (Leslie Stewart, pers. comm). Habitat for the leopard lizard is flat or gently sloping shrublands with a large percentage of open ground. Hammerson (1999) describes other habitat associations in southwest Colorado including areas along the Dolores River where leopard lizards inhabit areas with sandy-rocky soils and scattered sagebrush, junipers, and skunk brush in canyon bottoms. Other habitats within Montezuma County include mesa tops above canyons. These habitats are found within the project area, mostly north of Rincon Canyon. Like the desert spiny lizard, the longnose leopard lizard has a small home range from 1.6 to 6 acres in size (Hammerson 1999). It is slightly more limited in its activity period (from May to early August) and they have an unwary behavior, which makes them vulnerable to human exploitation (Hammerson 1999).

The desert spiny lizard is also on the State Director's Sensitive Species List, and is listed in the CANM proclamation. It is likely to occur within the project area. The primary period of activity is from May to September with some activity in April and October, during warm weather (Hammerson 1999). Habitat includes shrub-covered dirt banks and sparsely vegetated rocky areas near flowing streams or arroyos (Hammerson 1999). Courtship takes place in May and hatchlings first appear in early August. Adults stay within a small home range (1.6 to 6 acres) from year to year (Hammerson 1999). Similar to the longnose lizard, Rincon Canyon and areas to the north have suitable habitat for this species.

The Mesa Verde night snake is not on the State Director's Sensitive Species List

and may be found in the Project Area. This snake inhabits landscapes (rocky slopes and canyons) that are generally not suitable for extensive development (Hammerson 1999). These types of landscapes would also not be traversed by the seismic vehicles. Hammerson (1999) stated that the habitat for this snake is largely intact and not threatened, and the distribution of this snake in western Colorado is probably more extensive than is now known.

b. Environmental Consequences

(1) Proposed Action

Because no riparian vegetation would be removed, the BLM has determined that the Proposed Action or the alternatives would have no effect on the southwestern willow flycatcher. No consultation would be required with the U.S. Fish and Wildlife Service.

If this activity is conducted during the late spring/early summer, there may be impacts to the desert spiny and long nose leopard lizards since vibroseis vehicles would be traveling across country and potentially damaging habitat by crushing burrows and/or harming individual animals. There is potential for an individual to be crushed by the vehicle, particularly the leopard lizard, which is typically unwary of human activity. To minimize impact due to crushing burrows and harm to individuals of the species, a requirement would be placed on the operator to have a wildlife monitor accompany vehicles traveling off road from Rincon Canyon north to the edge of the Project Area. With this requirement and given the low percentage of land disturbed (2%) under this alternative, impacts to these two lizard species are anticipated to be insignificant.

(2) Shot Hole/Helicopter Alternative

This alternative would have negligible impacts to threatened, endangered, and sensitive wildlife species. Activities during the spring and summer months could disturb the desert spiny and longnose leopard lizard but there would be less likelihood of direct harm since the lizards are more active and there would be no cross-country travel into suitable habitat.

(3) Shot Hole/Buggy Alternative

The leopard lizard and desert spiny lizard may be affected by this alternative since the portable rig would be driving over source lines repeatedly to complete the testing. Burrows used by these lizards along the line of traffic would likely be crushed and unusable upon completion of the project. This may result in displacement of animals. The requirement of the operator to have a wildlife monitor, as described in the Proposed Action, would also be required in this alternative.

(4) Existing Roads Alternative

There would be no impact to threatened, endangered, or sensitive wildlife species under this alternative since activities would be restricted to existing roads.

(5) No Action Alternative

There would be no effect of this proposed project on threatened, endangered, or sensitive wildlife species.

**12. General Wildlife Species**

a. Affected Environment

Within the project area no habitat for any general wildlife species is considered limited or critical (e.g. critical or severe big game winter ranges). This area is not designated deer and elk winter range under the 1984 RMP. Resident deer can be found within and adjacent to the project area. Wintering deer also utilize the area. Elk are rare in this area and would be limited by insufficient cover for winter and little summer forage.

Several species of reptiles and amphibians are likely to be found within the project area including the bull snake, striped whipsnake, red-spotted toads, and collared lizards. Most are either highly mobile, have a large home range, or are likely to be found in riparian areas where there would be no impacts from this project.

Birds within the project area are typical of those associated with shrubsteppe habitats. According to Bock et al. (1993), the most important shrubsteppe neotropical migrant birds are horned lark, sage thrasher, Brewer's sparrow, vesper sparrow, and western meadowlark, all of which are ground nesting birds. The sage thrasher and Brewer's sparrow are more linked to sagebrush communities and have

not been located during casual bird counts (Leslie Stewart and Cliff Stewart pers. comm). Other neotropical birds that have been noted in the vicinity include the uncommon black-throated sparrow, gray flycatcher and gray vireo; and the more common Bewick's wren, black-throated gray warbler, blue bird, Say's phoebe, and ash-throated flycatcher. Birds in this environment are primarily influenced by extreme and irregular fluctuations in precipitation and ecosystem productivity. As a result, they are highly opportunistic and ecologically adaptable (Bock et al. 1993).

Other mammals that may be within the project area include: red and gray fox, raccoon, desert shrew, possibly the Merriam's shrew, jackrabbit, desert cottontail, chipmunks, ground squirrels, prairie dogs, woodrats, several species of mice, and ringtail (Fitzgerald et al. 1994).

b. Environmental Consequences

(1) Proposed Action

If the project were conducted during the late fall and winter months, there would be negligible effects to individual animals since the migratory birds would be gone and lizards/amphibians hibernating.

If these activities were conducted in the spring and/or summer there would likely be impacts to several species. The vibroseis vehicles may destroy bird nests found on the ground and in low growing shrubs during the critical months of May and June, when most nesting is likely to occur. Disturbance from the combined activities may cause some birds to abandon their nests. Although renesting attempts are likely, these generally result in smaller clutch sizes and lower fledgling success (Chris Schultz, pers. comm). Burrows that serve as refuge for reptiles, amphibians, and small mammals may be compacted by the vehicles or the vibrating plate. While the seismic activities may result in the loss of some wildlife individuals, the low percentage of land disturbed would impact a small percentage of the population and suitable habitat. Given the small percentage of land impacted and the secure population status of these species, potential impacts to general wildlife species are considered insignificant.

During the operations of this project, deer may be disturbed or displaced from the area. They would return upon completion of the project.

(2) Shot Hole/Helicopter Alternative

Under this alternative, there would be little impacts to terrestrial wildlife. The helicopter would disturb birds but that should be limited to the immediate vicinity of the work. If this project were conducted in the late spring/early summer, there would be possible disturbance to nesting birds. This disturbance would be short-lived and unlikely to cause nest failures.

This alternative would have little impact on reptiles except those individuals found within the immediate vicinity of the shot-holes. Those animals would likely leave the vicinity but could retreat to nearby burrows and be disturbed or injured by the detonation.

Deer are highly mobile and easily disturbed. They would retreat a safe distance from the activity and disturbance. Other mammals would also disperse and be likely to return to the area once operations have been completed.

(3) Shot Hole/Buggy Alternative

This alternative would result in repeated trips by the portable rig for the duration of the project, which would have a greater impact than the explosives. If the project is conducted during the late fall and winter months, there would be negligible effects to individual animals since the migratory birds would be gone and lizards and amphibians would be hibernating.

If these activities were conducted in the spring and/or summer there would likely be impacts to several species for the duration of the project similar to those described in the Proposed Action.

(4) Existing Roads Alternative

There would be negligible effects to the species described above. Since vehicles would be restricted to roads, there would be the potential for disturbance in areas immediately adjacent to the roads. Individuals are likely to retreat to safe refuges and be unaffected by the activities. Animals along existing roads are also likely to be accustomed to a certain amount of traffic. Activities on tertiary and closed roads may be more likely to disturb animals since there would be some traffic.

(5) No Action Alternative

There would be no impacts. Management activities would remain unchanged within the Project Area.

**13. Invasive Non-Native Species**

a. Affected Environment

A partial inventory of noxious weeds was conducted within CANM in 2001. The area inventoried included the proposed project area. Within the project area several infestations of Russian Knapweed (*Centaurea repens*) were documented. Russian Knapweed is considered a noxious weed species. These infestations are located on public lands adjacent to McElmo Creek (T.35N., R.20W., Sec. 2, SW¼NW¼) and along an existing road on Hamilton Mesa (T.35N., R.20W., Sec. 1, SW¼NE¼). Russian Knapweed infestations also exist on private lands along portions of McElmo Creek within and adjacent to the proposed project area. Another invasive, non-native is cheatgrass, which is discussed in more detail in the Vegetation section.

Activities with the surface disturbances similar to the Proposed Action have potential to spread of noxious weeds including Russian Knapweed. Ground disturbance and other activities have the potential to encourage weed infestation, and possible off-road travel could infect new areas. Seeds or parts of noxious weed plants may be transported by vehicles traveling through the area increasing the potential for further infestations.

b. Environmental Consequences

(1) Proposed Action

This alternative would have the potential to increase infestation of noxious weeds including Russian Knapweed. Ground disturbance and other activities have the potential to encourage weed infestation, and it's possible that off-road travel could promote weed spread. Seeds or parts of noxious weed plants may be transported by vehicles traveling through the area, increasing the potential for further infestations. The protective measures listed in Appendix 1 would reduce this impact to the level of insignificance.

(2) Shot Hole/Helicopter Alternative

This alternative would reduce the potential spread of noxious weed infestations because there would be no off-road vehicle travel by vibroseis buggies. Shot-holes would be drilled via heliportable drills instead.

(3) Shot Hole/Buggy Alternative

The impacts associated with the spread of invasive, non-native species under this alternative would be similar to the Proposed Action.

(4) Existing Roads Alternative

This alternative would reduce the potential for spread of noxious weed infestations because there would be no off-road vehicle travel by vibroseis buggies.

(5) No Action Alternative

There would be no additional impacts related to the spread of invasive, non-native species under this alternative.

**14. Hazardous or Solid Waste**

Diesel fuel and small amounts of substances such as vehicle lubricating and hydraulic oil would be used in the field during project operations for maintenance of project vehicles under all action alternatives. Inadvertent spillage of these could contaminate natural resources. Vehicle accidents or damage could result in fuel spills. With implementation of the waste disposal measures described in Appendix 1, no significant impact is foreseen under any alternative.

**15. Forestry**

Common to all action alternatives, some light trimming of trees may occur during surveying. Pruning can create beetle infestation sites. Due to the current beetle problems in the area, pruning should be kept to a minimum. All branches that are cut from trees need to be lopped to lie within two feet of the ground surface and be scattered away from the stem of the tree. The spread of the root system of a pinyon tree is within two tree heights of the tree. Running an 18 ton HVII 351 vibroseis buggy with vibrators close to any tree may damage the root system. If the trees root systems become severely damaged the tree may not be able to support all the above ground portions of the tree or may die. Appendix 1 contains the requirement that vehicles stay a minimum of two crown diameters from trees when possible. Given the

scattered distribution of trees in the project area, the rooting depths of these trees, and general resistance of the soil to compaction, as well as the protective measure placed on the Operator, impacts to trees from the Proposed Action or any alternative is considered to be minimal.

## 16. Noise

No specific noise sensitive areas (e.g. sage grouse leks, crucial big game habitat, raptor nest sites, schools, hospitals, residences within or adjacent to the project area) have been identified. Noise levels from the vehicles and/or helicopter would increase in the area for the duration of the project. However, no significant impact is anticipated due to the localized and temporal nature of this project and its associated noise, regardless of the alternative.

## 17. Livestock Grazing

a. Affected Environment

The proposed Project Area encompasses portions of the Lower McElmo, Adam Lewy, Flodine Park, Hamilton Mesa and East McElmo Grazing Allotments. These grazing allotments are administered by the BLM. There are currently six grazing permittees that have grazing permits within the project area. With the exception of the Lower McElmo Allotment, which is currently permitted for domestic sheep grazing, the remaining allotments are permitted for use by cattle. These grazing allotments are permitted for winter and spring use periods, thus grazing is authorized from December through May each year.

b. Environmental Consequences

With the increase in vehicle use associated with the action alternatives there would be an increased potential of gates being left open as well as damage to existing fences. These actions would increase the potential for disruption in livestock control as well as livestock grazing management within the affected allotments. However, it is anticipated that the proposed activity would occur during the time of year when these allotments are not used by livestock.

## 18. Visual Resources

a. Affected Environment

The project area does not fall within any of the Outstanding Scenic Areas (as described in the San Juan/San Miguel RMP, p. 2-50), nor is there current interim management direction specific for visual resources for the CANM. It should therefore be managed as a Class III Visual Resource Management Area. The objectives of this class are to partially retain the existing character of the landscape; the level of change to the landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer (VRM Manual 8410).

b. Environmental Consequences

(1) All Alternatives Except the No Action Alternative

Implementation of any of the alternatives that would allow a geophysical survey to be conducted would attract visual attention during the duration of the project. Activities would not dominate the landscape. Dust would be observed from operations as well as visual site of the vehicles or helicopter. Their presence would be short-termed.

(2) Proposed Action and Shot Hole/Buggy-Transported Drill

Vehicle travel in off-road areas would result in tracks. The development of the track would be directly related to the number of trips that were made on the track. The staggered pattern of vibroseis buggies would result in more, but less developed tracks, as compared to a single-file pattern. The Operator commitment to drive in a weaving pattern would result in a non-linear feature and therefore be less noticeable. Tracks would not dominate the landscape. An observation of a vibroseis project that was conducted in a similar environment near the project area indicates that tracks are not noticeable after seven years.

Some public may ignore the off-road prohibition and drive on the tracks. Any further development of tracks would be directly related to the degree to which the public accessed these tracks. A requirement for the operator to reclaim of the first 50 feet of tracks leading from open roads (see Appendix 1) and the weaving driving pattern should reduce the likelihood that the public would notice the tracks. Impacts to visual resources would be expected to be minimal.

(3) No Action

There would be no changes to the viewshed of the project area.

**19. Public Health and Safety**

a. Affected Environment

The BLM and Montezuma County maintain public roads in the Monument. Some BLM roads have been closed to public use or reclaimed.

b. Environmental Consequences

(1) Shot Hole/Helicopter-Transported Drill and Shot Hole/Buggy-Drill Alternatives

Twenty percent of source points would be located on existing roads. Shot holes would be drilled on these roads. Drilling, setting off of explosives, and plugging of the holes would result in a potential threat to public safety. Safety measures found in Appendix 1 would ensure that public could not access areas where drilling activities were active.

**20. Recreation**

The Project Area does not contain any designated trails and/or recreation sites. There is occasional All-Terrain-Vehicle (ATV) use along the various roads throughout the Project Area. Current guidance and Interim Management for the CANM specific to vehicular traffic states that:

> "… the area will be closed to cross-country, off-road travel by motorized vehicles and mechanical vehicles, including mountain bikes…"

Since the seismic vehicles would be traveling off-road and cross-country, the Proposed Action and the Shot Hole/Buggy alternatives have the potential of creating future travel routes by motor vehicles and off-highway vehicles. To prevent an increase in off-road travel routes, several measures were included in Appendix 1 as requirements for the Operator. They include staying off slopes greater than 40%, preventing tire ruts, weaving travel along the source lines to prevent more noticeable straight-line effects, and rapidly reclaiming soil disturbance along existing roads. With implementation of these requirements, future use of the source lines by public off-highway vehicles should be minimized, which also reduces the indirect impact on cultural, soils, and vegetation resources.

## 21. Socio-Economic

The cost of a 3D vibroseis operation is dependent on many variables, including survey design (number of source points and recording devices, etc.), depth to target geologic formations, environmental considerations, availability of subcontractors, etc. In addition the desire of the operator to protect trade secrets (proprietary information) also makes determination of this project's cost difficult. For comparison purposes in this analysis, information obtained through the Internet was used (www.anwr.org/techno/3dseismi.htm) to provide an estimate of the cost. From this information, the cost of a 3D vibroseis operation was estimated to be about $10,000 per $km^2$, or about $40.50 per acre. Based on this estimate, the total cost for the Proposed Action would run about $516,000. The Lessee estimated that the Shot Hole/Helicopter alternative would cost about 3 to 4 times more than the Proposed Action, or between $1.5 and $2.0 million. The Lessee estimated that the Shot Hole/Buggy Alternative would cost about twice as much as the Proposed Action, or about $1 million.

## 22. Cumulative Impacts

Cumulative impacts are those impacts which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.

In *Southern Utah Wilderness Alliance*, *et. al*, 122 IBLA 165, 168 (1992), the Interior Board of Land Appeals (IBLA) held that a geophysical project and the subsequent drilling of a well in the project area are not connected actions. This is because drilling activity can take place with or without seismic operations, and that seismic activity may lead to no drilling as much as it could lead to drilling. Therefore, drilling subsequent wells in the Project Area is not considered a connected or cumulative action.

No cumulative effect on cultural resources was identified. Cultural site-avoidance, monitoring, and other protective mitigations provided in Appendix 1 should minimize potential environmental impacts associated with the seismic operation. The requirement to inventory areas that have already had disturbance would prevent a cumulative effect from this Proposed Action and alternatives.

The primary existing disturbances in the Project Area are the existing roads and oil and gas development and outdoor recreational use. Of the 12,700 acres within the Project Area, there are about 7 producing wells and about 15 abandoned or dry hole wells as well as about 42 miles of 2D seismic line and about another 42 miles of existing roads (refer to Figures 3 and 4). Total existing soil disturbance is estimated to be about 220 acres (110 acres of well pads, 50 acres of 2D seismic lines, and 60 acres of roads),

which is in various degrees of reclamation and re-vegetation. Added to the anticipated disturbance associated with the Proposed Action (243 acres), there would be a cumulative soil disturbance of 463 acres, or a little more than 3.6 % of the Project Area. This is not considered a significant impact to the soils, biological soil crusts, or vegetation resources.

There would be no measurable increase in soil erosion/stream sedimentation in the affected watersheds. Wildlife species populations would not be significantly impacted from anticipated cumulative effects, due to the overall small percentage of land disturbed and their ability to recover from the projected minimal incidental mortality.

Even with the anticipated increased illegal public off-road use indirectly associated with this geophysical, the incremental decrease in vegetation condition due to the seismic activity is not anticipated to be a significant impact, primarily due to the small percentage of land affected.

## IV. CONSULTATION AND COORDINATION

Consultation with the Colorado State Historic Preservation Office (SHPO) is currently ongoing for this project and will be completed prior to implementation of the Proposed Action or any of the other alternatives.

### Interdisciplinary Team Members

The following personnel from the BLM and US Forest Service provided input into this EA.

Tim Bottomley, Colorado State Office (BLM), Planning and Environmental Coordinator
Don Englishman-San Juan PLC (BLM), Environmental Protection Specialist
Clyde Johnson - San Juan PLC (BLM), Lands & Realty specialist
Helen Mary Johnson – San Juan PLC (BLM), Minerals Supervisor
Matthew Janowiak - San Juan PLC (BLM), Geohydrologist
Mike Jensen – Dolores Field Office (BLM), Range Conservationist
Laura Kochanski-CANM (BLM), Archaeologist
Bob Lange - San Juan PLC (USFS), Hydrologist
Randy Lewis - San Juan PLC (BLM), Environmental Protection Specialist
Kathy Nickell - Dolores Field Office (BLM), Wildlife Biologist
Stephanie Odell - San Juan PLC (BLM), Hazardous Materials and Public Health
Jeff Redders - San Juan PLC (USFS), Soil Scientist
Kelly Shanahan - San Juan PLC (USFS), Watershed and Air Program ManagerLeslie Stewart – Dolores Field Office (USFS), Ecologist
Penny Wu - Dolores Field Office (USFS), Recreation Specialist

# Bibliography

Anasazi ACEC Management Guidelines and Environmental Assessment, July, 1986.

Andrews, A. and R . Righter. 1992. Colorado Birds. Denver Museum of Natural History. 442 pp.

Belnap, Jayne. Personal Communicaiton, April 5, 2002.

Belnap, Jayne 2002. Preliminary Report on the Impacts of Thumper Trucks on Soils in the Big Flat Area.

Belnap Jayne, R. Rosentreter, S. Leonard, J. H. Kaltenecker, J. Williams, D. Eldridge. 2001. Biological Soil Crusts: Ecology and Management. USDI Bureau of Land Management Technical Reference 1730-2.

Belnap, Jayne 1995. Surface disturbances: their role in accelerating desertification. Environmental Monitoring and Assessment 37:39-57.

Belnap, J., Harper, K.T., and S.D. Warren 1994. Surface disturbance of cryptogamic soil crusts: nitrogenase activity, chlorophyll content, and chlorophyll degradation. Arid Soil Research and Rehabilitation 8:1-8.

Binkley, D. et al., 1997. Status of Air Quality and Related Values in Class I National Parks and Monuments of the Colorado Plateau. Colorado State University and National Park Service, pp. 11-1 to 11-21.

Brock, C.E., V.A. Saab, T.D. Rich, and D.S. Dobkin. Effects of livestock grazing on neotropical migratory landbirds in western North America in Finch, D.M. and P.W. Stangel, eds. 1993. Status and management of neotropical migratory birds; 1992 September 21-25; Estes Park, CO. Gen. Tech. Rep. RM-229. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 422 pp.

Chevron U.S.A. Inc., Hunter Creek Exploratory Well: Environmental Assessment and Finding of No Significant Impact, Janauary, 1992. Prepared by PIC Technologies, Inc., for the U.S. Forest Service and the BLM.

Colorado Bird Distribution: Latilong Study, by the Colorado Field Ornithologists: Records as of October 1, 1982, Zoological Collections, Denver Museum of Natural History, Denver, Colorado. Colorado Natural Heritage Program. 2000. CNHP Rare, Threatened, Endangered and Sensitive Species Overlays and Accompanying Reports for the San Juan Field Office.

Copeland, S., K. Savig, and J. Adlhoch, 2001. Integrated Report of Optical, Aerosol, and Scene

Monitoring Data, Weminuche Wilderness 1988-1998. USDA Forest Service and Air Resource Specialists.

Cross Canyon Wilderness Study Area Study Report, BLM.

Eldridge, D.J., and R.S.B. Greene 1994. Microbiotic soil crusts: a review of their roles in soil and ecological processes in the rangelands of Australia.

Environmental Assessment No. CO-030-SJ-93-54: Geophysical Exploration, Western Geophysical's Island Butte 3D project 1993.

Environmental Assessment No. CO-030-SJ-92-8: Geophysical Survey in Cross Canyon and Squaw/Papoose Canyon WSA's, 1992.

Fitzgerald, J.P., C.A. Meaney, and D.M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History and University Press of Colorado. 467 pp.

Hammerson, G.A. 1999. Amphibians and reptiles in Colorado. University Press of Colorado. 484 pp.

Interim Management Policy and Guidelines for Lands Under Wilderness Review (BLM Manual: H-8550-1, 1987).

Haynes, D.D., Vogel, J.D., and D.G. Wyant 1972. Geology, Structure, and Uranium Deposits of the Cortez Quadrangle, Colorado and Utah. Department of the Interior, U.S. Geological Survey.

Introduction to Microbiotic Crusts. 1997. USDA Natural Resources Conservation Service.

Johansen, Jeffrey R. 1995. Cryptogamic Crusts of Semiarid and Arid Lands of North America. Journal Phycol. 29: 140-147.

Johansen, J.R. and S.R. Rushforth 1985. Cryptogamic soil crusts: seasonal variation in algal populations in the Tintic Mountains, Juab County, Utah. Great Basin Naturalist 46 (4): 14-21.

Keys to Soil Taxonomy, Soil Survey Staff, eighth edition, 1998; USDA Natural Resources Conservation Service.

King, Dr. Kenneth, A Vibration Study of the Archaeological Ruins, Hovenweep National Monument, Utah-Colorado, Open File Report 87-181, U.S. Geological Survey, Denver, Colorado. (1987)

Ladyman, J.A.R., and E. Muldavin 1996. Terrestrial Cryptogams of the Pinyon-Juniper Woodlands in the Southwestern U.S.: A Review. USDA Forest Service. General Technical report RM-GTR-280.

McAllister, Martin E., "Areas and Issues in Future Research on Archaeological Resource Protection" in Tools to Manage the Past: Research Priorities for Cultural Resources Management in the Southwest, General Technical Report RM-164, U.S. Forest Service Fort Collins, Colorado. (1988)

National Cooperative Soil Survey. June 2000. Sheppard Series Description found at www.statlab.iastate.edu/soils/osd/dat/S/SHEPPARD.HTML.

National Soil Survey Handbook, Soil Survey Staff, 1993, USDA Soil Conservation Service.

Nickens, Paul R., Signa L. Larralde, and Gordon C. Tucker Jr., A Survey of Vandalism to Archaeological Resources in Southwestern Colorado, Cultural Resource Series No.11, Bureau of Land Management, Denver, Colorado. (1981).

Pellant, Mike, Patrick Shaver, David A. Pyke, Jeffrey E. Herrick. 2000. Interpreting Indicators of Rangeland Health, version 3, technical reference 1734-6, USDI Bureau of Land Management.

Rafferty, Dawn L., and James A. Young. 2002. Cheatgrass competition and establishment of desert needlegrass seedlings. Journal of Range Management 55: 70-72.

Ramsey, Douglas K. 2002. Soil Survey of Cortez Area, Colorado, Parts of Dolores and Montezuma Counties. USDA Natural Resources Conservation Service.

San Juan-San Miguel Planning Area, Wilderness Final Environmental Impact Statement, November, 1990.

San Juan-San Miguel Resource Management Plan and Final Environmental Impact Statement, 1985, BLM.

San Juan-San Miguel Resource Management Plan Amendment and Final Environmental Impact Statement, 1991, BLM.

Spackman, S., B. Jennings, J. Coles, C. Dawson, M. Minton, A. Kratz, and C. Spurrier. 1997. Colorado Rare Plant Field Guide. Prepared for the Bureau of Land Management, the U.S. Forest Service and the U.S. Fish and Wildlife Service by the Colorado Natural Heritage Program.

Spotted Owl Survey Summary Notes, 1991, SJRA, BLM.

Stewart, Cindy L. 1995. 3-D Solutions to 2-D Pitfall: Seismic Dectection of Carbonate Buildups, Kiva Field, Paradox Basin, San Juan County, Utah. High Definition Seismic Guidebook – 1995, p. 177-183.

U.S. Fish and Wildlife letter to Sally Wisely, January 22, 1993.

U.S. Fish and Wildlife letter to Sally Wisely, January 28, 1993.

USDI Bureau of Land Management, Colorado. 1997. Standards for Public Land Health and Guidelines for Livestock Grazing Management in Colorado Environmental Assessment.

USDI Bureau of Land Management, Colorado. 1997. Standards for Public Land Health and Guidelines for Livestock Grazing Management in Colorado Environmental Assessment.

Weber William A. and R. C. Wittmann. 2001. Colorado Flora Western Slope, Third Edition. University Press of Colorado.

Western Regional Climate Center, NOAA, Average precipitation for Hovenweep National Monument, Utah - Station 424100.

# Appendix 1

The following mitigations are common to all alternatives (unless otherwise specified). They are project design features developed to minimize impacts to the environment. They would be required as Conditions of Approval for any forthcoming BLM authorization related to this project.

Cultural Resources Protection

1. Cultural sites with standing architecture will be avoided by 300 feet for vibroseis testing, or by the distance determined to be appropriate based on depth and size of charge for shot hole testing.

2. Cultural sites with rock art will be avoided by 100 feet for vibroseis testing, or by the distance determined to be appropriate based on depth and size of charge for shot hole testing.

3. All cultural sites will be flagged for avoidance.

4. Archaeological monitoring will be required in those instances where geophones must be drilled into hard surfaces.

5. Permitted archaeologists will monitor all project operations including, but not limited to, seismic testing on source lines, helicopter operations, staging activities, and reclamation activities, in order to insure site avoidance and compliance with other protective conditions for cultural resources. A minimum of one permitted archaeologist will be present with each crew working on the source lines. The permitted archaeologist will be responsible for directing proper avoidance of cultural resources during operations, for spot-checking on the operations, and for scheduled and unscheduled field appearance at the level judged necessary to achieve site protection. Permitted archaeologists will also be responsible for assisting with protection of, and identifying and assessing any cultural resources discovered during the operations.

6. If subsurface cultural resources are found during project operations, all work in the vicinity of the resource will cease and the Operator will notify the BLM immediately. The operator will take any additional measures requested by the BLM to protect the resource until it can be adequately evaluated by the permitted archaeologist, and the BLM archaeologist, if necessary.

7. If human remains are encountered during project operations, all work in the vicinity of the remains will cease and the remains will be protected from further exposure or damage. The Operator will notify the BLM immediately.

8. All employees of the operator and any subcontractors must be informed by the operator before commencement of operations that any disturbance to, defacement of, or removal of archaeological, historical, or sacred material will not be permitted. Violation of the laws that protect these resources will be treated as law enforcement/administrative issues. The Operator(s) will be held accountable for the conduct of their employees and subcontractors in this regard.

9. The operator shall take any additional measures requested by the BLM during the course of operations to provide adequate levels of site protection. These may include but are not limited to:

    a. Increased archaeological monitoring
    b. Restrictions on operations due to inclement weather
    c. More frequent compliance checks
    d. Site fencing or use of restrictive barriers
    e. Site damage evaluations
    f. Verification of site locations
    g. Special reclamation measures to reduce erosion or discourage vandalism

10. To adequately avoid cultural resources, all operations (including cultural resource monitoring) on these lines must be completely closed down ½ hour after sunset and must not resume until ½ hour before sunrise. This requirement may be waved if the operator provides adequate changes to their operations that satisfy the BLM's concern that markers designating avoidance areas are visible during low light conditions.

11. Disclosure or release of information regarding the nature and location of archaeological, historic, or sacred sites without written approval by the BLM is prohibited under the provisions of the Archaeological Resources Protection Act. Cultural resource permittees of the BLM are allowed to use this information during the course of their project(s) for site protection purposes only, and unauthorized use or distribution of this information (which includes locational information present in cultural resource reports) is considered a violation of federal statute. The permitted archaeologist shall be bound by the conditions of their permit which stipulates that all information gathered from Federal lands including reports, photographs, maps etc. is the property of the Federal Government and cannot be provided or released to anyone other than the Federal Government land managing agency. Operators may be provided with a copy of the report and/or maps in order to insure proper protection of sites, however, they must assure proprietary protection and cannot release this information to anyone but project personnel to be used during the course of the project.

12. The operator shall rake locations where vibroseis vehicles leave open road routes onto cross-country travel areas, or closed or tertiary roads for a minimum of 50 feet to re-contour the road edge topography and to cover tracks and obvious tread marks in an attempt to

prevent the use of these routes by casual off road users. Sites will be seeded with a seed mix approved by the BLM.

Soils Resource Protection

13. No cross-country travel on slopes greater than 40% by vibroseis and drill-mounted buggies, drill rigs, and/or other motor vehicles. The operator is responsible for identifying and maintaining these restrictions.

14. Operations will be suspended if weather conditions or soil/slope conditions would result in ruts 3" deep or greater. Ruts are measured from the top of the tread indentation to the undisturbed soil surface. Reclamation of any ruts in excess of 3" deep shall include hand-raking and seeding the disturbed area (type of seed mix to be approved by the BLM).

15. Vehicles are not allowed on lands other than roads during periods when Uzacol, Zwicker, and Claysprings series soils are too wet. These soils are too wet when the soil moisture content exceeds the plastic limit. If soils within six inches of the surface can be rolled into threads 3 millimeters in diameter without breaking or crumbling, they are too wet.

16. The operator shall minimize the potential for soil compaction and for impacts to biological soil crusts by minimizing vehicle passes over the same piece of ground.

17. The operator shall educate field crews in the identification of biological soil crusts and Sheppard soils prior to project initiation to minimize unnecessary impacts to these areas.

18. The operator shall also avoid spinning the tires of vehicles to minimize the potential for soil displacement and for impacts to biological soil crusts.

19. The operator shall avoid Sheppard soils (small sand dune features), when feasible, by driving around them. If Sheppard soils are disturbed by vehicles and/or vibrating pads, the operator shall fill in tracks and pad locations with adjacent soils using shovels or rakes, and replant uprooted vegetation if possible. The work should be done within one day following disturbance.

Water Resources/Wetlands, Riparian Protection

20. With the exceptions identified in Appendix 2, the Operator will be required to establish and maintain 350 ft. buffer zones around perennial surface water features identified in the project area. Any activity within these buffer zones and not listed as an exception in Appendix 2 will require an on-site analysis by the BLM.

21. Vehicles will not cross perennial water features, except on existing roads or at designated crossing areas. A perennial surface water crossing has been identified on Yellow Jacket Creek and is in SWNE of section 34 of T36N 20W. Vehicles will stay between designated

flagging when making this crossing.

22. Washes or alluvial valleys will not be crossed if water is visible in the channel.

23. No wetland/riparian vegetation may be removed during the placement of geophones along recording lines. Helicopter drops of equipment to support recording lines must be outside the 350-foot buffer for perennial water features, unless the drop can be located outside of the riparian zone and only after site-specific approval by the BLM.

Vegetation Resouces Protection

24. The operator will reseed all disturbed areas where BLM has determined that the site will not naturally revegetate in a reasonable time, or that soil stability is threatened. Selected areas will be reseeded by drilling seed with a seed mix approved by the BLM. The BLM may allow the seed to be hand broadcasted and raked if the potential for surface disturbance from bringing in a seed drill would be greater than the area that needed seeding. Native seeds will be used and local varieties will be used where available. Seeding will be conducted in the fall (October). An example seed mix recommended by the BLM is provided below.

| **Common Name** | **Scientific Name** | **Variety** | **Pounds per acre PLS** |
|---|---|---|---|
| Squirrel tail | Elymus elymoides | Bottlebrush | 2 |
| Indian Ricegrass | Acnatherum hymenoides | Rimrock | 5 |
| Alkali Sacaton | Sporobolus airoides | VNS | 2 |
| Sand Dropseed | Sporobolus cryptandrus | VNS | 2 |

**Table 3:** BLM recommended seed list.

25. The operator will clean all off-road equipment to remove seed and soil (may contain seed) prior to commencing operations on public lands within the project area. The BLM will monitor disturbed areas for the spread of noxious weeds and treat infestations as necessary to prevent additional spread.

26. The operator will avoid shrubs to the maximum extent possible be weaving vehicles around shrub patches.

27. The operator will avoid the five long-term trend studies within the project area. The operator will contact the BLM at least 5 days prior to work in the vicinity of a trend plot, so that the BLM can flag the avoidance area.

Sensitive Plant Species Protection

28. If the project occurs after May 1 surveys will be conducted for *Astragalus cronquistii, Astragalus naturitensis,* and *Amsonia jonesii* on appropriate habitats during the blooming/fruiting period. If any of these species are found the locations will be avoided with a 50-foot buffer.

Sensitive Wildlife Species

29. A wildlife monitor will be required to accompany vehicles when traveling off existing roads and trails from Rincon Canyon north to the edge of the project area.

Hazardous/Solid Waste

30. The geophysical operator shall clean up all diesel, hydraulic and lubricating oil, and fuel , or other spills, including the contaminated soils. All spill-related material shall be hauled to an approved disposal site. All solid waste, i.e. flagging and stakes, shall be picked up and removed to an approved solid waste refuse site.

Livestock Grazing

31. All gates within the project area will be left as they are found; i.e. open gates will be left open, closed gates will be closed.

32. If any damage to existing fences occurs as a result of the operations, they must be immediately repaired per approved BLM fence specifications.

33. Removal or alteration of existing range improvements will be prohibited unless prior BLM approval is obtained

Public Health and Safety

34. (Applicable to the Shot Hole Alternatives) Portions of roads would be closed one-half mile on either end of road where drilling activities are expected to be active. Signs will be located at the closest intersections on either side of the next day's planned drilling activities indicating road closures and warning the public that access would be restricted for the next 24 hours.

## Appendix 2

Exceptions to 350-foot Buffer Requirement for Perennial Water Feature and Wetland/Riparian Vegetation.

| Perennial Water Feature | Geophysical Source No. | Description |
|---|---|---|
| Yellow Jacket Creek (N. of McElmo Canyon Road and Yellow Jacket Creek) | 61696039, 61706040, 61726042 | These sites are on ranching roads along a dry bench outside the riparian zone. |
| | 61756043 | This site is located beyond the riparian zone, but has an access route on a steep slope greater than 40 percent. The access route will be changed to avoid this steep slope. |
| | 61896062, 61946063, 61946065 | These sites are on a dry bench beyond the riparian zone. |
| | 61956069, 61956070, 61956071 | The access to the sites is over difficult terrain very close to the riparian zone and stream channel. These three sites will be relocated or removed from the survey. |
| Yellow Jacket Creek (N. of McElmo Canyon Road and S. of Yellow Jacket Creek) | 61786049, 61796050, 61806051, 61806054, 61956077, 61966078 | These sites are on a dry bench beyond the riparian zone. |
| | 62026083, 62026084, 62026085, 62026086, 62026087, 62026088, 62026089 | These sites are along an existing road and will not impact the riparian zone along Yellow Jacket Creek. |
| McElmo Creek (S. of McElmo Canyon Road and N. of McElmo Creek) | 61636039, 61616040, 61616041, 61656066, 61666067 | These sites are mostly on ranching roads along a dry bench outside the riparian zone. |
| Stockpond Reservoir in Sections 13 and 14 T35N 20W) | 61046084, 61046085 | These sites are located in short grass and shrubland below the impoundment and are beyond the wetland vegetation zone. |
| Stockpond Reservoir in Section14 T35N 20W) | 61096079 | This site is on a rocky outcrop beyond the wetland zone. |
| | 61096080 | This site is on an existing road. |

| | | |
|---|---|---|
| McElmo Creek (S. of McElmo Canyon Road and S. of McElmo Creek) | 61626052, 61636053, 61636054, 61649084, 61656085, 61656086, 61656087, 61656088, 61656089 | These sites mostly are mostly on ranching roads along a dry bench outside the riparian zone. |
| Stockpond Reservoir in Sections 13 and 14 T35N 20W) | 61046084, 61046085 | These sites are located in short grass and shrubland below the impoundment and are beyond the wetland vegetation zone. |
| Stockpond Reservoir in Section14 T35N 20W) | 61096079 | This site is on a rocky outcrop beyond the wetland zone. |
| | 61096080 | This site is on an existing road. |