BLM

United States Department of the Interior
Bureau of Land Management

Environmental Assessment for the Colorado Oil Shale Research, Development, and Demonstration (RD&D) Lease Tracts Project

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White River Field Office
220 E Market St
Meeker, CO 81641

DOI-BLM-CO-110-2011-0177-EA

May, 2012

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U.S. Department of the Interior

Bureau of Land Management

ENVIRONMENTAL ASSESSMENT

NUMBER: DOI-BLM-CO-110-2011-0177-EA

CASEFILE/PROJECT NUMBER: Site 1 - COC 74299; Site 2 - COC 74300

PROJECT NAME: Colorado Oil Shale Research, Development, and Demonstration (RD&D) Lease Tracts Project

LEGAL DESCRIPTION:

Site 1 - Lots 1, 2, 3, and 4 of Section 35, T1S, R98W, 6th Principal Meridian, Rio Blanco County, Colorado

Site 2 - Lots 1, 2, 7, and 8 Section 34, T1S, R98W, 6th Principal Meridian, Rio Blanco County, Colorado

APPLICANT:

Site 1: Natural Soda Holdings Inc. (NS)

Site 2: ExxonMobil Exploration Company (EM)

1 INTRODUCTION

1.1 Purpose & Need For The Action

The purpose of the action is to manage the exploration and development of oil shale resources on Public Lands in a manner that avoids, minimizes, reduces, or mitigates potential impacts to other resource values. The Federal Land Policy and Management Act of 1976 (FLPMA) (Public Law 94-579, 43 United States Code [USC] 1701 et seq.) recognizes minerals development as one of the "principal" uses of public lands. Federal mineral leasing policies (Mineral Leasing Act of 1920, 30 USC 181-287) and the regulations by which they are enforced recognize the statutory right of lease holders to develop federal mineral resources to meet continuing national needs and economic demands so long as undue and unnecessary environmental degradation is not incurred.

The Bureau of Land Management's (BLM) need with regard to this project is to respond to the Applicants' requests to acquire RD&D leases covering the subject lands. The Energy Policy Act of 2005, Public Law 109-58, §369(c), codified procedures for leasing the public lands for RD&D projects. Round two leases would contain approximately 160 acres, with an associated preference lease area of approximately 480 contiguous acres, convertible to a commercial lease in the future following a showing by the lessee, that it has produced commercial quantities of shale oil from the lease and additional BLM review in accordance with the regulations in 43 CFR Part 3900. Additional NEPA analysis would be required prior to commercial development of the preference lease acreage.

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Decision to be Made: This Environmental Assessment (EA) analyzes impacts to the quality of the human environment from leasing two tracts nominated by separate commercial entities. Because the nominated lease tracts are adjacent, the BLM determined that preparation of one EA analyzing the environmental consequences associated with leasing both lease tracts is appropriate. The applicants' proposals involve separate methods of shale oil extraction and the EA analyzes two separate Proposed Actions. The Authorized Officer will review the environmental analysis presented in the EA and make separate decisions with respect to each proposal on whether or not the individual RD&D lease would be recommended for issuance by the BLM.

Prior to ground disturbing activities the proponent must submit a detailed Plan of Development (POD) for the BLM's approval. After submittal a NEPA review of POD would occur.

1.2 Scoping, Public Involvement, And Issues

1.2.1 Scoping

Scoping was the primary mechanism used by the BLM to initially identify issues. Internal scoping was initiated when the project (two proposals) and plans for public scoping were discussed with the BLM management team on April 11, 2011; subsequently the project was presented to the White River Field Office (WRFO) interdisciplinary team on August 23, 2011.

External scoping was initiated by posting a description of this project on the WRFO's on-line National Environmental Policy Act (NEPA) register on April 14, 2011 as well as releasing the posting to the press. The project posting announced a public scoping comment period beginning on April 18, 2011 and ending at the close of business on Tuesday, May 17, 2011.

The public posting also announced that public meetings would be held April 27 and 28, 2011,in Rifle, Colorado and in Meeker, Colorado, respectively, where representatives of both companies and the BLM would be available to answer questions about the proposed oil shale leases and activities. Letters containing the dates, time and location of the public meetings along with the location of available information and comment solicitation were sent to four Colorado counties (Rio Blanco, Garfield, Mesa, and Moffat), four Colorado state agencies (Colorado Division of Parks and Wildlife, Colorado Department of Natural Resources, Colorado Department of Public Health and Environment Water Quality Control Division, Colorado Department of Public Health and Environment Air Pollution Control Division), and four federal agencies (Dinosaur National Monument, U.S. Environmental Protection Agency, US Forest Service White River National Forest [Meeker & Glenwood Springs offices], and U.S. Fish & Wildlife Service Western Colorado Office). The BLM requested that written public comments be sent to Paul Daggett, BLM WRFO, 220 E. Market Street, Meeker, CO 81641 by mail or via email to wrfomail@blm.gov.

1.2.2 Issues

Issues and concerns raised through BLM internal scoping, as well as by four individuals, and two organizations (Be the Change USA; Colorado Division of Parks and Wildlife) who submitted comments during the scoping period are summarized below. Issues and concerns were raised in response to BLM's initiation of scoping, and in light of public review of NS' and EM's respective Plans of Operations & Maps of Lease Areas that were provided electronically as links in the on-

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line posting and press release (April 14, 2011) on the WRFO's Second Round of Oil Shale RD&D Leasing webpage (http://www.blm.gov/co/st/en/fo/wrfo/Oil_Shale_-_Round_2.html):

- Viability of process and overall energy efficiency in recovery of energy versus energy input requirements for both proposals.
- Residual waste products and potential contamination of ground water and surface waters for both proposals.
- Greater surface disturbance versus underground impacts.
- Amount and potential scarcity of available water and energy to meet needs of oil shale production while providing adequate supply to support agriculture and residential populations.
- Damage to land, ecosystems, tourism, hunting, and air quality.
- Escalation of rate of climate change and excessive costs for the State of Colorado.
- Impacts to wilderness preservation.

2 PROPOSED ACTIONS AND ALTERNATIVES:

2.1 Background/Introduction:

Kerogen is a solid organic substance comprising a portion of some rock units. Rock units with unusually high kerogen contents are informally termed "oil shales." When kerogen is subjected to heating or potentially to other physical or chemical processes, it can yield a liquid hydrocarbon substance similar to conventional crude oils. The Piceance Basin of northwestern Colorado contains substantial oil shale resources beneath public lands administered principally by the Department of the Interior (DOI) through the BLM.. Section 369(c) of the Energy Policy Act of 2005 directed the Department of the Interior to establish a leasing program for research and development of oil shale. Under this Act, the Secretary of the Interior was to make available for leasing such lands as the Secretary considers to be necessary to conduct research and development activities with respect to technologies for the recovery of liquid fuels from oil shale resources on public lands in Colorado, Utah, and Wyoming. The first round of Research, Development and Demonstration (RD&D) leases to meet these criteria were issued in 2006 and 2007. Of the six RD&D leases, five RD&D leases were issued in Colorado in the area administered by the BLM WRFO.

The DOI identified that an additional round (Round 2) of intensive research and development is needed to test the technical, economic, and environmental feasibility of proposed technologies to extract liquid fuels from oil shale resources on public lands. Nominations for a second round of RD&D leases were solicited for by the BLM in the Federal Register in November of 2009 (74 Fed. Reg. 211, Nov. 3, 2009). Two nominations were received for public lands in Colorado proposing the leasing of two adjacent 160-acre tracts located approximately 20 miles west-northwest of Rio Blanco, Colorado (**Attachment 1**). These proposals underwent a financial and technical review and are now, through this process, undergoing an environmental analysis. If this analysis finds there are no significant impacts to leasing these lands for RD&D purposes, then the BLM will not need to prepare an environmental impact statement (EIS) to support decision-making regarding issuance of the RD&D leases applied for by each of the companies. The

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proposed RD&D leases each comprise 160 acres with a preferential lease right to an additional 480 acres. Each RD&D lease, if issued, would require the applicant to submit, as a standard lease term, a Plan of Development (POD) for each applicant's oil shale RD&D project. The lease applicants have submitted a POO along with their lease applications, as required, to assist BLM in evaluating the possible environmental consequences associated with issuance of these oil shale RD&D leases. The preferential lease right would allow the lessee to apply to add acreage to the existing lease upon demonstration of the ability for commercial production.

The purpose of the Applicants' RD&D proposals is to achieve a "proof of concept." That is, while laboratory experiments and theoretical calculations indicate that various in-situ methodologies could support viable commercial options, none has been thoroughly field tested to evaluate the practical application. These proposed RD&D projects provide the opportunity to practically apply those technologies under actual conditions. The project results would advance knowledge of these methodologies regardless of whether or not they prove to be commercial.

The sites identified by NS and EM overlie high grade oil shale and sodium resources. NS' strategy is to incorporate their expertise in solution mining of nahcolite (sodium bicarbonate) with an innovative in-situ method for extracting kerogen from oil shale to commercially develop the oil shale resources. EM' strategy is to construct and operate two electrically conductive heating elements within induced fractures to heat in situ the kerogen-rich zones of surrounding oil shale. Heating would liquefy the kerogen and the resulting shale oil would be collected from drilled production wells located between and on either side of the two fractures.

This EA presents the evaluation of the environmental consequences associated with granting each of these proposed leases. The two are analyzed together, because of their proximity, and similarities in their affected environments. While their analysis is being conducted simultaneously, the BLM will make two decisions, one for each proposed lease, and will, if appropriate, issue two decision records, each with attached Conditions of Approval (COAs), if appropriate. Any oil shale RD&D lease would be issued with sufficient measures to allow the BLM to monitor for and prevent unnecessary and undue degradation to public lands.

This EA evaluates a Proposed Action and a No Action Alternative for each of the proposed lease tracts. In addition, for each Proposed Action, this EA presents proposed mitigation measures that could be applied, if approved, to prevent/reduce environmental consequences identified in the analysis. Therefore, the Decision Record associated with each of these proposed lease tracts may approve the Proposed Action, the Proposed Action with Mitigation (specified), or the No Action.

To achieve the Department of the Interior's goals for the RD&D program to advance knowledge of effective technology, economic viability, and sound environmental management, the FR notice contained specific requirements for a complete application, including:

- Description of the lands, not to exceed 160 acres together with any rights-of-way (ROWs) required to support the development of the oil shale RD&D lease;
- Narrative description of the proposed methodology for recovering oil from oil shale, including a description of all equipment and facilities needed to support the proposed technology;
- Narrative description of the results of laboratory and/or field tests of the proposed technology;

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- Schedule of operations for the life of the project and proposed plan for processing, marketing, and the delivery of the shale oil to the market;
- Map of existing land use authorizations on the nominated acreage;
- Estimated oil and/or oil shale resources within the nominated acreage boundary;
- Method of oil storage and/or spent oil shale disposal;
- Description of any interim environmental mitigation and reclamation measures;
- Description of methods of final reclamation and abandonment and associated projected costs; and
- Proof of investment capacity, and a statement from a surety qualified to furnish bonds to the U.S. government for the amount for which the applicant qualifies under the surety's underwriting criteria.

BLM has determined the RD&D leases would be issued for an initial term of 10 years with an option to extend for up to 5 additional years upon demonstration that a process leading to commercial production is being diligently pursued;

Regulatory concepts for the federal oil shale RD&D program would be reflected through the terms of the lease form. The lease would be the governing document for the oil shale RD&D project until the project succeeds and converts to a commercial lease, fails to meet the goals of the program, or the lease terms expire. The BLM would incorporate lease terms addressing incentives for development, conditions for environmental protection, appropriate bonding, and a provision to convert a successful RD&D project into a commercial lease. The RD&D lease would be issued for 10 years with the option to extend for up to five years if diligence is demonstrated. Rental fees would be waived for five years and royalties would be waived as long as the lease holder is not selling oil shale products or producing commercial quantities from the leasehold.

EM and NS each identified a test site with physical and environmental attributes favoring in-situ extraction, including but not limited to:

> Geology – The Parachute Creek Member of the upper Green River Formation contains seven thick, rich oil-shale zones including the R8, R7 (Mahogany Zone), R-6, R-5, R-4, R-3, and R-2 zones. Existing data (e.g., data extrapolated from Fischer Assay evaluations of rock samples obtained from existing core holes) support the estimates of oil potential to provide the opportunity to successfully demonstrate the technologies. EM's technology would target the R-4, R-3, and R-2 zones while NS' technology would target the R-2 zone (**Attachment 2 -** Stratigraphic Chart).
>
> Topography – Mostly level surfaces reduce environmental impacts and enhance access, construction of roads, well pads, pits, facilities, etc.
>
> Hydrologic Characteristics – Impacts to ground water would be minimized by restricting the experimental extraction processes to those zones below and isolated from shallow freshwater aquifers.

The proposed NS RD&D 160 (156.34)-acres lease tract is comprised of Lots 1, 2, 3, and 4 of Section 35, T1S, R98W (**Attachments 1a and 1b**). NS' preference right lease consists of lots 5

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through 12 of Section 35; Lots 5,6, 11, and 12 of Section 36; totaling 468.9 acres. The proposed EM RD&D 160-acre (155.82 acres) lease tract is comprised of Lots 1, 2, 7, and 8 of Section 34, T1S, R98W, 6th Principal Meridian, Rio Blanco County, Colorado (**Attachments 1a and 1b**). The remainder of Section 34, totaling 476.32 acres is reserved as EM' preference right lease.

The two proposed lease tracts lie within the topographic and structural Piceance Basin on the north sloping ridge separating Ryan Gulch, tributary to Piceance Creek, from Yellow Creek, tributary to the White River. Elevations of the adjacent tracts range from 6,520 to 6,770 feet. Topography occupied by the proposed lease tracts is principally broad soil-covered ridges and mesas. Pinyon-juniper (PJ) forest and sagebrush-grassland are the dominant vegetation types present within the lease tracts. Both tracts have areas that have been previously disturbed by oil and gas development and/or nahcolite solution mining activities.

2.2 NS RD&D Project (COC 74299) Proposed Action

2.2.1 Process Summary

NS' proposed in situ process for converting kerogen from the Green River Formation oil shale into shale oil and extracting it to the surface uses high temperature supercritical or near supercritical water in conjunction with carbon monoxide, sodium bicarbonate and sodium aluminate to break the chemical bonds of kerogenaceous oil shale. A description of the proposed leaching and chemical conversion process is presented in NS' Plan of Operations (POO) which was submitted to the BLM for leasing evaluation on March 2, 2011.

NS intends to initially drill and complete an Oil Shale Reactor (OSR) production well/wells to test the effectiveness of their leaching and chemical conversion technology on a small scale. A 40-foot (plus or minus) reactor vertical interval(See **Figure 2.1**) at the base of the Parachute Creek Member Saline Zone (depth interval of approximately 2,830 to 2,870 feet) and within the R-2 rich oil shale zone) is proposed for the initial test, which is intended to produce approximately 100 barrels of shale oil. Following the initial test, additional reactor intervals of similar thicknesses higher up in the Saline Zone may be selected within the OSR well for subsequent testing. In the event of mechanical difficulties with the initial well, or a determination to extend the research project, an offset replacement OSR well or wells could be drilled. A maximum of 600 vertical feet of rock (15 intervals) would be converted. The total vertical interval would be spread out among a maximum of three OSR wells.

This technique would use a best management practice by testing multiple intervals in a single production hole. The in-situ heating and recovery would occur at a depth substantially below fresh water aquifer zones of the Green River Formation and within an interval which is isolated from and does not contain groundwater. Approximately 750 feet of formation separate the base of the B-Groove Aquifer, the deepest aquifer likely to contain water suitable for domestic, stock, or agricultural purposes, from the top of the initial OSR. Approximately 450 feet separate the base of the Dissolution Surface Aquifer (with total dissolved solids TDS levels in the 25,000 to 100,000 mg/l range) from the top of the test interval for the proposed initial OSR.

The feasibility test is to be divided into three parts and is summarized below:

1. <u>Phase 1: Pre-conversion solution mining</u> - Phase 1 would entail:

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a. Drilling a conventional vertical wellbore to access the lower part of the Saline Zone (containing the R-2 zone), comprising the lowermost portion of the Parachute Creek Member:

b. Solution mining the nahcolite within the selected interval of the Saline Zone (R-2) to form an in situ reactor interval for conversion of the oil shale's kerogen into shale oil.

   i. Heated brine (barren liquor) produced by NS' existing sodium bicarbonate production facility would be piped and injected into the reactor interval via the production well to dissolve the nahcolite in the OSR and to form the leached interval which would act as the kerogen conversion or reactor chamber.

   ii. Following nahcolite extraction from the reactor zone, the zone would be dewatered in preparation for kerogen conversion.

   iii. The sodium bicarbonate-enriched brine produced by solution mining the nahcolite would be treated in the existing NS sodium bicarbonate production facility.

c. Design and construction of surface RD&D processing and recovery facilities would begin during Phase 1 and would continue during Phases 2 and 3 as appropriate.

2. Phase 2: Shale oil liquefaction - The kerogen within the oil shale would be liquefied into shale oil within the solution-mined, leached reactor interval using NS' chemical conversion technology.

   a. The completed wellbore would accommodate the installation of a downhole burner capable of partially oxidizing natural gas with air or oxygen to produce carbon monoxide, some hydrogen, and heat for bringing the reactor up to the temperature required for kerogen conversion.

   b. The well design would enable water, carbon monoxide, and potentially hydrogen and catalysts to be pumped into the leached reactor interval from the surface. The gases and water would reach a temperature of 300 to 350 degrees Centigrade (572 to 662 degrees Fahrenheit) to liquefy the kerogen.

   c. As the liquefaction reaction progresses, water, sodium salts and aluminum salts would be released from the reactor walls, along with shale oil that has been liberated in the creation of the leached interval.

3. Phase 3: Extraction of shale oil and other products - The generated gas and liquid hydrocarbon phases and other byproducts would be removed from the reactor chamber through either an appropriate pressure and temperature let-down system or downhole pump.

   a. Conversion process products would be brought to the surface to be processed through a scrubber and/or combustor and then vented.

   b. Production of shale oil and natural gas would be sustained until approximately 100 barrels of shale oil is produced from a specific reactor interval.

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On completion of testing of the initial well, additional production and associated monitoring wells could be constructed on the RD&D lease, subject to BLM approval, for continued testing and expansion of the technology development prior to commercial production. NS seeks to start the RD&D project as early as 2012, but not later than 2014. A diagram illustrating the conceptual borehole arrangement is included as **Figure 2.1**.

NS has delineated a 15.6-acre parcel within the 160 acre RD&D proposed lease area (**Figure 2.2**). The western side of the initial project area consists of a previously disturbed area which is being reclaimed. The portion of the reclamation area located within the initial project area would be used to site a utility corridor without incurring additional project surface disturbance. Other surface disturbances are expected to include an access road, a well pad sized to accommodate the processing equipment and up to three wells, and a natural gas supply pipeline to provide gas to power the OSR burner.

The main pad configuration (OSR Well Pad) is intended to accommodate a centralized process equipment area (200' x 200') and up to three OSR wells. This pad area is anticipated to be roughly triangular shaped and current plans would result in a disturbance to approximately 3.4 acres if all of the OSR wells are eventually drilled. Because well pad design is somewhat preliminary and may be altered pending additional information, it is possible that an additional three acres may be required for the well pad. Therefore, a 6.4-acre well pad disturbance has been assumed for purposes of this EA. It is intended to drill the initial OSR-1 well near the west portion of the OSR Well Pad. One or both of the optional OSR locations may be utilized if it is determined that the OSR-1 location is unsuitable or if the OSR-1 location is successful and it is determined to continue the project. Access to the well pad would be via a short spur road extending from the northeastern corner of the triangular pad to an existing road.

A listing of Applicant-committed Design Features (ACDFs) included to protect the natural and human environment have been included as **Appendix A**.

2.2.2 Construction

Access Roads - Existing roads on and accessing the NS nominated lease would be utilized minimizing new surface disturbance. A new short spur road would be constructed to connect the proposed well pad to an existing road. The road would have a total disturbed width of 20 feet and be constructed in approximately one day using standard road construction equipment. The road would be surfaced with native (locally-excavated) materials and aggregate, as necessary, to provide year-round all weather access. Non-native surfacing materials would be acquired from local permitted sources. Additional roads may be constructed in the future, coincident with project expansion subject to BLM approval and additional NEPA compliance, as appropriate.

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Figure 2.1 NS OSR During Oil Shale Conversion and Oil Recovery Process

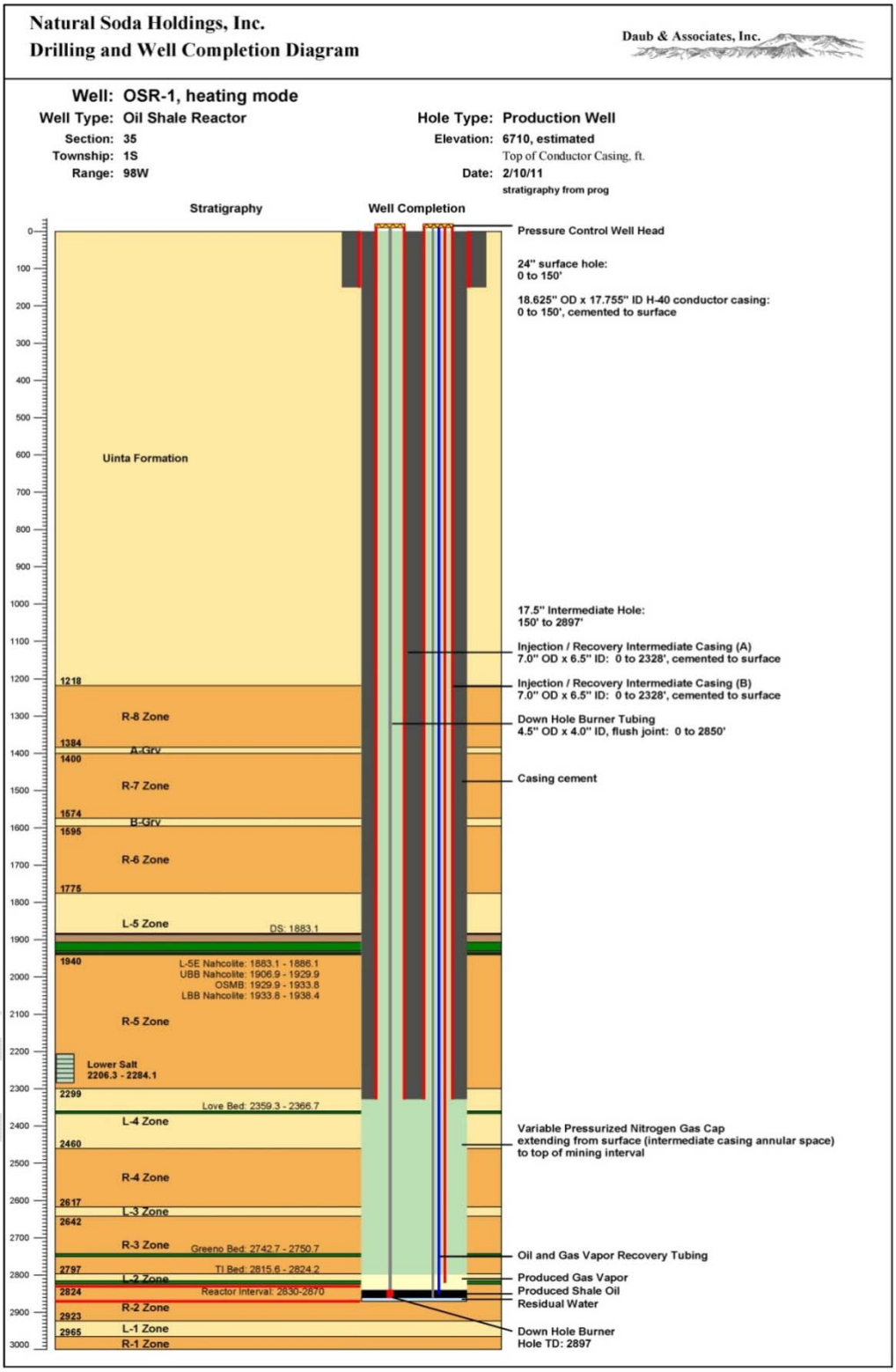
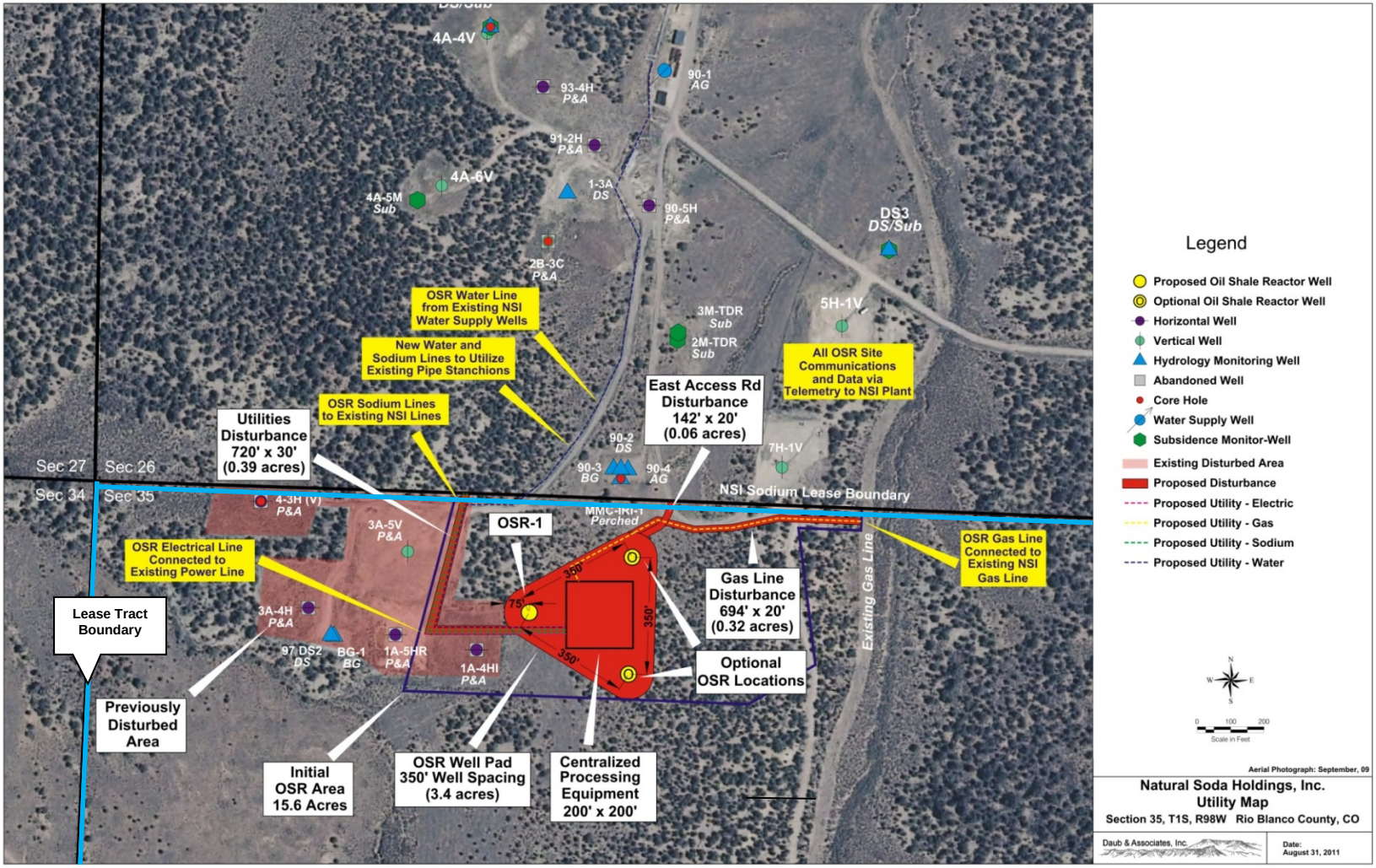


Figure 2.2 NS Proposed Project Layout



Well Pad - Up to three OSR wells, a single monitoring well, and project production facilities would be located within one triangular well pad. The project pad would be constructed using heavy equipment, including dozers, a backhoe, and heavy haul trucks. The pad would be graveled as necessary to provide year-round all weather access. Gravel would be obtained in a manner and from a source similar to that used for road construction. The pad would contain the process facilities area, which would be the site of those facilities required to produce the test shale oil and associated byproducts. Construction of the well pad would take approximately 15 days.

Utility Corridor - A utility corridor would be constructed to provide piped transport of water, sodium liquids, and electric power to the production facilities from existing NS wells. The corridor would run along the western edge of the initial project area, entirely within the previously disturbed area. Pipelines would be above ground, insulated and installed on stanchions, and would connect with an existing corridor containing NS sodium pipelines. The pipelines would extend beyond the proposed lease tract, but would be installed on existing stanchions and would not incur additional disturbance. Electric power would be transported using new temporary lines from an existing power line which extends to within the proposed lease tract. The utility corridor would occupy a long-term (life-of-project) 30-foot ROW.

Gas Supply Pipeline - A natural gas supply pipeline would be constructed from the facilities process area approximately 700 feet east to an existing natural gas pipeline along the northern portion of the proposed least tract. New surface disturbance associated with the proposed gas pipeline would be restricted to BLM surface entirely within the proposed RD&D lease. The pipeline would be buried, constructed of steel or fiberspar of grades sufficient to safely contain gas pressures, and estimated to be of approximately 4-inch diameter.

Pipeline excavation, installation, and burial would be accomplished using standard pipeline installation methods with heavy equipment such as excavators, trenchers, and graders. Pipeline construction rates are estimated at four days/mile, assuming eight hours of daily operations. Therefore, pipeline installation would likely require one to two days.

Soil erosion control practices that would be implemented by NS during and following construction are contained within the NS stormwater management plan (SWMP). If it is deemed necessary to modify the SWMP in any way, a revised SWMP would be directly submitted to the Colorado Department of Health and Environment (CDPHE).

2.2.3 Drilling and Completion:

Drilling - The drilling of the OSR well and the single monitoring well would be conducted using a combination of an air mist and/or mud drilling medium with the option of reverse circulation using a conventional rotary drilling rig. This medium has provided for the successful drilling of the numerous wells on the NS sodium leases, and is expected to be satisfactory for the drilling of the wells on the NS-nominated 160 acre RD&D Lease. The mud would be a bentonite-based fluid with polymer (Pol-E-Flake) added to maintain a density between 9.0 and 9.5 lb/gal. Circulation would be normal, and any lost circulation zones would be remedied by flushing the hole with lost circulation material in the form of sawdust, shredded paper, walnut hulls, Diamond Seal® (a commercial synthetic polymer used for lost circulation control), or similar materials. It is anticipated that less than 100 bbls of water would be used daily during the drilling operations.

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A single mud pit would be dug and used to contain the drilling mud while drilling the OSR well. Upon completion of the drilling activities, the drilling fluid would be removed and disposed of at an appropriate off-site waste disposal facility, and the pit would be filled in, recontoured and reclaimed.

During drilling, the formations penetrated are known to be normally pressured (0.433 psi/ft). At 3,000 ft. true vertical depth (TVD), a formation pore pressure of approximately 1,300 psi is anticipated. Anticipated drilling fluid mud weights would be such that there would not be the possibility of exceeding the formation fracture gradient (0.9-1.0 psi/ft). Pressure control equipment would meet NS and Onshore Oil and Gas Order #2 requirements.

The OSR well is anticipated to use 18 5/8-inch carbon steel conductor casing to a depth of approximately 150 feet. The well would use 7-inch permanent (intermediate) casing and 4 ½-in. production tubulars, which would be fabricated of a specialty alloy to meet the temperature, pressure and strength criteria for the system. Tubulars may consist of something similar to a nickel-iron-chromium alloy to an austentitic nickel based alloy.

Thermal insulating cement would be used in the annulus of the 7-in. casing for the OSR well. Cement for both casing strings would be circulated back to the surface or tremied into the annulus. The monitoring well would use Portland Type I/II cement with 2% calcium chloride on both the conductor and intermediate casing strings. Cement would be circulated to the surface on the monitoring well hole. Specific cement formulations would be designed prior to the need, allowing for the most current research data to be used and ensuring the most appropriate cement product for the expected conditions, in compliance with the BLM drilling permit.

Completion - NS would not employ any artificial fracturing methods or proppants in the OSR well drilling or production operations. However, minor rock fracturing within the OSR as a result of thermal expansion of the oil shale during the heating of the water is expected.

2.2.4 Surface Disturbance:

NS is committed to the use of best management practices to minimize unnecessary surface disturbance (**Appendix A**). The larger well pad size will be constructed only if necessary to implement the project. Additionally, NS may need to relocate the area of operations to another portion of the 160- acre lease tract should subsurface or other conditions dictate a change of location. All of the disturbance would be located on lands managed by BLM. A summary of the anticipated amounts of construction and life-of-project surface disturbance resulting from implementation of NS' proposed lease acquisition and initial RD&D program is indicated in **Table 2.1**.

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Table 2.1 NS Oil Shale Lease Tract Anticipated Surface Disturbance

Facility	Multiplier: Well Pad Count or Length (ft.) (Maximum)	Size (acres) or ROW (ft.) Initial/ LOP	Estimated Short-term Surface Disturbance (Maximum / ac)	Estimated Long-term Surface Disturbance (Maximum / ac)
OSR Triangular Well Pad [1]	1	6.4	6.4	6.4
Centralized Process Equipment Pad [2]	1	0.9	0.0	0.0
East Access Road [3]	140	20	0.1	0.1
Gas Pipeline	700	50 / 20	0.8	0.3
Utilities [4] (2 sodium pipelines) (1 water pipeline) (1 electrical line)	720	30	0.0	0.0
Totals [2]			7.3	6.8

[1] Well pad layout and pad are preliminary and will be between 3.4-6.4 acres.

[2] Contained within the triangular well pad disturbance

[3] Connects well pad to existing road

[4] Utility pipelines extend beyond the RDD lease, but will be installed above ground on existing pipe supports

2.2.5 Production Facilities, Process, and Rates:

Facilities - Process facilities would be installed within a 200 x 200 feet portion of the triangular pad. Surface facilities would be designed, built, monitored and operated in accordance with industry best practices to ensure the surrounding environment is protected in accordance with the BLM and U.S. Environmental Protection Agency (EPA) regulations and applicable mining, environmental and other laws related to aboveground storage tanks for petroleum and chemical products.

Figure 2.3 is a schematic of the layout of the proposed surface facilities involved in the construction of and development from the OSR well. Above ground shale oil storage tanks and support systems would be constructed, tested and labelled in accordance with Underwriters Laboratories specifications for aboveground storage of flammable and combustible liquids (UL-142). The tanks would be equipped with the option to be blanketed with an inert gas such as nitrogen or carbon dioxide. Tanks would be installed on-site in conjunction with appropriate secondary containment (vertical dikes or similar approved containment systems) to prevent spills and contain possible leaks. Best management practices would be employed to ensure all surface facilities are safe, secure and operate properly. A listing of proposed production equipment is included in **Table 2.2**.

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Figure 2.3 NS Surface Facilities Layout

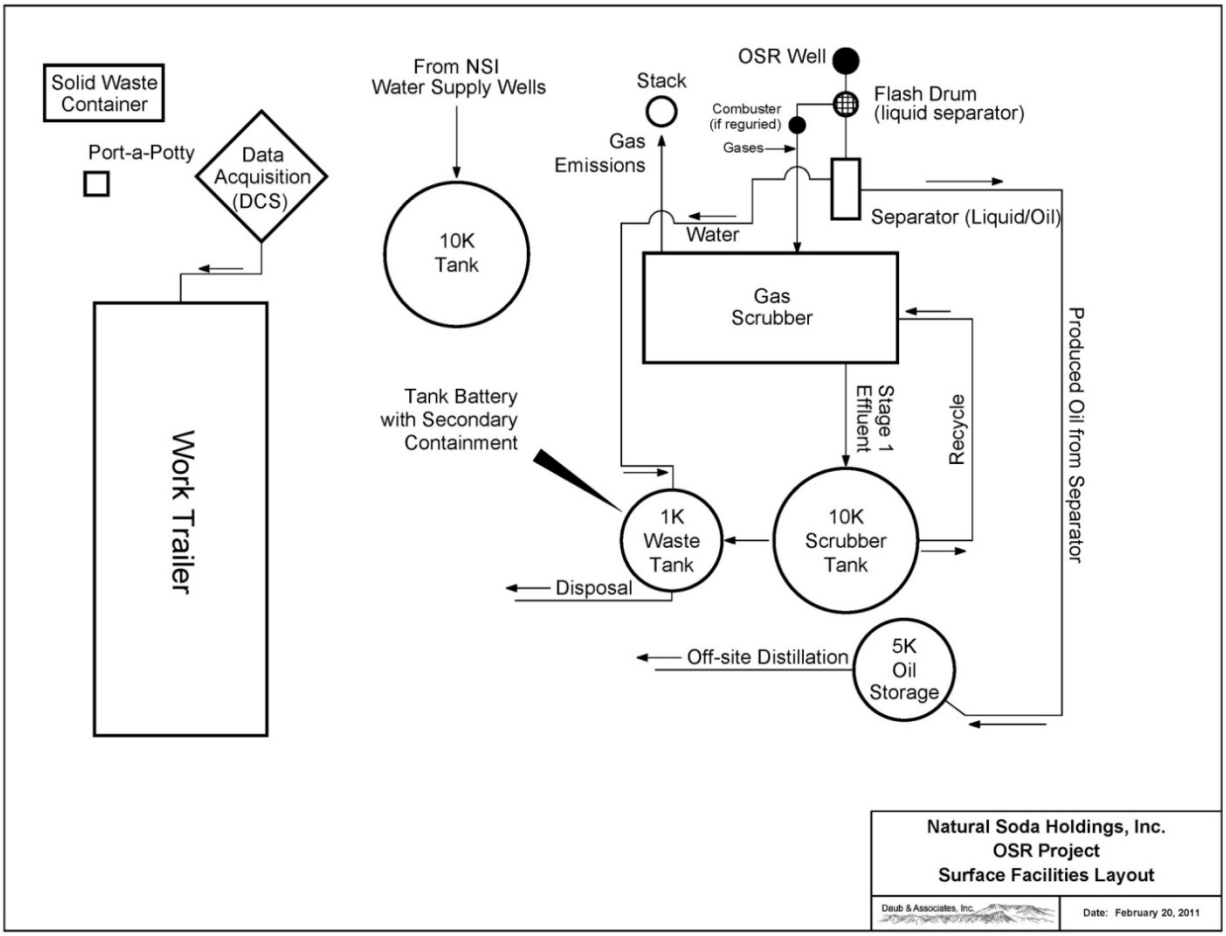

Table 2.2 Expected Production Equipment

Production Equipment	
Down-hole burner	Shale oil storage tank
Surface boiler (If needed)	Scrubber and scrubber water tank
Various instrumentation with telemetry capability	Waste water tank
Down-hole pump	Water supply tank
Various surface transfer pumps	Instrument/electrical enclosure
Flash drum and liquid-oil separator	Gas/liquid sampling equipment
Reactor off-gas combustor (If needed)	Office/work trailer
Reactor off-gas scrubber	

Production Process Phase 1: Nahcolite Mining - The first phase in the development of shale oil would involve using conventional vertical well technology to solution-mine the nahcolite within a select interval of the Saline Zone and form an in situ reactor interval within the saline mineral-rich zone hundreds of feet below the Dissolution Surface Aquifer. The sodium bicarbonate-enriched brine would be processed in the existing NS sodium bicarbonate production facility.

Heated spent brine (barren liquor) from one of NS' existing barren liquor supply lines would be used to dissolve the nahcolite in the OSR, thus forming a leached interval (LI) which would act as the reactor chamber. NS would use the knowledge and expertise from its extensive historical drilling operations and the drilling, completion and solution mining activities from the Deep Vertical Production Well (DVPW). NS drilled and completed the DVPW in 2011 on their existing adjacent sodium lease. NS would monitor the quantity of sodium bicarbonate produced from the OSR chamber by laboratory assay and mass balance.

Following nahcolite extraction, the LI would be dewatered in preparation for the second phase of the process. A pump and screen would be lowered into the LI and all liquids would be pumped to the surface for recovery and disposal.

Production Process Phase 2: Oil Shale Liquefaction - The second phase in the development of the shale oil would be to use NS' chemical conversion technology to liquefy the kerogen in the oil shale. The OSR well would utilize a conventional completion technique which would comply with appropriate Underground Injection Control (UIC) regulations. The well completion would accommodate a downhole burner capable of partially oxidizing natural gas with air or oxygen to produce carbon monoxide, some hydrogen, and heat for bringing the reactor to production temperature. Optionally, the well design would also enable water, carbon monoxide and potentially hydrogen and catalysts to be pumped into the reactor LI. The gases and water would be heated to approximately 300 - 350 degrees Centigrade (572°-662° F) to liquefy the kerogen. The wellhead would also be equipped with a pressure control system to maintain pressure as high as possible without approaching formation fracture pressure. The well design includes a second tube which can be used for downhole instrumentation. Finally the well design provides access to remove the products **(Figure 2.1**).

It is uncertain whether mixing would be required to ensure that the liquefaction reaction is not constrained by mass transfer issues. NS' experience in solution mining indicates that thermal currents set up by heating the reactor LI would supply adequate mixing. The water and gases that are injected into the LI may be pre-heated prior to injection. These would act as heat transfer agents in the reactor LI.

As the liquefaction reaction progresses, water, oil, sodium salts and aluminium salts would be released from the reactor walls along with the oil shale that had been liberated in the establishment of the LI. The products would be brought to the surface on a semi-continuous basis utilizing either reactor LI pressure or a downhole pump. Process off-gases from Phase 2 would be scrubbed and/or combusted and then vented. On a commercial scale, process off-gases could be sent to a waste heat boiler for thermal efficiency and/or cogeneration to support nahcolite and oil shale production. Temperature, pressure and timing parameters would be developed during the pilot test to optimize the product mix.

Production Process Phase 3: Shale oil Extraction - The third and final phase of development would involve the extraction of the shale oil and additional products of the conversion process. It is anticipated that the liquefaction reaction would generate liquids with a wide boiling range so it is envisaged that hydrocarbons would be in the gas and liquid phases within the reactor. In order to collect the high boiling liquids, recycled oil may be injected to solubilize the heavy end liquids and provide an extraction medium.

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The products would be removed from the reactor while it is at high temperature and pressure through either an appropriate pressure and temperature let-down system or downhole pump. This provides a mechanism to manage the residence time for liquids produced in the reactor.

On a commercial scale, the reaction would be limited by the ability to increase the heat input into the reactor to maintain the reaction temperature as the volume of the reactor increases. As such the reaction would be self-limiting and there would be an economic life for each well.

At least 10 barrels of product oil would be isolated under an atmosphere of nitrogen in drums and shipped to a petroleum analysis laboratory where its components and overall market value would be determined.

Produced Water Processing - The initial RD&D phase would utilize NS' water management facilities associated with the nearby sodium bicarbonate processing facility for water storage and evaporation.

Production Rates - Production of shale oil and gas is to be sustained until approximately 100 barrels of shale oil have been produced from a particular reactor interval. At this time laboratory experiments are being conducted to help define some of the variables which would affect production rates. The RD&D project is designed to determine rates of production and resource recovery factors which would ultimately lead to an economic oil shale recovery process.

2.2.6 Reclamation and Abandonment:

Reclamation - The proposed post-production land use is designed to be consistent with the historic and current land use. Livestock grazing and wildlife habitat, with its associated hunting activities, are historic and current land uses. Additional recent land use activities include nahcolite mining and processing for bicarbonate production, oil shale RD&D operations and oil and gas development. The proposed post-production land use is anticipated to be livestock grazing, wildlife habitat, oil/gas exploration and production, oil shale development and production, and mineral resource recovery. The reclamation plan is designed to ensure establishment of a permanent vegetative cover which meets or exceeds the BLM WRFO success criteria.

A diverse, effective and permanent vegetative cover would be established at the project site on all lands disturbed by production operations. Plant species selected for revegetation would be self-renewing and capable of withstanding the climatic and soil conditions found in the project area. Reclamation would be conducted in a manner that encourages the prompt establishment of vegetative cover and a return of productive capabilities. All reclaimed areas would be fenced with three or four-strand barbed wire fence conforming to BLM Type D fence specifications, until bond release.

Site-specific reclamation procedures have been identified for the two types of reclamation activities that would occur on the project area:

1) Reclamation activities that would follow construction and those routine disturbances associated with the well field operations (interim reclamation), and

2) Reclamation activities that would be associated with the cessation of production operations (final reclamation).

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Many of the specific, routine reclamation procedures associated with each of these two types of activities are identical, whereas some of the activities that would be associated with final decommissioning of the production operations are different from routine interim reclamation activities. A listing of specific design features intended to improve reclamation success have been included in **Appendix A**.

Abandonment - Plugging and abandonment, subject to BLM approval, would occur if a well is deemed unusable for future use as a monitor or production well. Prior to plugging and abandoning of an OSR production well, the two 4.5-in. production and injection tubing strings set inside the two 7.0-in. casing strings would be removed from the wellbore. A bridge plug may be set near the top of the OSR interval. The residual brine would be left in the OSR interval and would stabilize and support the OSR interval.

Once there is no further use for an OSR interval, all tailings may be injected into the interval and wells which would be plugged and abandoned in compliance with all regulatory requirements. Core holes would be plugged and abandoned or converted to monitoring wells per BLM specification. Some of the NS monitor wells may be maintained to provide additional ground water monitoring for the NS sodium operations.

NS would cement the well to surface after borehole preparation is complete. As a minimum, the following plugs within the casing would be required (per NS EPA UIC Class III Area Permit):

- a cast iron bridge plug (CIBP) would be placed at the base of the production casing, and the interval from the top of the CIBP to the Dissolution Surface would be cemented;
- the entire Dissolution Surface Aquifer interval (See **Figure 2.1**) plus fifty feet above would be cemented;
- the entire B-Groove Aquifer interval (See **Figure 2.1**) would be plugged, and the plug would extend fifty feet above and below the aquifer;
- the entire A-Groove Aquifer interval (See **Figure 2.1)** would be plugged, and the plug would extend fifty feet above and below the aquifer; and
- the final plug would extend from the surface to 165 feet below ground level. The intervals between the cement plugs would be filled with a bentonite based plugging mud and/or cement.

Other cement plugs or revised plugging procedures may be required based on cement bond log (CBL) analyses and casing recovery results. Any remaining casing would be cut off and removed to a depth of two feet below grade. An appropriate surface location marker would be installed at grade. The well abandonment would conform to Environmental Protection agency (EPA) underground Injection Control (UCI) permit and BLM requirements.

Any surface facilities present at the cessation of production operations would be dismantled and either salvaged or removed for disposal. Concrete foundations would be broken up and buried on-site at least three feet below final grade. The underground natural gas and water pipelines would be disconnected, purged, and abandoned in place to avoid disruption of previous reclamation. Surface pipelines would be removed. Surface infrastructure such as buildings, tanks, foundations and associated structures that cannot be used by NS' sodium bicarbonate facility would be removed from the site and the site re-contoured and revegetated.

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2.2.7 Products and Byproducts:

The estimated 100 bbls of shale oil that would be produced from each reactor interval over the life of the RD&D project would be stored temporarily in on-site tanks until it can be transferred to a local analytical facility. Minor amounts of solids produced as a result of the kerogen conversion process would be brought to the surface and temporarily stored in waste tanks. Consistent with best management practices (BMPs), most circulation water used in the conversion process would be recycled. Spent recirculation fluids would be removed from the OSR, as necessary, and stored in an on-site waste water tank prior to approved disposal. This unrecyclable waste water from the conversion process is expected to be limited to less than 10 barrels (bbls) per day. As a BMP, NS would create a slurry composed of the solids which were brought to the surface as a by-product of the kerogen conversion process and the spent circulation water. This slurry would then be returned to an exhausted OSR interval. Should this process prove unfeasible, the solid and liquid waste by-products would be removed and disposed of in a timely manner at an appropriate off-site solid waste and/or liquid disposal facility by a contracted waste disposal company.

2.2.8 Water Requirements:

Water would be needed for construction and drilling activities, the recovery of sodium minerals, shale oil processing, dust control, testing, and if necessary, mitigation of ground water contamination, if any. It is expected that all fresh water for drilling, dust control, and other needs would be piped or trucked approximately 0.75 miles to the site from existing NS water wells (WSW-2 and/or 90-1) or other NS water resources and stored in a temporarily-placed tank of up to 10,000 gallons capacity. Piped water would be delivered by an insulated above ground pipeline located on existing pipe supports and would result in no new surface disturbance. The fresh water tank is not expected to require lined storage containment. Sodium solution process water supplied to the OSR facility would originate from existing NS sodium bicarbonate production operations located adjacent to the proposed NS lease tract and would be piped to the OSR and surface production facility. Piping would be the same as for the fresh water line and would not incur additional new surface disturbance.

NS' current estimates of freshwater use for Phases 1 through 3 on the RD&D lease are provided in **Table 2.3**. These estimates represent an average over the life of the project. Anticipated water use for drilling and dust control of the initial RD&D OSR is estimated at 3,000 bbls of water. Water use is not expected to exceed one acre-foot per year for the life of the RD&D project. Stated goals of the project are to answer questions such as process feasibility, economics and total water usage. Due to the RD&D nature of the project, it is anticipated that data gathered would yield improved water usage practices and estimates. NS is in possession of existing water rights (88 CW420) capable of producing 1,445 acre feet (ac-ft) of water per year. Recent average usage has been approximately 125 ac-ft annually. Current usage plus the proposed project would thus be adequately covered by existing NS water rights.

Table 2.3 Water Use Estimates for NS RD&D Lease Tract

Use	Fresh Water Estimates
Drilling & Dust Control	100 bbls per day up to 30 days of drilling and construction
Post-drilling Operations/production	10 bbls per day for life of RD&D operations
Total	**Less than 1 acre-foot per year for life of the RD&D project**

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2.2.9 Electrical Power Requirements:

Temporary overhead power lines and associated ROW would be required to bring electrical power from the existing power line that terminates within the proposed OSR site.

2.2.10 Natural Gas Requirements:

Natural gas would be provided to the OSR site via the proposed pipeline that would connect into an existing natural gas pipeline that supplies the nearby existing sodium bicarbonate production facility. Additional natural gas is not expected to be required. However, upon detailed design, if supplemental natural gas is required; a pipeline would be constructed (See **Figure 2.2**) to tie in to local gas gathering and distribution lines within the nominated lease tract to supply gas to the site.

2.2.11 Air Emissions and Waste Materials:

Air Emissions - Construction phase emissions would include nitrogen oxides (NO_x), volatile organic compounds (VOCs), and particulates. The Phase 1 sodium solution mining would be a closed-loop system. NS' air emissions during Phase 1 should be minimal to non-existent. NS' Phase 2 and 3 shale oil recovery system is expected to produce only minor emissions due to the limited scope of the production process being employed under RD&D program conditions. Emissions would be captured and directed through an on-site scrubber. The captured wastes would be contained in a 1,000 gallon waste tank.

Solid Wastes - Drilling the OSR wellbore and the monitoring well would produce rotary drill cuttings and drilling fluid. Drill cuttings would be disposed of in the on-site pit used during drilling operations. The in situ process would leave the spent oil shale within the confined oil shale reactor interval. Any process tailings from the above-ground processing may be slurried back into the OSR before associated wells are plugged and abandoned in compliance with all regulatory requirements.

Cleanup activities would occur on an ongoing basis during all aspects of the site preparation, well drilling and site operations. All construction and drilling-related debris would be removed and disposed of at an approved off-site disposal area. All household and other approved trash would be collected in on-site animal-proof containers and periodically hauled to NS' nearby garbage bay and taken to a county landfill. The NS garbage bay is emptied monthly by Waste Management, located in Meeker, Colorado.

Liquid Wastes - During the production phase, wastes would be produced in the form of spent oil shale and waste water from the production well. The water would be analyzed for potential contaminants. Waste water resulting from the chemical breakdown of the oil shale would be recaptured and recirculated as a BMP to minimize the water usage and reduce the amount of wastes produced by the research operation. Any waste water that cannot be recaptured and recirculated or returned to a spent reactor interval would be trucked off-site for disposal at an appropriate disposal facility by a contracted fluid disposal company.

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2.2.12 Personnel and Traffic:

Contracted workers and NS employees during both phases would commute to the lease tract from Rangely, Meeker, Rifle, Parachute, Silt and/or Grand Junction, Colorado, as is currently done by NSI employees who work at the nearby sodium bicarbonate production plant. However, there is the potential for trailers to be brought to the site during the drilling of the initial production hole to temporarily house the drilling contractors, which NS has done in the past. With a successful RD&D effort and continued expansion of the project, to a commercial stage, there remains the possibility that local housing would be developed on or near the proposed oil shale lease or on NS' sodium leases.

Construction - An estimated 10 to 20 employees and/or contractors would be required during the drilling and construction operations of the initial production hole. These personnel would work 12-hour shifts, working both day and night so as to sustain a 24-hour operation. The number of personnel working on the project at any given time would fluctuate, depending on the amount and type of work being done.

Operations - During production operations, an estimated 5 to 10 employees and/or contractors would be required to sustain the development and recovery of the shale oil from the production hole. These personnel would work 12-hour shifts, similar to the drilling phase personnel. Some existing employees would be utilized at the NS processing plant, involved in the processing of leached nahcolite from the production hole.

Traffic - Due to the commuting requirement, the majority of project-related traffic would be from Rifle, Colorado to the project area via Highway 13, Piceance Creek Road (RBC 5), RBC 24 and RBC 31. Minor traffic may also originate from locations near Meeker, Colorado and Rangely, Colorado, by way of State Highways 13 and 64, respectively. Because of the relatively minor influx of individuals required for the project, only a slight increase in the amount of traffic on these roads is anticipated. This increase is expected to vary with current operations. Traffic would increase by less than 20 vehicles per day. Carpooling would be utilized whenever possible to minimize road traffic and decrease potential safety hazards.

2.2.13 Project Schedule:

The drilling of the initial production hole is anticipated to commence as early as 2012, but no later than 2014, dependent upon RD&D lease issuance. Surface facilities would be constructed or brought to the site after the hole has been completed. Production operations are anticipated to begin approximately three months after the completion of the initial production hole, and are expected to continue until sufficient quantities of shale oil are produced to demonstrate the success of the chemical conversion technology and the economic feasibility of the process. Timing estimates are contingent upon timely receipt of any required permits.

2.3 EM Proposed RD&D Project (COC 74300) Proposed Action

2.3.1 Process Summary

EM proposes to test an in situ shale oil production process to determine the feasibility of supporting a commercially viable production enterprise. The process involves the underground conversion of oil shale kerogen to producible shale oil and gas.

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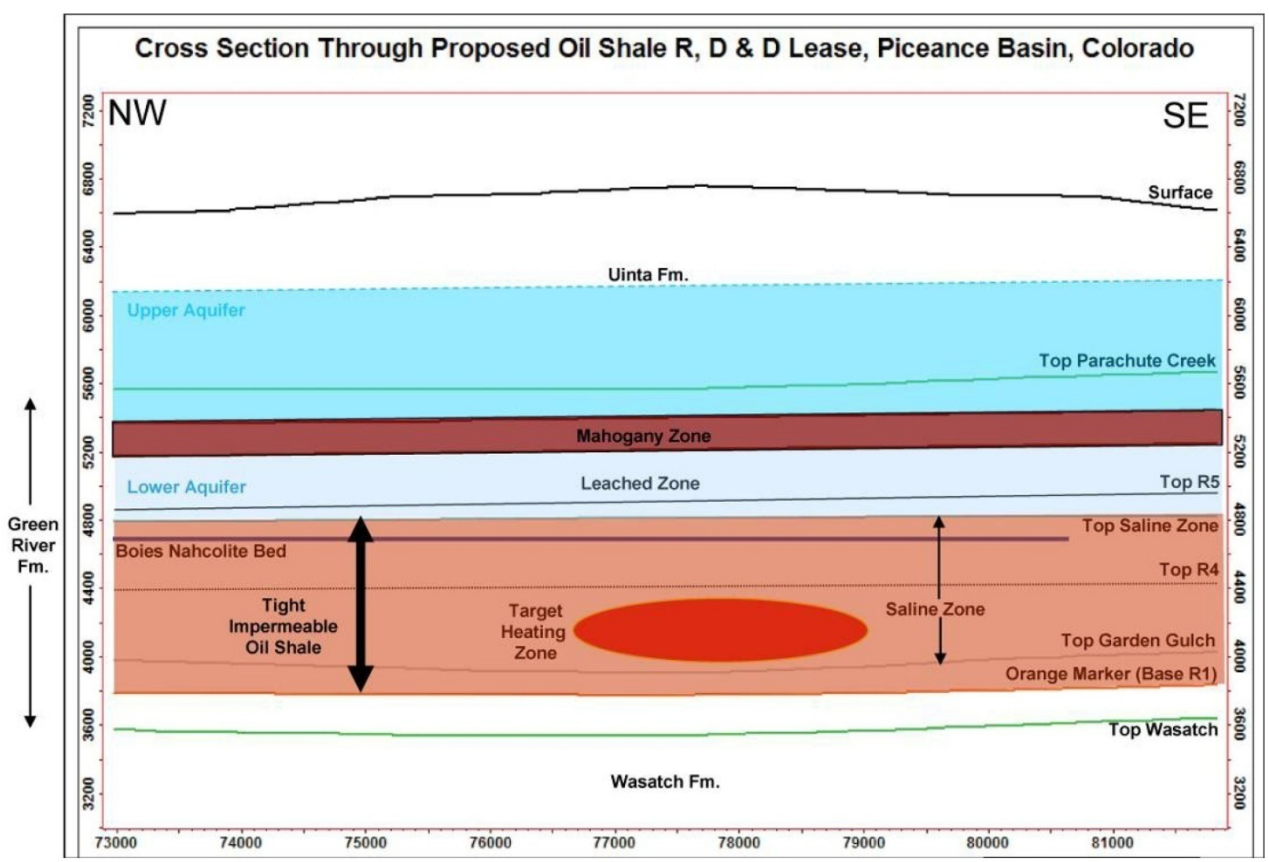
The process is designed to heat oil shale in situ by drilling horizontal cased heater wells at the desired depth within the targeted oil shale zones up to 1,200 feet in length, and up to 120 feet apart. These horizontal sections would be hydraulically fractured to allow insertion of a planar resistive heating element made of a nonhazardous, electrically-conductive material. A separate connector well would be drilled perpendicular to, and connect the toes of, the planar elements. Heat would be delivered to the oil shale formation by conducting electricity through the planar heating elements. Solid organic matter in the oil shale (kerogen) would gradually convert to shale oil and natural gas. The oil and gas would be recovered by vertical production wells that would be drilled at some distance from and along the length of the in situ planar heating elements. A test to determine the recoverability of sodium minerals would occur after completion of the oil and gas production phase. It is expected that up to 1,500 bbl of water could be used to test sodium mineral recovery.

EM proposes to design its field development such that the in situ process zone (pyrolysis and production zone) is isolated from proximate aquifer(s). As part of the appraisal well program, the application of small water fracture methods (fracs) is planned in the target stratigraphic zones in and around the target heating zone. These small fracs would provide local fracture orientation and the magnitude of in situ stress. The orientation and stress state information would be used to plan the in situ planar heating elements and limit them to the target heating zone. Thus, an impermeable seal would be maintained around the developed volume (**Figure 2.4**).

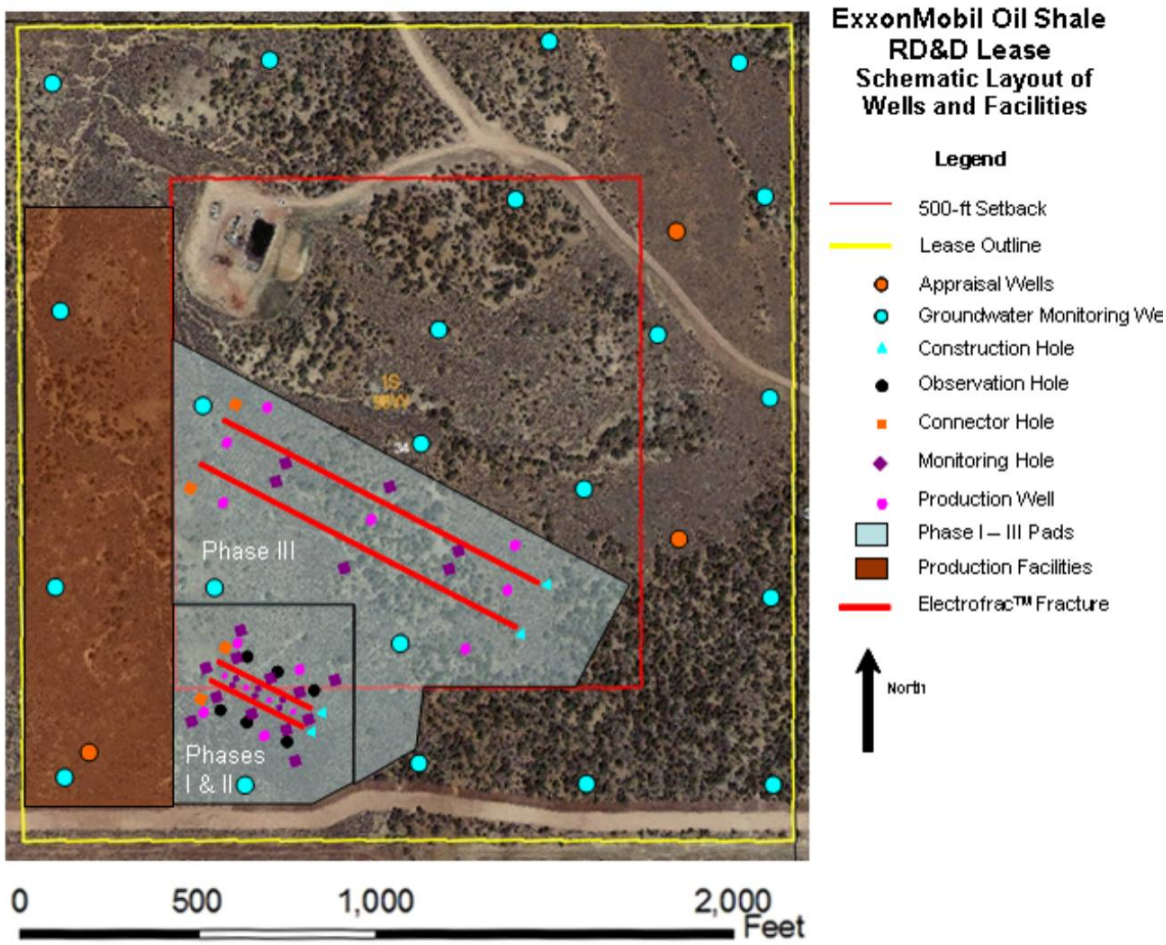
The in situ oil shale conversion process would be tested in two demonstrations of different scale. The in situ construction, heating, and recovery would occur below and isolated from fresh water aquifer zones of the Green River Formation. Monitoring and observation wells would be installed prior to oil shale conversion operations.

Figure 2.4 Hydrologic Isolation of EM Proposed Pyrolysis Zone



Activities on the RD&D lease would be year-round and continuous to facilitate the work required to target a commerciality decision by the end of the initial ten-year lease term. A conceptual layout of the proposed action is indicated in **Figure 2.5**.

Figure 2.5 EM Lease Tract Conceptual Layout



The RD&D project is to be divided into five parts that are summarized below:

1. <u>Appraisal (years 1-2 timeframe)</u> - key components of this initial phase of the process would be to:
    a. Construct access roads to the lease tract from existing road network and within the lease to process pad, to geologic appraisal and ground water monitoring well pads.
    b. Construct up to four one-acre well pads and drill a single well on each for geologic appraisal to evaluate the downhole target zones for determining locations for future oil shale extraction experiments.
    c. Construct 17 one-acre well pads and drill up to 24 ground water monitoring wells on the 17 constructed well pads to obtain baseline data. Multiple wells may be

drilled per pad, depending on the number of aquifers/water-bearing units being monitored.

d. Construct up to a 20-acre process pad to support infrastructure including field office.

e. Design and build infrastructure on process pad.

f. Apply for appropriate permit approvals (federal, state, and county).

g. At end of appraisal, appraisal pads would be reclaimed, with 0.1 acre of disturbance if converted to ground water monitoring wells

2. Phase I (year 3) –in situ planar heater construction at depth (small scale) would result in:

   a. Construction of a six-acre production pad to support drilling, completion, and operation of in situ planar heating elements and three connector wells; drilling of six instrumented monitoring wells and 24 observation holes to confirm integrity of the heating elements.

      i. Construction of access road on lease to Phase I and II production pad from point of lease tract access.

   b. Drill the remainder of the ground water monitoring wells (up to 48 total including Year 2 activity) from the previously constructed pads.

   c. Drilling/constructing up to three small, parallel in situ planar heaters (each approximately 300 feet in length and up to 120 feet apart) at depth in a target oil shale zone (R-4 and lower [deeper] zones of rich oil shale) at a depth of approximately 2,425 to 2,940 feet beneath the surface. Construction would include:

      i. Verification of the electrical continuity/connectivity of the constructed heating elements.

      ii. Drilling/constructing three electrical-connection wells to complete an electrical circuit between the far ends of the in situ planar heating elements.

      iii. Evaluation of characteristics and confinement to target zone.

   d. Drilling of six monitoring holes for geophone insertion to monitor heating element construction and monitor subsurface progress during tests, and up to 24 observation holes.

   e. At the end of Phase I, the ground water monitoring well pads would be reclaimed. Of the 17 acres of initial disturbance, 0.2 acres of disturbance would remain.

3. Phase II (year 4) –Energized operations at depth (small scale) would involve:

   a. Drilling up to approximately 12 production wells and 12 additional monitoring holes from the six-acre production pad.

   b. Construction and operation of an electrical power line from the existing power line that borders the southern boundary of the lease tract that would be sized to

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meet power requirements of up to ~1.7 megawatts (MW) per heating element plus facilities needed for Phase II activity.

c. Electrifying up to two of the constructed in situ planar heating elements installed in Phase I to heat the surrounding oil shale to pyrolysis temperature and to produce oil and gas. Electrifying the in situ planar heating elements would allow:

   i. Verification of the effectiveness and reliability of the electrified elements to heat adjacent oil shale to conversion temperatures over a projected six-month period.

   ii. Assessment of fluid properties of shale oil and gas produced at depth from EM's process.

   iii. Assessment of ground water protection measures.

d. The Phase II trial is expected to produce small volumes of up to 75-170 barrels of oil per day (BOPD), 40-80 barrels of water per day (BWPD), and 50-350 thousand standard cubic feet per day (Mscfd) of gas.

4. Phase III (years 5 - 10) – Commercial-scale pilot testing of EM's in situ planar heating technology would target demonstration of EM's technology on a commercial scale over a two to five year period - near but not overlapping the location of Phases I and II, and would involve:

   a. Construction of a five-acre multi well production pad to support drilling, completion, and operation of three in situ planar heater wells.

      i. Construction of access road on lease to Phase III production pad from point of lease tract access from off lease or from existing road on lease.

      ii. Drilling/construction of up to three in situ planar heater elements (each up to approximately 1,000 feet in length, up to 120 feet apart, and fractures extending up to 75 feet vertically above and below the well bore) at depth in the same oil shale zones drilled in Phase I and tested in Phase II.

   b. Construction of a two-acre connector multi-well pad to support drilling, completion, and operation of up to three in situ connector wells.

      i. Construction of access road on lease to Phase III connector multi-well pad from point of lease tract access from off lease or from existing road within the lease area.

      ii. Drilling/construction of up to three in situ planar heater elements (each up to approximately 1,000 feet in length and up to 120 feet apart) at depth in the same oil shale zones drilled in Phase I and tested in Phase II.

   c. Construction of up to six one-acre well pads to support production wells, element monitoring wells, and observation holes. Some of these wells and holes may be drilled from the 5-acre or 2-acre pads described above.

      i. Construction of access roads on lease to the six multi-purpose well pads from point of lease tract access from off lease or from existing roads within the lease area.

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ii. Drilling up to approximately 12 production wells, 12 monitoring holes, and 24 observation holes, separate from those proposed in Phases I and II.

d. Construction and operation of up to an additional 7 acres of surface disturbance to support ancillary facilities.

i. Construction of access roads on lease to the ancillary facilities' from point of lease tract access from off lease or from existing roads within the lease area.

e. Construction and operation of an electrical power line (possible upgrade of the Phase II power line) from White River Energy Association (WREA) to meet power requirements of up to ~4MW per heating element for up to two elements plus facilities needed for Phase III activities.

f. Collection of information necessary to determine the overall commerciality of EM's process: hydrocarbon recovery, environmental acceptability, and economic viability.

g. Phase III operations are anticipated to produce peak rates of 400-700 BOPD, 350 Mscfd to 6 million standard cubic feet per day (MMscfd) of gas, and 200-300 BWPD.

h. Target geologic horizons where Phase III tests were conducted may be flushed with water to confirm the ability to recover viable sodium minerals after the shale oil extraction process is complete.

5. Phase IV (years 11-15) – An optional Phase IV would be a repetition of the Phase III pilot test at a separate location, likely involving additional disturbance similar to that for Phase III. All parameters are assumed to be the same as for Phase III and identical additional disturbance has been assumed.

A listing of Applicant-committed Design Features (ACDFs) protective of the natural and human environment have been included as **Appendix B**.

2.3.2 Construction

Roads - Road construction needs on and off lease would be mostly limited because a mature road network already exists to access the lease tract from off lease. On-lease, gravel and native surface roads are present. Additional roads would likely be constructed to connect EM's RD&D acreage with nearby Rio Blanco County Road 83 (RBC 83). An estimated 0.5 mile of existing road upgrade and/or new road would be needed to access the lease tract boundary from RBC 83 (**Attachments 1a and 1b**). An estimated maximum of one mile of existing road upgrades and new roads would be needed within the proposed lease to connect facilities and production pads. An additional (up to) two miles of on lease access roads would be constructed to connect the network of ground water monitoring and appraisal locations. Routing, construction, and reclamation of new roads would comply with the BLM and U.S. Forest Service (USFS) *Surface Operating Standards for Oil and Gas Exploration and Development (Gold Book)* (BLM and USFS 2007). New roads would follow existing tracks and trails where possible.

Roads would be designed to the standard of BLM local roads, with 14-foot single and 24-foot double lane running widths, with intervisible turnouts, if required. Roads would use a 40-foot

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construction ROW. Single lane roads would be used for access to monitoring and appraisal wells. Roads would be surfaced with native materials and additional aggregate, where necessary, to provide all-weather access. Non-native surfacing materials would be acquired from local permitted sources. Construction of approximately 3.5 miles of project roads is expected to require about 17 days, using equipment similar to that discussed under well pad construction, below.

Well Pads - During years 1-2, it is anticipated that appraisal and ground water monitoring well pads would be up to 1.0 acre in size, including mud pits. Small tests may be conducted in the appraisal wells and/or ground water monitoring wells on the penetrated formations, to determine minimum in situ stress direction. The appraisal wells are planned to be abandoned or converted to ground water monitoring wells. Completion of interim reclamation would leave a 30-foot radius around each well for monitoring access, adjacent to an access road. The access road and small access wellpad would be maintained for each ground water monitoring well to ensure access for periodic sampling and monitoring and maintenance, as needed. In addition to the well pads, a process pad or area up to 20-acres in size would be constructed to house various project facilities.

The estimated size of the pad that would be used for both Phase I and II wells is approximately six acres (exclusive of utilities right-of-way [Phase II], an access road, and pipeline to deliver produced fluids to the Production Facility), and would include accommodations for drilling (including mud pits), fracturing, and building electrical connections. It would also include several monitoring and direct observation holes to characterize the heating elements. Tests may be conducted in the Phase I wells and holes to determine minimum in situ stress directions in the underlying formations.

The estimated size of the pads supporting Phase III and Phase IV wells and facilities would consist of five acres for the single heaters pad, two acres for the single connectors pad, seven acres for the single ancillary facilities pad, and one acre for each of the six multi-purpose pads (exclusive of utilities right of way, an access road, and pipeline to deliver Phase III and IV produced fluids to the Production Facility). The Phase III and IV pads would include accommodations for drilling (including mud pits as needed), fracturing, and building electrical connections. It would include several monitoring and direct observation holes to characterize the heating elements, as well as space for long-term production facilities.

Phase facility pads would be graveled as necessary to provide year-round all weather access. Production pads would be constructed with an estimated five pieces of heavy equipment (low boy hauler, dozer, grader, gravel hauling heavy truck, and backhoe). Well pad and process facility construction during years one and two would take approximately 105 days. Pad construction during Phase I would require approximately 14 days. Well pad construction during Phase III and Phase IV each would require approximately 48 days.

Pipelines - A products gathering pipeline would be constructed for Phases II, III, and IV, each Phase requiring up to approximately 0.25 mile. Depending on layout, these pipelines may be tied in together. Products would include combined water, gas, and shale oil that would be transported to the production facility. Although the exact dimensions of the pipeline cannot be estimated until detailed production facilities design is complete, a maximum six-inch diameter pipeline has been assumed for purposes of analysis. During construction, a ROW of up to 50 feet width would be required. Interim reclamation following installation would result in reclamation of the

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entire ROW, however a 14-foot wide corridor would be maintained for inspection purposes. Pipe would be composed of steel, fiberspar, or a material of sufficient strength to safely contain pressures obtained during the production process.

A buried natural gas supply or distribution pipeline may be required, depending on the amount and heating value of gas produced during the production process. By-product gas would be used, as feasible, to power production operations. If there is insufficient quantity or quality of gas for these purposes, natural gas would be transported to the production facility from a nearby pipeline. If there is more by-product gas than required, and if it is of sufficient quality to be sold, the potential natural gas pipeline would be used to transport surplus gas to the sales pipeline. A maximum six-inch diameter pipe has been assumed for purposes of analysis. Pipe would be composed of steel, fiberspar, or a material of sufficient strength to safely contain pressures obtained during the production process. It is not certain that this pipeline would be constructed, but it has been assumed for purposes of this analysis. Interim reclamation would be consistent with that performed for the products gathering pipeline.

Buried pipeline excavation, installation, and burial would be accomplished with an estimated three pieces of heavy equipment (excavator, trencher, and grader) over a one to two day period. Pipeline construction rates are estimated at four days/mile, assuming eight hours of daily operations. A buried natural gas supply or distribution pipeline would each require about two days of construction.

Power Line – Up to approximately 3,750 feet of power/utility lines would be constructed and operated. The power line would utilize a 25-foot wide ROW. The ROW would be cleared using equipment and personnel similar to that used for roads construction. Construction and permitting of the power lines would be performed by WREA.

2.3.3 Drilling and Completion

Drilling - Wells would be drilled using conventional drilling rigs and methods typically utilized for oil and gas wells and water wells. Wells would be required for a number of purposes, but can be generalized to those used for geologic appraisal and construction of the heating elements, and those used for production and various types of monitoring purposes. The former wells would be drilled with a larger rig while a smaller rig would be used for the latter well types. The basic well types include:

- Construction - wells with vertical and horizontal components used to create the element fractures;
- Connection - wells which would make an electrical connection between the heating elements;
- Production - wells which would recover the liquefied oil shale kerogen;
- Geologic appraisal - Drilled and/or cored holes to establish local geologic characteristics;
- Ground water monitoring - wells drilled to various aquifers to monitor potential contamination;
- Observation - well drilled to allow monitoring of fracturing process using seismic instruments; and

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- Element monitoring - wells drilled to monitor the heating elements.

The exact locations, casing specifications, and cement characteristics of each well type are not necessarily determined at this time pending acquisition of additional geologic information.

Drilling fluids would include compressed air and/or fresh water. Approved non-contaminating additives (e.g., bentonite, cellulosic polymer and/or biodegradable surfactants) would be used to enhance drill cuttings carrying properties. If areas are encountered while drilling that are prone to lost circulation, bridging materials such as calcium carbonate, nutshells, and/or fibers may be added to the drilling fluid. Minimal use of weighting material is anticipated, which may include calcium carbonate or sodium bicarbonate. Drilled wells would use reserve pits or closed-loop circulation as determined by site-specific conditions.

During drilling, the formations penetrated are anticipated to be normally pressured (0.433 psi/ft). At 3000 ft TVD, a formation pore pressure of approximately 1,300 psi is anticipated. Pressure control equipment would meet EM and appropriate agency requirements.

EM anticipates using 5.5-in K-55 17 lb/ft (5320 psi burst pressure) casing in construction/heater wells and production wells. Up to three construction/heater wells, 12 production wells, and one produced water injection well (if needed) are planned for each of Phases II, III, and IV. Heater well life is planned for five years, producer well lives are planned for ten years.

Surface casing for heater and production wells would be set to a depth sufficient to protect the deepest usable aquifer and cemented back to surface to prevent communication among shallow aquifers and deeper production zones. Depending on the intended use of the well (heater, producer, injector, etc.), the well may be drilled with directional control to the target of interest. Producer/injector wells are anticipated to be vertical while the construction/heater wells are anticipated to have a horizontal interval of up to approximately 1,000 feet, depending on Phase. In all cases, EM anticipates running the inner casing string to the total drilled depth of the well and cementing this string back to surface level. Producer wells may require some form of artificial lift, in which case a tubing string may be used to convey produced fluids back to the surface.

Surface casing for monitor wells would be cemented to surface. Casing would be composed of steel, poly, fiberglass, or composite pipe, depending on the use of the well.

Determination of cement volumes would be made with the assumption that surface and production casing for construction, connector, and production wells would be cemented back to surface. Typical slurry volumes would be 50 ft^3 for surface casing and 500 ft^3 for production casing. Cements would be neat slurries of Class G cement with silica added to provide thermal stability.

For each well, a completed application for permit to drill package would be submitted to the appropriate regulatory agencies for approval and required permits obtained prior to drilling each well.

Completion - The heating elements are built by fracturing the construction holes and filling the fractures with a nonhazardous, electrically conductive material, such as a mixture of calcined coke and cement. The horizontal section of the construction holes would be cased with electrically nonconductive pipe (likely fiberglass or other non-conductive tubulars designed for downhole use), 5.5-in. in diameter. In Phase I, approximately 150,000 lb of calcined coke and

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60,000 lbs of Portland cement would be pumped into the formation for each heating element. In Phase III, approximately 1,000,000 lbs calcined coke and 400,000 lbs of Portland cement would be pumped into the formation for each heating element.

2.3.4 Surface Disturbance:

A summary of the number of surface pads and count of various well types, by operational phase, is indicated in **Table 2.4**. A summary of the amounts of construction and life-of-project surface disturbance resulting from implementation of EM's proposed lease acquisition and RD&D project is presented in **Table 2.5**. Because the number and location of facilities and resulting surface disturbance is not definitely known at this time, a maximum number of facilities and an associated estimated maximum surface disturbance has been assumed for this EA. Preliminary development operations during the 15-year RD&D lease period (10-year initial plus optional 5-year extension) including interim reclaimed areas are expected to disturb up to approximately 112.7 acres within the lease (**Table 2.5**) (**Figure 2.5**). Surface disturbances are expected to include access roads, power/utility line, pipelines, and well and facility pads. The application of interim reclamation measures following construction would reduce the extent of continuing disturbance for the long-term life of the RD&D operations to approximately 40.5 acres (**Table 2.5**) excluding roads, utilities, and pipelines.

Although EM has proposed to locate their proposed RD&D operations and associated disturbance within the southwestern portion of the RD&D lease, EM may need to relocate the area of operations to another portion of the 160- acre tract should subsurface or other conditions necessitate a change of location. All of the disturbance would be located on lands managed by the BLM.

2.3.5 Production Facilities, Process, and Rates:

Facilities - For each phase, site buildings would include a temporary building or trailer for office space, and a warehouse or storage shed for equipment such as pipes, valves, fittings, and controls. A safety/security fence would surround the temporary building or areas of activity, as needed to protect livestock and wild game. Building(s) may be tied-in with the local electrical grid pending discussion with WREA. Otherwise, electricity would be supplied from portable generators equipped with appropriate noise and emission controls. Fresh water for all needs would be trucked to the site.

Production facilities and infrastructure to support storage, processing, and disposition of produced fluids would be appropriately sized and erected onsite during each phase of testing to accommodate the respective expected fluid production rates. Although produced fluid compositions are expected to be similar between Phase II and III, the different size of streams may require different equipment size and types to achieve the required processing. Electric motor-driven equipment would be considered, when feasible, for noise mitigation purposes. If engine-driven equipment is used, noise controls would be employed to maintain allowable noise limits at the lease boundary.

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Table 2.4 EM Surface Pads and Well Counts, by Operational Phase

Well Pad / Facility Type	Count	Pad Size (ac.)	Disturbance (ac.)	Well Count	Year
Appraisal					
Geologic Appraisal	4	1.0	4.0	4	2
GW Monitoring	17	1.0	17.0	24	2
Process Pad	1	20.0	20.0	0	2
Phase I					
GW Monitoring	*	*	*	24	3
Ph.I& II Production Pad	1	6.0	6.0		3
Construction Wells		Within Ph. I & II Production Pad		3	3
Connection Wells		Within Ph. I & II Production Pad		3	3
Element Monitoring		Within Ph. I & II Production Pad		6	3
Observation Holes		Within Ph. I & II Production Pad		24	3
Phase II					
Production Well		Within Ph. I & II Production Pad		12	4
Element Monitoring		Within Ph. I & II Production Pad		12	4
Phase III					
Heaters Multi-well Pad	1	5.0	5.0	3	6
Connectors Multi-well Pad	1	2.0	2.0	3	6
Multi-Purpose Pads	6	1.0	6.0		6
Production Well		Within Ph. III Multi-Purpose Pads		12	6
Element Monitoring		Within Ph. III Multi-Purpose Pads		12	6
Observation Holes		Within Ph. III Multi-Purpose Pads		24	6
Ancillary Facilities Pad	1	7.0	7.0	0	6
Phase IV					
Heaters Multi-well Pad	1	5.0	5.0	3	11
Connectors Multi-well Pad	1	2.0	2.0	3	11
Multi-Purpose Pads	6	1.0	6.0		11
Production Well		Within Ph. IV Multi-Purpose Pads		12	11
Element Monitoring		Within Ph. IV Multi-Purpose Pads		12	11
Observation Holes		Within Ph. IV Multi-Purpose Pads		24	11
Ancillary Facilities Pad	1	7.0	7.0	0	11
TOTAL	41		87.0	206	

* Ground water monitoring well pads constructed during the Appraisal phase would be used to drill additional ground water monitoring wells during Phase I, as deemed necessary from the appraisal information. A total of up to 48 ground water monitoring wells are planned.

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Table 2.5 EM Oil Shale Lease Tract Anticipated Maximum Surface Disturbance

Facility	Multiplier: Well Pad Count or Length (ft.) (Maximum)	Size (acres) or ROW (ft.) Initial/ LOP	Estimated Short-term Surface Disturbance (Maximum / ac.)	Estimated Long-term Surface Disturbance (Maximum / ac.)
Appraisal and Ground water Monitoring Well Pads (Outside of facility and Phase Disturbance)				
Appraisal Wells	4	1.0	4.0	0.1
GW Monitoring Wells	17	1.0	17.0	0.2
Process Pad	1	20.0	20.0	
Phase I-IV Surface Production Facilities				
Phase I and II Pads[1]	1	6.0	6.0	0.2
Phase III Pads [1]				
Heaters Pad	1	5.0	5.0	5.0
Connectors Pad	1	2.0	2.0	2.0
Multi-Purpose Pads	6	1.0	6.0	6.0
Ancillary Facilities	1	7.0	7.0	7.0
Phase IV Pads [1]				
Heaters Pad	1	5.0	5.0	5.0
Connectors Pad	1	2.0	2.0	2.0
Multi-Purpose Pads	6	1.0	6.0	6.0
Ancillary Facilities	1	7.0	7.0	7.0
Linear Facilities (Outside of facility and Phase Disturbance)				
Roads				
Monitoring and Appraisal[2]	10,560	40 / 14	9.6	3.4
Facilities and Phase Pads [2]				
Off Lease	2,640	40 / 24	2.4	1.5
On Lease	5,280	40 / 24	4.8	2.9
Pipelines				
Product Gathering	3,750	50 / 14	4.3	1.2
Natural Gas	2,000	50 / 14	2.3	0.6
Power Line	3,750	25	2.2	2.2
Total			112.7	52.3

[1] Pad includes Observation, Monitoring, Construction, Connector Holes, and Production Holes.

[2] Does not include access within Phase Pads and Facilities disturbance area. Assumes maximum disturbance.

[3] Does not include roads, on-lease product gathering pipelines, and utilities.

Disturbance levels are estimated maximum values and does not account for coincidental acreage of monitoring/appraisal pads with production and process facilities.

A process block flow diagram illustrating a proposed configuration for EM's proposed facilities is presented in **Figure 2.6.** An associated listing of expected production facilities equipment is included in **Table 2.6**.

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Figure 2.6 EM Proposed Production Facilities Layout

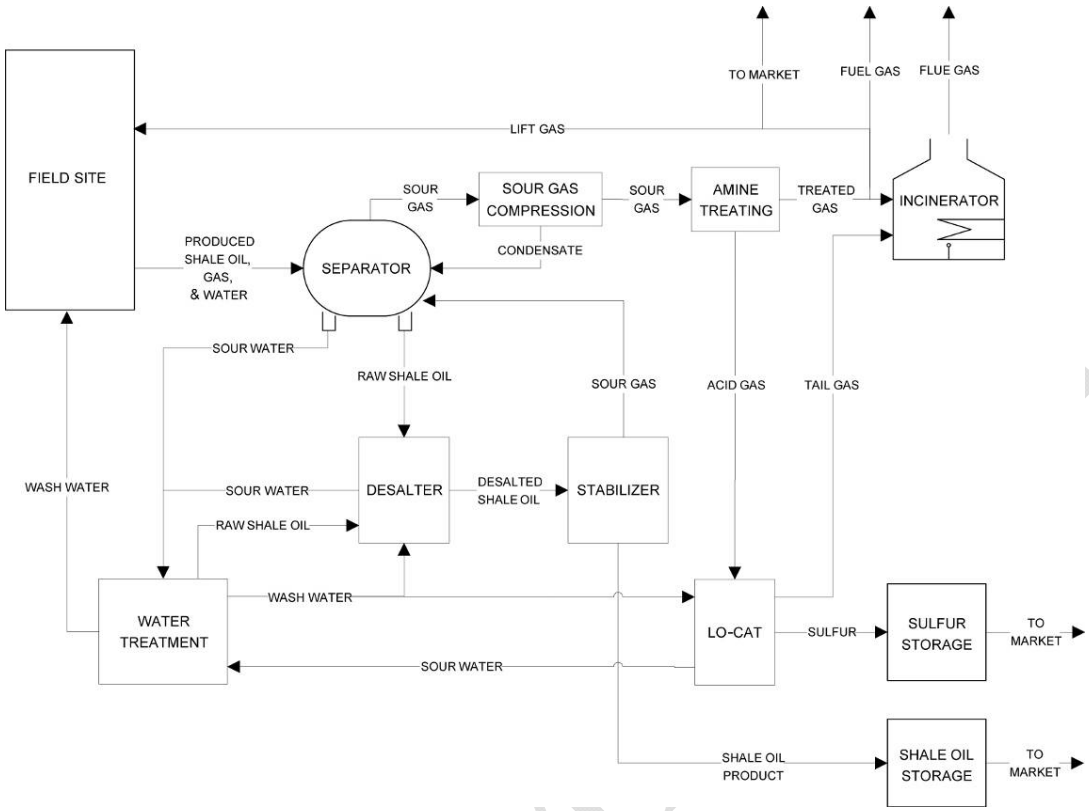

Table 2.6 Expected Production Equipment

Equipment Type	
Portable generators	Stabilizer
Three-phase separator	Lo-Cat skid unit
Compression system	Water treatment facility
Amine treating skid unit	Produced water storage vessels
Gas incinerator	Sulfur storage vessels
Desalter	Shale oil storage vessels

* Equipment list may change pending appraisal findings and any associated process design changes

Production Process - Pending detailed design, specific process units may be substituted or absent at the very small rates expected during Phase II operations. The facilities design would be finalized after the site-specific environmental analysis and in accordance with all permits for the RD&D lease.

The produced stream would be a mixture consisting of gas, oil, water, and some impurities (e.g., hydrogen sulfide [H_2S] and carbon dioxide [CO_2]). The stream components would be separated and treated for the removal of impurities using typical oil and gas industry processes and facilities.

When the produced stream reaches the surface, a three-phase separator would separate it into gas, liquid hydrocarbon, and water streams. The gas and water leaving the separator would be 'sour' streams because of the presence of sulfur compounds and CO_2. After initial separation, the

sour gas would be compressed and cooled to condense out any remaining sour water and/or liquid hydrocarbon. The condensed liquids would be routed appropriately for further handling.

Gas Processing - Once compressed and cooled, the sour gas may be sent to a fixed-bed absorber or an amine treating unit, which would include absorber and stripper columns. In the amine treating unit absorber column, the gas would be contacted with an aqueous solution of methyl diethanolamine (MDEA), or other selective solvent, which would absorb H_2S, other sulfur compounds, CO_2, and other acids. The absorption is selective in that it removes a very high fraction of the sulfur compounds but only a portion of the CO_2. A large portion of the resulting clean gas would be used for process fuel and other purposes, such as production well lift gas, as needed. If sufficient quantities of clean gas are available, the gas may be sent to market. The most likely destination for gas from this facility would be one of the gas processing plants that serve the Piceance Basin. If sales are not practical, gas could be burned in a properly permitted incinerator designed to minimize emissions of CO and NO_x. In the stripper column, the MDEA would be continually regenerated for reuse. Regeneration involves removing sulfur and other compounds from the MDEA solution. This process creates an acid gas stream containing H_2S and CO_2.

The acid gas would be sent to a Lo-Cat unit where the H_2S would be converted to elemental sulfur. The tail gas from the Lo-Cat unit would be incinerated. The Lo-Cat process yields a relatively small water stream. Ammonia (NH_3) in the gas would have no detrimental effect on the Lo-Cat process and would end up as ammonium compounds in the water stream, which would be treated. The small amount of residual NH_3 in the tail gas would not substantially contribute to NO_x emissions from the gas incinerator. The Lo-Cat process makes a high quality sulfur product that should be marketable. Elemental sulfur generated through the Lo-Cat process would be temporarily stored onsite in appropriate vessels prior to shipping offsite for disposal or sale. Skid-mounted amine units and Lo-Cat units are commercially available in the required size.

Alternate gas processing may be necessary pending appraisal findings that could affect process design. This could include scrubbing of gases prior to incineration, after incineration, or a combination of both.

Liquid Hydrocarbon Processing - Liquid hydrocarbon may contain substantial concentrations of salts and may, therefore, be desalted after leaving the separator. In the desalter unit, recycled wash water would be added to the liquid hydrocarbon to dissolve the salt. The saltwater and hydrocarbon streams would then be separated and routed appropriately. The salt water would be treated or appropriately disposed, and the liquid hydrocarbon would be sent to a stabilizer unit where it would be conditioned for storage and transport.

Stabilization involves removing light components to reduce the vapor pressure of the oil for convenient and safe storage and shipment. In the stabilizer unit, the oil would be distilled into light (gas) and heavy (oil) fractions. The gas would be injected into the inlet of the three-phase separation unit for further processing, and the oil would be sent to appropriate storage vessels.

The facilities would include an array of safety systems typical of EM production facilities. This includes an overpressure protection system, with pressure relief devices that vent through a piping system that terminates at a lighted flare. The flare system would only be used for emergency pressure relief. The flare would be designed during the detailed design of production facilities.

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Alternate liquid hydrocarbons processing may be necessary pending appraisal findings that could affect process design.

Produced Water Processing - The sour water streams from the three-phase separator and the Lo-Cat unit may be treated for reuse or disposal. The water treatment facility would remove H_2S from the sour water and may include equipment for recovering sodium minerals from produced water. Any remnant oil recovered by the water treatment facility may be sent to the desalter for further treating. Sour gas recovered from the water treatment facility would be sent to the Lo-Cat unit for removal of sulfur compounds.

Alternate produced water processing may be necessary pending appraisal findings that could affect process design.

Production Rates - Phase II estimated peak production rates are for up to approximately 75-175 BOPD, 50-350Mscfd of gas, and 40-80 BWPD. The heating elements are planned to be energized for approximately 6 months. Production is expected to begin soon after the onset of heating and continue for some time after heating stops. It is anticipated that only two heater elements would be operated during each phase of the project.

Phase III and Phase IV estimated peak production rates are for up to approximately 400 to 700 BOPD, 350 Mscfd to 6 MMscfd of gas, and 200 to 300 BWPD. The heating elements would be operated for up to approximately 5 years. Shorter or longer operation times may be used, depending on the size and spacing of the heating elements. Production would begin soon after the onset of heating and would continue for some time after heating stops. If suitable for sale, gas would be processed and distributed through nearby sales gas pipelines. The oil would be collected, some would be used for processing research, and the remainder would be trucked for sale or disposal. The quantity of oil available for potential sale from phase III and IV operations is not expected to be sufficient to support a commercial operation.

2.3.6 Reclamation and Abandonment:

Reclamation - Following construction, the need for temporary stabilization measures for cut/fill slopes as part of interim reclamation would be evaluated based upon rock content and degree of slope. In areas of rock content greater than 50 percent, no erosion control measures on slopes would be implemented, and primary BMPs would be wattles at the toe of the fill slope. Where there is less than 50 percent rock content, surface roughening and erosion control blankets may be used to stabilize the fill slopes. If field conditions do not allow for effective surface roughening or installation of erosion control blankets, hydromulching may be used. If hydromulching is used, the seed would be sprayed at double the drill seeding rate followed by application of hydro-mulch.

EM would return disturbed areas to approximate original contour and rehabilitate the roads and RD&D locations to a satisfactorily revegetated, safe and stable condition per BLM specifications. If final reclamation requires disturbance greater than one acre, stormwater permit coverage under the State's stormwater program would be reopened. Natural drainage patterns would be restored and stabilized by application of BMPs per approved SWMP for this site. These BMPs include surface roughening, permanent seeding and may include use of erosion control blankets following regrading operations. Storm runoff from the regraded areas would continue to be controlled using wattles and other appropriate BMPs until stabilization of the reclaimed area has been achieved.

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Mud pits would be reclaimed per applicable regulations. In addition to pits for drilling and completions, EM may use truck-mounted, temporary steel tanks (400-500 barrels [bbl]) or temporary contractor-supplied above-ground steel drilling pits (10 ft x 30 ft x 6 ft deep) with a secondary containment berm.

Stockpiled soil would be incorporated into the regraded area in locations available for final recontouring. Shale/rock would be placed in the lower portions of filled areas as appropriate. Following regrading, areas compacted by earthworks would be scarified to a minimum depth of 6 inches and the stockpiled topsoil would be distributed evenly across the reclaimed area.

The seedbed would be prepared by disking or ripping prior to spreading topsoil. The area would be seeded with the approved BLM seed mixture. Seed would be certified and free of noxious weeds. Seed certification tags would be submitted to the area manager. Seed would be drilled 'on contour' to a depth no greater than ½ inch. In areas too steep to operate the seed drill, seed would be broadcast at double the seeding rate and harrowed into the soil. Alternatively, hydromulching may be used in these areas. If hydromulching is used, the seed would be applied first at double the seeding rate prior to hydromulch application.

Depending upon the location of the surface disturbance, EM would use the BLM-recommended seed mixes listed in **Table 2.7**. The rolling loam sites would be seeded with Mix 2 and the pinyon juniper sites would be seeded with Mix 3. If the plot spans two range sites, it is expected that BLM would recommend the seed mix of the majority site.

Slopes of gradient 3:1 (33 percent) or steeper would be covered with wildlife-friendly biodegradable fabrics (such as, but not limited to, jute blankets, Curlex, etc.). Following seeding and placement of biodegradable fabrics (as required), woody debris cleared during initial construction would be pulled back over the recontoured and reshaped areas to act as flow deflectors and sediment traps. Available woody debris would be evenly distributed so as not to account for more than 20 percent of total ground cover (or 3 – 5 tons/ acre)

After reclamation is concluded, livestock grazing would be excluded from reclaimed portions by installation of a four-strand BLM Type-D barbed wire fence with braced wooden corners. Once reclaimed plant species are fully established, the fence would be removed after a minimum of two growing seasons. Additional reclamation efforts would be undertaken if, after the first growing season, there are no positive indicators of successful establishment of seeded species (i.e., germination).

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Table 2.7 Probable Reclamation Seed Mixes

Mix	Cultivar	Species	Scientific Name	Application Rate (PLS/ac.) [1]
2	Arriba	Western Wheatgrass	*Pascopyrum smithii*	4
	Rimrock	Indian Ricegrass	*Achnatherum hymenoides*	3.5
	Whitmar	Bluebunch Wheatgrass	*Pseudoroegneria spicata ssp. inermis*	4
	Lodorm	Green Needlegrass	*Nassella viridula*	2.5
	Timp	Northern Sweetvetch	*Hedysarum boreale*	3
		Sulphur Flower	*Eriogonum umbellatum*	1.5
	Alternates: *			
		Needle and Thread	*Hesperostipa comata spp. comata*	3
		Scarlet Globemallow	*Sphaeralcea coccinea*	0.5
3	Rosanna	Western Wheatgrass	*Pascopyrum smithii*	4
	Whitmar	Bluebunch Wheatgrass	*Pseudoroegneria spicata ssp. inermis*	3.5
	Rimrock	Indian Ricegrass	*Achnatherum hymenoides*	3
		Needle and Thread Grass	*Hesperostipa comata ssp. comata*	2.5
	Maple Grove	Lewis Flax	*Linum lewisii*	1
		Scarlet Globemallow	*Sphaeralcea coccinea*	0.5
	Alternates: *			
	Critana	Thickspike Wheatgrass	*Elymus lanceolatus ssp. lanceolatus*	3
		Sulphur Flower	*Eriogonum umbellatum*	1.5

[1] Pounds live seed/acre

The BMPs to be employed during reclamation would include surface roughening, seeding and erosion control blankets. Runoff from the regraded areas would continue to be controlled at the perimeter of the disturbed area using wattles. These measures would continue to be maintained around the perimeter of the site until stabilization of the reclaimed areas has been achieved. Noxious weed control would be performed 1 – 2 times annually (during the growing season). Applications would be performed by a certified pesticide applicator.

Abandonment - Once it has been determined that a well has no further use, non-permanent downhole equipment would be retrieved (e.g., pumps used for production wells) and the well would be cemented back to surface to prevent migration of fluid within the casing. During the experimental phases of the project, it is anticipated that instrumentation (e.g., temperature, seismic, etc.) would be cemented in several of the monitoring wells. These wells would be left in their previously completed state with cement added to fill their casing back to surface where necessary. Casing would be cut off below grade and a "plugged and abandoned" (P&A) marker with well data would be installed.

For Phase II small scale tests, abandonment operations are expected to begin in, and possibly extend beyond, year 4. For Phase III pilot, abandonment operations are expected to begin in, and possibly extend beyond, year 10. For the Phase IV pilot, abandonment operations are expected to begin in, and extend beyond, year 15.

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2.3.7 Products and Byproducts:

Produced oil would be collected, analyzed, used for processing experimentation, stabilized (as needed), and trucked off-site for appropriate disposal or sale. The quantity of oil available for potential sale is not expected to be sufficient to support a commercial operation. Onsite tankage would be used to temporarily store oil prior to loading onto trucks.

Produced gas would be analyzed and processed to remove H_2S. The remaining gas would likely be consumed onsite, incinerated, flared, or piped to local gas gathering lines for further offsite processing.

Produced water would be analyzed and used for processing experimentation, stripped of H_2S and trucked offsite for appropriate disposal. If at a later time, water injection is proposed, it is understood that additional NEPA review may be required and water injection facilities do not constitute a part of the Proposed Action. The feasibility of these options would be evaluated based on the current available infrastructure at the time of detailed design. Processed produced water may be temporarily stored in on-site tankage prior to loading onto trucks.

Spill prevention measures would be in place to prevent, mitigate, and control any spills. The stormwater drainage system is expected to minimize potential to allow contact between runoff and any process fluids or products. Drilling mud pits are to be designed to minimize potential for discharge of drilling fluids other than for collection and appropriate disposal.

2.3.8 Water Requirements:

Water would be needed for construction and drilling activities, shale oil processing, dust control, testing the recovery of sodium minerals, and if necessary, mitigation of ground water contamination, if any. It is expected that fresh water for drilling, dust control, and other needs would be trucked to the site and stored in tanks located in a bermed area. Fresh water tanks are not expected to require lined storage.

The source of fresh water for the project is anticipated to be EM's existing water rights within the region. ExxonMobil Exploration Company and its affiliated sister companies own rights to substantial volumes of surface and ground water within the Piceance Basin. The closest potential EM water source to the proposed lease tract includes the Love Ranch and B&M Reservoir ponds which receive water from Piceance Creek under an existing water right (98CW0259). As the proposed project is research in nature, it has not been determined at this time that the Love Ranch or B&M Reservoir ponds would definitely be the project water source.

Instantaneous water requirements would vary depending on the nature of on-going operations (drilling, initial heating, production, nahcolite recovery, and reclamation). To the extent practical, EM would treat water for reuse and would plan field operations in phases such that peak requirements for water (and other resources such as power) are moderated. If water is to be piped, approval of the pipeline would be through a separate NEPA analysis and Decision Record and the pipeline does not constitute a part of the Proposed Action. After analysis and testing, recovered water to test nahcolite recovery is expected to be disposed of in a manner similar to other produced water.

EM's current estimates of fresh water use for operations on the RD&D lease are provided in **Table 2.8**. Because the actual amounts of water required are not definitely known at this time, maximum estimated volumes have been estimated for this EA. It is expected that the water use

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per barrel of oil produced for a commercial development would be substantially less than the research, development, and demonstration efforts described herein.

Table 2.8 Maximum Water Use Estimate for EM RD&D Lease Tract

Year	Fresh Water (bbls)	Fresh Water (ac-ft)	Phase
1	39,000	5.03	Appraisal
2	50,000	6.45	
3	80,000	10.31	I
4	55,000	7.09	II
5	82,000	10.57	III
6	55,000	7.09	
7	11,000	1.42	
8	11,000	1.42	
9	11,000	1.42	
10	11,000	1.42	
11	55,000	7.09	IV
12	11,000	1.42	
13	11,000	1.42	
14	11,000	1.42	
15	11,000	1.42	
Total	504,000	64.97	

Work on the RD&D lease would help to better define water needs for commercial in situ oil shale development and may identify opportunities to reduce water use. Water use estimates include all estimated water required for production and testing operations, including nahcolite recovery following test shale oil production.

2.3.9 Electrical Power Requirements:

Phase II construction would include bringing in electrical power from a WREA existing powerline which runs along the southern boundary of the lease tract, as supply to the heating elements built in Phase I (up to 2 each at up to approximately 1.7 MW), as well as for the production facilities and office and building space sited in the production facilities area. It is expected that temporary overhead power lines and associated ROW would be used to tie-in to the WREA power lines running along the southern boundary of the proposed RD&D lease. The power demands for the production facilities, office, and building space, would be determined at a later time, through detailed design of these facilities. It is possible that WREA may need to upgrade the lines leading to our tie-in, pending review of appraisal information and subsequent detailed design of our electrical power needs.

For Phase III and Phase IV, up to approximately 4 MW of electrical power from the nearby power grid would be delivered to each of the two heating elements to resistively heat the formation. Power would be acquired and transmitted to the required locations similar to that discussed for Phase II.

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2.3.10 Natural Gas Requirements:

Additional natural gas is not expected to be required. However, upon detailed design, if supplemental natural gas is required, it could be trucked to site, or a federal ROW could be required to tie in to local gas gathering and distribution lines to supply gas to the site. In the event a ROW is required, it would be approved through a separate decision-making, including appropriate NEPA review, and does not constitute a part of this proposed action.

2.3.11 Air Emissions and Waste Materials

Air Emissions. Likely sources of project-related air emissions include exhausts from drill rigs, power generating equipment and vehicles, and potential fugitive emissions from the surface facilities and vehicle activity. An incinerator may be used for final off-gas treating to control CO and NO_x emissions. The largest air emission is expected to be CO_2, as vent gas and exhaust from hydrocarbons combusted onsite. The emergency flare is expected to oxidize all sour gases and natural gas that must be relieved from the processing system, in the event of an emergency. Major sources of anticipated fugitive dust emissions include construction activities, use of paved and unpaved roads, and unenclosed storage piles. Major factors that determine the transport of dust plumes include soil condition, wind speed, and vehicular traffic. EM would use industry best practices prescribed by regulations to reduce fugitive dust emissions from vehicular traffic and surface disturbance.

Solid Wastes. Small quantities of solid wastes would be generated throughout the life of the RD&D project. These wastes include construction wastes, garbage, and other miscellaneous solid wastes. Solid wastes would be sorted in appropriate trash containers for off-site disposal in accordance with applicable regulations. Hazardous waste or other wastes, such as used oils, lubricants, hydraulic fluids, paints, and chemical reagents would be disposed off-site in accordance with applicable regulations. Sanitary waste streams would be sent off-site for disposal in accordance with applicable regulations. No pollutants are expected to be released into surface or ground waters.

Sulfur recovered from gas treating and produced water stripping, would be stored onsite in appropriate storage units, until loaded onto trucks for appropriate offsite disposal or sale.

Drill cuttings that comprise soil and rock would be dewatered on-site. Depending on the results of its toxicity characteristics (as determined by the EPA's Toxicity Characteristic Leaching Procedure [TCLP]) (EPA 2011), the dewatered cuttings may either be buried below grade, if non-hazardous, or disposed off-site in accordance with applicable regulation. When buried below grade, the affected area would be revegetated in accordance with applicable regulations during the reclamation phase. Wastewater/drilling fluids separated from the drill cuttings may contain constituents of concern, such as oil and grease, and suspended and dissolved solids. This wastewater from drilling may be treated for reuse or injection at an approved offsite facility.

2.3.12 Personnel and Traffic

During construction of wells and facilities, craft and labor employees and contractors would total approximately 120 workers. The construction phase would involve a maximum of 30 vehicles per day going to and from the site (approximately 10 commercial trucks and 20 passenger vehicles). Employee transportation would be by private vehicles.

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During ongoing operations, total staff may be as large as 20 employees and contractors, who would make an estimated five to ten round trips per day in total. These workers would likely be housed in hotels (if nonresidents) or in typical residential housing (if residents of the Western Slope) in Rifle, Meeker, Rangely, Silt, Parachute, or Grand Junction, CO.

2.3.13 Project Schedule:

A graphic representation of the proposed EM project schedule is illustrated in **Figure 2.7**.

Figure 2.7 EM Project Schedule

Activities	Year														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Appraisal															
Design & build infrastructure															
Drill appraisal / GW wells															
Phase I															
Build production pad															
Drill construction & connector wells															
Drill monitoring wells															
Phase II															
Heat pilot test fracture															
Drill production & monitoring wells															
Phase III															
Build heater, connector, and other pads															
Build ancillary facilities pad															
Drill production & monitoring wells															
Heat pilot test fracture															
Phase IV															
Build heater, connector, and other pads															
Build ancillary facilities pad															
Drill production & monitoring wells															
Heat pilot test fracture															

2.4 No Action Alternative

The No Action Alternative would not allow issuance of the nominated second round RD&D leases and surface management would remain the same as current. These nominated RD&D leases are within the area identified in the White River Record of Decisions/Resource Management Plan ROD/RMP as the multimineral zone. Technical, economic, and environmental feasibility of proposed technologies to extract liquid fuels from within the multimineral zone would not occur, since existing RD&D leases are located outside of the multimineral zone.

2.5 Alternatives Considered But Not Carried Forward

Besides the Proposed Action, the Proposed Action with Mitigation (specified), and the No Action Alternatives for each lease tract, no additional alternatives were considered.

2.6 Plan Conformance Review

The proposed action is subject to and has been reviewed for conformance with the following plan (43 CFR 1610.5, BLM 1617.3):

> Name of Plan: White River Record of Decision and Approved Resource Management Plan (White River ROD/RMP), as amended by the Approved Resource Management Plan Amendments/Record of Decision for Oil Shale and Tar Sands Resources to Address Land

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Use Allocations in Colorado, Utah, and Wyoming and Final Programmatic Environmental Impact Statement (also known as the Oil Shale and Tar Sands Programmatic EIS and Record of Decision [OSTS-PEIS]).

Date Approved: July 1, 1997. Amended November 17, 2008.

Decision Language: "Designate 343,358 acres of land within the most geologically prospective oil shale area as available for application for leasing for commercial oil shale development in accordance with applicable federal and state regulations and BLM policies." (OSTS-PEIS ROD Page A-6)

"At the discretion of the Secretary of the Interior, research scale lease tracts will be considered within lands available for oil shale leasing. Approval of research tracts will be based on the merits of the technology proposed." (White River ROD/RMP page 2-6)

3 AFFECTED ENVIRONMENT, ENVIRONMENTAL CONSEQUENCES & PROPOSED MITIGATION

3.1 Analysis Specifications

3.1.1 Direct and Indirect Effects

Effects to environmental resources or values resulting from implementation of the proposed projects may be either beneficial (positive) or detrimental (negative) and may vary in duration from short-term, typically less than three years, to long-term which would encompass project life and may be permanent in the absence of successful restoration or reclamation. Effects anticipated for this project may be negligible (little or no effect to the resource), low (effects are difficult to detect and cause minimal change to the resource), and moderate (effects which are readily apparent but which do not meet the criteria of significant impacts). Effects may be either direct, caused by the action, and occurring at the same time and place as the proposed actions, or indirect, caused by the action, but occurring at another time or location.

Analysis of effects resulting from implementation of the proposed actions assumes application of ACDFs (**Appendices A and B**). Additional mitigations and BMPs **(Appendices C and D**) are proposed for application by the appropriate BLM resource specialist where indicated in the text below.

The direct and indirect impacts of the proposed actions, both as proposed, and as proposed with mitigation (specified), and the No Action alternative on the resources/issues brought forward for discussion are discussed in this section.

3.1.2 Cumulative Effects

Cumulative effects are defined in the Council on Environmental Quality (CEQ) regulations (40 CFR 1508.7) as "*...the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions*." **Table 3.1** lists the past, present, and reasonably foreseeable future actions within the area that might be affected by the proposed action. The geographic scope used for analysis varies for each cumulative effects issue and is described in the Environment Consequences section for each resource, where

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applicable. For this analysis, future actions are considered to be limited to those for which some formal notice or permit application has been made and does not include potential developments which are speculative.

Table 3.1 Past, Present, and Reasonably Foreseeable Actions

Action Description	STATUS		
	Past	Present	Future
Livestock Grazing	X	X	X
Wild Horse Gathers	X	X	X
Recreation	X	X	X
Invasive Weed Inventory and Treatments	X	X	X
Range Improvement Projects : Water Developments Fences & Cattleguards	X	X	X
Wildfire and Emergency Stabilization and Rehabilitation	X	X	X
Wind Energy Meteorological Towers			X
Oil and Gas Development: Well Pads Access Roads Pipelines Gas Plants Facilities	X	X	X
Power Lines	X	X	X
Oil Shale RD&D Leasing	X	X	X
Seismic Projects	X	X	X
Vegetation Treatments	X	X	X

For this EA, BLM examined various files and GIS information and determined that livestock grazing, wild horse gathers, recreation usage, invasive weed treatments, range improvements, wildfire reclamation, and seismic projects would either continue at historical levels into the future and/or resulted in minimal impacts to the human environment and have not been further considered in this document, apart from how their effects are represented by description of the Affected Environment. Wind energy meteorological towers have been proposed for the area. While wind energy developments may occur in the future, no specific applications for such projects have been made and they have not been considered in this EA.

The analysis areas selected for each analyzed resource, and the rationale for their selections, are indicated in **Table 3.2**. Surface disturbance estimated from GIS data for different types of projects for the different cumulative effects analysis areas (CEAAs) is indicated in **Table 3.3**. A map of CEAAs is included as **Attachment 3**.

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Table 3.2 Cumulative Effects Analysis Areas

Resource	Cumulative Effects Analysis Area	CEAA Area (Acres)	Rationale
Air Quality	WRAP Piceance Basin	16,077,440	The WRAP III 201 projected oil and gas emissions inventory represents the best readily available data set for air quality cumulative analysis and is of sufficient size to accommodate a mobile resource.
Geology and Minerals	Yellow Creek - Piceance Creek Watershed	589,825	The CEAA encompasses most of the local oil and gas development and is somewhat areally separated from other oil and gas development to the west and south. It also overlaps the highest potential oil shale development areas.
Soil Resources*	Yellow Creek Watershed	168,931	All project disturbance would occur within the upper reaches of this watershed. Soil transport would be downstream within the watershed.
Surface and Ground Water Quality*	Yellow Creek Watershed (surface water) Yellow Creek - Piceance Watershed (ground water)	168,931 589,825	All project surface water flow would be to the Yellow Creek watershed. The combined Yellow Creek-Piceance watershed overlies much of the local Uinta-Animas aquifer and the project facilities are centrally located within the watershed.
Vegetation*	Yellow Creek - Piceance Creek Watershed	589,825	The combined watershed is of sufficient size to contain most local cumulative impacts to vegetation and the project facilities are located near the center of the combined watershed.
Invasive, Non-native Species	Yellow Creek - Piceance Creek Watershed	589,825	Dispersal of invasive seeds from the project and transport into the project area would cross both watersheds.
Special Status Animal Species	Yellow Creek - Piceance Creek Watershed	589,825	The combined watershed represents the principal area of local water withdrawals potentially affecting the endangered Colorado River fish.
Migratory Birds	Colorado Parks & Wildlife Game Management Unit 22	632,894	The CEAA is sufficiently large to account for most potential cumulative impacts to local migratory species.
Terrestrial Wildlife*	Colorado Parks & Wildlife Game Management Unit 22	632,894	The CEAA includes the range of local big game species and encompasses the local range of smaller, less mobile, species.

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Resource	Cumulative Effects Analysis Area	CEAA Area (Acres)	Rationale
Cultural Resources	Not Selected	NA	As cultural resource sites would be avoided, there would be no direct, indirect, or cumulative impacts
Paleontological Resources	Yellow Creek - Piceance Watershed	589,825	Surface-disturbing activities would be confined to the Uinta Formation. The CEAA covers the majority of the Uinta Formation exposed in the center of the Piceance Basin.
Visual Resources	Yellow Creek - Piceance Watershed	589,825	Facilities and construction or production traffic would be largely confined within the combined watershed area.
Fire Management	Yellow Creek - Piceance Creek Watershed	589,825	The CEAA encompasses portions of seven Fire Management Zones and the bulk of historic fires in the Basin east of Parachute Creek and south of the White River. The project facilities are centrally located within the CEAA.
Forest Management	Colorado Parks & Wildlife Game Management Unit 22	632,894	The combined watershed is of sufficient size to contain most local cumulative impacts to forest vegetation and the project facilities are located near the center of the combined watershed. The CEAA contains approximately 337,000 acres of PJ forest (CDWR 2011)
Rangeland	Square S Allotment	79,550	The allotment is of sufficient size and logical extent to serve as the CEAA for rangeland management.
Realty Authorizations	Yellow Creek - Piceance Creek Watershed	589,825	The CEAA encompasses most of the local oil and gas development and is somewhat areally separated from other oil and gas development to the west and south. Much past, present, and foreseeable realty actions are oil and gas related.
Recreation	Colorado Parks & Wildlife Game Management Unit 22	632,894	The project facilities are centrally located within the GMU and the principal impact to recreation in the area would be to hunting.
Access and Transportation	Yellow Creek - Piceance Creek Watershed	589,825	All local roads which would potentially be used to serve the project area are contained within the CEAA.

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Table 3.3 Cumulative Effects Surface Disturbance Estimates

Facility Type and Cumulative Effects Analysis Area (CEAA)	Count or Miles	Facility Dist. (ac.) or ROW (ft.)	Total Dist. (ac.)	Count or Miles	Facility Dist. (ac.) or ROW (ft.)	Total Dist. (ac.)
	Past and Present Activities			Reasonably Foreseeable Activities		
CPW Game Management Unit 22 - Total			16,771			3,632
Industry - Total			5,909			2,373
Oil & Gas Wells	742	4.7	3,487	455	1.2	546
Gas Plants & Facilities	5	86.6	433	0	0	0
Sodium Mining & Processing	2	34.0	68	0	0	0
Oil Shale RD&D	5	5.2	26	7	85.9	601
Electric Transmission	128.9	0.0	0	5.3	25	16
Pipelines - Reclaimed	782.9	0.0	0	0	0	0
Pipelines - Unreclaimed	190.8	81.9	1,895	113.9	88	1,210
Roads - Total			6,416			5
Highways	33.6	60.0	244	0	0	0
County Roads	328.5	40.0	1,593	0	0	0
Other Roads	1,888.9	20.0	4,579	2.1	20	5
Vegetation Treatments - Total	194	22.9	4,446	NA	NA	1,254
Yellow Creek-Piceance Watershed			15,810			3,447
Industry - Total			5,686			2,274
Oil & Gas Wells	722	4.7	3,393	438	1.2	526
Gas Plants & Facilities	5	86.6	433	0	0	0
Sodium Mining & Processing	2	34.0	68	0	0	0
Oil Shale RD&D	5	5.2	26	7	85.9	601
Electric Transmission	120.1	0.0	0	4.9	25	15
Pipelines - Reclaimed	729.6	0.0	0	0.0	0	0
Pipelines - Unreclaimed	177.8	76.4	1,766	106.1	88	1,132
Roads - Total			5,980			5
Highways	31.3	55.9	228	0	0	0
County Roads	306.1	37.3	1,484	0	0	0
Other Roads	1,760.4	18.6	4,268	2.0	20	5

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Facility Type and Cumulative Effects Analysis Area (CEAA)	Count or Miles	Facility Dist. (ac.) or ROW (ft.)	Total Dist. (ac.)	Count or Miles	Facility Dist. (ac.) or ROW (ft.)	Total Dist. (ac.)
	Past and Present Activities			Reasonably Foreseeable Activities		
Vegetation Treatments - Total	181	21.4	4,143	NA	NA	1,169
Yellow Creek Watershed			4,098			1,155
Industry - Total			1,198			819
Oil & Gas Wells	122	4.7	573	51	1.2	61
Gas Plants & Facilities	1	86.6	87	0	0	0
Sodium Mining & Processing	1	17.0	17	0	0	0
Oil Shale RD&D	3	5.2	16	5	85.9	430
Electric Transmission	34.4	0.0	0	1.4	25	4
Pipelines - Reclaimed	209.0	0.0	0	0.0	0	0
Pipelines - Unreclaimed	50.9	21.9	506	30.4	88	324
Roads - Total			1,713			1
Highways	9.0	16.0	65	0	0	0
County Roads	87.7	10.7	425	0	0	0
Other Roads	504.2	5.3	1,222	0.6	20	1
Vegetation Treatments - Total	52	6.1	1,187	NA	NA	335
Square S Allotment			2,445			709
Industry - Total			1,079			550
Oil & Gas Wells	145	4.7	682	115	1.2	138
Gas Plants & Facilities	1	86.6	87	0	0	0
Sodium Mining & Processing	2	34.0	68	0	0	0
Oil Shale RD&D	1	5.2	5	3	85.9	258
Electric Transmission	16.2	0.0	0	0.7	25	2
Pipelines - Reclaimed	98.4	0.0	0	0.0	0	0
Pipelines - Unreclaimed	24.0	10.3	238	14.3	88	153
Roads - Total			806			1
Highways	4.2	7.5	31	0	0	0
County Roads	41.3	5.0	200	0	0	0
Other Roads	237.4	2.5	576	0.3	20	1
Vegetation Treatments - Total	24	2.9	559	NA	NA	158

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Analysis Specifications: Data for the cumulative impacts analysis included a number of GIS files that were obtained from the WRFO covering areal disturbance (principally oil and gas or other industrial facilities), roads, pipelines, powerlines, and vegetation treatments. Coverage included both public, state, and private lands. Data were clipped to the area of CPW GMU 22. The area of GMU 22 is the largest CEAA of those selected for surface disturbing activities and largely contains the other, smaller, CEAAs. Oil and gas well data were obtained from the Colorado Oil and Gas Conservation Commission (COGCC). The COGCC data were individually clipped to each of the four CEAAs.

The BLM data were examined and gas plants and facilities, sodium mining operations, and oil shale RD&D lease tracts were located for each CEAA. For the other disturbance sources (roads, pipelines, and vegetation treatments), disturbance was estimated proportional to the size of the CEAA in comparison to the area of GMU 22.

Past and present wells were determined to have an average disturbance of approximately 4.9 acres. For foreseeable wells, which are those for which an APD has been issued by COGCC but for which no operations have been conducted, the average disturbance per well is only 1.2 acres. This is because most of the foreseeable wells would be drilled on existing well pads containing multiple wells. Past (pre-2011) pipeline and power line disturbance was assumed to be reclaimed. Disturbance widths for pipelines and powerlines were estimated to be 100 feet and 25 feet, respectively. Because many pipelines overlap in the same ROW, the average pipeline disturbance width is approximately 88 feet. A 25-foot disturbance for power lines was assumed, but life-of-project disturbance would only be where support poles are placed.

3.1.3 Standards for Public Land Health

In January 1997, the Colorado BLM approved the Standards for Public Land Health. These standards cover upland soils, riparian systems, plant and animal communities, special status species, and water quality. Standards describe conditions needed to sustain public land health and relate to all uses of the public lands. Because a standard exists for these five categories, a finding must be made for each of them in an EA. These findings are located in specific elements listed below.

3.1.4 Affected Resources

The CEQ Regulations state that NEPA documents "must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail" (40 CFR 1500.1(b)). While many issues may arise during scoping, not all of the issues raised warrant analysis in an EA. Issues would be analyzed if: 1) an analysis of the issue is necessary to make a reasoned choice between alternatives, or 2) if the issue is associated with a significant direct, indirect, or cumulative impact, or where analysis is necessary to determine the significance of the impacts. **Table 3.4** lists the resources considered and the determination as to whether they require additional analysis.

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Table 3.4 Resources and Determination of Need for Further Analysis

Determination[1]	Resource	Rationale for Determination
Physical Resources		
PI	Air Quality	Implementation of the Proposed Actions would result in emissions of fugitive dust, criteria pollutants, and potentially hazardous air pollutants (HAPs). The analysis will assess direct and indirect impacts to air quality and air quality related values.
PI	Geology and Minerals	Implementation of the Proposed Actions would result in long-term or permanent impacts to mineral resources, including nahcolite, oil shale, and natural gas, in the vicinity of the proposed lease tracts. Oil shale exploitation may result in conflicts with other mineral development projects.
PI	Soil Resources*	Implementation of the Proposed Actions would result in disturbance to the surface and the soils within the proposed lease tracts. Potential impacts would include: • Direct effects of accelerated soil erosion and indirect effects of down-gradient deposition and stream sedimentation. • Effects resulting from soil salvage, storage, redistribution, and management (tillage and amendments) on reclamation and revegetation of replaced soil materials. • Direct effects of spills on soils and indirect effects of spills on down-gradient surface and subsurface water quality. • Direct effects to soil permeability and infiltration capacity resulting from construction-related soils compaction.
PI	Surface and Ground Water Quality*	Implementation of the Proposed Actions has the potential to affect local surface water through increased sediment transport and spills. Potential effects to local water resources may include: • Direct effects to surface water from discharges of process or other high salinity waters or contaminants resulting from leaks, spills, or storm events. • Direct effects on overland flow and ground water recharge patterns from construction and operation of facilities. • Direct effects to ground water within and/or immediately adjacent to the subsurface zones undergoing experimental oil shale recovery operations. • Direct effects to shallow aquifers from drilling, casing, and operating wells. • Direct effects of surface and ground water withdrawals to supply freshwater for operations.
Biological Resources		

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Determination[1]	Resource	Rationale for Determination
NI	Wetlands and Riparian Zones*	The project areas are located at least 1.8 and 2.1 linear miles and more than three miles along the drainages from the nearest potential riparian areas in Yellow Creek and Piceance Creek, respectively. Applicant design features would minimize the potential for project-related sedimentation or spills that would affect these areas. NS withdrew 151 and 102 ac-ft from its two water supply wells in 2010-2011 and the project would increase withdrawals less than an additional one ac-ft annually. Withdrawals below 220 ac-ft annually have been determined to have no anticipated impact to in-channel flow (BLM 1987) EM would require an average 4.3 ac-ft and a maximum 10.6 ac-ft annually over the project life. At this stage of the project, the exact location(s) of the surface or ground water derived from EM existing water rights has not been determined, but would likely come from ponds withdrawing water from Piceance Creek. The projected average and maximum annual EM withdrawals would represent approximately 0.04% and 0.09% of average annual Piceance Creek flow at Ryan Gulch, respectively (USGS 2012).
PI	Vegetation*	Implementation of the Proposed Actions would result in disturbance to the surface and direct losses of vegetative cover and wildlife forage.
PI	Invasive, Non-native Species	Vegetation clearing and transport of vehicles from outside the local area have the potential to spread noxious or invasive plant species.
PI	Special Status Animal Species*	Project-related water depletions would result in impacts to the endangered Colorado River Basin fish species. A Biological Assessment has been prepared and submitted to the USFWS.
NP	Special Status Plant Species*	Field surveys conducted over the entire area of the proposed lease tracts plus a 100 meter buffer did not locate any special status plant species. Habitat suitable for many of the plant species was not located.
PI	Migratory Birds	Disturbance to local vegetation may affect seasonal habitats, including nesting habitats, for raptors and other migratory birds.

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Determination[1]	Resource	Rationale for Determination
NI	Aquatic Wildlife*	Yellow Creek near the proposed lease tracts is classified as fully supporting for aquatic life warm 2 and is located a minimum of approximately two linear miles from the proposed projects. Yellow Creek downstream, below the confluence with Barcus Creek and to the White River, is impaired due to impacts to aquatic life and high levels of iron. Piceance Creek near the proposed lease tracts is provisionally considered impaired for aquatic life. The White River, approximately 12 linear miles north northeast of the proposed projects also supports higher-order aquatic vertebrates (CDWaR 2012). NS withdrew 151 and 102 ac-ft from its two water supply wells in 2010-2011 and the project would increase withdrawals less than an additional one ac-ft annually. Withdrawals below 220 ac-ft annually have been determined to have no anticipated impact to in-channel wetland flow (BLM 1987) EM would require an average 4.3 ac-ft and a maximum 10.6 ac-ft annually over the project life. At this stage of the project, the exact location(s) of the surface or ground water derived from EM existing water rights has not been determined but would likely come from ponds withdrawing water from Piceance Creek. The projected average and maximum annual EM withdrawals would represent approximately 0.04% and 0.09% of average annual Piceance Creek flow at Ryan Gulch, respectively (USGS 2012)..
PI	Terrestrial Wildlife*	Disruption of existing vegetation would remove some habitat used by local terrestrial wildlife species. Potential effects would include: • Loss of protective vegetative cover and forage productivity due to clearing of vegetation. • Displacement away from human activity. • Direct effects of project implementation on big game and nongame species from human activity resulting in mortalities from vehicle collisions, open pits, and poaching.
NI	Wild Horses	The project area is not within the Piceance-East Douglas Herd Management Area.

Heritage Resources and the Human Environment		
PI	Cultural Resources	NS' lease tract - A Class III inventory report (Elkins 2011) indicates no historic properties listed as eligible for National Register of Historic Places (NRHP) listing are present; however, a previous survey within the lease tract identified a site for which the Colorado Office of Archaeology and Historic Preservation (OAHP) has recommended as "needs data" because of its potential for buried cultural deposits. EM's lease tract - A Class III inventory report (Kintz 2011) indicates no historic properties potentially eligible for NRHP listing will be affected.
PI	Paleontological Resources	The proposed projects are located in an area underlain by the Uinta Formation

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NP	Native American Religious Concerns	No Native American Religious Concerns are known in the area. Requests for tribal consultation for both lease tracts were mailed to tribes with a prior noted interest in this area on October 14, 2011. The Ute Mountain Ute, The Southern Ute Indian Tribe, The Ute Indian Tribe of the Uintah and Ouray Reservation, and the Eastern Shoshone Tribe were mailed letters on October 14, 2011. After the 30 days follow up phone calls and emails were conducted. The Eastern Shoshone Tribe was consulted with and they had no concerns. No other replies were received.
PI	Visual Resources	Implementation of the Proposed Actions would result in alterations to the existing viewshed within a Class III VRM area.
NI	Hazardous or Solid Wastes	Hazardous or solid wastes would be managed, captured, and disposed of in accordance with applicable regulations and policies. For long-term facilities, sanitary waste would be managed using septic systems conforming to requirements of CDPHE and Rio Blanco County. NS would: • Truck off-site for disposal waste rotary drill cuttings, drilling fluids, and other residual waste water. • Confine spent oil shale debris within the oil shale reactor interval at depth. • Collect and transport construction, drilling, and operational trash and wastes off-site to approved disposal facilities. EM would: • Dewater drill cuttings onsite, test for toxicity, and either bury non-hazardous cuttings onsite and below grade or dispose offsite in accordance with applicable regulations. • Collect construction materials, garbage, and other solid wastes and transport off-site for disposal at an approved facility.
PI	Fire Management	Woodland areas disturbed will generally create excessive dead and down woody material, especially in materials that are left for reclamation.
NI	Social and Economic Conditions	The pilot scale (limited numbers of workers) and RD&D nature of the two projects along with phased approach to be applied for both projects will add a small increment to the overall levels of existing oil and gas development activities in the WRPA. Minor increases in local commercial activity and use of law enforcement services would be anticipated for Rio Blanco County and the communities of Meeker, Rangely, and Rifle.
NP	Environmental Justice	According to the most recent Census Bureau statistics (2010), the local population within the WRFO does not contain disproportionate numbers of minority or low income groups who would be adversely affected by the proposed projects.
Resource Uses		
PI	Forest Management	Implementation of the Proposed Actions would result in removal of some PJ forest and require long periods of recovery to return to pre-disturbance forest conditions.
PI	Rangeland Management	Construction activities would alter the vegetative character of the project area and remove some foraging habitat for the lives of the projects. Vegetative changes would result in impacts to management of the local rangeland.

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NI	Floodplains, Hydrology, and Water Rights	The project area is located almost two miles from the nearest mapped 100-year floodplains in Yellow and Piceance creeks and their tributaries. EM and NS would supply water needs for project development from current water rights 98CW259and 88CW420, respectively.
PI	Realty Authorizations	There are existing pipeline, road, telephone, and water line ROWs. New authorizations for off lease access roads would need to be issued to NS and EM, and telephone and power lines would need to be authorized. These future ROWs would either not result in new surface disturbance or the proposed disturbance has been analyzed in this EA.
PI	Recreation	The project area is located within a PJ woodland with dispersed recreational activities, particularly hunting. Project implementation would affect recreational opportunities within the lease tracts, particularly hunting.
PI	Access and Transportation	Project implementation, particularly during the construction phases, would increase traffic on local roads.
NP	Prime and Unique Farmlands	There are no Prime and Unique Farmlands within the project area.
Special Designations		
NP	Areas of Critical Environmental Concern	There are no ACECs in the vicinity of the project area.
NP	Wilderness	There are no designated Wilderness Areas, Wilderness Study Areas (WSAs) or identified Lands with Wilderness Character in the project area.
NP	Wild and Scenic Rivers	There are no designated Wild and Scenic Rivers within the WRFO.
NP	Scenic Byways	There are no Scenic Byways within the project area.

[1] NP = Not present in the area impacted by the Proposed Action or Alternatives.NI = Present, but not affected to a degree that detailed analysis is required. PI = Present with potential for impact analyzed in detail in the EA.
* Public Land Health Standard

3.2 Air Quality And Climate

3.2.1 Affected Environment

The description of existing air quality and climate applies equally to both lease tracts.

The proposed lease tracts are situated in western Colorado, in an area of rugged topography which can result in large climate variations over short distances. Elevations within the proposed lease tracts are approximately 6,600 atop a ridge. Topography within the lease tracts is low with slopes off the ridge crest typically less than 5 percent in the vicinity. The most representative climatic data for the area were obtained during 1948-1991 from the Little Hills Oil Shale site, located approximately 14 miles northeast of the proposed lease tracts at an elevation of 6,140 feet. A summary of climate data from this station is indicated in **Table 3.5**.

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Table 3.5 Proposed Lease Tracts Climatic Summary

Reading	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	37.1	41.8	47.9	58.2	68.2	78.8	85.8	83.3	76.2	64.0	48.5	39.1	60.8
Average Min. Temperature (F)	3.4	8.2	16.8	24.1	31.6	38.1	45.0	43.6	33.9	23.8	14.5	5.8	24.1
Average Total Precipitation (in.)	0.74	0.78	1.23	1.45	1.36	1.14	1.25	1.60	1.14	1.29	0.99	0.94	13.91
Average Total Snowfall (in.)	11.1	9.1	11.2	5.1	1.0	0.1	0.0	0.0	0.1	2.3	6.4	10.4	56.8
Average Snow Depth (in.)	7	6	2	0	0	0	0	0	0	0	1	3	2

Percent of possible observations for period of record (1948-1991).
Max. Temp.: 94.4% Min. Temp.: 95.4% Precipitation: 97% Snowfall: 92.8% Snow Depth: 85.8%

Source: WRCC 2011.

Wind data most representative of the vicinity of the proposed lease tracts were obtained at the Cathedral Bluffs oil shale site in 1984, located approximately 12 miles to the southeast. Measured wind speeds in the area were generally low to moderate, 12 mph or less approximately 94 percent of the time. Wind directions were dominantly from the southwest (**Figure 3.1**) (BLM 2007).

The National Ambient Air Quality Standards (NAAQS) are maximum levels for certain pollutants set by EPA based on health criteria ("criteria pollutants") under terms of the Clean Air Act (40 CFR Part 50). Colorado has developed its own set of standards (CAAQS), which generally equate to the NAAQS. In addition, the Clean Air Act mandates limitations on certain emissions above established baseline levels under the Prevention of Significant Deterioration (PSD) program. PSD Class I areas, defined by the Clean Air Act, have lower increments than that permitted in Class II areas. A summary of the NAAQS and CAAQS standards, PSD increments, and estimated ambient background levels for criteria pollutants in the vicinity of the proposed lease tracts are indicated in **Table 3.6**.

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Figure 3.1 Wind Directions Frequency Plot, Cathedral Bluffs Oil Shale Site, 1984

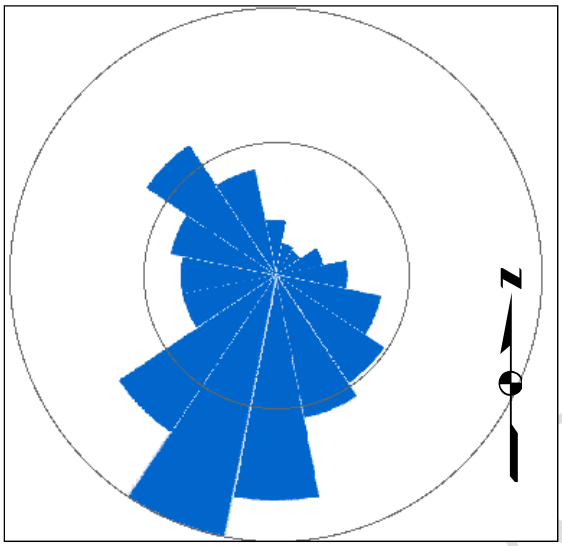

Table 3.6 Criteria Pollutant Standards, PSD Increments, and Ambient Air Quality

Pollutant	National and Colorado Ambient Air Quality Standards (NAAQS[1] and CAAQS[2])		PSD Increment[3]		Estimated Background Concentrations[4]
	Concentration	Averaging Time	Class I	Class II	
Carbon Monoxide (CO)	9,000 ppb 10,000 µg/m^3	8-hour	n/a	n/a	1 ppm [4d]
	35,000 ppb 40,000 µg/m^3	1-hour	n/a	n/a	1 ppm[4d]
Lead (Pb)	0.15 µg/m^3	Rolling 3-month Average	n/a	n/a	0.06 µg/m^3 [4e]
Nitrogen Dioxide (NO_2)	53 ppb	Annual	2.5 µg/m^3	25 µg/m^3	3 ppb
	100 ppb	1-hour	n/a	n/a	43 ppb [4a]
Particulate Matter (PM_{10}) [5]	150 µg/m^3	24-hour	8 µg/m^3	30 µg/m^3	44 µg/m^3 [4a]
Particulate Matter ($PM_{2.5}$) [6]	15.0 µg/m^3	Annual	n/a	n/a	4 µg/m^3 [4a]
	35 µg/m^3	24-hour	n/a	n/a	10 µg/m^3 [4a]
Ozone (O_3)	75 ppb	8-hour	n/a	n/a	72 ppb[7]
Sulfur Dioxide (SO_2)	75 ppb	1-hour	n/a	n/a	12 ppb [4c]
	0.5 ppm	3-hour	25 µg/m^3	512 µg/m^3	5 ppb
Colorado Standard	700 µg/m^3	3-hour	25 µg/m^3	512 µg/m^3	9 ppb [4b]

Source: EPA 2010a

[1] EPA NAAQS http://www.epa.gov/air/criteria.html, October 2011
[2] CAAQS from Colorado Air Quality Control Commission Report to the Public 2009-2010
[3] 40 CFR 51.166
[4] CDPHE - Chick 2012. NO_2 & SO_2 1-hr levels represent highest hourly concentrations.

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[4a] Greasewood Hub, 2009-2010
[4b] Unocal Oil Shale Project, 1983-1984
[4c] Holcim Portland Cement, 2005-2006
[4d] American Soda Plant Parachute 2003-2005
[4e] Denver Municipal Animal Shelter 2009
[5] Particulate matter less than 10 microns in effective diameter
[6] Particulate matter less than 2.5 microns in effective diameter
[7] 2007-2008 Dinosaur National Monument 4th max values

The proposed lease tracts are located approximately 12 miles from the center of the combined areas of Rio Blanco and Garfield counties, located within the Colorado Air Quality Control Commission's (CAQCC) nine-county Western Slope Region. Principal air pollution sources include emissions from motor vehicles, oil and gas development, coal-fired power plants, coal mines, sand and gravel operations, windblown dust, and wildfires and prescribed burns (CAQCC 2011). Facility emissions in the two-county area are dominated by emissions related to oil and gas exploration, processing, or transportation. Total 2008 facility criteria pollutant emissions from stationary point sources within the two-county area:

CO	NH_3	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOCs
5,524.90	0.00	7,615.39	1,480.49	593.06	102.31	12,603.98

Rio Blanco - Garfield counties 2008 emissions in tons per year (EPA 2012)
VOCs: total volatile organic compounds, NO_x: nitrogen oxides

Areas which are in compliance with the NAAQS are termed "attainment" areas, and all of western Colorado is currently considered an attainment area. Pollutants of principal concern are particulates and ozone, although monitoring data are sparse. There are nine particulate monitors in the two-county area, all located along the I-70 corridor. Air quality index trends suggest that ambient particulate levels have been increasing in the 2000s. EPA has estimated that, under continuous monitoring, the Rifle and New Castle areas would have experienced 3-4 days of PM_{10} 24-hour standard exceedances in 2007 and 2008. The average value of Air Quality Index (AQI) 90th percentile PM_{10} levels for 2005-2008 in the two-county area was 48.75, within the upper values of the "good" category (EPA 2010).

Ozone pollution has become an increasing concern in oil and gas development areas in the west in recent years. Ozone is formed by photochemical reactions among various nitrogen oxides (NO_x) and volatile organic compounds (VOCs), both of which may be produced from oil and gas exploration and production operations, as well as from other sources. Ozone data have been obtained at Colorado National Monument in Mesa County since 2007 and monitors were established in Palisade (Mesa County) and Rifle, in the two county area, in 2008. No full-year data for the latter two monitors were available from the EPA AirData website, which has recently undergone major changes and some data formerly accessible are no longer available. There were no exceedances of the NAAQS standard at the Colorado National Monument monitor in 2007-2008, and partial year 2008 results from the Palisade and Rifle monitors also met the 1-hour and 8-hour standards (EPA 2010, CAPCD 2009). Full-year raw monitor data from the Rifle monitor for 2009 and for an EnCana monitor located along Colorado Highway 13 about 16 miles east-southeast of the proposed lease tracts for 2008 and 2009 indicated attainment of the ozone standard. For both monitors, highest 2008 data were higher than highest 2009 values (Volante 2010).

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An unexpected ozone issue has been the recognition of high levels of wintertime ozone in the upper Green River Basin in Wyoming and the Uinta Basin in northeast Utah. Although the phenomenon of wintertime ground level ozone formation is poorly understood, there have been concerns that ozone formation precursors arising from oil and gas development could be responsible (Streater 2011).

BLM placed ozone monitors in Rangely and Meeker in 2010 and monitored ozone concentrations over the 2010-2011 winter. The Meeker monitor did not record exceedances of either the 1-hour or 8-hour NAAQS standards, although levels up to 80 and 73 ppb, respectively were noted. In Rangely, the 1-hour standard was not exceeded (maximum value of 96 ppb), the 8-hour limit was exceeded (maximum level of 88 ppb) during three days in February 2011. The monitors are part of the National Park Service's Gaseous Pollutant Monitoring Program (NPS 2011) and were established, funded and operated by the BLM.

With respect to PSD, the vicinity of the proposed lease tracts is considered Class II. The nearest Class I area is the Flat Tops Wilderness, located approximately 45 miles to the east, and there are a number of other wilderness areas and national parks and monuments located within 100 miles. Dinosaur National Monument (about 35 miles to the northwest) and Colorado National Monument (about 50 miles to the southwest) are Class II areas which are regulated by CDPHE as Class I with respect to SO_2. Project emissions could potentially affect these areas. The PSD Class I and II increments (**Table 3.6**) are evaluated to determine levels of concern and do not represent a PSD increment consumption analysis which would be required under air permitting regulations.

In addition to incremental increases in criteria pollutant emissions, the PSD program monitors changes in air quality-related values (AQRV), including impacts to visibility and regional haze and reductions in the acid neutralizing capacity of sensitive receptors. Visibility monitoring is performed by the Interagency Monitoring of Protected Visual Environments (IMPROVE) Program. The closest IMPROVE monitors to the proposed lease tracts are in the PSD Class I Mt. Zirkel and Maroon Bells-Snowmass wilderness areas, approximately 100 miles northeast and 90 miles southeast, respectively. An additional monitor using IMPROVE-quality equipment, but which was not part of the IMPROVE network, operated for about five years from a location in the Flat Tops Wilderness at 9,575 feet 60 miles east of the proposed lease tracts. Data from this site were in good agreement with data obtained from the closes IMPROVE sites listed above (Holland 2012). Visibility in the Rocky Mountains and Colorado Plateau, including the proposed lease tracts, is generally considered to be very good, with an estimated standard median visual range of more than 150 km (Trijonis *et al* 1990).

The transfer of air pollutants to terrestrial or aquatic surfaces comprises atmospheric deposition, reported as the rate of mass deposited per given area (kg/ha/year). Pollutants are removed by both wet (precipitation) and dry (gravitational settling and surface adherence of gaseous pollutants) depositional processes. The deposition of acids, such as sulfuric acid (H_2SO_4) and nitric acid (HNO_3) is of particular concern. Acid deposition occurs when SO_2 and NO_x emissions are transformed in the atmosphere and returned to the surface. Wet deposition is monitored by the cooperative National Atmospheric Deposition Program (NADAP) The closest NADAP monitors to the proposed lease tracts were operating at Ripple Creek Pass in the Flat Tops Wilderness, approximately 60 miles to the northeast of the proposed lease tracts at 9,600 feet elevation and approximately the same distance to the north at Sand Spring in Moffat County, at an elevation of 6,550 feet. The latter is considered more representative of the proposed lease

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tracts. Nitrate deposition at Sand Spring has been generally consistent from 1979-2010 at around 3 kg/ha/yr. Sulfate deposition has shown a sharp decrease from nearly 6 kg/ha/yr in 1979 to around 2 kg/ha/yr in 2009 (NADP 2012).

Dry deposition is monitored by the EPA's Clean Air Status and Trends Network (CASTNET). The nearest monitor is located approximately 95 miles to the southeast at 9,600 feet elevation. Because of the topographic difference and distance from the Project, data from the station are not considered representative of the proposed lease tracts (CASTNET 2012).

Certain atmospheric components including water vapor, carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) have the ability to act as "greenhouse gases" (GHGs) by absorbing incident solar radiation reflected from the ground and increasing ambient air temperature. Water vapor is the most important greenhouse gas (GHG). Anthropogenic deforestation and industrial processes in the last 200 years have increased emissions of GHGs, particularly CO_2, such that the atmospheric concentration of CO_2 has increased by 35 percent in the last 150 years to approximately 379 parts per million (ppm). Observed average temperature increases in various parts of the world have been contemporaneous with increased GHG concentrations in the atmosphere. Governmental initiatives to control GHG emissions have resulted from this observed trend and from future projections of this trend continuing as indicated by certain computer climate projection models (IPCC, 2007). In the U.S., the primary source of anthropogenic greenhouse gas emission is fossil fuel combustion. Fossil fuels are responsible for supplying approximately 85 percent of U.S. primary energy needs and approximately 98 percent of estimated anthropogenic CO_2 emissions (EIA, 2008).

3.2.2 Environmental Consequences of the Proposed Actions

Direct and Indirect Effects: Emission of air pollutants would occur from construction of well and production pads, access roads, and pipelines, from drilling and completion operations, and from test production operations. Coarse (PM_{10}) and fine ($PM_{2.5}$) fugitive particulate emissions would be associated with construction operations and long-term travel on unpaved roads. Construction particulate emissions would be mitigated using water and/or chemical suppressants. Construction, drilling, and completion heavy equipment engines would result in emissions of particulates, NO_x CO, SO_2, and VOCs. Test production operations would result in varying levels of NO_x CO,SO_2, and VOCs. Calculations are best estimates based on current understandings of the processes, but estimates may change depending on results from the research projects.

Air quality impacts resulting from oil and gas development are estimated using air modeling techniques. Various modeling software packages have been tested and approved or superseded according to EPA recommendations. Some model programs are oriented at more localized, project-level impacts and a specific range of pollutants whereas others are designed for assessment of a broader pollutant mix and regional impacts. On June 23, 2011, the Department of Interior, Department of Agriculture, and EPA signed a Memorandum of Understanding (Air Quality MOU) regarding the methodology to use for analyzing impacts to air quality and AQRVs during NEPA evaluations of federal oil and gas development projects. The memorandum indicates those instances in which air modeling should be used during NEPA analysis and which models are recommended for a given project. The MOU is strictly applicable only to oil and gas development (as separate from oil shale research projects), but has been consulted in reaching determinations about modeling requirements for the Proposed Actions.

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NS Lease Tract: Air pollutant emissions from the NS Proposed Action would be relatively minor as the proposed operations would result in small levels of surface disturbance and short-term operations of the test recovery method. Total estimated maximum project air emissions (not annual emissions) are summarized in **Table 3.7**. The table assumes a maximum of 15 intervals tested in up to three OSR wells.

Table 3.7 NS Proposed Project Estimated Maximum Air Emissions

Activity	Calculated Total Project Emissions (Tons)							
	PM_{10}	$PM_{2.5}$	SO_2	NO_x	CO	VOCs	HAPs	CO_2e
Operations/Process								
Operations Traffic (Paved Road)	0.38	0.09						
Operations Traffic (Dirt Road)	9.45	0.95						
Gas Venting			33.60	241.84	39.37			13,190.8
Oil Storage Tank						0.15		
Fugitives						1.40	0.00	2.65
Well Pad/Access Road Construction								
Low Boy Hauler (Paved Road)	0.00	0.00						
Low Boy Hauler (Dirt Road)	0.01	0.00						
Gravel Hauler (Paved Road)	0.00	0.00						
Gravel Hauler (Dirt Road)	0.03	0.00						
Bulldozing	0.85	0.04						
Grading	1.83	0.05						
Bulldozer (tailpipe)	0.02	0.02	0.03	0.30	0.08	0.01	0.01	19.22
Grader (tailpipe)	0.01	0.01	0.02	0.16	0.03	0.01	0.00	11.53
Skid Steer (tailpipe)	0.00	0.00	0.00	0.03	0.01	0.00	0.00	1.92
Graveling	0.00	0.00						
Uncovered Areas	4.96	0.74						
Pipeline Construction								
Heavy Truck Traffic (Paved Road)	0.00	0.00						
Heavy Truck Traffic (Dirt Road)	0.01	0.00						
Light Truck Traffic (Paved Road)	0.00	0.00						
Light Truck Traffic (Dirt Road)	0.16	0.02						
Construction equipment (tail pipe)	0.05	0.05	0.05	0.64	0.26	0.06	0.01	30.28
Earth Moving	0.00	0.00						
Uncovered Areas	0.18	0.03						
Well Drilling								
Drill Rig Engine	1.42	1.33	0.38	20.04	4.32	1.63	0.02	739.58
Drilling Heavy Truck Traffic (Paved Road)	0.19	0.05						
Drilling Heavy Truck Traffic (Dirt Road)	1.03	0.10						
Drilling Light Truck Traffic (Paved Road)	0.10	0.02						
Drilling Light Truck Traffic (Dirt Road)	2.36	0.24						
Well Completion								
Light Truck Traffic (Paved Road)	0.02	0.00						
Light Truck Traffic (Dirt Road)	0.09	0.01						
Completion Engine	0.01	0.01	0.00	0.19	0.04	0.02	0.00	6.92
Rig Hauling								
Heavy Truck Traffic (Paved Road)	0.01	0.00						
Heavy Truck Traffic (Dirt Road)	0.01	0.00						

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Activity	Calculated Total Project Emissions (Tons)							
	PM_{10}	$PM_{2.5}$	SO_2	NO_x	CO	VOCs	HAPs	CO_2e
Project Emissions								
Total	23.45	3.83	34.10	263.57	44.20	3.30	0.04	14,016.7
Average Annual Emissions								
Total	2.93	0.48	4.26	32.95	5.53	0.41	0.01	1,752.1

The duration of each phase of the project is unknown. A conservative estimate of annual emissions is developed by averaging the project 10-year total emissions over an 8-year period

Table values of 0.00 indicate emissions levels less than 0.01 TPY

After reviewing the project emissions inventory (summarized in **Table 3.7**), BLM has determined that the increase in area emissions estimated which would result from implementation of the NS Proposed Action would not be a "Substantial Increase in Emissions," in terms of the Interagency Air Quality MOU. Project emissions would not cause or contribute to exceedances of the NAAQS and would not negatively impact AQRVs in any Class I or sensitive Class II airshed. Detailed descriptions of air emissions-generating processes are provided in **Appendix E**.

Emissions of GHGs would be relatively minor (**Table 3.7**). Emissions of GHGs would be larger under the EM proposed action and general GHG effects are discussed in more detail in that section.

EM Lease Tract: RD&D activities on the EM lease tract could last for up to 15 years. Total estimated project air criteria pollutant and VOCs emissions (not annual emissions) are summarized in **Table 3.8**.

Table 3.8 EM Proposed Project Estimated Air Emissions

Activity	Calculated Total Project Emissions (Tons)						
	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	VOCs	TOTAL
Operations/Process							
Thermal Oxidizer	0.00	0.00	227.17	565.33	190.83	59.80	1,043.13
Tanks	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fugitive Equipment Leaks	0.00	0.00	0.00	0.00	0.00	28.70	28.70
Light Truck Traffic (Paved Road)	1.13	0.28	0.00	0.00	0.00	0.00	1.41
Light Truck Traffic (Dirt Road)	5.15	0.51	0.00	0.00	0.00	0.00	5.66
Heavy Truck Traffic (Paved Road)	4.62	1.13	0.00	0.00	0.00	0.00	5.76
Heavy Truck Traffic (Dirt Road)	48.82	4.88	0.00	0.00	0.00	0.00	53.70
Well pad and Access Road Construction							
Low Boy Hauler (Paved Road)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Low Boy Hauler (Dirt Road)	0.04	0.00	0.00	0.00	0.00	0.00	0.04
Gravel Hauler (Paved Road)	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Gravel Hauler (Dirt Road)	0.13	0.01	0.00	0.00	0.00	0.00	0.14
Bulldozing	0.30	0.16	0.00	0.00	0.00	0.00	0.46
Grading	4.34	0.47	0.00	0.00	0.00	0.00	4.81
Bulldozer (tailpipe)	0.15	0.14	2.99	0.32	0.84	0.14	4.56
Grader (tailpipe)	0.09	0.08	1.57	0.19	0.34	0.08	2.35

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Activity	Calculated Total Project Emissions (Tons)						
	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	VOCs	TOTAL
Backhoe (tailpipe)	0.04	0.04	0.97	0.09	0.30	0.11	1.55
Graveling	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipeline Construction							
Heavy Truck Traffic (Paved Road)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heavy Truck Traffic (Dirt Road)	0.02	0.00	0.00	0.00	0.00	0.00	0.02
Light Truck Traffic (Paved Road)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Light Truck Traffic (Dirt Road)	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Construction equipment (tail pipe)	0.00	0.00	0.09	0.01	0.04	0.01	0.15
Earth Moving	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Water & Observation Well Drilling							
Drill Rig Engine	12.29	11.53	173.24	3.30	37.33	14.05	251.74
Drill Rig Boiler	0.31	0.08	6.10	0.06	1.53	0.06	8.14
Drilling Heavy Truck Traffic (Paved Road)	1.74	0.43	0.00	0.00	0.00	0.00	2.16
Drilling Heavy Truck Traffic (Dirt Road)	20.18	2.02	0.00	0.00	0.00	0.00	22.20
Drilling Light Truck Traffic (Paved Road)	1.46	0.36	0.00	0.00	0.00	0.00	1.82
Drilling Light Truck Traffic (Dirt Road)	6.65	0.67	0.00	0.00	0.00	0.00	7.32
Rig Move Heavy Truck Traffic (Dirt Road)	0.13	0.01	0.00	0.00	0.00	0.00	0.14
Rig Move Light Truck Traffic (Dirt Road)	0.50	0.05	0.00	0.00	0.00	0.00	0.55
Water & Observation Well Completion							
Light Truck Traffic (Paved Road)	0.11	0.03	0.00	0.00	0.00	0.00	0.13
Light Truck Traffic (Dirt Road)	0.48	0.05	0.00	0.00	0.00	0.00	0.53
Completion Engine	0.16	0.15	2.25	0.04	0.48	0.18	3.27
Water &Observation Well Rig Hauling							
Heavy Truck Traffic (Paved Road)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heavy Truck Traffic (Dirt Road)	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Appraisal & Heating Element Well Drilling							
Drill Rig Engine	3.91	3.67	55.12	1.05	11.88	4.47	80.10
Drill Rig Boiler	0.09	0.02	1.73	0.02	0.43	0.02	2.30
Drilling Heavy Truck Traffic (Paved Road)	0.29	0.07	0.00	0.00	0.00	0.00	0.37
Drilling Heavy Truck Traffic (Dirt Road)	3.42	0.34	0.00	0.00	0.00	0.00	3.77
Drilling Light Truck Traffic (Paved Road)	0.52	0.13	0.00	0.00	0.00	0.00	0.64
Drilling Light Truck Traffic (Dirt Road)	2.35	0.24	0.00	0.00	0.00	0.00	2.59
Rig Move Heavy Truck Traffic (Dirt Road)	0.04	0.00	0.00	0.00	0.00	0.00	0.05
Rig Move Light Truck Traffic (Dirt Road)	0.50	0.05	0.00	0.00	0.00	0.00	0.55
Appraisal & Heating Element Well Completion							
Light Truck Traffic (Paved Road)	0.02	0.00	0.00	0.00	0.00	0.00	0.02
Light Truck Traffic (Dirt Road)	0.07	0.01	0.00	0.00	0.00	0.00	0.09
Completion Engine	0.04	0.04	0.56	0.01	0.12	0.05	0.82
Appraisal & Heating Element Well Rig Hauling							
Heavy Truck Traffic (Paved Road)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Heavy Truck Traffic (Dirt Road)	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Appraisal & Heating Element Well Frac Activities							

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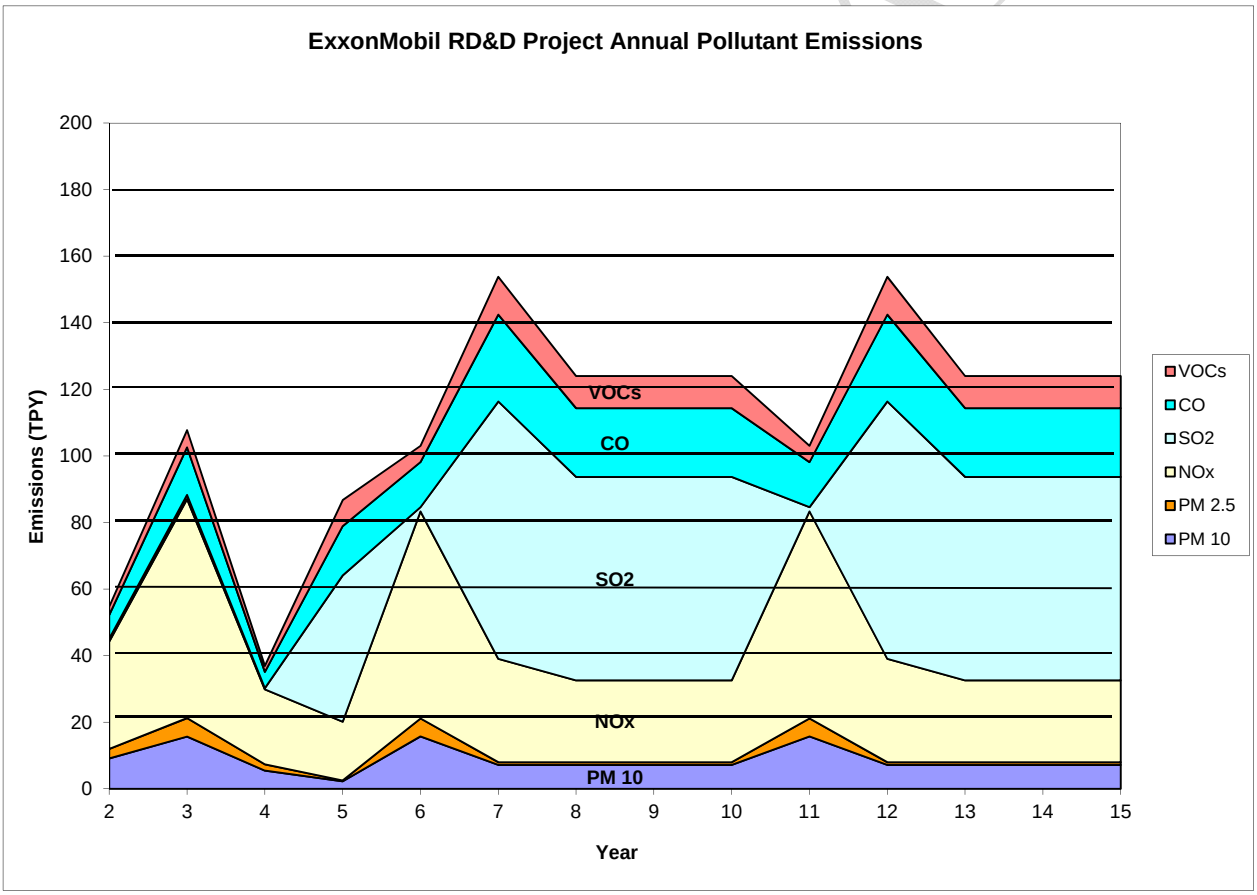
Activity	Calculated Total Project Emissions (Tons)						
	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	VOCs	TOTAL
Heavy Truck Traffic (Paved Road)	0.11	0.03	0.00	0.00	0.00	0.00	0.13
Heavy Truck Traffic (Dirt Road)	1.22	0.24	0.00	0.00	0.00	0.00	1.47
Frac Engine	0.02	0.00	0.35	0.00	0.09	0.00	0.47
Total	121.49	27.94	472.14	570.44	244.19	107.65	1,543.86

A summary of the estimated annual emission levels of various criteria pollutants and VOCs is graphically illustrated in **Figure 3.2**.

In addition to the pollutants indicated in **Figure 3.2**, implementation of the EM Proposed Action would generate small levels of hazardous air pollutants (HAPs). Maximum HAPs output would be 0.24 tons per year (TPY) in years 7 and 12. Average HAPs emissions would be approximately 0.16 TPY.

Figure 3.2 EM Proposed Project Estimated Annual Air Emissions



Assumed maximum annual emissions. Assumes optional Phase IV development starting year 11

Air quality modeling has not been performed for this project. In 2006, ExxonMobil Production Company conducted air quality modeling to determine potential effects from oil and gas development within the 29,680 acre Piceance Development Project (PDP) (NEPA analysis documented in CO-110-2005-219-EA, for which a FONSI and Decision Record was issued by

the WRFO in April 2007). Air quality impacts were estimated using the AERMOD modeling software. The northern portion of the PDP project area is located between two and eight miles due east of the proposed EM lease tract, and proportionally closer to the Class I Flat Tops Wilderness airshed. Construction and development in the PDP project area was assumed to occur over approximately 15 years and production would continue for 30 years or longer. A comparison of average annual air pollutant emission levels between the PDP project ant EM' proposed oil shale RD&D projects is illustrated in **Table 3.9**.

Table 3.9 Average Annual Air Pollutant Emissions PDP and EM Proposed Actions

Project	Average Annual Emissions (TPY)						
	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	VOCs	HAPs
PDP	18.10	17.60	445.40	16.40	311.90	234.50	29.30
Proposed Action	8.68	2.00	33.72	40.75	17.44	7.69	0.16
Difference (TPY)	-9.42	-15.60	-411.68	24.35	-294.46	-226.81	-29.14
Difference (%)	47.9%	11.3%	7.6%	248.4%	5.6%	3.3%	0.5%

Modeled impacts for the PDP project indicated that NAAQS and CAAQS standards would not be violated by the full project development and modeled concentrations were below applicable PSD Class II increments. Air modeling was used to predict maximum impacts from PM_{10}, $PM_{2.5}$, NO_2, and SO_2 at the PSD Class I Flat Tops Wilderness and at Dinosaur National Monument (Class II, but regulated by CDPHE as Class I for SO_2). Modeled concentrations were well below PSD Class I increments at both areas. Nitrogen and sulfur total deposition and changes to acid neutralizing capacity for three lakes in the Flat Tops Wilderness were calculated to be below significance thresholds, and maximum visibility impacts to the wilderness area were calculated to be 0.97 dv, or just barely noticeable. Finally, modeling for maximum concentrations of various oil production-related HAPs at the nearest human residence indicated emissions below threshold levels (BLM 2007). It should be qualified that the 2006 modeling did not account for more recent NAAQS standards such as 1-hour NO_2 and 1-hour SO_2.

Direct scaling of modeling results to different numbers of emitters and emissions outputs is not reliable. However, locations of the two projects, the types of pollutants emitted, and the similar distances from the nearest Class I airsheds invite obvious comparisons. In a qualitative sense, the fact that PM_{10}, $PM_{2.5}$, NO_x, CO, VOCs, and HAPs emissions from the Proposed Action would be substantially less than those from the PDP proposed action suggests that NAAQS standards and PDS increments would not be violated by these pollutants (Van Horne 2012).

Emissions of SO_2 from the Proposed Action would be substantially greater than those modeled for the PDP project. The PDP modeling estimated impacts for 3-hour, 24-hour, and annual SO_2 levels. The latter two standards have since been revoked by EPA and modeling did not account for the more recent 1-hour standard. The model results for 3-hour SO_2 resulted in maximum impacts of approximately 4 percent of the NAAQS standard, approximately 5 percent of the local Class II PSD increment, and approximately 1 percent of the Class I PSD increment at the Flat Tops Wilderness. The PDP modeling indicated no exceedances of the BLM's 1dv visibility change standard for Class I areas. On the days of highest visibility impacts, the dominant components affecting air quality were nitrate (NO_3) and NO_2, rather than SO_2. (BLM 2007). Because the modeled effects of SO_2 emissions for the Piceance Development Project were so

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minimal compared to the NAAQS standard and PDS increment, it could be argued that emissions from the same general area, but at 248 percent of the modeled volume, would still remain below the NAAQS standard and PSD increment at the nearest Class I airshed. This evaluation may be accurate, however it is less certain than the evaluation based on the other pollutants. That is because the emissions would be at a higher temperature and result from a higher source, as the principal SO_2 emissions originate from the stack of the thermal oxidizer (Van Horne 2012). Under current Colorado new source air permit modeling guidelines, the SO_2 emission levels from the EM project would be sufficient to likely trigger air modeling requirements (CAQCD 2011a).

Computation of project impacts resulting from ozone formation require the use of complex photochemical grid air models. Such modeling was not performed for the PDP EA and has not been conducted for this project. Regional photochemical grid modeling is being conducted for the amendment to the White River Resource Management Plan and the Proposed Action would be included within that modeling effort.

Various parameters would be measured and/or data would be collected during the research project that would be used to evaluate potential air impacts for subsequent commercial development. Examples of possible data items may include, but are not necessarily limited to:

- Fuel/electricity consumed per bbl or MMscf produced;
- Vented gas analyses;
- Grab samples or "stack" testing at amine treatment, scrubber, etc.; and
- Destruction efficiency of thermal oxidizer, scrubber, etc.

Direct emissions of greenhouse gases were calculated for the emissions inventory and reported as carbon dioxide equivalents (CO_2e). A summary of direct project annual GHG emissions is indicated in **Figure 3.3**. In addition to direct impacts, EM's use of electricity to power the heating elements would result in indirect emission of GHGs from the electric utility. The EM proposal includes maximum power levels of up to 1.7 to 4.0 MW per heating element, depending on the phase of the project. The length of time during which the power levels would be applied is undetermined at this time and is one objective of the research project. Phase II heating would operate for up to six months and Phase III and Phase IV (if implemented) could operate for up to 60 months. Depending upon the source of the electricity purchased by the local utility, which is unknown at this time, CO_2 emissions are estimated to range from approximately 0.51 tons/MW-hour (natural gas generation) to approximately 1.08 tons/MW-hour (coal generation) (Hodges and Rahmani 2009). Assuming maximum energy use levels, average annual CO_2 emissions from electrical power generation would be approximately 24,000 to 52,000 tons, depending on the source of the power generation.

Power would be obtained from existing power generation facilities which have been previously permitted. No electrical power generation facilities would be constructed or operated specifically for this project.

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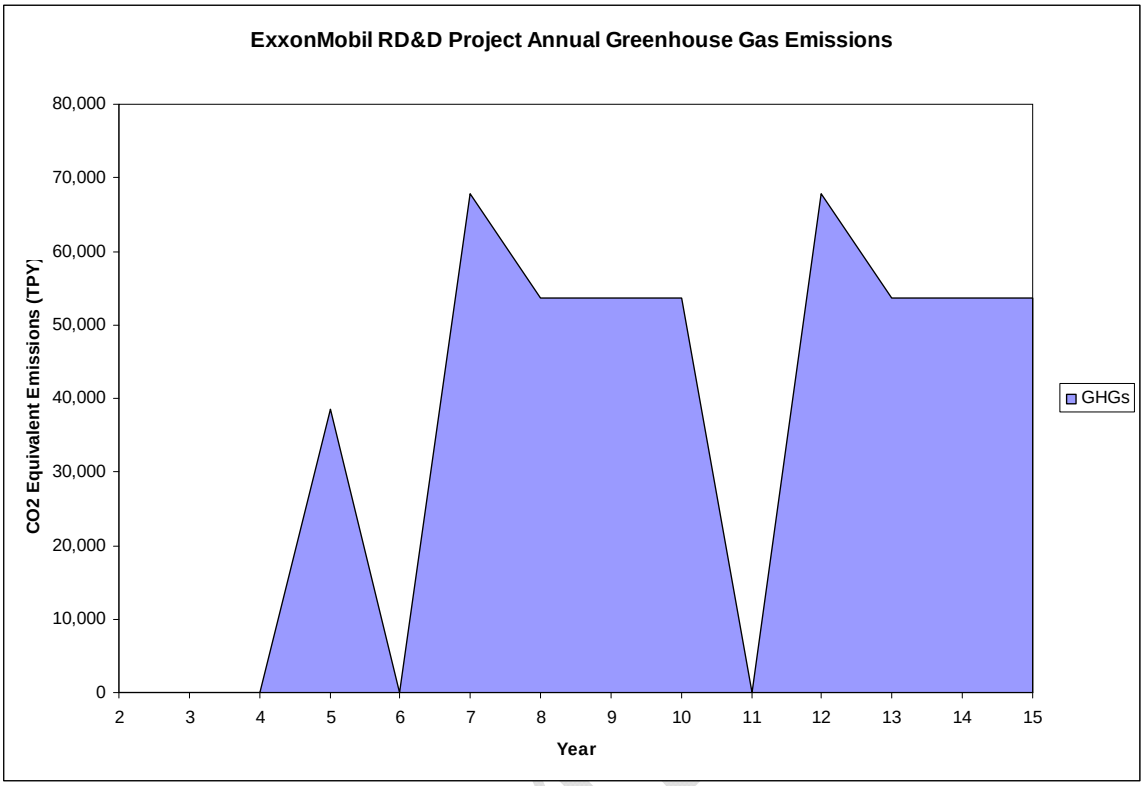
Figure 3.3 EM Proposed Project Estimated Direct Annual Greenhouse Gas Emissions



Greenhouse gas levels are a global issue. Emissions of GHGs, principally CO_2 and water vapor, from the Proposed Action would be almost entirely attributable to operation of the thermal oxidizer. The assessment of GHG emissions, their relationship to global climatic patterns, and the resulting impacts is an ongoing scientific process. It is currently not feasible to know with certainty the net impacts from the proposed action on climate—that is, while BLM actions may contribute to the climate change phenomenon, the specific effects of those actions on global climate are speculative given the current state of the science. The BLM does not have the ability to associate a BLM action's contribution to climate change with impacts in any particular area. The science to be able to do so is not yet available. The inconsistency in results of scientific models used to predict climate change at the global scale coupled with the lack of scientific models designed to predict climate change on regional or local scales, limits the ability to quantify potential future impacts of decisions made at this level and determining the significance of any discrete amount of GHG emissions is beyond the limits of existing science. When further information on the impacts to climate change is known, such information would be incorporated into the BLM's planning and NEPA documents as appropriate. Project GHG emissions would contribute incrementally to local and global ambient levels.

Cumulative Effects: The CEAA for air quality is the Western Regional Air Partnership (WRAP) Phase III Piceance Basin, which consists of Chafee, Delta, Eagle, Garfield, Gunnison, Lake, Mesa, Moffatt, Pitkin, Rio Blanco, and Routt counties, Colorado. The CEAA encompasses an area of slightly more than 16,000,000 acres. The most complete, readily available estimate of 2012 annual emissions for the CEAA is likely the inventory prepared for oil and gas emissions

by WRAP in 2009 (Bar-Ilan *et al* 2009). That inventory was scaled upward for this analysis to account for current numbers of producing wells in the CEAA compared to the estimates made in 2009. A summary of the WRAP estimated 2012 emissions compared to the projected emissions from the NS and EM oil shale projects is indicated in **Table 3.10**.

Table 3.10 Estimated WRAP 2012 Piceance Basin Oil and Gas Emissions plus the Proposed Action

County	NO_x (tons/yr)	VOCs (tons/yr)	CO (tons/yr)	SO_x (tons/yr)	PM (tons/yr)
Chaffee	0	0	0	0	0
Delta	113	91	166	0	3
Eagle	0	0	0	0	0
Garfield	6,447	19,119	4,945	7	259
Gunnison	81	312	63	0	3
Lake	0	0	0	0	0
Mesa	1,888	2,494	1,706	4	54
Moffat	1,332	2,081	1,002	1	29
Pitkin	0	57	0	0	0
Rio Blanco	3,843	4,754	2,688	92	168
Routt	28	21	12	0	0
Totals	**13,732**	**28,928**	**10,582**	**105**	**516**
EM Annual Average	33.72	7.69	17.44	40.75	10.67
NS Total Emisions	8.84	2.25	1.87	11.98	22.43

Modified from Bar-Ilan *et al* 2009

Through complex interactions on a global scale, GHG emissions cause a net warming effect of the atmosphere, primarily by decreasing the amount of heat energy radiated by the earth back into space. Although natural GHG atmospheric concentration levels have varied for millennia (along with corresponding variations in climatic conditions), industrialization and burning of fossil carbon sources have caused GHG concentrations to increase.

This incremental contribution to global GHG gases cannot be translated into effects on climate change globally or in the area of this site-specific action. As oil and gas production technology continues to improve, and because of the potential development of future regulation or legislation, one assumption is that reductions in the rate or total quantity of GHG emissions associated with oil and gas production are likely. As stated in the direct/indirect effects section under climate change, the assessment of GHG emissions and the resulting impacts on climate is an ongoing scientific process. It is currently not feasible to know with certainty the net impacts from the proposed action on global or regional climate—that is, while BLM actions may contribute to the climate change phenomenon, the specific effects of those actions on global climate are speculative given the current state of the science. Therefore, the BLM does not have the ability to associate an action's contribution in a localized area to impacts on global climate change. Further, an Intergovernmental Panel On Climate Change (IPCC) assessment states that difficulties remain in attributing observed temperature changes at smaller than continental scales. It is currently beyond the scope of existing science to predict climate change on regional or local scales resulting from specific sources of GHG emissions.

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3.2.3 Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the proposed projects would be denied, no direct, indirect, or cumulative project-related emissions would occur and there would be no project related impacts to air quality and AQRVs from either project. Impacts to air quality would result from continuation of existing management actions on the public lands.

3.2.4 Proposed Mitigation

Mitigations apply equally to both lease tracts.

AIR-1 - The Applicant shall employ dust suppression techniques (i.e., freshwater use) whenever there is a visible dust trail behind service vehicles. Any technique other than the use of freshwater as a dust suppressant on BLM lands will require prior written approval from BLM.

3.3 Geology And Minerals

3.3.1 Affected Environment

The description of existing geology and minerals applies equally to both lease tracts.

General Geology - The two lease tracts are located within the northeastern portion of the Uinta-Piceance Petroleum Province, comprised of the Uinta and Piceance basins, east-west trending features of Laramide (late Cretaceous-early Tertiary) age, subdivided by the north-south trending Douglas Creek Arch. The Piceance Basin is bounded on the north and east by the Axial Basin Uplift and Grand Hogback, by the Gunnison and Uncompahgre uplifts on the south, and by the Douglas Creek Arch on the west. The basin is asymmetrical, roughly 90 by 135 miles in extent, with an area of approximately 12,500 sq. mi. In the deepest portion the sedimentary section exceeds 20,000 feet in thickness (USGS 2002).

Both lease tracts occupy a dissected upland situated on a northeasterly-trending ridge located between the Stake Springs Draw - Yellow Creek drainages on the northwest and the Ryan Gulch - Piceance Creek drainages to the southeast. The ridge stands approximately 300 feet above the flanking drainages, with elevations in the lease tracts ranging from about 6,600 to 6,700 feet. Within both lease tracts, surface bedrock consists of Unit 5 of the upper portion of the Uinta Formation. The surface bedrock is composed of buff-weathering silty marlstone.

Rock units which would be affected by the two projects consist of lower Uinta and upper Green River formations. The Uinta Formation is mainly composed of brownish sandstones with some subsidiary siltstones and marlstones deposited in fluvial environments, which gradually infilled the older Green River lacustrine environment. The Green River Formation is principally composed of light gray marlstones with subsidiary sandstones and oil shales. A stratigraphic chart denoting rock units in the vicinity of the proposed lease tracts is included as **Attachment 2**.

The valleys bordering the ridge containing the lease tracts are floored with Quaternary (Holocene) alluvial fill with some remnant Pleistocene alluvial terrace deposits along the sides of Piceance Creek (Duncan 1976, Duncan 1976a, Hall and Smith 1994).

Mineral Resources - Mineral resources with the potential for near-term economic exploitation located in the vicinity of the proposed lease tracts include oil shale, oil and gas, and sodium minerals.

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The Green River Formation in the Piceance Basin contains layers of heavily organic, dolomitic marlstones termed oil shale, principally located in the Parachute Creek Member of the formation. The in-place assessed resource in the basin has been estimated at 1,500 billion barrels of shale-derived oil, the world's largest known oil shale deposit. The Green River Formation contains numbered layers identified as alternately rich (R-zones) and lean (L-zones) with respect to oil shale content, and the USGS has estimated the total yield of eight rich layers in the vicinity of the proposed lease tracts to be approximately 3,200,000 barrels/acre (Johnson *et al* 2010). The lease tracts are located in the areas identified as available for oil shale leasing and development in the RMP (BLM 1997, as amended by the programmatic oil shale EIS, BLM 2008). Below the two lease tracts, the top of the oil shale-rich Mahogany zone, in the upper portion of the oil shale interval, is located at depths between about 1,450 and 1,650 feet below the surface.

Bedded and disseminated nodular deposits of sodium minerals, principally nahcolite (naturally occurring sodium bicarbonate $NaHCO_3$), with subsidiary amounts of dawsonite ($NaAl(OH)_2CO_3$), and halite (NaCl) are present in the central portion of the Piceance Basin Green River Formation depocenter. These minerals are associated with oil shale layers in the lower and middle portion of the Parachute Creek Member. Nahcolite, is the only sodium mineral in the basin which is currently commercially exploitable. The nahcolite-bearing interval is mapped as being as much as 1,400-1,500 feet thick in the depocenter, thinning towards the basin margins, and contains about 43.3 billion short tons of reserves. While bedded nahcolite occurs, most of the mineral occurs as variable-sized aggregates within the oil shale. The proposed lease tracts overlie the central portion of the nahcolite deposit (Brownfield *et al* 2010).

Active nahcolite solution mining is occurring at the Natural Soda Inc.'s (NSI) facility located immediately north of the NS proposed lease tract. High-grade (>80%) nahcolite is recovered from the "Boise Bed" utilizing a combination of directionally drilled horizontal and vertical injection/recovery well pairs and processed at the plant on-site. The plant produces both food and industrial grade sodium bicarbonate (Cappa *et al* 2007). The mine has been in production since 1991, and in 2011 produced approximately 132,800 short tons of sodium bicarbonate.

American Soda, LLP (AMSO), a division of Solvay America, Inc., initiated solution mining of nahcolite in 2000 from federal leases at a facility located three miles northeast of the proposed lease tracts. The process dissolved nahcolite from bedded nahcolite and nahcolitic oil shale at depths of 1,500-2,000 feet. Heated water was injected and recovered from single vertical wells with dual completions casing with on a 300 foot spacing. AMSO predicted a cavity configuration of 600 feet in height and a final average cavity diameter of 200 feet maintaining a 100 foot-wide barrier pillar between cavities (BLM 1999). AMSO's target zone is in the saline zone of lower portion of the Parachute Creek Member, about 700 feet below the Mahogany zone. Operations at the processing plant were discontinued in April 2004 following a failure to economically produce soda ash from the nahcolite (Hardy *et al* 2003). (Business Wire 2004). No sodium production is occurring from AMSO's federal sodium leases (BLM 2010).

Neither of the proposed RD&D tracts are encumbered by federal sodium leases. Any sodium minerals recovered as a byproduct of the oil shale experimental extraction processes would belong to the federal government.

Natural gas has been produced in the area since 1940 from the Tertiary Wasatch Formation, from the Douglas Creek Member of the Green River Formation, and from the Cretaceous Mesaverde Formation (Wray *et al* 2002). The Mesaverde gas is the principal objective of most of the current

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drilling in the area. Each well is expected to drain an area of 10 to 20 acres. All federal oil and gas mineral estate in the area is currently leased or held by existing production for continued oil and gas development (BLM 2010). Both of the proposed lease tracts are encumbered by federal oil and gas leases COC60735 and COC62052 committed to Williams Production RMT (Williams) Ryan Gulch Oil and Gas Exploratory Unit COC68239X. EM's proposed lease tract is also encumbered by a Williams' producing natural gas well (RGU 31-34-198) and well pad.

3.3.2 Environmental Consequences of the Proposed Action:

Direct and Indirect Effects: Implementation of the Proposed Actions could interfere with development of oil and gas resources if additional well pads for oil and gas wells are not allowed within the proposed lease tract. Oil and gas development in the area must already consider avoidance of impacts to existing sodium mining operations and oil shale extraction. Current oil and gas development in the area is largely oriented towards the Mesaverde Formation, located at depths of 6,000 feet or more below the target oil shale horizon. Implementation of directional drilling techniques, already commonly practiced in the area, would permit oil and gas development while avoiding oil shale development surface facilities. Configuration of the proposed lease tracts could increase the bottom hole directional distance of future gas wells by more than 1,300 feet on the southern portion of the sodium mining area.

Drilling in and around the vicinity of the Project Area could be affected by geologic characteristics of portions of the Green River and Wasatch formations. Both units are known to contain zones prone to lost circulation, particularly the informally named Dissolution Surface and A and B Groove zones within the Green River Formation Parachute Creek Member. Circulation problems in these zones can also affect the integrity of casing cement jobs. These potential problems are manageable using careful drilling techniques, appropriate mud, cement, and casing design, and performing proper post-cementing integrity evaluations according to BLM requirements.

NS Lease Tract: Extraction of the shale oil resource would not be likely to interfere with development of the sodium mineral resource as the NS technology provides for initial solution mining of the sodium prior to oil shale extraction and would use NSI's existing facilities for of the recovery of the sodium resources in the development OSR. Previous AMSO sodium solution mining activities and cavity development indicate NS proposed OSRs, located greater than 100 feet from the lease tract boundary, would not affect the solid mineral resources or resource recovery adjacent to the lease tract boundaries. NS does not have the lease rights to the sodium minerals nor does the proposed oil shale RR&D lease grant these rights. However the amount of nahcolite resources recovered from OSR in the Proposed Action is low. In the R-2 zone tonnage estimates are 25 to 40 tons of nahcolite per 100 barrels of oil shale recovered. Under the Proposed Action, maximum nahcolite extraction from the test wells would be 375 to 600 tons.

The NS lease tract is encumbered by federal oil and gas lease COC 60735, issued to WPX Energy RMT, LLC (51 percent) and ExxonMobil Oil Corp. (49 percent). A stipulation is attached to the lease which allows drilling only in the event that the BLM Authorized Officer is satisfied that drilling will not interfere with the mining and recovery of oil shale deposits or the extraction of shale oil by in situ methods.

EM Lease Tract: Extraction of the oil shale resource has the potential to interfere with development of the sodium mineral resources underlying the proposed lease tract. The EM

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process does not provide for preliminary solution mining of the sodium prior to oil shale extraction. EM's proposal includes the demonstration only of the recoverability of sodium minerals subsequent to the oil shale extraction process. EM does not have the lease rights to the sodium minerals nor does the proposed oil shale RR&D lease grant these rights. EM's demonstration would help determine the viability of oil shale recovery within the saline zone without rendering the sodium resources unrecoverable. On the ground activities associated with the development of the RD&D lease tract could indirectly impact additional oil and gas wells that could be drilled from Williams' existing RGU 31-34-198 well pad by RD&D construction activities delaying or interfering with access to well pad RGU 31-34-198.

The EM lease tract is encumbered by federal oil and gas leases COC 60735 and COC 62052, issued to WPX Energy RMT, LLC (51 percent) and ExxonMobil Oil Corp. (49 percent). A stipulation is attached to the leases which allows drilling only in the event that the BLM Authorized Officer is satisfied that drilling will not interfere with the mining and recovery of oil shale deposits or the extraction of shale oil by in situ methods.

Cumulative Effects: The cumulative impacts analysis area for geology and minerals is the Yellow Creek-Piceance Creek watershed, and area of 589,825 acres. The proposed RD&D tracts would increase acres of surface area unavailable for oil and gas development below oil shale leases from 430 acres to approximately 750. This could require additional lengths in horizontal drilling for the recovery of the oil and gas resources underlying the proposed RD&D tracts and Natural Soda's sodium mine area. Due to the relative small removal of sodium resources for demonstration purposes of the proposed projects future recoverability the remaining sodium resources would not be substantially affected.

3.3.3 Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the proposed projects would be denied, and there would be no direct, indirect, or cumulative project-related impacts. Ongoing impacts to geology and minerals would result from continuation of existing management actions on the public lands.

3.3.4 Proposed Mitigation:

NS Lease Tract: Mitigation measures specific to the NS tract include:

GEOL-1 - The use of Natural Soda's existing facilities/ponds on its sodium lease should only be for the processing of nahcolite as approved in NSI's 2010 Mine Plan during the development of the OSR.

EM Lease Tract: Mitigation measures specific to the EM tract include:

GEOL-2 - To limit interference with the use of Williams' existing well pad RGU 31-34-198 EM should contact Williams prior to commencement of construction activities associated with the RD&D lease tract.

3.4 Soils

3.4.1 Affected Environment

The soils within the proposed combined, adjacent RD&D lease tracts are subdivided, mapped, and described as five soil mapping units (**Table 3.11**) (Tripp et al. 1982). The five soil map units

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are composed of four base soils classification units or series that singularly or combination with another of the four soil series (a soil complex) make up the five map units. The four soil series and therefore the five soil map units are similar in base physical and chemical characteristics. They are:

- derived from mostly calcareous sandstone (SS) parent materials of the Uinta Formation,
- soils textures are sandy loams to loams,
- soil permeabilities are moderate to moderately rapid, and
- all are well drained.

Principal sources of differences among the soils are soil thickness or depth to bedrock, coarse fragment content (rock content), and steepness of slope (**Table 3.10**). Soils range in depth from as little as 10 inches (shallow) for the Redcreek and Rentsac soils, to 20 to 40 inches (moderately deep) for Piceance soils, to greater than 60 inches (deep) for the Yamac soils. Coarse fragment content in the soil ranges from 25 to 80 percent across the extent and within the profiles of Rentsac soils. Slopes range from 2 to 15 percent for the moderately deep Piceance and deep Yamac soils to 5 to 50 percent for the shallow Redcreek and Rentsac soils. Runoff ranges from slow to medium for Piceance and Yamac soils on less steep slopes to medium to rapid for Redcreek and Rentsac soils on steeper slopes. Associated water erosion hazard ranges from moderate to high for all but the Yamac soils (slight to moderate). These differences in affected soils typically lead to corresponding differences in the effectiveness of applied measures to stabilize disturbed soils and re-establish vegetative cover as part of reclamation.

The terrain/topography and soils support native vegetation of pinyon-juniper (PJ) woodland, PJ/mountain shrub or sagebrush mix, sagebrush, shrub/grass/forb mix, sagebrush/grass mix range across the landscape of both lease tracts (HWA 2011a) with dominance of vegetation types and mixes controlled principally by soil depth (from shallow to deep) and rock content (very rocky, high coarse fragment content to no rocks), respectively.

NS Lease Tract: Within the NS lease tract, the distribution of soils and key soil characteristics that contribute the evaluation of soil stability and reclamation potential are identified in **Table 3.12**. The dominant moderately-deep Piceance and deep Yamac soils comprising 114 acres (70 percent) of the 160-acre tract occupy the less steep sagebrush and grasslands areas between the areas (30 percent of lease tract) of steeper terrain that support the 48 acres of shallow, rockier Redcreek and Rentsac soils and associated PJ forest. Less steep slopes, thicker soils (moderately deep to deep), lower coarse fragment contents, higher available water holding capacities, and low salinity levels for the Piceance and Yamac soils present a higher potential for successful stabilization and reclamation. The steeper slopes, shallow soils, higher coarse fragment contents, and very low water holding capacities of the Redcreek and Rentsac soils present greater limitations on successful stabilization of disturbed soils and their reclamation.

EM Lease Tract: Within the EM lease tract, the distribution of soils and key soil characteristics that contribute the evaluation of soil stability and reclamation potential are identified in **Table 3.13**. The dominant moderately-deep Piceance and deep Yamac soils comprising 123 acres (73 percent) of the 160-acre tract occupy the less steep sagebrush and grasslands areas between the areas (27 percent of lease tract) of steeper terrain that support the 35 acres of shallow, rockier Redcreek and Rentsac soils and associated PJ forest. Less steep slopes, thicker soils (moderately deep to deep), lower coarse fragment contents, higher available water holding

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capacities, and low salinity levels for the Piceance and Yamac soils present a higher potential for successful stabilization and reclamation. The steeper slopes, shallow soils, higher coarse fragment contents, and very low water holding capacities of the Redcreek and Rentsac soils present greater limitations on successful stabilization of disturbed soils and their reclamation.

3.4.2 Environmental Consequences of the Proposed Action:

Direct and Indirect Effects: Potential impacts to soils from the proposed action include removal of vegetation, mixing of soil horizons, soil compaction, increased susceptibility to erosion, loss of topsoil productivity and contamination of soils with petroleum constituents should spills occur. If reclamation is successful and spills are contained and cleaned up, impacts from this project would be minor and localized to disturbed areas.

Proposed clearing of vegetative cover, salvage of soil for post-construction reclamation, grading/excavation and placement of subsoil and geologic materials (cuts and fills) as part of construction of pipelines, roads, and well pads would result in short-term (1-3 years) effects (pipelines, road sides, and interim reclaimed portions of well pads); and long-term effects (life-of-project) under road running surfaces and wellpad operating surfaces.

NS Lease Tract: Initial construction disturbance acreages would total approximately 7.3 acres for the triangular wellpad, access road, natural gas pipeline, and utility ROW (**Table 2.1**).Approximately 0.4 acre of disturbance associated with the utility ROW would occur on existing disturbance. New disturbance would therefore total 6.8 acres. With the successful application of post-construction interim and final reclamation measures, as appropriate; long-term, life-of-project disturbance would be reduced to approximately 4.3 acres. Interim reclamation of portions of the triangular wellpad and access roadsides and post-construction final reclamation of the natural gas pipeline would stabilize and revegetate approximately 2.1 acres of the initial 6.8 acres of new disturbance. Disturbance avoidance and Reclamation measures applied by NS would be consistent with those applicable measures presented in **Appendix A** NS ACDFs and applied BLM mitigations indicated in **Appendix C**.

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Table 3.11 Soil Map Unit Characteristics of the Combined Nominated Oil Shale RD&D Lease Tracts.

Map Unit Symbol - Name	Components / %	Acres / % of Combined Tracts	Position	Parent Material	Depth Class / Depth to bedrock	Ecological/Range Site
64 - Piceance fine sandy loam, 5 to 15% slopes	Piceance fine sandy loam / 85	57.3 / 18	uplands and ridgetops	eolian deposits and colluvium derived from sand stone (ss)	Moderately Deep / 20 and 40 inches	Rolling Loam
70 - Redcreek-Rentsac complex, 5 to 50% slopes	Redcreek sandy loam / 60 Rentsac channery loam / 30	30.0 / 9	mountainsides and ridges	eolian deposits and residuum derived from ss residuum derived from ss	Shallow / 10 to 20 inches Shallow / 10 to 20 inches	P-J Woodland
73 - Rentsac channery loam, 5 to 50% slopes	Rentsac channery loam / 80	36.7 / 12	ridges, foothills, and sideslopes	residuum derived from ss	Shallow / 10 to 20 inches	P-J Woodland
75 - Rentsac-Piceance complex, 2 to 30% slopes	Rentsac channery loam, 8-30% slopes / 60 Piceance fine sandy loam, 2-15% slopes / 30	24.5 / 8	uplands, broad ridges, and foothills	residuum derived from ss eolian deposits and colluvium derived from ss	Shallow / 10 to 20 inches Moderately Deep / 20 and 40 inches	P-J Woodland Rolling Loam
104 - Yamac loam, 2 to 15% slopes	Yamac loam / 85	170.9 / 53	rolling uplands, terraces, and alluvial fans	eolian and alluvial deposits	Deep / greater than 60 inches	Rolling Loam
Total		319.4 / 100				

Source of information: Tripp et al. 1982

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Table 3.12 Limiting Factors to Soil Stabilization and Revegetation in the 160-acre NS Lease Tract.

Map Unit Symbol - Name	Components / %	Acres / % of Lease Tract	Coarse Fragment (Rock) Content	Erosion Hazard[1] Water / Wind	Available Water Holding Capacity	Salinity Levels
64 - Piceance fine sandy loam, 5 to 15% slopes	Piceance fine sandy loam / 85	26.3 / 16	Up to 10%	M - H / M - H	Moderately low	Non-saline
70 - Redcreek-Rentsac complex, 5 to 50% slopes	Redcreek sandy loam / 60 Rentsac channery loam / 30	30.1 / 19	0% 25% to 50%	M - H / M - H M - H / L	Very low Very low	Non-saline Non to slightly saline
73 - Rentsac channery loam, 5 to 50% slopes	Rentsac channery loam / 80	18.1 / 11	25% to 50%	M - VH / L	Very low	Non to slightly saline
104 - Yamac loam, 2 to 15% slopes	Yamac loam / 85	87.7 / 54	5%	S - M / L	Moderate to High	Non-saline
Total		162.2 / 100				

Source of information: Tripp et. al. 1982

[1] Erosion hazard ratings: S - slight; M - moderate; H - high; and VH - very high

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Table 3.13 Limiting Factors to Soil Stabilization and Revegetation in the 160-acre EM Lease Tract.

Map Unit Symbol - Name	Components / % of Map Unit	Acres / % of NS Tract	Coarse Fragment (Rock) Content of Topsoil %	Erosion Hazard[1] Water / Wind	Available Water Holding Capacity	Salinity Levels
64 - Piceance fine sandy loam, 5 to 15% slopes	Piceance fine sandy loam / 85	31.0 / 20	Up to 10%	M - H / M - H	Moderately Low	Non-saline
73 - Rentsac channery loam, 5 to 50% slopes	Rentsac channery loam / 80	19.7 / 13	25% to 50%	M - VH / L	Very Low	Non to slightly saline
75 - Rentsac-Piceance complex, 2 to 30% slopes	Rentsac channery loam, 8-30% slopes / 60 Piceance fine sandy loam, 2-15% slopes / 30	22.0 / 14	25% to 50% Up to 10%	M - H / L M - H / M - H	Very Low Moderately Low	Non to slightly saline Non-saline
104 - Yamac loam, 2 to 15% slopes	Yamac loam / 85	84.8 / 53	5%	S - M / L	Moderate to High	Non-saline
Total		157.5 / 100				

Source of information: Tripp et. al. 1982

[1] Erosion hazard ratings: S - slight; M - moderate; H - high; and VH - very high

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Facilities may be located anywhere within the 160-acre nominated lease tract. Assuming the equal distribution of facilities within the lease tract, the 6.8 acres of new disturbance would be distributed proportionally among the soils based on their percent composition within the tract. Based on the limiting factors to successful soil stabilization and reclamation for the tract's soils (**Table 3.12**), one could anticipate 4.5 acres (70 percent of the 6.4-acre disturbance) would occur on the moderately deep to deep soils with low rock content, low salinity, moderately low to high water holding capacity, and slight to high erosion potential with high potentials corresponding to local areas of steeper slopes. The remaining 1.9 acres would likely occur on mostly shallow soils with high rock content, non to slightly saline, very low water holding capacity, moderate to very high water erosion hazards. Those portions of the 1.9 acres with steep slopes (slopes greater than 15 percent and especially slopes (fragile soils) greater than 35 percent) would likely be avoided where feasible.

To address the lease tract's soils' limiting factors, topsoil materials would be salvaged. For life-of-project facilities, topsoil will be spread to a comparable pre-disturbance depth on stable cut and fill slopes and other areas along the edge of the well and central facilities pad, access road ROW, and pipeline ROW separate from fill materials placed as part of construction. For areas of temporary disturbance that would under-go reclamation after construction, salvaged topsoil would be stockpiled in shallow piles along the edge of disturbance. Stored topsoil and cut and fill material loss from facilities construction would be controlled by stabilizing measures implemented in accordance with storm water management control measures and interim or final reclamation requirements. Post-construction and ultimately post-abandonment of the well pad and access road would require the application of interim and final reclamation measures and monitoring, respectively. Surface stabilization and protection, particularly for cut and fill slopes supporting operating facilities, and recontouring, surface stabilization and preparation, topsoil spreading, seedbed preparation, seeding, and application of erosion control treatments (mulching) and features (culverts and water bars) would limit the amount and duration of accelerated soil loss from disturbed areas and promote the recovery of protective cover and forage productivity of areas no longer needed for project operations. Measures applied would be those described in the Reclamation and Abandonment Section of NS' Proposed Action and in **Appendix A** Natural Soda ACDFs. Monitoring of reclamation success would continue until bond release. For the first three years following the application of reclamation and revegetation measures, cover, productivity, and composition would me measured and followed by appropriate response to resolve any problems.

Pipeline construction would be promptly followed by the implementation of final reclamation measures. Again, measures applied would be those described in the Reclamation and Abandonment Section of NS' Proposed Action and in **Appendix A**.

Should a second or even a third interval be tested, the interim reclaimed area or areas would likely be re-disturbed to provide sufficient space to drill and develop the second or third interval's OSR. Although development operations would be mostly similar to those conducted for the first interval, new disturbance would be mostly confined to areas first disturbed for development of the first OSR or to areas previously disturbed. Locations of disturbance reclaimed by interim measures could be re-disturbed; however, no disturbance of previously undisturbed lands or more than the original 6.8 acres is anticipated. Effects would be anticipated to be closely similar to those noted above for the first interval OSR.

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During any part of the RD&D operation, contamination of surface and subsurface soils could occur from leaks or spills of hydrocarbons and process water from project vehicles and facilities during construction and operations including well drilling and completion. Such leaks or spills could compromise the productivity of the affected soils. Depending on the size and type of spill, the impact to soils would primarily consist of the loss of soil productivity for the area impacted by the extent of the spill. In addition, hydrocarbons released to surface soils may infiltrate the soil and, under the right conditions, could migrate downward and possibly contact and introduce contaminants to shallow ground water. Spills would be reported promptly to appropriate local, state, and federal agencies, and remediation would be implemented in compliance with the approved SPCC Plan for NS' proposed RD&D project.

EM Lease Tract: Initial construction disturbance acreages for phases Appraisal, I, II, III, and IV would total approximately 112.7 acres for all project phases', both on and off the proposed lease tract, access roads, well pads, ancillary facilities, pipelines, and power lines (**Table 2.5**). With the successful application of post-construction interim and final reclamation measures, as appropriate; long-term, life-of-project disturbance would be reduced to approximately 52.3 acres. Interim reclamation of portions of well pads and access roadsides and post-construction final reclamation of the product gathering and natural gas pipelines would stabilize and revegetate approximately 60.4 acres of the initial 112.7 acres of new disturbance. The reclaimed 60.4 acres would also include final reclamation of those facilities for Phase Appraisal, I, II, and III no longer needed for Phase IV operations. Given the phased development of the project and the application of interim and final reclamation, no more than 50 to 60 acres would be considered disturbed, not undergoing reclamation/revegetation, at any point in time for the life-of-project. Disturbance avoidance and Reclamation measures applied by EM would be consistent with those applicable measures presented in **Appendix B** EM Applicant-committed Design Features and applied BLM mitigation measures included in **Appendix D**.

Facilities may be located anywhere within the approximately 160-acre nominated lease tract. Assuming the equal distribution of facilities within the lease tract, the approximately 112.7 acres of new disturbance would be distributed proportionally among the soils based on their percent composition within the tract. Based on the limiting factors to successful soil stabilization and reclamation for the tract's soils (**Table 3.13**), one could anticipate 83 acres (73 percent of the 113-acre disturbance) would occur on the moderately deep to deep soils with low rock content, low salinity, moderately low to high water holding capacity, and slight to high erosion hazards with high potentials corresponding to local areas of steeper slopes and/or sandy soil textures . The remaining 30 acres would likely occur on mostly shallow soils with high rock content, non to slightly saline, very low water holding capacity, moderate to very high water erosion hazards. Those portions of the 30 acres with steep slopes (slopes greater than 15 percent and especially slopes greater than 35 percent) would likely be avoided where feasible.

To address the tract's soils' limiting factors, topsoil materials would be salvaged and stockpiled along the edge of the well and central facilities pad, access road ROW, and pipeline ROW separate from fill materials placed as part of construction. Stored topsoil and cut and fill material loss from facilities construction would be controlled by stabilizing measures implemented in accordance with storm water management control measures and interim or final reclamation requirements. Post-construction and ultimately post-abandonment of the well pads, access roads, process pad, and ancillary facilities, both on and off lease, would require the application of interim and final reclamation measures and monitoring, respectively. Surface stabilization and

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protection, particularly for cut and fill slopes supporting operating facilities, and recontouring, surface stabilization and preparation, topsoil spreading, seedbed preparation, seeding, and application of erosion control treatments (mulching) and features (culverts and water bars) would limit the amount and duration of accelerated soil loss from disturbed areas and promote the recovery of protective cover and forage productivity of those areas no longer needed for project operations. Measures applied would be those described in the Reclamation and Abandonment Section of EM's Proposed Action and in **Appendix B** EM ACDFs. Additional reclamation efforts would be undertaken if, after the first growing season, there are no positive indicators of successful establishment of seeded species.

Pipeline construction would be promptly followed by the implementation of final reclamation measures. Again, measures applied would be those described in the Reclamation and Abandonment Section of EM's Proposed Action and in **Appendix B**.

During any part of the RD&D operation, contamination of surface and subsurface soils could occur from leaks or spills of hydrocarbons and process water from project vehicles and facilities during construction and operations including well drilling and completion. Such leaks or spills could compromise the productivity of the affected soils. Depending on the size and type of spill, the impact to soils would primarily consist of the loss of soil productivity for the area impacted by the extent of the spill. In addition, hydrocarbons released to surface soils may infiltrate the soil and, under the right conditions, could migrate downward and possibly contact and introduce contaminants to shallow ground water. Spills would be reported promptly to agencies, and remediation would be implemented in compliance with the approved SPCC Plan for EM's proposed RD&D project.

Cumulative Effects: The cumulative effects analysis area is the Yellow Creek watershed, an area of 168,931 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 4,098 acres (2.4 percent). Disturbance from foreseeable actions is estimated to be 1,155 additional acres (0.7 percent) (**Table 3.3**). In general, up to approximately 120 acres of direct soil disturbance from both RD&D projects within the boundaries of the lease tracts is likely to reduce soil productivity and may lead to temporary accelerated soil erosion and instability of soils in localized areas until effective reclamation BMPs for soil stabilization and revegetation are applied.

3.4.3 Environmental Consequences of the No Action Alternative

Should the No Action Alternative be selected, there would be no direct, indirect, or cumulative impacts to the soils from oil shale RD&D activity.

3.4.4 Proposed Mitigation

Measures applicable to both lease tracts would include:

SOIL-1 - All new infrastructure and well pads on either lease tract will be located on old disturbance to the maximum extent possible to avoid additional disturbances in the project area.

SOIL-2 - NS and EM will apply committed actions in their respective Plan of Operations (POOs) and in their respective Proposed Actions for achieving interim reclamation on existing facilities when any new disturbance or infrastructure is planned.

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SOIL-3 - Salvaged topsoil will be respread during interim reclamation on stable cut and fill slopes and other areas, do not keep topsoil stored in piles during the interim reclamation.

SOIL-4 - Excess salvaged topsoil will be placed in shallow stockpiles adjacent to construction zones and operational facilities to support and maintain those characteristics of topsoil that will aid in future reclamation and revegetation efforts.

SOIL-5 - All new roads and existing access roads that will routinely be used more than 4 times a month for RD&D operations or are observed to have ruts more than three inches deep will be crowned and ditched according to BLM Manual section 9113 standards and surfaced for all-weather use. Surfacing must in include at least six inches of compacted aggregate that can be composed of different gravel sizes and road base as appropriate for the soils and topography. Road design should allow for travel on the roads with service vehicles when soils are saturated.

SOIL-6 - Gully crossings within both lease tracts will conform to BLM Manual 9112 standards and be stable without erosion for 10 year storm events and not fail with 25-year storm events.

SOIL-7 - An impervious liner with a thickness of at least 24 mils will be required for any secondary containment structures or pits that contain liquids to be installed for new facilities or used for drilling.

3.4.5 Finding on the Public Land Health Standard for Upland Soils (Standard 1)

Due to the historic, current, and future development of mineral resources and continued grazing in this area, the overall soil productivity is diminished from the potential for this area. While soil productivity in areas occupied for life-of-project facilities, including the two proposed oil shale RD&D projects, will be lost, the application of interim and ultimately final reclamation of disturbed lands including the previously occupied by facilities before decommissioning will restore soil productivity to some extent equal to or better than surrounding landscape, assuming appropriate land management.

NS Lease Tract: For NS' lease tract, soils productivity will likely be restored to equal, possibly better than the surrounding landscape due the application of proposed reclamation measures, commitment to monitor and to respond with additional reclamation measures until bond release, and the limited, 6.8 acre extent of total disturbance for the project.

EM Lease Tract: The EM proposal would disturb 112.7 acres of a 160 acre lease parcel which is slightly over 70 percent of the surface. Within the lease tract, bisected by ephemeral drainages, it is unlikely, even with application of the best practices, that the productivity of the site would achieve productivity similar to current conditions. Stormwater protection measures and best management actions are likely to leave the disturbed sites without excessive erosion or instability, but it is likely that predominant, previously-disturbed soils of this lease parcel will be less productive than the surrounding mostly undisturbed terrain even after final reclamation due to the high percentage of surface disturbance.

3.5 Surface & Ground Water Quality

3.5.1 Affected Environment

The description of existing water resources applies equally to both lease tracts.

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The proposed lease tracts are located in the headwaters of ephemeral drainages tributary to Yellow and Piceance creeks, located near the center of the USGS 4th-order watershed, hydrologic unit code (HUC) 14050006. This watershed encompasses an area of approximately 904 sq. miles, which drains to the north to the White River. (Seaber *et al* 1987). The lease tracts are entirely contained on highlands separating perennial Yellow Creek, to the northwest, from perennial Piceance Creek and its intermittent tributary Ryan Gulch to the south and southeast (CDWR 2001). The lease tracts are located near the divide between these drainages, although direct drainage from all proposed facilities would be to the Yellow Creek side of the divide. As more hydrologic data are available from Piceance Creek, and both streams drain similar terrain and underlying lithology, this analysis has included the entire 4th-order watershed.

Piceance Creek tributaries are assigned stream segmentation code COLCWH16 by the Colorado Water Quality Control Commission (CWQCC 2012a) under recent updates (January 2012) to Regulation 37, dealing with classifications and numeric standards for the Lower Colorado River Basin. The Ryan Gulch confluence with Piceance Creek forms the boundary between the upper, cold water portions of Piceance Creek (segments COLCWH14a and 14b) and its lower, warm water portion (COLCWH15), extending north to the confluence with the White River. Yellow Creek and its tributaries are assigned segmentation code COLCWH13b above the confluence with Barcus Creek and COLCWH13c from Barcus Creek to the confluence with the White River.

Water quality assessments done in 2010 under requirements of the federal Clean Water Act have determined that Piceance tributaries (COLCWH16) are fully supporting of agricultural uses and warm water aquatic life. Lower Piceance Creek (COLCWH15) is evaluated as being fully supportive of agricultural uses, warm water aquatic life and secondary contact recreation. Yellow Creek and its tributaries have been found to be fully supporting of agriculture, warm water aquatic life, and secondary contact recreation (CWQCC 2010).

The 2012 303(d) list has included several stream segments on the listing of impaired streams and on the monitoring and evaluation list. These segments are downstream of the project area (CWQCC 2012b). The mainstem of Piceance Creek is provisionally listed as impaired for aquatic life from Ryan Gulch to the confluence with the White River. Yellow Creek from Barcus Creek to the White River is listed as impaired for total recoverable iron and aquatic life standards. Ryan Gulch is on the monitoring and evaluation list for Escherichia coli (E. coli) bacteria. Aquatic life listings are based on macroinvertrabrate sampling that measured a biological community different than the expected or reference condition. New provisional listings for aquatic life will go through a data gathering process for at least two years, since no water quality parameter has been identified as being responsible for the biological community measured.

Water quality in Piceance and Yellow creeks and their tributaries is principally related to ground water quality, as approximately 80 percent of the annual flow comes from discharge from alluvial and bedrock (Uinta Formation, in the vicinity of the lease tracts) aquifers. The total dissolved mineral load in Piceance Creek increases in a downstream direction from an upstream average of about 1.5 tons/day transported to about 122 tons/day transported near the confluence with the White River. Principal constituents include bicarbonate, sulfate, and sodium. Dissolved solids concentrations diminish during high runoff periods and increase during the irrigation season because of added mineral content in irrigation runoff (Tobin 1987). Water quality has been sampled in Piceance Creek by the U.S. Geological Survey (USGS) over varying times and

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for various components. Four USGS stations with long-term sample history are or were located in the upper reaches near Rio Blanco, near the confluence with Black Sulphur Creek, at the confluence with Ryan Gulch, and above the confluence with the White River. Summary data from these stations demonstrate the general degradation in water quality in a downstream direction for such parameters as total dissolved solids (TDS), total hardness, and dissolved oxygen. Similar data from Yellow Creek are limited to two stations in Corral Gulch, to the west of the lease tracts, and one station at the confluence with the White River. A summary of surface water quality information in the watershed containing the proposed lease tracts is indicated in **Table 3.14** (BLM 2006, USGS 2012).

Table 3.14 Average Surface Water Quality Piceance-Yellow Creeks Watershed

Location	USGS Station	pH	Water Quality Data (mg/l)						
			TDS	HCO_3	Ca	Mg	Na	Cl	SO_4
Piceance Creek Drainage									
Piceance Creek below Rio Blanco	09306007	8.3	709	532	72	47	118	16	197
Black Sulphur Creek near Rio Blanco	09306175	8.1	1,104	574	97	93	146	10	455
Piceance Creek below Ryan Gulch	09306200	8.3	1,046	645	81	81	178	16	386
Piceance Creek at White River	09306222	8.4	1,556	1,178	60	82	426	63	417
Yellow Creek Drainage									
Corral Gulch at 84 Ranch	09306244	8.1	1,311	608	109	106	184	18	554
Corral Gulch near Rangely	09306242	7.9	892	511	87	70	132	12	345
Yellow Creek at White River	09306255	8.5	2,343	1,433	42	129	669	109	691

Source: BLM 2006, USGS 2012

Flow in local streams typically peaks in the spring in response to runoff of winter snowmelt and spring rainfall. Transit time from the headwaters of Piceance Creek to the White River probably takes about one day during high flow periods and several days when flow rates are low (Taylor 1987). The nearest USGS gaging station to the proposed lease tracts, with long-term records is located at the confluence of Ryan Gulch into Piceance Creek, approximately 3.5 miles east of the lease tracts (Station 09306200, 1965-2010). Peak mean daily flows measured at this station have occurred in late April and May. Average mean daily flow has varied from 18 to 66 ft^3/sec. (cfs). Average maximum daily flows have varied from 46 to 534 cfs and average minimum daily flows have varied from 0.15 to 16 cfs. Piceance Creek drains an area of 652 sq. miles.

Long-term flow rates from Yellow Creek are available from the station at the confluence of Yellow Creek with the White River (Station 09306255, 1973-2011), approximately 17 miles north of the lease tracts. Yellow Creek drains an area of 262 sq. miles. Average daily flow rates from the two gaging station are graphically represented in **Figure 3.4**(USGS 2012). Average monthly flow rates in Piceance Creek at Ryan Gulch are roughly 10 times the Yellow Creek discharge into the White River (Taylor 1987).

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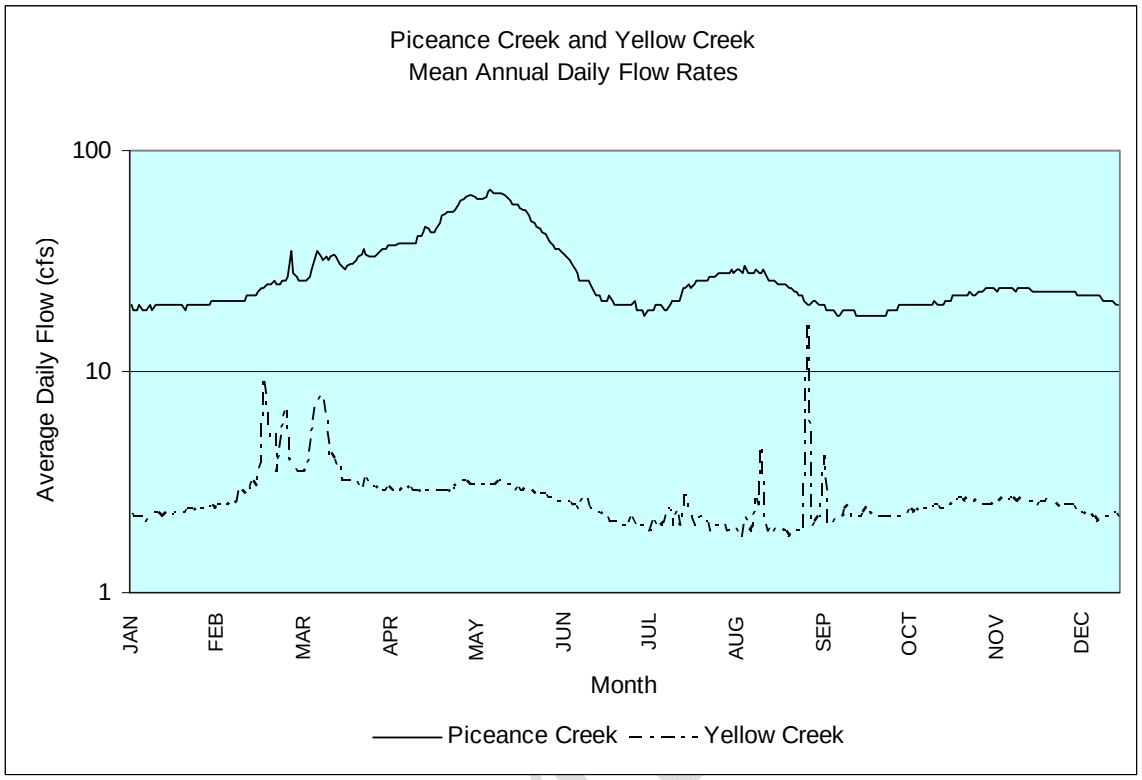
Figure 3.4 Piceance and Yellow Creek Daily Flow Rates



Source: USGS 2012. Piceance Creek Station 09306200, 1965-2010, Yellow Creek Station 09306255, 1973-2011

Ground water - Aquifers in the vicinity of the proposed lease tracts include shallow alluvial aquifers limited to flooring local floodplains, the Tertiary Uinta-Animas aquifer, and the Cretaceous Mesaverde aquifer. The term "aquifer" refers to a permeable body of rock capable of yielding quantities of ground water to wells and springs. The Mesaverde aquifer represents the principal target of current gas drilling in the area and would be located at depths of 7,000 feet or greater, according to existing well data. None of the operations associated with the proposed actions would affect the Mesaverde aquifer, and it will not be discussed further in this EA.

There are no springs located within approximately two miles of the proposed lease tracts. Identified springs in the area are limited to ground water flow from Uinta Formation bedrock into local drainage alluvial aquifers (BLM 2009, CDWR 2011). Springs will not be discussed further in this EA.

The Uinta-Animas aquifer consists of portions of the Green River and Uinta formations. The aquifer is divided into upper and lower units by the oil shale-rich Mahogany zone in the upper portion of the Parachute Creek Member of the Green River Formation, which retards water movement vertically. The upper aquifer system in the vicinity of the proposed lease tracts is around 1,400 feet thick and extends to the surface, while the lower aquifer system is around 300-400 feet thick. Hydraulic conductivities range from less than 0.2 to 1.6 ft/day in the upper aquifer system, with well yields of 1-900 gpm. Within the lower aquifer system, conductivities range from less than 0.1 to more than 1.2 ft/day and wells can yield up to 1,000 gpm (Topper et al 2003). In contrast, the intervening Mahogany (R-7) Zone is around 200 feet thick. The Mahogany Zone exhibits horizontal conductivities of 0.0003 to 0.1 ft/day and vertical

conductivities of 0.0001 to 0.03 ft/day and forms a somewhat leaky confining layer between the upper and lower aquifer systems (**Table 3.15)**. Vertical movement out of the horizon targeted by the proposed action would be inhibited by these layers (Taylor 1982). Ground water flow is towards the northeast.

Table 3.15 Uinta-Animas Aquifer Vertical Hydraulic Conductivities, Piceance Basin

Formation	Aquifer	Ave. Saturated Thickness (ft)	Vertical Hydraulic Conductivity (ft/day)	
			Low	High
Uinta	Upper	400	1.3E-03	5.6E-01
Green River		300	1.7E-03	8.0E-01
	Mahogany Zone	160	1.0E-04	3.0E-02
	Lower	190	3.9E-04	8.6E-02

The base of the lower aquifer varies across the basin. On the margins, the base is typically formed by the top of the Garden Gulch Member of the Green River Formation. In the central portion of the basin, including the area of the proposed lease tracts, the lower portion of the Parachute Creek Member, informally identified as the "Saline Zone" (Robson and Banta 1995), contains deposits of evaporites, and is not water-bearing. The upper portion of the Parachute Creek Member is informally identified as the "Leached Interval." Within this zone, the height of which varies across the basin, ground water movement has resulted in the leaching and removal of evaporite minerals. A chart summarizing the hydrologic conditions below the proposed lease tracts is included as **Attachment 2**.

Subsurface Uinta-Animas aquifers have been identified in the vicinity of the proposed lease tracts from wells drilled in support of NS' existing nahcolite solution mining operations. Within the Upper Aquifer System, two aquifers have been identified:

- Perched Aquifer - the informally named "Perched Aquifer" is present or may be present at a depth of around 500 feet. The Perched Aquifer consists of water-bearing sandstones within the Uinta Formation which directly overlie more impermeable shale units with the Thirteenmile Creek Tongue of the Parachute Creek Member and is local in extent, unlike the aquifers described below. In the vicinity of the lease tracts, the aquifer is approximately 20 ft thick. The Thirteenmile Creek Tongue interfingers with the Uinta Formation below the lease tracts.
- A-Groove Aquifer - the informally named "A-Groove Aquifer" consists of fractured oil shale and marlstone at the base of the Upper Aquifer System and immediately overlying the Mahogany Zone of the Parachute Creek Member. The aquifer is typically 15-20 feet thick and is located at a depth of around 1,300-1,400 feet (Daub and Associates 2011).

The Uinta-Animas Lower Aquifer System below the lease tracts occurs below the Mahogany Zone and above the Saline Zone. Two aquifers have been identified:

- B-Groove Aquifer - the informally named "B-Groove Aquifer" consists of fractured oil shale and marlstone and is about 20-25 feet thick. The aquifer occurs at a depth of around 1,500-1,600 feet.
- Dissolution Surface Aquifer - the informally named "Dissolution Surface Aquifer" occupies an interval of 50-70 feet immediately overlying the Saline Zone. The aquifer

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crosses stratigraphic horizons and below the lease tracts is likely to occur within the L-5 or upper R-5 oil shale zones. The aquifer consists of fractured and rubblized oil shales and marlstones, commonly with solution features. It occurs at depths of around 1,800-2,000 feet below the lease tracts (Daub 2012).

Water quality within the Uinta-Animas aquifer varies between the upper and lower units and within the upper and lower units themselves. In the vicinity of the proposed lease tracts, TDS values in the upper aquifer are between 500 and 1,000 mg/l, while salinities in the lower aquifer typically range from around 1,000 to 3,000 mg/l, although values as high as 16,000 mg/l have been reported locally. These ranges are a result of combining samples from different aquifers within the larger aquifer system, and result in an overly simplified view of water quality. For example, the TDS values in the upper portion of the lower aquifer (B-groove) are often lower than the most productive part of the A-groove. Water quality is variable among the different aquifers within a given aquifer system.

Within the Lower Aquifer System, fractures have allowed vertical transport of more saline waters from the Saline Zone into the overlying rocks which has degraded water quality. Water chemistry is dominated by sodium and bicarbonate in both upper and lower units, with calcium and magnesium observed in portions of the upper aquifer. Concentrations of most solutes are higher in the lower than the upper aquifer (BLM 2007, Robson and Banta 1995, Tobin 1987). A summary of local aquifer water quality values is indicated in **Table 3.16**.

Table 3.16 Ground water Properties, Vicinity of the Lease Tracts (mg/l)

Parameter	Alluvial Aquifer		Upper Uinta-Animas Aquifer		Lower Uinta-Animas Aquifer	
	Range	Mean	Range	Mean	Range	Mean
Potassium	0.8-6.8	2.5	0.2-6	1.5	0.4-78	11
Sodium	66-2,900	490	55-650	210	230-16,000	3,980
Calcium	2.4-120	57	7.4-110	50	2.8-15	7.4
Magnesium	3.6-160	80	9.8-187	60	3.0-26	9.5
Bicarbonate	336-3,560	1,220	307-918	550	493-40,000	9,100
Chloride	5.2-270	42	3.4-63	16	1.3-2,900	690
Sulfate	41-1,500	430	34-850	320	4.2-350	80
Fluoride	0.1-33	4.6	0-12	1.4	5.0-66	28
TDS	469-6,720	1,750	345-2,180	960	491-38,900	9,400

Source: BLM 2007

Water quality within the Perched, A-Groove, and B-Groove aquifers is sufficiently good (TDS values < 10,000 mg/l) that these are considered underground sources of drinking water (USDW). Levels of dissolved solids within the Dissolution Surface Aquifer are high, 25,000-100,000 mg/l, and this aquifer is not considered a USDW (Daub 2012).

Ground water production rates in the immediate vicinity of the lease tracts are poorly known. All but one of the permitted wells located within two miles of the lease tracts are completed in the Uinta Animas aquifer system. Then other well, located almost two miles to the northwest, is completed in the Yellow Creek alluvial aquifer(CDWaR 2008).

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Almost all of the permitted wells in the immediate vicinity are operated by Natural Soda, including two industrial water supply wells, both completed in the A-Groove. These wells have deliverability rates ranging from 43 to 118 gpm. Natural Soda also operates 35 monitoring wells. These wells are completed in the Perched Aquifer (eight wells), A-Groove (four wells), B-Groove. (nine wells), and Dissolution Surface (14 wells) (Daub 2012).

3.5.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: Implementation of the proposed actions would result in varying levels of surface disturbance which could lead to increased sediment transport into local drainages. Operational activities could result in spills of potentially hazardous substances to the ground which could affect local drainages or near-surface aquifers. Both projects propose the drilling of varying numbers of operational and monitoring wells. Leaks from improperly cased wells could affect local aquifers. The EM proposed action would include generation of vertical, induced fractures in underlying strata which have the potential to affect local aquifers.

NS Lease Tract: Surface Water - Implementation of the proposed action would result in disturbance to the surface which would affect less than 10 acres in the short- and long-term. The lease tract is located on the northwest side of a ridge crest which forms the drainage divide between Yellow Creek and Piceance Creek watersheds. An intermittent stream which exits the lease tract near the northwest corner provides the closest connection to Yellow Creek, more than three miles along the channel to then north-northwest. Project disturbance would likely occur more than 300 feet from the intermittent drainage. Project activities are not proposed which result in disturbance to any intermittent drainage within the lease tract. A SWMP would be developed and implemented in compliance with regulations of CDPHE to minimize the potential for sediment transport away from disturbed areas.

It is uncertain that any of the 303(d) listed stream segments identified in the affected environment would be impacted by these RD&D leases, since the RD&D leases are in ephemeral headwater basins, several miles upstream from these stream segments. Surface disturbance that increases sediment loads and changes surface runoff patterns have the potential to increase overall sediment yields from a basin and could contribute to additional sediment in these downstream areas. With best management practices to address stormwater control it is not likely that disturbance associated with the NS Lease track (10 acres) would measurably increase sediment yields. Changes in groundwater quality that may be tributary to the alluvial aquifers in Piceance Creek and Yellow Creek could change water quality in these listed segments. However, with observation wells it is likely that contaminants would be detected long before they reach alluvial aquifers downstream that contribute ground water to the impaired stream segments. Mitigation of any ground water contamination would be dependent on the type and amounts of the pollutants and a mitigation plan would be established at that time. Water and sodium liquids pipelines would be installed above ground on stanchions and result in negligible surface disturbance. The proposed natural gas pipeline would be buried; installation is expected to last only 1-2 days, and reclamation would follow installation as soon as reasonably feasible. A spill prevention, control, and countermeasure (SPCC) plan would be developed and implemented which would minimize the potential for spills of potentially hazardous materials to the ground and include plans for quickly cleaning up any spills which should occur.

Ground Water - The principal potential impacts to ground water resources are anticipated to arise from leaks in the casing of the proposed well(s). The well(s) would be drilled in a manner and to

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a stratigraphic horizon with which NS has familiarity from its adjacent solution mining operations in the Boies Bed and drilling of a deeper stratigraphic test hole. Drilled wells are expected to be designed and constructed in a manner which experience has indicated would result in technically competent completions. Casing cement design has accounted for the thermal requirements. No hydraulic fracturing operations are proposed and the shale oil extraction process is an extension of NS' existing solution mining operations. The only identified permitted water supply wells within two miles are used to supply industrial water for solution mining operations. All but one are operated by NS or related companies. No permitted wells used for domestic, agricultural, or stock purposes are located within two miles of the nominated lease tract.

All of the proposed shale oil extraction activities would occur within the Saline Zone, which does not contain water. The closest aquifer is the Dissolution Surface Aquifer, located more than 400 feet vertically above the uppermost portion of the OSR interval. The closest underground source of drinking water (USDW) would be the B-Groove Aquifer which would be located more than 700 feet above the uppermost portion of the OSR interval. Intervening oil shale-rich horizons act to reduce vertical hydraulic conductivity above the horizon targeted by the proposed action. Monitoring wells will be used to confirm the vertical isolation of the ground water zones that will be developed.

The current and proposed monitoring wells installed by NS would be used to monitor local aquifers for any potential impacts resulting from the shale oil extraction activities.

EM Lease Tract: Surface Water - Implementation of the proposed action would result in disturbance to the surface which would affect up to approximately 113 acres in the short-term and 52 acres for the long-term, depending on the number of phases of the proposed action which are implemented and their locations. The exact sites which would be disturbed are undetermined at this time, pending further evaluation following granting of the lease. The lease tract is located on the northwest side of a ridge crest which forms the drainage divide between Yellow Creek and Piceance Creek watersheds. The northeast corner and west sides of the proposed lease tract are crossed by intermittent streams which drain to the north to Yellow Creek, more than three miles along the course of the drainage. A SWMP would be developed and implemented in compliance with regulations of CDPHE to minimize the potential for sediment transport away from disturbed areas.

It is uncertain that any of the 303(d) listed stream segments identified in the affected environment would be impacted by the EM Lease Tract, since it is located in an ephemeral headwater basin, several miles upstream from these stream segments. Surface disturbance that increases sediment loads and changes surface runoff patterns have the potential to increase overall sediment yields from a basin and could contribute to additional sediment in these downstream areas. With best management practices to address stormwater control it is not likely that disturbance associated with the EM Lease track (60 acres at any one time) would measurably increase sediment yields. Changes in groundwater quality that may be tributary to the alluvial aquifers in Piceance Creek and Yellow Creek could change water quality in these listed segments. However, with observation wells it is likely that contaminants would be detected long before they reach alluvial aquifers downstream that contribute ground water to the impaired stream segments. Mitigation of any ground water contamination would be dependent on the type and amounts of the pollutants and a mitigation plan would be established at that time.

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The proposed natural gas supply pipeline would be buried, while the products gathering pipelines may be buried or laid on the surface. Installation methods are undetermined at this time, but would be of short duration since the pipeline lengths would be limited and would result in a short installation period. Reclamation of the pipeline ROWs would follow installation as soon as is reasonably feasible. Installation of the proposed power line would be of short duration and would be followed by reclamation of the ROW.

A SPCC plan would be developed and implemented which would minimize the potential for spills of potentially hazardous materials to the ground and include plans for quickly cleaning up any spills which should occur.

Implementation of the proposed action could occur over a period of up to 15 years and the potential for sediment transport and spills would last for the duration of the project and until completion of final reclamation.

Ground Water - Impacts to ground water resources could arise from leaks in the casing of the various types of proposed wells. Drilling conditions to the target project horizons are generally well understood as a result of the NS adjacent solution mining operations. Construction and connection holes would require drilling horizontal segments. Drilled wells would be permitted only following review and approval of the well design. Casing cement design has accounted for the thermal requirements. Well designs would be reviewed by BLM engineers prior to approval. The only identified permitted water supply wells within two miles are used to supply industrial water for solution mining operations. All but one are operated by NS or related companies. No permitted wells used for domestic, agricultural, or stock purposes are located within two miles of the nominated lease tract.

All of the proposed shale oil extraction activities would occur within the Saline Zone, which does not contain water. The vertically closest aquifer is the Dissolution Surface Aquifer, which is likely located more than 500 feet vertically above the uppermost portion of the EM target extraction horizon. The closest USDW would be the B-Groove Aquifer which would likely be located more than 800 feet above the top of the EM target extraction zone. Vertical hydraulic conductivities in the Uinta-Animas aquifer in the Piceance Basin are lower in the Lower Aquifer and Mahogany oil shale zone than in the Upper Aquifer, as indicated in **Table 3.15**. Vertical movement out of the horizon targeted by the proposed action would be inhibited by these layers.

Implementation of the proposed action would require the construction of vertical fractures from horizontal wellbores for installation of the heating elements. Construction of the fractures would use conventional hydraulic fracturing technology which is commonly used in oil and gas field development, including fracturing associated with horizontal well segments. Fracturing operations would be confined solely to the wells supporting the heating elements. Fracturing would not be used in the completion of any other wells, including the shale oil production wells. The fracturing fluids would consist largely of calcined coke and Portland cement. These materials would be confined to the generated fractures, which are designed to extend up to 75 feet vertically above and below the horizontal well bore segment. The fractures would thus be confined within the lower portion of the Saline Zone. The top of the EM target zone of interest (top of the R-4 zone) would be located approximately 800 feet or more vertically below the closest USDW.

Cumulative Effects: For surface water, the cumulative effects analysis area is the Yellow Creek watershed, an area of 168,931 acres. Past and present analyzed surface disturbing activities

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within the CEAA are estimated to equal 4,098 acres (2.4 percent). Disturbance from foreseeable actions is estimated to be 1,155 additional acres (0.7 percent). For ground water, the CEAA is the combined Yellow Creek-Piceance Creek watershed, an area of 589,825 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 15,810 acres (2.6 percent). Disturbance from foreseeable actions is estimated to be 3,447 additional acres (0.7 percent) (**Table 3.3**). Impacts to surface water from the NS proposed action are not anticipated. Impacts to surface water from the EM proposed action have a greater potential to result in sediment transport beyond the lease tract as a result of the potential for surface disturbance of up to 70 percent of the tract. This disturbance, up to 112.7 acres, or about 0.07 percent of the Yellow Creek watershed, would incrementally add to disturbance from other past, present, and foreseeable developments in the watershed. The principal mitigation for sediment transport would be compliance with the project stormwater pollution prevention plan (SWPPP). Impacts to ground water resources extending beyond the boundaries of the lease tracts and beyond the direct and indirect effects are not anticipated for either project.

3.5.3 Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the proposed projects would be denied, no direct, indirect, or cumulative project-related emissions would occur and there would be no project related impacts to water resources from either project. Impacts to water quality would result from continuation of existing management actions on the public lands.

3.5.4 Proposed Mitigation

Mitigations would apply equally to both lease tracts.

WATR-1 - Wellpad storage tanks will be surrounded by an impermeable secondary containment structure capable of containing 110 percent of the contents of the largest tank.

3.5.5 Finding on the Public Land Health Standard for Water Quality (Standard 2)

Currently, Yellow Creek and Piceance Creek downstream of the project area are not meeting the classified use standards set by the Colorado Water Quality Control Commission and some segments are on the impaired water list according to section 303(d) of the Clean Water Act. Implementation of the proposed actions in conformance with incorporated design features and additional recommended mitigation measures would be unlikely to affect the impaired stream segments identified in the Affected Environment.

3.6 Vegetation

3.6.1 Affected Environment

Eight vegetation classes occur in the nominated EM and NS oil shale RD&D lease tracts, as delineated and described by the Colorado Vegetation Classification Project (CDOW 1997). Vegetation classes were ground-truthed and modified as necessary in 2011 (HWA 2011a). In general, sagebrush/grass mix and pinyon-juniper/sagebrush are the most common vegetation classes, with pinyon-juniper forest also common. Stands of PJ/sagebrush were generally observed to be less mature than the PJ stands. Pinyon-juniper stands tend to have sparse understories and larger trees, indicating a later success. A summary of observed vegetation classes is indicated in **Table 3.17.**

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Old growth trees are relatively common in late successional stands of the EM and NS lease tracts, characterized by large size and accumulation of mass in the upper branches. The criteria used to differentiate between old growth and mature PJ forest is described in the Forest Management section.

Table 3.17 Vegetation Classes Observed within the NS and EM Nominated Oil Shale RD&D Lease Tracts in 2011

Succession Stage	Vegetation Class	Colorado Vegetation Classification Project Description	Field Observations
Pre-Succession	Commercial	High density urban areas with little vegetation, parking lots, buildings, etc.	Roads and well pads.
	Reclaimed Land	Not included; Added to reflect field observations	Pipelines and reclaimed well pads. Mix of native (seeded) and non-native vegetation; Crested Wheatgrass in some areas.
Early-Succession	Shrub/Grass/Forb Mix	Mixed grass/forb and shrub/grass rangeland.	Very similar to below, but with higher proportion of forbs.
	Sagebrush/ Grass Mix	Co-dominant sagebrush shrubland and perennial Grassland. Principle shrub species include Big Sagebrush and Black Sagebrush. Principle grass species include: Crested Wheatgrass, Bluebunch Wheatgrass, and Blue Gramma.	Needle and Thread grass, Indian Ricegrass, Prairie Junegrass, milkvetches, locoweeds, Cryptantha, Spiny Phlox, buckwheats, asters, Scarlet Globemallow, Prickly Pear Cactus, Snakeweed and Rabbitbrush common.
Mid-Succession	Sagebrush Community	Shrubland principally dominated by ARTR2, ARNO4, and/or ARFI2. Often associated with Rabbitbrush (CHNA2), Bitterbrush (PUTR2), Broom Snakeweed (GUSA2), various grasses, and mixed cacti. Greasewood (SAVE4), Serviceberry (AMAL2 or AMUT), Snowberry, or Winterfat (KRLA2) may also be present as secondary species.	Spineless Horsebrush (TECA2) also common.
	PJ- Sagebrush Mix	Co-dominant woodland and shrubland. Woodland consists of Pinyon Pine and Utah Juniper or Rocky Mountain Juniper at densities just above 25%. Big sagebrush grows in the interspaces between the trees and may comprise at least 25% cover.	Generally immature stands of PJ.
Late-Succession	PJ- Mountain Shrub Mix	Co-dominant deciduous/coniferous woodland. Conifer species are Pinyon Pine and Utah or Rocky Mountain Juniper. Deciduous tall shrubs are dominated by Gambel Oak, Mountain Mahogany, Serviceberry, and Sagebrush.	Antelope Bitterbrush and Snowberry common in understory.
	Pinyon- Juniper	Coniferous woodland principally co-dominated by Pinyon Pine (PIED) and Utah Juniper (JUOS) or Rocky Mountain Juniper (JUSC2). Understory is sagebrush, mixed mountain shrubs, or	Relatively sparse understory of native grasses and forbs (Indian Ricegrass, Needle and Thread grass, Bluebunch Wheatgrass, Cryptanth species).

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Succession Stage	Vegetation Class	Colorado Vegetation Classification Project Description	Field Observations
		grasses, usually at less than 25% cover	

Source: CDOW 1997, HWA 2011a

NS Lease Tract: The vegetation of the NS lease tract is dominated by PJ/sagebrush and sagebrush/grass mix. PJ forest is also common, as indicated in **Table 3.18**.

Table 3.18 Vegetation Class Composition for the NS Lease Tract

Vegetation Class	Acres	Percent of Lease Tract Area
Commercial	6.8	4.3
Pinyon-Juniper	19.6	12.5
PJ-Mtn Shrub Mix	1.6	1.0
PJ-Sagebrush Mix	65.8	42.1
Reclaimed Land	1.2	0.8
Sagebrush Community	1.3	0.8
Sagebrush/Grass Mix	60.1	38.4
TOTAL	156	100

EM Lease Tract: The EM lease tract is dominated by PJ/sagebrush and sagebrush/grass mix. PJ and PJ/mountain shrub mix are also common, as indicated in **Table 3.19**.

Table 3.19 Vegetation Class Composition for the EM Lease Tract

Vegetation Class	Acres	Percent of Lease Tract Area
Commercial	8.5	5.4
Pinyon-Juniper	26.5	17.0
PJ-Mtn Shrub Mix	19.2	12.3
PJ-Sagebrush Mix	49.1	31.5
Reclaimed Land	5.0	3.2
Sagebrush Community	2.4	1.5
Sagebrush/Grass Mix	41.0	26.3
Shrub/Grass/Forb Mix	4.5	2.9
TOTAL	156	100

3.6.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: Vegetation resources would be directly affected by the construction of infrastructure, which differs between the two project areas. Direct effects would involve removal of native vegetation, potentially including old-growth trees, resulting in a loss of habitat for wildlife. Soil could be removed and/or damaged during the life of the project due to erosion, mixing of soil horizons, compaction, degradation during storage, and/or contamination. Limiting factors affecting revegetation success for affected soils could be exacerbated by blading

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and excavation during construction. This could limit reclamation success, affecting the reestablishment of native vegetation and reducing grazing land available for wildlife and livestock.

Noxious/invasive plant species could become an increased component of plant communities due to ground disturbance and seed dispersing activity in the area. Non-native cheatgrass may be particularly problematic, as this species is capable of invading a variety of habitats, often becoming a dominant species in rangelands throughout the western U.S. (Pellant 1996, Allen and Meyer 2002). While some non-native species can provide nutritious forage for wildlife and livestock, cheatgrass is only palatable for a short portion of the growing season.

Portions of the NS and EM lease tracts where vegetation would be removed would be reverted to an early succession stage following development. The general trend of succession in PJ ecosystems is well understood, with grass/forbs communities being gradually replaced by shrubs, and eventually by trees which can live more than 400 years (Buttery and Gillam 1983, Erdman 1970). In the context of vegetation classes identified in the EM and NS lease tracts, succession following commercial development and reclamation would tend to occur as follows:

Early Succession: Sagebrush/grass mix and shrub/grass/forb mix would tend to occur earlier in succession. Shrubs take longer to establish than grasses and forbs, and would become more dominant towards the later stages of early succession. Species planted during reclamation and weedy species would be dominant during the first few years of succession.

Mid-Succession: Sagebrush and PJ sagebrush mix communities generally occur during mid-succession. Over time PJ trees encroach on sagebrush, and eventually become co-dominant.

Late-Succession: As PJ stands mature, the proportion of the understory dominated by shrubs decreases. Mature/old-growth stands tend to have sparse understories with grasses commonly observed.

While general successional trends are well understood, not all communities progress towards mature PJ forest in the same fashion. Jacobs et al. (2008) found that mature PJ forests occupy landscapes that are distinct from those occupied by immature forests. Moisture gradients and changes in soil across the landscape make certain areas more conducive for PJ forest, while rangeland dominated by sagebrush is more prevalent in other areas. For example, in the Piceance Creek area, drainages and flat plateaus are often dominated by sagebrush, while PJ forest is more commonly observed on rolling hills. Drainages tend to have high densities of basin big sagebrush (*Artemisia tridentata tridentata*) and/or Wyoming big sagebrush (*A.tridentata wyomingensis*) whereas flat upland areas support sparser shrublands dominated by Wyoming big sagebrush. While encroachment of PJ onto rangeland does occur, this has been found to be more common in New Mexico than Colorado (Jacobs et al. 2008). Within the EM and NS lease tracts, a mosaic of sagebrush dominated rangeland and mature PJ forest should be expected to occur in late-succession conditions.

NS Lease Tract: Natural Soda has identified approximately 7.3 acres that would be disturbed, 6.8 acres of which would be long-term disturbance. The area where development will be concentrated (NE quarter of NW quarter of section 35, T1S R98W) has been identified as primarily PJ-sagebrush mix and sagebrush/grass mix (**Table 3.20**), which are both relatively early successional stages. In addition to the proposed 7.3 acres, NS may also develop in areas that have been previously disturbed, and are classified as either commercial or reclaimed

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vegetation classes. Development in areas with pre-existing disturbance, in addition to relatively small acreages of proposed disturbance, would reduce negative effects to vegetation.

Table 3.20 Vegetation Classes Likely to be Disturbed by NS Development

Vegetation Class	Percent	Estimated Acres
Commercial	4.30	0.31
Pinyon-Juniper (PJ)	12.51	0.91
PJ-Mtn Shrub Mix	1.00	0.07
PJ-Sagebrush Mix	42.14	3.08
Reclaimed Land	0.80	0.06
Sagebrush Community	0.80	0.06
Sagebrush/Grass Mix	38.44	2.81
TOTAL	100.00	7.30

EM Lease Tract: ExxonMobil has estimated 112.7 acres of disturbance may occur within the project area, with 52.3 acres being long term. Given that this is the majority (>70 percent) of the project area, it is reasonable to assume that vegetation classes would be impacted proportionally to their occurrence (**Table 3.21**), with PJ/sagebrush and sagebrush/grass mix being most common, and therefore most impacted by infrastructure. Habitat fragmentation may be a concern in the EM portion of development, given the high proportion of land that would be disturbed. Interim and final reclamation measures would attempt to re-establish native vegetation as quickly as possible, minimizing the amount of time that the ecosystem would be disturbed/fragmented. Disturbed forests would remain fragmented for much longer than sagebrush and sagebrush/grass mix, given that PJ trees generally take over 100 years to reach maturity, and at least 300 years to reach old growth (see Forest Section).

Table 3.21 Vegetation Classes Likely to be Disturbed by EM Development

Vegetation	Percent	Estimated Acres
Commercial	5.39	6.07
Pinyon-Juniper (PJ)	16.98	19.12
PJ-Mtn Shrub Mix	12.29	13.84
PJ-Sagebrush Mix	31.47	35.44
Reclaimed Land	3.20	3.60
Sagebrush Community	1.50	1.69
Sagebrush/Grass Mix	26.27	29.58
Shrub/Grass/Forb Mix	2.90	3.27
TOTAL	100.00	112.70

Cumulative Effects: The CEAA is the combined Yellow Creek-Piceance Creek watershed, an area of 589,825 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 15,810 acres (2.6 percent). Disturbance from foreseeable actions is

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estimated to be 3,447 additional acres (0.7 percent) (**Table 3.3**). Implementation of either of the Proposed Actions would incrementally result in additive cumulative effects to vegetation proportional to the approximately 120 acres of direct and indirect effects of each project. Anticipated effects would be similar to those cumulative effects described for soils under both nominated lease tracts.

3.6.3 Environmental Consequences of the No Action Alternative

In the event that the EM an NS lease tracts are not approved, no direct, indirect or cumulative impacts associated with the proposed actions would occur.

3.6.4 Proposed Mitigation

Measures applicable to both lease tracts include:

VEG-1 - Cut trees with a chain saw and/or mechanical shears and cutting brush with a hydro-axe or similar equipment as close to the ground as possible (six inches or less).

VEG-2 - Leave stumps and root balls in place except in areas requiring topsoiling, or as necessary to create a safe and level workspace.

VEG-3 - Shred or chip brush and salvage with topsoil.

VEG-4 - Salvage and replace topsoil to preserve and replace existing seed banks and return organic matter needed for seed establishment to the soil. Protect and preserve topsoil as outlined in the Soils Section.

VEG-5 - Restore pre-construction contours, drainage patterns, and topsoil.

VEG-6 - Prepare a seedbed (scarifying, tilling, harrowing, or roughening) prior to seeding where needed to improve revegetation potential.

VEG-7 - Install and maintain erosion control measures until vegetation becomes established, using certified weed-free materials.

VEG-8 - Seeding methods should be drill seeding to ensure proper seed placement (broadcast seeding will be used only in areas where steep slopes make drill seeding impossible, and seeding rates will be doubled). Recommend seeding between September 1 and March 15.

VEG-9 - Complete drill and/or broadcast seeding prior to redistribution of woody material.

Mitigations indicated in the Invasive, Non-native Species section (following) would also apply to this section.

3.6.5 BMPs

In addition to required mitigations, BLM-recommended BMPs include:

VEG-B1 - Minimize vegetation removal to the extent necessary to allow for safe and efficient construction activities.

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3.6.6 Finding on the Public Land Health Standard for Plant and Animal Communities (Standard 3)

Due to the historic, current, and future development of mineral resources and continued grazing in this area, the overall vegetative cover and productivity is diminished from the potential for this area. While vegetation in areas occupied for life-of-project facilities, including the two proposed oil shale RD&D projects, will be lost, the application of interim and ultimately final reclamation of disturbed lands including the previously occupied by facilities before decommissioning will restore vegetative cover and productivity equal to or better than surrounding landscape, assuming appropriate land management.

Due to the historic, current, and future development of mineral resources and continued grazing in this area, the overall soil productivity is diminished from the potential for this area. While soil productivity in areas occupied for life-of-project facilities, including the two proposed oil shale RD&D projects, will be lost, the application of interim and ultimately final reclamation of disturbed lands including the previously occupied by facilities before decommissioning will restore vegetative cover and productivity to some extent less than, equal to, or better than surrounding landscape, assuming appropriate land management.

NS Lease Tract: For NS' lease tract, vegetative cover and productivity will likely be restored to equal, possibly better than the surrounding landscape due the application of proposed reclamation measures, the commitment to monitor and to respond with additional reclamation measures until bond release, and the limited (6.8 acre) extent of total disturbance for the project.

EM Lease Tract: The EM proposal would disturb 112.7 acres of a 160 acre lease parcel which is slightly over 70 percent of the surface. Within the lease tract, bisected by ephemeral drainages, there is the potential that even with application of the best practices, the reestablishing vegetation of the site would not achieve productivity similar to current conditions. Stormwater protection measures and best soils management and reclamation actions are likely to leave the disturbed sites without excessive erosion or instability, but there is the potential that the effects to soils from disturbance of approximately 70 percent of the lease tract may result in less productive growth media for the plants in comparison to current conditions for some initial period of years. Over time, the soils should improve as growth medium due to added organic matter, pedogenic development, and expanded protective vegetative cover.

3.7 Invasive, Non-Native Species

3.7.1 Affected Environment:

The Colorado Noxious Weed Act (Title 35 Article 5.5, enacted 1996) defines noxious weeds as plant species that are not indigenous to the State of Colorado and which aggressively invade or are detrimental to economic crops or native plants; are poisonous to livestock; are carriers of detrimental insects, diseases, or parasites; or the presence of the plant is detrimental to the environmentally sound management of natural or agricultural ecosystems. This definition applies to species listed by both the state and local governing bodies. Federal agencies are responsible for consideration of invasive species impacts under terms of Executive Order 13112. Numerous species of noxious weeds have been recognized by the Colorado Weed Management Association (CWMA) and are grouped into three categories: Lists A, B, and C (CWMA 2009).

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Species in List A have limited distribution throughout the state, and are designated by the Commissioner for eradication on all county, state, federal, and private land. Many of these species are currently not known to exist in Colorado, but the potential for spread from neighboring states is feasible (CWMA 2009). List B includes species for which a state noxious weed management plan is required to stop their spread. List C includes species that are common in Colorado. Optional programs provide resources to governing bodies that choose to require management of List C species, however, prevention of these weed species is not state-mandated (CWMA 2009). Twenty-two noxious weed species, listed in **Table 3.22**, either occur, or have the potential to occur in the Piceance Basin, based on nearby observation (HWA 2008, 2009).

In support of this analysis, a noxious weed survey was conducted for the NS and EM lease tracts during July 2011 (HWA 2011a). In compliance with the BLM-WRFO standards (BLM-WRFO 2009b, 2011), the survey extended 200 feet from the lease tract boundaries.

In general, weeds were relatively infrequent within the NS and EM lease tracts and surrounding 200-foot buffer survey areas, with a total of seven noxious weed species located. Cheatgrass was common throughout the two survey areas in low densities of approximately 1 percent cover or less. Higher densities were primarily observed around existing and reclaimed well pads and reclaimed pipelines.

In addition to the noxious weed species surveyed, the following non-noxious weedy species were observed: pinnate tansymustard (*Descurainia pinnata*), curlycup gumweed (*Grindelia squarrosa*), Russian thistle (*Salsola tragus*), desert madwort (*Alyssum desertorum*), yellow sweetclover (*Melilotus officinalis*), and lambsquarters (*Chenopodium album*).

Table 3.22 Noxious Weeds with the Potential to Occur in the Piceance Basin.

Noxious Weed	Scientific Name	List Status
Black henbane	*Hyoscyamus niger*	B
Bull thistle	*Cirsium vulgare*	B
Canada thistle	*Cirsium arvense*	B
Common burdock	*Arctium minus*	C
Common mullein	*Verbascum thapsus*	C
Common teasel	*Dipsacus fullonum*	B
Cheatgrass	*Bromus tectorum*	C
Field bindweed	*Convolvulus arvensis*	C
Halogeton	*Halogeton glomeratus*	C
Hoary cress (whitetop)	*Cardaria draba* *C. pubescens*	B
Houndstongue	*Cynoglossum officinale*	B
Knapweed, diffuse	*Centaurea diffusa*	B
Knapweed, Russian	*Acroptilon repens*	B
Knapweed, spotted	*Centaurea maculosa*	B
Leafy spurge	*Euphorbia esula*	B
Musk thistle	*Carduus nutans*	B
Perennial pepperweed	*Lepidium latifolium*	B
Plumeless thistle	*Carduus acanthoides*	B
Salt cedar	*Tamarix* spp.	B
Scotch thistle	*Onopordum acanthium* *O. tauricum*	B
Toadflax, dalmation	*Linaria dalmatica*	B
Toadflax, yellow	*Linaria vulgaris*	B

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NS Lease Tract: The majority of weeds located within the 218-acre NS lease tract survey area were outside of the actual 160-acre lease tract, but within the 200-foot survey buffer. **Table 3.23** identifies noxious weeds that were located during summer 2011 field surveys within the NS lease tract (HWA 2011a). Halogeton, a list C status species, was abundant only near existing well pads. Most other weeds were near access roads and pipelines. Diffuse knapweed, a list B status species, was located near the existing access road, and was not located in the EM lease tract; only the NS lease tract. This species is not widespread in the Piceance Basin, and could be controlled if treated to avoid spreading and monitored closely.

Table 3.23 Noxious Weeds Located within the NS Lease Tract

Noxious Weed	# Occurrences	Estimated Population Size	Occupied Area (m^2)	List Status
Bull thistle	4	<10	70	B
Canada thistle	1	<10	10	B
Halogeton	4	101-300	2,091	C
Diffuse knapweed	2	10-50	104	B
Common mullein	2	51-100	327	C
Cheatgrass	*Present*			C

Source: HWA 2011a

EM Lease Tract: As with the NS lease tract, noxious weeds were concentrated near areas of existing disturbance/development within the 207-acre EM survey area. **Table 3.24** identifies noxious weeds that were located during summer 2011 field surveys within the EM lease tract (HWA 2011a). Halogeton was located on an existing well pad, while other noxious weed species were concentrated along pipelines.

Table 3.24 Noxious Weeds Located within the EM Lease Tract

Noxious Weed	Occurrences	Estimated Population Size	Occupied Area (m^2)	List Status
Bull thistle	3	10-50	30	B
Canada thistle	2	10-50	20	B
Halogeton	3	101-300	1,253	C
Common mullein	1	<10	10	C
Musk thistle	1	10-50	280	B
Cheatgrass	*Present*			C

Source: HWA 2011a

3.7.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: The description of project effects relating to noxious weeds applies equally to both lease tracts.

Surface-disturbance associated with oil shale development within the NS and EM lease tracts will likely increase the potential for invasive/noxious weed populations. Ground disturbance provides an optimal location for weed establishment (Sheley et al. 1996), as weed species typically succeed in areas lacking competition from native plant populations. Furthermore,

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noxious weed seeds can be transported to development sites by heavy machinery and vehicles. Foreign materials used for reclamation such as straw, mulch and seed can also include noxious weed seeds. Even seed certified as "weed-free" is allowed to include a threshold of cheatgrass seed, making it important to seek out seed from trusted providers. Cheatgrass is an especially problematic weed species, as it is capable of invading a variety of habitats (Pellant 1996, Allen and Meyer 2002), including those with minimal disturbance. Invasive/noxious weed considerations would be similar for surface-disturbing activities associated with the EM and NS lease tracts. Diffuse knapweed was found only in the NS survey area, and should be controlled and monitored closely in this lease tract. The proposed monitoring for infestation and application of weed control or eradication measures would decrease the severity of noxious weed impacts associated with development.

Cumulative Effects: The CEAA is the combined Yellow Creek-Piceance Creek watershed, an area of 589,825 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 15,810 acres (2.6 percent). Disturbance from foreseeable actions is estimated to be 3,447 additional acres (0.7 percent) (**Table 3.3**). Noxious weeds present in the NS and EM lease tracts are primarily associated with existing areas of development/disturbance. Such areas of disturbance including those resulting from implementation of either oil shale RD&D project would likely be prone to weed infestations. The extent of infestation and persistence would be dependent on monitoring and treatment as part of future projects and activities within the320 acres of the two nominated lease tracts.

3.7.3 Environmental Consequences of the No Action Alternative

In the event that the EM or NS lease tracts are not approved, no direct, indirect or cumulative effects associated with an oil shale RD&D proposed action would occur.

3.7.4 Proposed Mitigation

Measures applicable to both lease tracts include:

INVA-1 - Project proponents will provide BLM with weed management plans to address treatment from pre-disturbance, the life of the project, and through final abandonment including a summary of methods used to monitor, treat, and report the presence of noxious or undesirable invasive weeds within the project area and surrounding area (i.e., within 200 feet of areas of direct use).

INVA-2 - Revegetate disturbed areas with approved, weed free seed mixes. To reduce the need for repeated bare ground herbicide treatments around facilities, apply alternative methods such as gravel, weed barrier fabric, or low-growing, disturbance-tolerant herbaceous vegetation as approved by the BLM.

INVA-3 - Conduct pre-construction field surveys prior to construction to identify existing noxious weed infestations within the lease tracts.

INVA-4 - Require vehicles and equipment to arrive at the work site clean, power-washed, and free of soil and vegetative debris capable of transporting weed seeds or other propagules.

Mitigation VEG-7 would also apply to this section.

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3.7.5 BMPs

In addition to required mitigations, BLM-recommended BMPs include:

INVA-B1 - Keep all disturbed areas as free of noxious weeds and undesirable species as practicable during drilling, production, and reclamation operations. Diffuse knapweed should be monitored particularly closely. Ensure that weed treatments are conducted in an effective manner compatible with approved seed mixes.

INVA-B2 - Consult with BLM and local weed agencies to develop treatment strategies for noxious weed infestations identified during surveys.

3.8 Special Status Animal Species

3.8.1 Affected Environment

The potential for occurrence of special status species is equally probable on either proposed lease tract.

Threatened and Endangered Species**:** No threatened or endangered animal species listed under the Endangered Species Act (ESA) are expected to occur within the NS or EM lease tracts (http://www.fws.gov/mountain-prairie/endspp/CountyLists/Colorado.pdf updated July 2010).

However, four fish species are federally listed as endangered within the Upper Colorado River Basin and its tributaries. Withdrawals of water from the surface or ground waters within the Basin have been determined to negatively impact these species. All four species are native to the Upper Colorado River Basin, where they were once abundant. They all inhabited the larger channels of the Colorado River and its major tributaries (BLM 2007). The White River below Rio Blanco Lake is designated critical habitat for Colorado pikeminnow populations that are currently confined to the river below Taylor Draw dam (BLM 1999). The Proposed Action is separated from the White River's critical habitat by roughly 3 miles of ephemeral channel and 13 valley miles of Piceance Creek, and from occupied pikeminnow habitat by an additional 26 miles of river. The endangered bonytail, humpback chub, and razorback sucker do not occur in Colorado portions of the White River, but water depletions in the White River system may affect downstream habitats occupied by these species in the Green River.

Bonytail habitat is primarily limited to narrow, deep, canyon-bound rivers with swift currents and whitewater areas (BLM 2007, Upper Colorado River Endangered Fish Recovery Program 1999). With no known reproducing populations in the wild today, the Bonytail is thought to be the rarest of the endangered fishes in the Colorado River system.

Colorado Pikeminnow were once abundant in the main stem of the Colorado River and most of its major tributaries in Colorado, Wyoming, Utah, New Mexico, Arizona, Nevada, California and Mexico. Now, they exist primarily in the Green River below the confluence with the Yampa River, the lower Duchesne River in Utah, the Yampa River below Craig, the White River from Taylor Draw Dam near Rangely downstream to the confluence with the Green River, the Gunnison River in Colorado, and the Colorado River from Palisade, downstream to Lake Powell. Biologists believe Colorado pikeminnow populations in the upper Colorado River basin are now relatively stable and in some areas may even be growing (BLM 2007).

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Humpback Chub live primarily in canyons with swift currents and white water. Historically, it inhabited canyons of the Colorado River and four of its tributaries: the Green, Yampa, White and Little Colorado Rivers. Now there are two populations near the Colorado/Utah border—one at Westwater Canyon in Utah and one in an area called Black Rocks, in Colorado. Though now smaller in number than they were historically, the two populations seem to be fairly stable in these two areas (BLM 2007).

Razorback Sucker is an omnivorous bottom feeder and is one of the largest fishes in the sucker family. Adult habitat varies depending on season and location. This species was once widespread throughout most of the Colorado River Basin from Wyoming to Mexico. Today, Colorado River Basin populations are only found in the upper Green River in Utah, the lower Yampa River in Colorado, and occasionally in the Colorado River near Grand Junction (Upper Colorado River Endangered Fish Recovery Program 1999).

BLM Sensitive Species: Although BLM-designated sensitive animal species are not afforded legal protection under the Endangered Species Act (ESA), the BLM and FWS maintain an active interest in their numbers and status. It is BLM policy to manage these species in a manner equivalent to Candidate species to preclude the need for listing under the ESA. Sensitive species in this section include those listed on the Colorado BLM State Sensitive Species List (BLM 2009) for the White River Field Office (**Table 3.25**). Those BLM sensitive species that may potentially be affected by the proposed project are discussed in more detail below. Those species that would not be expected to be affected are not discussed further.

Table 3.25 BLM –Sensitive Species that may Occur within the Lease Tracts

Common Name	Scientific Name
Mammals	
Big free-tailed bat	*Nyctinomops macrotis*
Fringed myotis	*Myotis thysanodes*
Spotted bat	*Euderma maculatum*
Townsend's big-eared bat	*Corynorhinus townsendii*
Birds	
Brewer's sparrow	*Spizella breweri*
Greater sage-grouse	*Centrocercus urophasianus*
Northern goshawk	*Accipiter gentilis*
Amphibians	
Boreal toad	*Anaxyrus boreas boreas*
Great Basin spadefoot	*Spea intermontana*
Northern leopard frog	*Rana pipiens*

Big free-tailed bat habitat includes rocky or canyon country where they roost in crevices on cliff faces or in buildings. Big free-tailed bats can migrate as far north as Canada. The diet largely consists of moths. Although big free-tailed bats are not known to breed in Colorado, they have been documented with acoustic surveys by the WRFO in the Piceance Basin.

Fringed myotis occupy coniferous forests and woodlands at moderate elevations in Colorado. Specific roosting habitats in Colorado include ponderosa pine, pinyon-juniper, and scrub oak. This species is also known to roost in rock crevices, caves, mines, and buildings. Fringed myotis

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are known to hibernate in caves and buildings, and do not make any major annual migrations. Although rare, the species occurs within Rio Blanco County (NDIS 2011), and may use pinyon-juniper snags or crevices on cliffs for roosting within or adjacent to the NS and EM lease tracts. No field work was conducted for fringed myotis in 2011.

Spotted bat habitat includes ponderosa pine of montane forests, pinyon-juniper woodlands, and open semidesert shrublands. Rocky cliffs are necessary to provide suitable roosting habitat, as is access to water. The diet consists of moths, grasshoppers, beetles, and other insects. Spotted bats have not been documented in Rio Blanco County (NDIS 2011), and suitable habitat such as rocky cliffs is not known to occur in the NS and EM lease tracts.

Townsend's big-eared bats may occur in many types of habitat including semi-desert shrublands, but often are found near forested areas including pinyon-juniper woodlands and open montane forests (Fitzgerald et al. 1994). Distribution of this species is most likely determined by the availability of roosts such as snags, caves, mines, tunnels, and crevices (rocks and trees) with suitable temperatures (Clark and Stromberg 1987). This species does not make any major annual migrations. Although uncommon, the species occurs within Rio Blanco County (NDIS 2011), and may use pinyon-juniper snags or crevices on cliffs for roosting within or adjacent to the NS and EM lease tracts. No field work was conducted for Townsend's big-eared bats in 2011.

Brewer's sparrow breeds in landscapes dominated by big sagebrush (*Artemisia tridentata*) throughout the Great Basin and intermountain West and winters in sagebrush shrublands and brush desert habitat in the southwestern United States and northern Mexico (Rotenberry et al. 1999). This species is a summer resident on mesas and foothills of western Colorado and local in lower mountains (NDIS 2011). The breeding season occurs during mid-April through August. They depart breeding grounds in October for their winter range found in southern California through northern Mexico. Brewer's sparrows occur in the North Hatch Gulch project area to the east and although they were not documented during surveys in 2011, they undoubtedly occur in both NS and EM lease tracts.

Greater sage-grouse have undergone a recent status review by the FWS in response to petitions requesting the listing of this species, across its range, under the ESA. A decision was released in 2009 and the sage-grouse was warranted but precluded for listing under the ESA. The greater sage-grouse remains a candidate species. Human activities during the breeding season may disrupt normal use of leks and subsequently affect local breeding success. Populations across the West have declined from historic levels due to a wide range of factors including drought, habitat loss, habitat fragmentation and habitat degradation (Connelly and Braun 1997, Braun 1998, Connelly et al. 2000, Connelly et al. 2004). No sage-grouse leks occur in or within four miles of the lease tracts. The closest active lek is approximately 9 miles east of the NS lease tract. Total attendance (i.e., total males and females) at this active lek has been fewer than 12 birds in recent surveys (personal communication, T. Knowles, CDOW). Large fraction of each lease tract (36% EM, 45% NS) are represented by woodland habitat types which generally are unsuitable sage-grouse habitat (Commons et al. 1999). The configuration of sagebrush communities within both nominated lease tracts are not currently considered appropriate for the support of sage-grouse nesting, brood-rearing, or winter use functions. Although both lease tracts are located within the historic range of greater sage-grouse, neither tract lies within the current over-all range designated by CPW. The closest designated sage-grouse habitat occurs over 6 miles west of the EM lease tract

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Northern goshawks primarily occur in dense, mature forest, but occasionally hunt in nearby open meadows. They tend to select stands with relatively large-diameter trees and high canopy closure for nesting (Siders and Kennedy 1995, Daw et al. 1998) but are documented by WRFO to have nested in 30 meter wide woodland stringers amid extensive chainings in the Yellow Creek watershed . Nesting habitat in the NS and EM lease tracts consist of mature and old-growth pinyon-juniper woodlands. Much of the pinyon-juniper woodlands within the lease tracts could be classified as mature stands (>300 years old). In the WRFO, goshawks typically select stands that display mature characteristics, but do not necessarily select stands that have developed conformation associated with advanced maturity. WRFO has found that stands comprised predominantly of ancient pinyon and juniper are not selected by accipters for nesting, due possibly to inappropriate structure offered by this age class. Goshawks exhibit high nest site fidelity but appear intolerant of surface developments and activities within a territory. Typically, they return to their breeding territories in late March or April and lay eggs in May. Chicks hatch by mid-June, fledge by late July and generally are independent by early September. Goshawks primarily hunt from perches and prey upon a variety of small and medium-sized mammals and birds. Nesting woodland raptors in the NS and EM lease tracts were surveyed in 2011 (HWA 2011). Although potential nesting habitat occurs in the area, no northern goshawk nests were documented within the NS or EM lease tracts in 2011 (HWA 2011).

Boreal toad occurs in wet areas in the vicinity of marshes, wet meadows, streams, beaver ponds, glacial kettle ponds, and lakes within subalpine forests. Boreal toads range from southeastern Alaska to northern Baja California, Utah, and northern New Mexico. The elevation range in Colorado is mainly 8,500 – 11,500 feet (CDOW 2011). Adults often feed in meadow and forest openings near water but sometimes in drier forest habitats. This species congregates near water bodies to breed from mid-May to July, dependent upon seasonal weather and elevation. Larvae metamorphose into small toads from late July through mid-September, mainly in August. The Colorado Herpetofaunal Atlas (CDOW 2011) contains no record of this species in the vicinity of either lease tract. No suitable habitat occurs within the lease tracts and there is no reasonable potential that this species will occur here in the future.

Great Basin spadefoot are found in pinyon-juniper woodlands, sagebrush, and semi-desert shrublands where they utilize permanent and temporary water sources for breeding (NDIS 2011). This species was observed within approximately five miles of the lease tracts near the confluence of Black Sulphur Creek and Piceance Creek in 1973 (CDOW 2011). Although they are locally common where they occur, no recent sightings have been documented within either lease tract. This species requires waters that persist for a minimum of 5 weeks to support metamorphosis. No such water features occur within the lease tracts and it is highly unlikely that Great Basin spadefoots would occur within either lease tract.

Northern leopard frogs usually inhabit areas in or near permanent water with aquatic vegetation, and are found in a wide variety of environments including deserts, plains, woodlands, and mountain meadows. This species occurs throughout North America, except on the West Coast, and generally is found north of the 40th parallel. A member of the true frog family (*Ranidae*), the northern leopard frog is an obligate of permanent water in plains, foothills, and montane zones. Although the Colorado Herpetofaunal Atlas (CDOW 2011) contains no record of this species within either lease tract, northern leopard frogs commonly are found along Piceance and Yellow Creeks, which are approximately 2 to 3 miles east and west of the NS and EM lease tracts (personal communication, H. Sauls, WRFO – BLM).

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3.8.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects:

Threatened and Endangered Animal Species: No threatened or endangered animal species are expected to occur within either lease tract; however, water consumption by both projects and the potential interruption of drainage from the two lease tracts by construction of facilities would result in downstream depletions of Colorado River Basin flows. Cumulative water depletions from the Colorado River Basin are considered likely to jeopardize the continued existence of the Colorado pikeminnow, as well as downstream populations of humpback chub, bonytail, and razorback sucker and result in the destruction or adverse modification of their critical habitat. In 2008, BLM prepared a Programmatic Biological Assessment (PBA) that addressed water depleting activities associated with BLM's fluid minerals program in the Colorado River Basin, but this assessment did not address the OSR process. Average annual water use over the life of the project should be used as the basis for consultations with FWS. The FWS will then prepare a Biological Opinion that addresses water depletions associated with OSR to determine if funding contributions to the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (Recovery Program) is necessary.

A project Biological Assessment (BA) has been prepared and submitted to the FWS. Based upon the analyses of the proposed actions, the determination of effect is "may affect, likely to adversely affect" the four Colorado River endangered fish species. The effect is "may affect, likely to adversely affect" because any depletion from the river basin is considered "likely to adversely affect" and prompts formal consultation. Incorporation of Reasonable and Prudent Measures (contributed funding of recovery program on a proportional basis) has been the mechanism where a jeopardy determination has been avoided. The Service may waive payments for depletions under 100 acre-feet (which is the case for these projects), but this is at their discretion. The Biological Opinion for this project has not been received from FWS.

BLM Sensitive Species: Construction activities associated with building well pads, temporary use areas, roads, pipelines and other facilities would, depending on species, result in the loss or alteration of sensitive species potential habitat within the lease tracts. The effects of these activities would begin with the construction phase and continue through drilling and completion and field operations and until suitable habitat character redevelops after reclamation.

The loss or alteration of habitat would generally be contained to a small geographic area and should have minimal impact on the abundance or distribution of sensitive species in the Piceance Basin. Direct and indirect influences imposed by proposed development of each lease tract are not anticipated to threaten the continued viability of any sensitive species.

Fringed myotis, spotted bat, and Townsend's big-eared bat could be temporarily displaced from foraging habitat due to disruptive activities, but development would have no measurable influence on the abundance or distribution of these species at the scale proposed. Potential long term displacement from potential roosting habitat could occur due to removal of pinyon-juniper. No disturbance is planned in the vicinity of perennial streams or wet meadows, which would reduce potential impact on northern leopard frog and foraging habitat of the three bat species. No perennial water occurs in the project areas and water depletion from the Colorado River Basin (under 100 acre-feet for these projects) will have no effect on habitats within the project areas. Impact on these species could include direct mortality due to crushing by construction

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equipment, reduction of potential bat roosting habitat, and temporary disturbance, displacement and avoidance. Suitable habitat exists outside of both nominated lease tracts and individuals displaced by construction could relocate along or near disturbance areas in adjacent habitat. Impacts from habitat disruption would last until revegetation efforts are successful and native vegetation is reestablished (± 30 years for sagebrush and >200 years for pinyon-juniper).

Based on the proposed development footprints for each project, the direct and indirect loss of sagebrush nesting habitat for Brewer's sparrow would extend to about 7 acres in the NS tract and 39 acres in the EM tract. Impacts to Brewer's sparrow would include the direct removal of habitat, and temporary disturbance and displacement for the length of the operations (15 years for EM). Potential impacts to migratory birds are described in more detail under the migratory bird section.

Across the NS and EM lease tracts, impacts on sage-grouse and sage-grouse habitat in general are expected to be minimal. It is considered unlikely that these lease tracts figured prominently in the historic support of sage-grouse because of the past and current interspersion of sagebrush and woodland habitats.

Although no goshawk nests were documented within the nominated lease tracts (HWA 2011), impacts to potential goshawk nesting habitat would be longer than life-of-project, until successful pinyon-juniper woodland regeneration occurs (200+ years). Avoidance of mature pinyon-juniper habitats would minimize impact to potential goshawk nesting habitat. This would probably avoid only the long term impacts associated with woodland regeneration and not the short term impacts because the areas of woodland stands are likely too small to effectively insulate raptor nests from the proposed disturbance. Potential impact to northern goshawks should be similar to those for all raptor species that are present. Potential effects are described in more detail under the Terrestrial Wildlife section.

NS Lease Tract: NS has identified approximately 7.3 acres that will be disturbed, 6.8 acres of which will be long term disturbance. The area where development would be concentrated (NE quarter of NW quarter of Section 35, T1S R98W) has been identified as primarily pinyon-juniper/sagebrush mix and sagebrush/grass mix (see Vegetation section), which are both relatively early successional stages. In addition to the proposed 7.3 acres, NS may also develop in areas that have been previously disturbed, and are classified as either commercial or reclaimed vegetation classes. The project location has no habitat suitable for fish and no affect on critical fish habitats is anticipated.

EM Lease Tract: EM has estimated 112.7 acres of disturbance may occur within the lease tracts, with 52.3 acres being long term. Areas reclaimed in shrub or pinyon-juniper habitat, which are mid- to late-succession stages, will be incapable of supporting use by wildlife that require these later successional stage habitats for many years (± 30 years for sagebrush and >200 years for pinyon-juniper). Given that this is the majority (>70 percent) of the nominated lease tract, it is reasonable to assume that habitat types would be impacted proportionally to their occurrence (see Vegetation section), with pinyon-juniper/sagebrush (northern goshawk habitat) and sagebrush/grass mix (Brewer's sparrow habitat) being most common, and therefore most impacted by infrastructure The project location has no habitat suitable for fish and no affect on critical fish habitats is anticipated.

Cumulative Effects: The CEAA is the combined Yellow Creek-Piceance Creek watershed, an area of 589,825 acres. Past and present analyzed surface disturbing activities within the CEAA

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are estimated to equal 15,810 acres (2.6 percent). Disturbance from foreseeable actions is estimated to be 3,447 additional acres (0.7 percent) (**Table 3.3**). Implementation of either of the Proposed Actions would incrementally result in additional impacts to special status animal species proportional to the direct and indirect effects of each project.

3.8.3 Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the proposed projects would be denied and construction would not occur on BLM-administered lands, and there would be no impact to threatened or endangered, candidate, or BLM sensitive species.

3.8.4 Proposed Mitigation

Mitigations applicable to both lease tracts include:

SSAN-1 - For raptor species, construction or forest clearing activity from February 1-August 15 would be prohibited, unless a survey indicates that no functional raptor nest sites would be impacted by these activities. No surface occupancy will be allowed within ¼ mile of a goshawk nest [NSO-02] or within 1/8 mile of other raptor species nests [NSO-03].

SSAN-2 - Raptor surveys consistent with the most-current WRFO raptor nest survey protocols will be conducted prior to construction periods during the nesting season. If an active nest is located appropriate WRFO timing stipulations will be applied. A ½-mile timing limitation buffer will be applied to active goshawk nests [TL-01] and a ¼-mile timing limitation buffer will be applied to other active raptor nests [TL-04].

3.9 Migratory Birds

3.9.1 Affected Environment

The description of existing conditions and habitat for migratory birds apply equally to both lease tracts.

The Migratory Bird Treaty Act of 1918 makes it unlawful to pursue, hunt, kill, capture, possess, sell, purchase, or barter any migratory bird, including the feathers or other parts, nests, eggs, or migratory bird products. In addition, Executive Order 13186 (signed in 2001) makes federal agencies responsible for implementing bird conservation principles by ensuring that any federal action evaluates its effects upon migratory bird populations. A variety of migratory birds utilize the vegetation communities within the lease tracts during the nesting period (typical peak May 15 – July 15) or during spring and fall migrations.

Opportunistic sightings of 21 migratory bird species were documented during surveys conducted in the EM and NS lease tracts in 2011 (HWA 2011, **Table 3.26**). Five of the species documented are species of concern identified by the FWS Birds of Conservation Concern (FWS 2008), the Partners in Flight North American Landbird Conservation Plan for the Intermountain West (Rich et al. 2004), or the Colorado Partners in Flight list for Physiographic Area 87 (**Table 3.27**).

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Table 3.26 Opportunistic Sightings of Migratory Bird Species in the Vicinity of the NS and EM Lease Tracts.

Common Name	Scientific Name	Common Name	Scientific Name
American Kestrel	*Falco sparverius*	Mountain Bluebird	*Sialia currucoides*
Ash-throated Flycatcher	*Myiarchus cinerascens*	Mountain Chickadee	*Poecile gambeli*
Black-chinned Hummingbird	*Archilochus alexandri*	Mourning Dove	*Zenaida macroura*
Blue-gray Gnatcatcher	*Polioptila caerulea*	Northern Flicker	*Colaptes auratus*
Chipping Sparrow	*Spizella passerina*	Pinyon Jay	*Gymnorhinus cyanocephalus*
Common Poorwill	*Phalaenoptilus nuttallii*	Red-tailed Hawk	*Buteo jamaicensis*
Common Raven	*Corvus corax*	Turkey Vulture	*Carthartes aura*
Cooper's Hawk	*Accipiter cooperii*	Vesper Sparrow	*Pooecetes gramineus*
Gray Flycatcher	*Empidonax wrightii*	Violet-green Swallow	*Tachycineta thalassina*
Juniper Titmouse	*Baeolophus ridgwayi*	White-breasted Nuthatch	*Sitta carolinensis*
Long-eared Owl	*Asio otus*		

Table 3.27 Migratory Bird Species of Concern Documented in and within 300 Meters of the Lease Tracts.

Common Name	Scientific Name	Common Name	Scientific Name
Gray Flycatcher	*Empidonax wrightii*	Pinyon Jay	*Gymnorhinus cyanocephalus*
Mountain Bluebird	*Sialia currucoides*	Juniper Titmouse	*Baeolophus ridgwayi*
Black-chinned Hummingbird	*Archilochus alexandri*		

Surveys for nesting raptors were conducted in and within 300 meters of both lease tracts by Hayden-Wing Associates, LLC on June 2-4, 16-18, and July 2, 2011 (HWA 2011). Broadcast calls were conducted at 40 stations and 840 acres of potential nesting habitat was surveyed (approximately 710 acres were suitable). Three Cooper's hawk nests and one unknown raptor nest were found during these surveys. One Cooper's hawk nest was active, one was visited and the remaining two nests were inactive. Three of the four nests are located in the southeast corner of the EM tract. These nests are located within 240 m of each other and likely represent a single nesting territory. The fourth nest is located approximately 179 m north of the NS lease tract. The majority of the survey area is flat, with patches of mature pinyon-juniper interspersed with sagebrush. Immature pinyon-juniper and sagebrush are co-dominant along transition zones between these two habitat types. Portions of the survey area consist of non-wooded habitat including sagebrush steppe, well pads and pipelines. No suitable cliff-nesting habitat occurs within 0.25 miles of the proposed development.

3.9.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: Direct and indirect impacts to migratory birds would result from the disturbance from construction and operation. Construction activities associated with building well pads, staging areas, roads, pipelines, power lines and other facilities would result in the loss or alteration of migratory bird breeding and foraging habitat within NS and EM lease tracts. Approximately 7.3 acres in the NS lease tract and 112.7 acres in the EM lease tract will be

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disturbed during construction and operation. Disturbance in the NS lease tract will include approximately four acres of pinyon-juniper habitat and less than three acres of sagebrush habitat. Disturbance in the EM tract will include approximately 68 acres of pinyon-juniper habitat and 31 acres of sagebrush habitat. Sagebrush habitat would require >30 years to reestablish, and pinyon-juniper from 100 to 300 years to return to pre-disturbance conditions. Impacts include disturbance to nesting individuals and displacement of birds that may result in abandonment of nests, deterring birds from nesting in the immediate vicinity, or destruction of nests.

Activities associated with construction of well pads, staging areas, roads, power lines and pipelines would increase effects of noise and human presence in the area and would likely be a primary cause for avoidance of the area by migratory birds during the RD&D phase. The effect of increased human presence and noise during the high intensity construction phase would be expected to be more pronounced than during the longer reduced-activity production phase. Sensory (noise) disturbance associated with construction is expected to result in avoidance of the construction site by migratory birds for the duration of the RD&D phase

The effects of these activities could begin with the construction phase and could continue through drilling and completion and operations until successful regeneration of habitats occur. Under natural succession, migratory bird habitat within the lease tracts would require extended periods of time to reach composition and successional stage comparable to existing conditions (see Vegetation section). Pinyon pine may require–200 years to reach maturity. These trees commonly reach 400 years of age and can exceed 500 years of age (Eisenhart 2004, Floyd et al. 2004). Reestablishment of sagebrush species may take 50-120 years for the arid-adapted Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) sub-species common to the lower elevations of the nominated lease tracts (Baker 2006). Mature pinyon-juniper including old-growth stands would be avoided and maintained in their entirety wherever possible.

Raptors often perch or nest on transmission towers or poles and accidental contact with lines can injure or electrocute birds. Electrocution occurs with fleshy parts such as wrists, feet or other skin make contact with energized parts. Raptor protection from power lines can be mitigated by providing adequate clearances to accommodate a large bird between energized and/or grounded parts (FWS 2005).

NS Lease Tract: NS has identified approximately 7.3 acres that would be disturbed, 6.8 acres of which would be long term disturbance. The dominant vegetation of the NS tract is PJ/sagebrush, sagebrush/grass mix and pinyon-juniper forest (See Vegetation section). These habitat types provide foraging, roosting, and nesting habitat for a variety of migratory bird species. If vegetation clearing coincides with the nesting season, direct loss of nests with eggs or young would occur. However, short-term disturbance of vegetation clearing should have no measurable impact on the abundance or distribution of migratory birds in the Piceance Basin or at the regional scale, i.e., the range of any particular species.

EM Lease Tract: EM has estimated 112.7 acres of disturbance may occur within the nominated lease tract, with 52.3 acres being long term. Areas reclaimed in shrub or pinyon-juniper habitat, which are mid- to late-succession stages, will be incapable of supporting use by migratory birds that require these later successional stage habitats for many years (> 30 years for sagebrush and >200 years for pinyon-juniper. Given that this is the majority (>70 percent) of the lease tract, it is reasonable to assume that habitat types would be impacted proportionally to their occurrence (see Vegetation section), with pinyon-juniper/sagebrush and sagebrush/grass mix being most

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common, and therefore most impacted by infrastructure. These habitat types provide foraging, roosting, and nesting habitat for a variety of migratory bird species. If vegetation clearing coincides with the nesting season, direct loss of nests with eggs or young would occur. However, short-term disturbance of vegetation clearing should have no measurable impact on the abundance or distribution of migratory birds in the Piceance Basin or at the regional scale, i.e., the range of any particular species.

Cumulative Effects: The CEAA is CPW Game Management Unit 22, an area of 632,894 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 16,771 acres (2.6 percent). Disturbance from foreseeable actions is estimated to be 3,632 additional acres (0.6 percent) (**Table 3.3**). Implementation of either of the Proposed Actions would incrementally result in additive impacts to migratory bird species proportional to the approximately 120 acres of direct effects of each project.

3.9.3 Environmental Consequences of the No Action Alternative

Under this alternative, the proposed project would be denied, construction would not occur on BLM-administered lands, and there would be no project-related effects.

3.9.4 Proposed Mitigation

Impacts to migratory birds would be reduced by implementing the following measures for both lease tracts:

MIGR-1 - For all non-raptor migratory birds, ground or vegetation disturbing activity will be avoided to the extent possible during the nesting season (May 15 – July 15).

MIGR-2 - To prevent raptor electrocutions when constructing powerlines, provide adequate clearances to accommodate a large bird between energized and/or grounded parts. It is recommended to use 60 inches of horizontal separation and 48 inches of vertical separation. If adequate clearances cannot be accomplished, covering or insulating phases or grounds is recommended. In addition, perch inhibitors may be used where clearances or cover cannot be used.

Special status animal species mitigations SSAN-1 and SSAN-2 also apply to this section.

3.10 Terrestrial Wildlife

3.10.1 Affected Environment:

The description of affected environment applies equally to both nominated lease tracts.

A variety of wildlife habitats and their associated species occurs in the NS and EM lease tracts. Each habitat type provides food, cover, and shelter for mammal, bird, amphibian, and reptile species that occur in northwest Colorado. Although all of the species are important members of native communities and ecosystems, most are common and have wide distributions within the state and region. Small mammal populations are poorly documented; however species likely to occur in the lease tracts display broad ecological tolerance and are widely distributed throughout the Great Basin and/or Rocky Mountain regions. No narrowly distributed or highly specialized species or sub-specific populations are known to occur within the lease tracts or adjacent lands within the analysis area. Perhaps the most specialized small mammal species that occur in the

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analysis area are those associated with rocky slopes and mature pinyon-juniper forest such as the pinyon mouse and bushy-tailed woodrat.

Of the variety of species present within an area, the BLM places management emphasis on certain species of value specific to locations within BLM-administered federal lands. The primary wildlife issues in relation to the proposed surface disturbance activity by NS and EM are potential impacts to big game winter range and raptor nesting areas. BLM sensitive species are discussed under the Special Status Animal Species section above.

Big Game: Elk and mule deer are the two big game species of concern for which potential impacts to individuals and their habitats, particularly winter habitat, are the focus of the analysis. We note that elk are of less concern within the context of managing human/ungulate interaction in the Piceance Basin than are mule deer. Although elk occur within the lease tracts, there is no known resident population. Much of the Piceance Basin is classified as elk summer and winter range. All of the NS and EM lease tracts are classified as elk winter range, but elk severe winter range areas do not overlap these lease tracts. No specific elk migration route or highway crossing has been identified within the lease tracts, but elk presumably migrate from higher elevation to lower elevation along Piceance Creek in the winter.

Research on elk/human interaction has shed light on several responses that could be expected in the NS and EM lease tracts during both construction and life-of-project phases of the Proposed Action. Elk generally tend to avoid infrastructure, such as roads, that channels human activity, and show strong selection for habitat features that provide security cover (Edge and Marcum 1985, Morrison et al. 1995, Rowland et al. 2000, Preisler et al. 2006). Elk have been shown to respond to human activity by modifying the size of the home range, shifting the home range away from human activity, moving long distances, and making complex movements (Webb et al. 2011a, 2011b). Some research has suggested negative demographic consequences associated with infrastructure development and associated human activity (Friar et al. 2008), while other research has shown that elk can adapt to infrastructure development and human activity associated with energy development (Dzialak et al. 2011, Webb et al. 2011b). It is important to note that, although 624 new wells were drilled during the period over which Dzialak et al. (2011) and Webb et al. (2011b) conducted their study, most energy-related infrastructure in the study area was developed before their study began. Although elk in that area have persisted at high numbers (Vitt 2007), behavioral and demographic responses of elk to initial development phases are undocumented. Another distinction between the study area of Dzialak et al. (2011) and Webb et al. (2011b) and NS and EM lease tracts discussed herein is that their previous work occurred throughout predominately private land versus the predominantly publicly-managed landscape in and around the NS and EM tracts.

Mule deer occur throughout the Piceance Basin and the NS and EM lease tracts. Important winter range habitat includes sagebrush-steppe, mountain shrub, agricultural areas, and pinyon-juniper or pine woodlands below 7,500 feet (Watkins et al. 2007). The winter diet is a diverse combination of browses, forbs, and cool-season grasses, with browses increasing in importance as snow accumulates (Hansen and Dearden 1975, Wallmo and Regelin 1981). Historically, the Piceance Basin has supported some of the highest mule deer densities in Colorado (NDIS 2011). Management of mule deer in the White River Field Office area aims to maintain habitat conditions sufficient to support a minimum of 24,900 mule deer in the Piceance Basin during winter (BLM 1997), with the larger objective of sustaining big game populations at levels commensurate with multiple use objectives and State-established population objectives. The NS

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and EM lease tracts are located within CPW Game Management Unit #22. CPW has designated Piceance Creek Road (CR 5) as a mule deer highway crossing area, which is 3–4 miles to the east of the nominated lease tracts. The NS and EM lease tracts are classified as mule deer winter range, and are also classified as severe winter range – a specialized component of winter range that periodically supports virtually all of an area's deer under the most severe winter conditions (i.e., extreme cold and heavy snow pack) (deVergie 2011). According to White River RMP stipulations, no surface-disturbing activity is allowed within mule deer severe winter habitat between December 1 and April 30 (BLM 1997). No specific mule deer migration route or highway crossing has been identified within the lease tracts, but mule deer presumably migrate from higher elevation to lower elevation along Piceance Creek in the winter. Mule deer also migrate west into the Piceance Basin from the Flat Tops Wilderness in the fall.

The issues surrounding mule deer conservation and energy development include potential demographic consequences of: 1) habitat loss or fragmentation, 2) behavioral responses such as displacement and changes in resource selection, 3) physiologic stress, and 4) secondary effects such as vehicle strikes (WAFWA 2010). Mule deer, like elk, tend to show general avoidance of human activity (*sensu* Rost and Bailey 1979, Freddy et al. 1986). Published information bearing directly on the interaction between mule deer and energy development comes from two areas – the Pinedale Anticline in western Wyoming *(*i.e., the Mesa; Sawyer et al. 2006; 2009, Sawyer and Nielson 2010) and Raton Basin in southern Colorado (Webb et al. 2011c, Van Dyke et al. 2012).

In western Wyoming, mule deer altered resource selection in developed areas and generally selected to be far from infrastructure associated with energy development (Sawyer et al. 2006, 2009). Abundance of mule deer in developed areas, as well as across the herd unit that encompassed those areas, declined over the course of the observation (Sawyer and Nielson 2010). Sawyer and Nielson (2010) note that assigning causes to the observed decline remains difficult, but they speculate reasonably that energy development could affect population performance if the observed behavioral responses cascade to demographic consequences.

In southern Colorado, Webb et al. (2011c) found that mule deer tended to avoid roads, but used habitat near producing well pads more frequently than expected. They found that the response of deer to infrastructure was dampened relative to the response of elk – a finding that is in contrast to previous work that showed that deer generally avoided human activity to a greater extent than elk (Rost and Bailey 1979). Van Dyke et al. (2012) found that mule deer occupied habitat directly adjacent to producing wells and suggested that, in southern Colorado, mule deer demonstrated the behavioral capacity to habituate to habitat modifications and other environmental changes associated with development for the extraction of energy resources. Vitt (2007) noted that mule deer numbers in the Data Analysis Unit in the Raton Basin declined, stabilized, and then increased slightly during the period of observation (1993-2006). Vitt (2007) noted that habitat modification as a consequence of this form of energy development was a concern, but that trends in the deer population were not explained by changes in the intensity of energy development. As in other areas where mule deer are in decline (*sensu* Ellenberger and Byrne 2011), Vitt (2007) noted that competition with increasing elk herds, habitat maturation, and other human activities were also issues of concern for long-term mule deer population trends.

While neither area, the Anticline nor Raton Basin, offers a perfect reference for expectation in Piceance, observations from both areas would be expected to be useful in informing judgment as

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to the potential impact of the NS and EM Proposed Action on mule deer. One factor that figures prominently in any effort to reconcile the different and, in some ways, contradicting observations on mule deer between the Anticline and Raton Basin is habitat. The Anticline is characterized by sagebrush and sagebrush-grassland steppe, whereas Raton Basin is characterized by rugged topography and steep slopes dominated by juniper, pine, and fir forest interspersed with mountain shrub and grassland communities. Topography and vegetation have been shown to ameliorate the effects of disturbance on ungulates (Edge and Marcum 1991; see below). If habitat plays a role in mediating mule deer response to human activity, it would be important to note here that the lease tracts and Raton Basin have several habitat features in common, whereas the Anticline differs substantially from these areas. Another important consideration, as mentioned above, is public access. In Raton Basin, public access was controlled by landowners. A defining feature of the Raton Basin landscape is spatial and temporal heterogeneity in local-scale land access and human activity arising from different, and even competing, land-use priorities among land owners. This contrasts with the publicly accessible landscape within which the NS and EM tracts occur. If public access in Piceance is distributed across the landscape in a relatively homogeneous way, then observations on the impact of human activity in places where access is more heterogeneous (such as Raton) would be excepted to carry less weight in terms of what to expect in Piceance. Ongoing research conducted by CPW would be expected to generate quantitative information bearing on these general observations.

Raptors: The mature pinyon-juniper woodlands , sagebrush communities, rock outcrops, and snags located in and within ¼ mile of the lease tracts provide potential nesting substrate and foraging habitat for great horned and long-eared owls, northern harriers, northern goshawks, Cooper's hawks, sharp-shinned hawks, red-tailed hawks, and American kestrels (Kingery 1998). Generally, raptors return to areas in which they have nested in the past, often using the same nesting territories. Nesting activities may be initiated in mid-February to late-April depending upon species. Nest occupation continues until chicks are fledged, which usually occurs from early June to mid-August. Raptor nesting is known to occur in suitable habitat within and adjacent to the lease tracts.

Surveys for nesting raptors were conducted in and within 300 meters of both lease tracts by Hayden-Wing Associates, LLC on June 2-4, 16-18, and July 2, 2011 (HWA 2011). Broadcast calls were conducted at 40 stations and 840 acres of potential nesting habitat was surveyed (approximately 710 acres were suitable). Three Cooper's hawk nests and one unknown raptor nest were found during these surveys. One Cooper's hawk nest was active, one was visited and the remaining two nests were inactive. The four raptor nests located within the survey area tended to be near patches of old growth forest. The majority of the survey area is flat, with patches of mature pinyon-juniper interspersed with sagebrush. Immature pinyon-juniper and sagebrush are co-dominant along transition zones between these two habitat types. Portions of the survey area consist of non-wooded habitat including sagebrush steppe, well pads and pipelines. No suitable cliff-nesting habitat occurs within 0.25 miles of the proposed development. Because nests in functional condition have the potential to be active in any given year, inactive raptor nest sites may be used in subsequent years. Eagles and their nests are protected from take or disturbance under the Bald Eagle Protection Act (16 USC §669 et seq.); inactive nests of other raptor species can conditionally be removed within the context of the Migratory Bird Treaty Act (16 USC, § 703 et seq.) (inactive nests), but removal of habitat supporting functional sites is not consistent with the White River RMP or CPW raptor management guidelines. .

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3.10.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: Sources of potential impacts to wildlife individuals and habitat that may be affected by the proposed project include the construction of access roads, pipelines (gathering system and flow lines), and well pads; the drilling of wells on each well pad, and the operation, monitoring, and maintenance of project facilities for the life-of-project. The potential impacts remaining following the application of mitigation measures to big game, particularly mule deer, and to raptors are addressed in this section.

Habitat loss: Impacts on big game and raptor species and their habitats would vary depending upon the requirements of each species and the undisturbed habitat present in the vicinity. Development activities could affect wildlife through disturbance, displacement, and mortality. A primary impact to wildlife would be the removal of existing vegetation and the resulting loss of cover, nesting, and foraging habitat. The degree of impact would depend on the type of habitat affected and the rate that vegetation would regenerate after application of reclamation measures. Herbaceous vegetation would likely reestablish within one to two years and big sagebrush-dominated communities would likely return to their pre-construction condition within 20 to 75 years following interim or final reclamation and successful control of noxious weeds. Mature pinyon-juniper woodlands would take from 100 to 300 years to return to pre-construction conditions following initial establishment. Tree recruitment may be limited during the first 50 years, which would add to the estimated time to reach maturity (Goodrich and Barber 1999).

Displacement: Development activities would also result in the displacement or avoidance of big game and raptor individuals from areas within or adjacent to areas of development activity. Reproductive success and nutritional condition could decrease due to increased energy expenditures that result from physical response to disturbance. In publicly accessible sage-steppe habitat, Sawyer et al. (2006, 2009) observed displacement of mule deer from areas undergoing energy development with no indication of re-occupancy of abandoned areas.

Big Game: Impacts to big game would include the loss of forage and protective cover, the mortality of individuals from vehicle strikes and poaching, and the displacement of individuals and groups from disturbed former habitat and from portions of the lease tracts where human activity and use of vehicles and equipment occurs.

Although there would be an extended period of loss for protective cover for elk and mule deer within the lease tracts, final and interim reclamation measures would be applied following construction to the lease tracts leaving a total of approximately 63.4 acres of residual disturbance for life-of-project production phase activities. Increased herbaceous cover in recently reclaimed areas would provide an offsetting or supplemental source of seasonal forage for wildlife in the short-term (Van Dyke et al. 2012). The residual disturbance would consist of roads and un-reclaimed portions of well-pads. In addition to BLM standard seed mixes to be applied as part of required mitigation (see Vegetation section), site-specific seed mixes that optimize restoration of big game forage are likely to be required, particularly for reclaimed pipeline ROWs where attracting big game to reclaiming ROWs would not conflict with vehicle activity and potential for collisions. Protective cover would be lost for an extended period of time, beyond life-of-project for the NS and EM lease tracts, but such cover exists on adjacent habitat and, depending on avoidance response, is available for use by affected animals.

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In the NS and EM lease tracts, behavioral responses by more adaptive and mobile elk such as changes in space use and movement could be expected but should not adversely affect local populations, provided that sufficient security cover remains available and measures are taken to minimize vehicle collisions and resultant mortality. Effects on less adaptive and more localized mule deer may be of greater consequence, particularly during periods of occupancy of severe winter range during severe winter conditions.

Increased traffic volume on roads within and near the NS and EM lease tracts could increase the frequency of vehicle strikes on elk and deer, particularly during construction and drilling phases. Increased human presence and improved road access within the NS and EM lease tracts could also result in increased poaching. These potential impacts would likely be greatest during the project implementation, but would remain for the life-of-project.

CPW began a mule deer study in the larger Piceance Basin in 2007 in areas that have shown heavy use of mule deer during critical winter months (CDOW 2011). They deployed GPS collars to estimate density, habitat use and movement patterns of female mule deer. They will also estimate fawn survival, female body condition and implement small scale habitat improvements. The NS and EM lease tracts are within the Ryan Gulch study area, which is one of the four study areas for the CPW project. Ryan Gulch is also being studied to identify deer behavioral responses to varying levels of development activity and to identify Best Management Practices for future application, although these are geared toward oil and gas which involves a different form of development activity. Radio-collared deer may use the NS and EM lease tracts, especially during the winter months based on previous CPW mule deer winter range estimates. The CPW study is expected to run through 2017 (possibly into 2019) and is intended to provide the information necessary to develop and implement a strategy designed to better balance future development in the NS and EM lease tracts with long-term sustainability of the mule deer herd.

Overall, the proposed actions for both NS and EM can be expected to affect big game behavior, elk to a lesser extent than mule deer because mule deer show strong fidelity to smaller areas. Considering the relatively limited extent of both Proposed Actions, mitigation efforts, and the CPW monitoring/habitat enhancement study, the Proposed Actions are not expected to have long-term population impacts of consequence. Importantly, the CPW study involves monitoring behavioral and demographic responses of mule deer to ongoing energy development and is expected to provide the information necessary to determine whether conservation intervention is necessary.

Raptors: Proposed activities and surface disturbance associated with either project would be capable of compromising the integrity of suitable woodland raptor nest habitat and removing nest substrate in the long term and disrupting prospective or ongoing nest efforts. Other potential forms of direct impact include mortality from vehicle collisions and contact with stored fluids that pose a drowning hazard, are toxic, or are capable of compromising the insulative properties of a bird's plumage. Indirect impacts to raptors may also include reduced reproductive performance due to reductions in prey populations.

Project development by NS and EM would disturb habitat for possible raptor prey species. The amount of short-term change in prey base populations created by construction is expected to be minimal in comparison to the overall level of small mammal populations. While prey populations on the NS and EM lease tracts would likely sustain some reduction during the development phase of the project, some prey species (habitat generalists) would be expected to

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respond positively to successful reclamation and easily attain pre-disturbance levels. For most prey species, the effects of the NS and EM Proposed Actions are expected to be localized with changes across the population likely within the range of historic variation. For these reasons, no measurable long-term reduction to the prey base would be anticipated.

NS Lease Tract: Those woodlands best suited for supporting woodland raptor nest activities in the NS lease tract consist of a 27-acre parcel in its east half. This woodland stand is not slated for RD&D development.

The largest contiguous stand of woodland within the proposed development footprint consists of an open-canopied 8-acre parcel that is part of a narrow (average 130 meters wide) 14-acre stand that parallels an existing well access road and pipeline corridor. Stand conditions are considered suboptimal for nesting use and there has been no documented historical use of this woodland stand by raptors. Projections for new surface disturbance within the footprint lie outside this stand and are relegated to fire-disclimax sagebrush communities around its margin that are presently being encroached by pinyon-juniper regeneration. Disclimax shrublands with pinyon-juniper expression, by nature, do not generally persist over timeframes sufficient to develop structure suitable for the support of accipiter nesting use.

The woodland raptor nest located during 2011 surveys (presumed Cooper's hawk) and nearest the NS lease tract is located in the center of a mature 37-acre stand about 170 meters north of the lease line and any anticipated RD&D development. This stand was first known to be occupied by accipiters in 1984. Since then, the stand has been sporadically occupied by accipiters (last known in 1998), great-horned owl, and red-tailed hawk. The degree of nest separation from the EM cluster suggests that this would be a unique Cooper's hawk territory.

EM Lease Tract: Those woodlands best suited for supporting woodland raptor nest activities consist of a 20-acre parcel in the southeast corner of the EM lease tract. All 3 nests found in the course of 2011 surveys and an additional active nest site known from 2008 (same cluster) within the EM tract were located in this mature stand. Woodlands within the stand represent about half of a larger contiguous stand (total of about 34 acres) straddling the lease tract's east boundary that was previously bisected by 2 parallel pipeline corridors (58 meter combined width). Despite the bisect, and based on its documented occupation by a pair of Cooper's hawk in 2008 and 2011, the integrity of the woodland stand as accipiter nest habitat remains intact. About 2.7 acres of the proposed development footprint encroach on the margin of this stand. The remaining 38 acres of woodlands in the lease tract represent suboptimal nest habitat with little likelihood for use in the foreseeable future. Although the stands have components that have the structural potential to serve as nest substrate, they are configured as narrow, open-canopied stringers in a sagebrush matrix or small stands that have been substantially reduced in size or continuity by roads and pads attributable to natural gas development.

Further encroachment on the woodland stand in the southeast corner of the EM lease would be expected to render the stand unsuitable for subsequent use by accipiters.

Cumulative Effects: The CEAA is CPW Game Management Unit 22, an area of 632,894 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 16,771 acres (2.6 percent). Disturbance from foreseeable actions is estimated to be 3,632 additional acres (0.6 percent) (**Table 3.3**). Implementation of either of the Proposed Actions would incrementally result in impacts to terrestrial wildlife species proportional to the approximately 120 acres of direct, as well as indirect effects, of each project.

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3.10.3 Environmental Consequences of the No Action Alternative

Under this alternative, the proposed would not occur on BLM-administered lands, and there would be no project-related effects.

3.10.4 Proposed Mitigation

Required additional mitigation measures include:

NS Lease Tract:

Special status animal species mitigation SSAN-2 would also apply here. The timing limitation stipulation would apply in Township 1 South, Range 98 West, Section 35, NW 1/4 Lot 3 and N 1/2 Lot 4.

EM Lease Tract:

Special status animal species mitigations SSAN-1 and SSAN-2 would also apply here. The NSO stipulation would apply in Township 1 South, Range 98 West, Section 34, Lot 8. The timing limitation stipulation would apply in Township 1 South, Range 98 West, Section 34, S 1/2 Lot 1, E 1/2 Lot 7, Lot 8.

Both Lease Tracts:

WILD-1 - Seed disturbed areas with native seed mixes as discussed in the Vegetation section. Detected weeds or invasive species would be controlled using herbicides and methods approved by WRFO and the RMP. BLM would identify particular seed mixes for seeding portions of the pipeline ROWs where big game forage is to be optimized. Strategic use of reclamation fencing would be required when and where necessary to achieve desired reclamation response (e.g., establishment of desired reclamation components).

WILD-2 - Provide all drivers with information and possible training describing the types of wildlife species in the area that are susceptible to vehicular collisions to reduce the potential for vehicle/big-game or vehicle/raptor collisions. Identify seasonal periods where reduced vehicle speeds would be implemented as a means to reduce potential for vehicle/wildlife collisions.

WILD-3 - Prevent accidental entries or inability of exit of temporary open excavations by wildlife, stock, and public by covering, fencing, sloping or flagging these areas.

WILD-4 - The operator shall prevent migratory bird access to facilities that store or are expected to store fluids which may pose a risk to such birds (e.g., drowning, toxicity, compromised insulation). Features that prevent access to such fluids must be in place and functional at all times until such facilities are removed or incapable of storing fluids. All lethal and non-lethal events that involve migratory birds inadvertently gaining access to fluids will be reported to the USFWS Special Agent in Grand Junction, Colorado (970-257-0795).

WILD-5 - Consistent with the 1997 White River RMP and CPW's 2008 "Actions to Minimize Adverse Impacts to Wildlife Resources", vegetation clearing and high intensity construction operations would not be allowed on big game severe winter ranges from January 1 to April 30 on any of the lease tracts (involves all acreage of each lease tract). Exceptions and modifications may be granted by the WRFO Field Office Manager consistent with those provisions provided for in the 1997 White River RMP.

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3.10.5 Finding on the Public Land Health Standard for Plant and Animal Communities (Standard 3)

Due to the historic, current, and future development of mineral resources and continued grazing in this area, the overall vegetative cover and productivity is diminished from the potential for this area. While vegetation in areas occupied for life-of-project facilities, including the two proposed oil shale RD&D projects, will be lost, the application of interim and ultimately final reclamation of disturbed lands including the previously occupied by facilities before decommissioning will restore vegetative cover and productivity equal to or better than surrounding landscape, assuming appropriate land management.

3.11 Cultural Resosources

3.11.1 Affected Environment

The description of existing conditions relating to cultural resources differs between the two lease tracts.

NS Lease Tract: A Class III cultural resource inventory of approximately 150 acres of the lease tract was conducted by Metcalf Archaeological Consultants in July 2011 (Elkins 2011). An additional 20.5 acres was excluded from survey as it was covered by two prior surveys (OAHP # RB.LM.R1083 and RB.LM.R296).The 2011 survey resulted in the update of one previously recorded historic artifact scatter (5RB5926) and the documentation of two new isolated finds (5RB6758 and 5RB6759). In addition, a previously recorded prehistoric lithic scatter (5RB396) is located within the previously inventoried portion of the parcel. Site 5RB5926 and isolated finds 5RB6758 and 5RB6759 are Officially Not Eligible for the National Register of Historic Places (NRHP) because they lack additional research potential, so no further work is recommended for these sites. Site 5RB396 has been determined Officially Needs Data by the Colorado Office of Archaeology and Historic Preservation (OAHP) because of its potential for buried cultural deposits.

The proposed lease area contains a large amount of existing disturbance mainly from well-used roads and an abandoned well. NS' existing active nahcolite well field is located immediately to the north of the newly proposed lease area, and Rio Blanco County roads RBC 24 and RBC 31 provide access to the lease area from Piceance Creek to the east.

EM Lease Tract: A cultural resource block inventory of approximately 94 acres was conducted in 2011 for this proposed project(Kintz 2011). Two previous inventories (OAHP# RB.LM.R1029 and RB.LM.NR1576) have been conducted in the past that cover the remaining acerage of the lease parcel. The 2011 survey resulted in the recovery of two previously recorded isolated finds(5RB6760 and 5RB6761) within the lease tract area. As isolated finds are categorically Not Eligible for the NRHP, no further work is recommended for these sites.

The proposed lease area is a relatively small area that encompasses the gentle slope of a ridge. There are more suitable areas for prehistoric and historic habitation in the surrounding landscape, as evidenced by higher site densities to the east. Furthermore, the sediments in the lease area are dominated by sandy shale residuum with little potential for buried cultural deposits. Sporadic prehistoric and historic use of the area was likely more common than longer term habitation.

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3.11.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: Potential impacts to cultural resources from the proposed action include potential destruction of identified cultural sites and the possibility of illegal collection activities.

NS Lease Tract: Site 5RB396 must be avoided by any construction activities that occur within the lease area in order to have no effects to cultural resources. Potential adverse affects to site 5RB396 can be avoided by ensuring maintenance of a 100-meter (330-feet) buffer from the site boundary, as recommended by the BLM White River Field Office. Complete avoidance of the 100- meter site buffer will require a relocation of some NS facilities. The site of the relocated facilities would be determined based on consultation between the BLM and NS.

EM Lease Tract: No NRHP-eligible sites have been located within the EM lease tract and there would be no anticipated effects to cultural resources.

Cumulative Effects: No CEAA has been determined for cultural resources. All effects to cultural resources would be avoided by relocating project disturbance, as necessary. As there are no direct or indirect effects from the proposed actions, there would be no cumulative effects.

3.11.3 Environmental Consequences of the No Action Alternative

Should the No Action Alternative be selected, the proposed projects would be denied and there would be no direct, indirect, or cumulative impacts to cultural resources resulting from oil shale RD&D activity.

3.11.4 Proposed Mitigation

Mitigation measures applicable to both lease tracts includes:

CULT-1 - The operator or lessee is responsible for informing all persons who are associated with the project that they will be subject to prosecution for knowingly disturbing archaeological sites or for collecting artifacts.

CULT-2 - If any archaeological materials are discovered as a result of operations under this authorization, activity in the vicinity of the discovery will cease, and the BLM WRFO Archaeologist will be notified immediately. Work may not resume at that location until approved by the AO. The operator or lessee will make every effort to protect the site from further impacts including looting, erosion, or other human or natural damage until BLM determines a treatment approach, and the treatment is completed. Unless previously determined in treatment plans or agreements, BLM will evaluate the cultural resources and, in consultation with the State Historic Preservation Office (SHPO), select the appropriate mitigation option within 48 hours of the discovery. The operator or lessee, under guidance of the BLM, will implement the mitigation in a timely manner. The process will be fully documented in reports, site forms, maps, drawings, and photographs. The BLM will forward documentation to the SHPO for review and concurrence.

CULT-3 - Pursuant to 43 CFR 10.4(g), the operator or lessee must notify the AO, by telephone and written confirmation, immediately upon the discovery of human remains, funerary items, sacred objects, or objects of cultural patrimony. Further, pursuant to 43 CFR 10.4(c) and (d), the operator or lessee must stop activities in the vicinity of the discovery and protect it for 30 days or until notified to proceed by the AO.

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NS Lease Tract: Mitigation measures specific to the NS tract include:

CULT-4 –No new surface disturbance is permitted within T 1S, R 98W, Sec 35 NENE of Lot 4, and T 1S, R 98W, Sec 35 N1/2NW of Lot 3.

3.12 Paleontological Resources

3.12.1 Affected Environment

The description of existing conditions relating to paleontological resources applies equally to both lease tracts.

Surface rocks in the vicinity of the proposed lease tracts are comprised of Unit 5 of the upper portion of the Uinta Formation of Middle Eocene age, and Quaternary alluvial deposits. The Uinta Formation is a potential source of fossil material of scientific importance. The alluvial deposits are generally not considered to be of paleontological significance. In the Piceance Basin, fossils identified from the Uinta Formation include titanotheres, uintatheres, myacid carnivores, turtles, crocodilians, fish, gastropods, insects, and plant remains (Armstrong and Wolny 1989). Surveys conducted for oil and gas development projects in the area have identified various vertebrate and plant fossils in the Uinta Formation (BLM 2007).

BLM Instruction Memorandum 2008-09 revised the method by which BLM characterizes the paleontological potential of rock units on the public lands. The Potential Fossil Yield Classification (PFYC) system rates geologic units based on their potential for containing vertebrate fossils or invertebrate or plant fossils of scientific significance, as well as their sensitivity to adverse impacts. Rock units are assigned numeric values of 1 to 5, with the higher number indicating units of greater concern for protection of fossil resources. The BLM Colorado State Office has determined that the Uinta formation in the area is a PFYC 5 unit, indicating highly fossiliferous strata that consistently produce fossils of scientific importance and that are at risk from human impacts. Management concern for Class 5 formations is high. Typically, pedestrian surveys by a qualified paleontologist prior to commencement of activities which could disturb the formations of interest, and monitoring of excavations of formations of interest, would be required (BLM 2007a).

3.12.2 Environmental Consequences of the Proposed Action

The description of project effects relating to paleontological resources applies equally to both lease tracts.

Direct and Indirect Effects: Development activities within the lease tracts which result in bedrock excavation of rock potentially containing fossils of scientific importance, such as construction of well pads, buried pipelines, and, potentially, roads, could lead to the direct loss of scientific information. Increased human presence in the proposed lease tracts during all phases of the Proposed Actions could increase the potential for illegal collection of fossils. In the event that construction of project components results in increased volumes of storm runoff, increased erosion of drainage channels could result in a faster rate of erosive loss to exposed fossil materials and/or the uncovering of previously buried materials. Mitigation measures associated with implementation of the Proposed Actions could increase the current paleontological knowledge base in the area.

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Cumulative Effects: The CEAA is the combined Yellow Creek-Piceance Creek watershed, an area of 589,825 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 15,810 acres (2.6 percent). Disturbance from foreseeable actions is estimated to be 3,447 additional acres (0.7 percent) (**Table 3.3**). Disturbance of up to 120 acres to the Uinta Formation from direct surface disturbance, as well as indirect effects to local fossils from collection, would incrementally and proportionally add to cumulative effects within the CEAA, which encompasses the bulk of the formation extent within the Piceance Basin.

3.12.3 Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the proposed projects would be denied, and there would be no direct, indirect, or cumulative project-related impacts. Ongoing impacts to paleontological resources would result from continuation of existing management actions on the public lands.

3.12.4 Proposed Mitigation

Mitigations would apply equally to both lease tracts.

PALE-1 - A paleontological monitor will be present prior to and during any excavation into bedrock of the Uinta Formation, at the direction of the BLM.

PALE-2 - The operator or lessee is responsible for informing all persons who are associated with the project operations that they will be subject to prosecution for disturbing or collecting vertebrate fossils, collecting large amounts of petrified wood (over 25lbs./day, up to 250lbs./year), or collecting fossils for commercial purposes on public lands.

PALE-3 - If any paleontological resources are discovered as a result of operations under this authorization, operator or lessee or any of their agents must stop work immediately at that site, immediately contact the BLM Paleontology Coordinator, and make every effort to protect the site from further impacts, including looting, erosion, or other human or natural damage. Work may not resume at that location until approved by the AO. The BLM or designated paleontologist will evaluate the discovery and take action to protect or remove the resource within 10 working days. Within 10 working days, the operator will be allowed to continue construction through the site, or will be given the choice of either (a) following the Paleontology Coordinator's instructions for stabilizing the fossil resource in place and avoiding further disturbance to the fossil resource, or (b) following the Paleontology Coordinator's instructions for mitigating impacts to the fossil resource prior to continuing construction through the project area.

3.13 Visual Resources

3.13.1 Affected Environment

The description of visual resources applies equally to both lease tracts.

Rolling uplands along a ridge top divide between Ryan Gulch and Piceance Creek to the south and east, and Yellow Creek to the north and west comprise the principal landforms in the vicinity of the two nominated lease tracts. The fairly broad ridge line supports varying cover of pinyon-juniper, mountain shrub or sagebrush vegetation, and grasslands with isolated rock outcrops.

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Both lease tracts include areas of active oil and gas and/or nahcolite mining facilities and reclaimed lands.

Views from ridge-top in the vicinity of the two lease tracts present panoramas of wooded ridges and slopes; gulches; and hillsides of shrubs, grasses, and rock exposure that display a mixture of green and gray vegetation and lighter-colored, rocky outcrops. From the valley bottoms of Yellow Creek, Ryan Gulch, and Piceance Creek, neither lease tract is visible, particularly from RBC 5 Piceance Creek Road along Piceance Creek which carries the most traffic. The majority of vehicles using RBC 5, RBC 24, RBC 31, and most likely RBC 83 are a variety supporting oil and gas development and production and to a lesser extent, nahcolite extraction and processing. Other traffic using these roads supports ranching operations and, seasonally, hunting and general dispersed recreation.

The two nominated lease tracts are BLM-administered federal lands that have been classified by the BLM in the RMP as visual resource management (VRM) Class III (BLM 1997). The Class III designation indicates the BLM's management objective for these lands, in terms of level of observed change allowable for an area, is to partially retain the existing character of the landscape by allowing moderate change. Moderate change may attract attention because of contrasting line, form, color, and texture, but it may not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

3.13.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: Visual contrasts, if observed from adjacent ridge tops and from the surrounding creek valleys and county roads, would be introduced by construction of the proposed facilities for both lease tracts, including roads, well and process pads, structures, and pipelines, and by the presence of drill rigs and well completion equipment. However, sight lines to both lease tracts from the adjacent ridge tops, creek valleys, and county roads would be limited due to the dissected terrain, change in elevation, and woodland vegetative cover. Views from segments of RBC 31 and RBC 83, both of which run adjacent to the two lease tracts, could provide sight lines into each lease tract; however the view of project facilities and activity would continue to be somewhat limited by screening of the rolling terrain and prevalent woodland vegetation. The construction of short segments of overhead power line for both projects would create some contrast, but power lines within both lease tracts are already present so contrast from new power lines would be additive but not new.

To lessen contrast, observable surface disturbance would be treated shortly after construction with final reclamation measures in the case of buried pipelines and with interim reclamation measures for access roads and well and process pads. This relatively immediate application of reclamation measures would reduce the visual contrast between new surface disturbance and adjacent undisturbed areas; however, some contrast would remain over time where observable, particularly where disturbance has resulted in the clearing of PJ forest.

NS Lease Tract: During the 15-year life-of-project, both interim and final reclamation of disturbance associated with access roads, well and process pads, and pipelines would reduce the magnitude and extent of contrast from construction and production operations within the 160-acre lease tract. During periods of construction and drilling/completion, equipment and areas of disturbance would create contrast in the short-term; however, interim and final reclamation and

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the absence of construction/drilling equipment would reduce visual contrast in the existing context of variable screening by the existing terrain and forest cover. In addition, the limited extent of actual disturbance and activity within the 160 acre lease tract would likely reduce contrast to an observer looking into the lease tract from near or far. Retention of VRM Class III designation would occur since the project should not dominate the view of a casual observer at distance or from a point nearby.

EM Lease Tract: Anticipated effects on visual resources to result from implementation of the EM proposed RD&D oil shale process within their nominated lease tract would be consistent with those effects described above for the NS lease tract. However, the greater extent of actual disturbance and activity within the 160 acre lease tract could increase contrast to an observer looking into the lease tract from near or far; however, the moderate degree of anticipated contrast following application of reclamation measures should not dominate the view of a casual observer and VRM Class III designation would be retained

Cumulative Effects: The CEAA is the combined Yellow Creek-Piceance Creek watershed, an area of 589,825 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 15,810 acres (2.6 percent). Disturbance from foreseeable actions is estimated to be 3,447 additional acres (0.7 percent) (**Table 3.3**). The increased human activity within the 320 acres of both lease tracts from RD&D activities combined with ongoing oil and gas development, nahcolite extraction, livestock grazing, and recreation (hunting) would incrementally add to the sources of contrast to the casual observer looking into the two lease tracts. Project-associated traffic would temporarily alter the local visual environment within the CEAA.

3.13.3 Environmental Consequences of the No Action Alternative

Direct, indirect, and cumulative effects would not occur should the No Action Alternative be selected.

3.13.4 Proposed Mitigation

Measures applicable to both lease tracts include:

VIS-1 - In consultation with the BLM WRFO Visual Resource Specialist, all above ground facilities will be painted a color selected from the BLM Standard Environmental Color Chart CC-001: June 2008 to blend with the surrounding landscape.

3.14 Fire Management

3.14.1 Affected Environment

The description of existing geology and minerals applies equally to both lease tracts.

The two, adjacent lease tracts are located within a B6-W Yellow Creek fire management polygon as outlined in the 2011 Northwest Colorado Fire Management Plan (BLM 2011a). Characteristic vegetation within B6-W Yellow Creek fire management unit described by BLM mapping consists of pinyon-juniper (PJ) forest, Wyoming big sagebrush, and greasewood (BLM 2011a).

The mature plant communities and relatively dry climate of the Piceance Basin make this area prone to fire, especially during the heat of summer when rains are infrequent and dry

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thunderstorms are common (BLM 2008a). Fires in this area typically move quickly as they gain momentum from the flashy fuels and considerable fuel loads associated with mature undisturbed pinyon-juniper woodland habitats. Fire events play an important role in this type of ecosystem, rejuvenating and maintaining healthy, diverse plant communities. Natural fire probably maintains woodlands at a constant overall acreage, but human interference in this natural cycle through fire suppression has extended the range of these woodlands. Fire suppression has greatly increased fuel buildup and enhanced the maturity and encroachment of shrubs and woodlands, thus producing older age plant communities with decreased diversity in structure and species composition.

The two lease tracts occupy areas (both Category B) where unmanaged wildfire is not desired (BLM 2011a). These are ecosystems where unplanned ignitions could have negative effects on identified resources unless resource constraints can be met or where mitigation can minimize or remove concerns. Fire suppression in these areas is aggressive; however, use of natural fires is not dismissed if suppression tactics could be used such that resource concerns could be mitigated. Negative effects of fire here include risks to private lands and urban interfaces, important cultural resources, areas with unnatural fuel buildups, and areas where the seed bank does not exist for natural reseeding. Mitigation efforts could include fuel reduction through mechanical means or prescribed fire to reduce fuel loading around private land and urban interfaces, creation of agreements to allow fire to cross from public to private lands, cultural resource inventories, preparation of rehabilitation plans prior to a fire event, etc. Once mitigation is in place, Category B areas could move into a C or D category where use of wildfire as a treatment for resource benefit would occur more frequently.

Between 1984 and 2009, there have been 21 recorded wildfires within approximately one mile of the two lease tracts, of which 11 have been recorded since 2000 (BLM 2009). The size of the areas affected by fire among the 21 fires ranged from essentially zero to 8.6 acres. There is no record of lands within either lease tract having burned in the recent past.

3.14.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: The description of project effects relating to fire management applies equally to both lease tracts. The increase of industrial activity from infrastructure construction (roads, pads, and pipelines), well drilling and completions, and RD&D production operations could conflict with the B polygon designation currently assigned to both nominated lease tracts. The two proposed RD&D projects would result in increased human and vehicle activity and location of additional surface facilities within the two lease tracts. Such developmental activity and facilities could restrict BLM's ability to use prescribed fire to achieve land management goals in the vicinity of the two tracts. Increased human and vehicle activity would also add to the risk of accidental fire ignition in the vicinity of the two tracts. Fires started accidentally during the construction, drilling/completion, and operation of either of the two RD&D projects could adversely affect land or resource management objectives for the affected vegetation communities.

PJ forest cover in excess of 50 percent for both lease tracts would be affected by cutting and clearing where proposed facilities including roads, pads, pipelines, and power lines would be located within the forested areas. Trees (diameters equal to or greater than four inches) within the areas to be cleared would be felled and cut up into four-foot lengths for pickup by the public. Tree limbs and woody brush, smaller than four inches in diameter, would be chipped and spread

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as mulch across the ROW. The replacement of the chipped woody debris would not exceed 20 percent ground cover; excess material would be removed from the site. No accumulations of felled trees would be left on or adjacent to the construction zones to create hazardous fuel conditions.

However, hazardous fuel conditions for access roads, well and process pads, and pipeline ROWs could be worsened by vegetation removal, soils disturbance, and opportunities for noxious weeds and cheatgrass to establish on the disturbed lands, thereby increasing fuel loads. Accumulations of dead vegetative material are receptive to fire brands and spotting from wind-driven fires and can greatly accelerate the rate of fire spread. In addition to the previously noted increased risk of accidental fires ignition from increased human and vehicle activity, the accumulation of hazardous fuels in the form of weed/cheatgrass infestation of disturbed lands within the two lease tracts could add to fire control problems in the event of an accidental fire or wildfire.

Accidental fires or wildfires would be aggressively suppressed in the vicinity of the two lease tracts during construction and for the life of either of the two proposed RD&D projects. Any naturally occurring fire in this area would likely be suppressed while small. Areas of mature vegetation communities adjacent to disturbance associated with the two proposed projects' lease tracts would likely continue a decline in diversity of plant species.

Cumulative Effects: The CEAA is the combined Yellow Creek-Piceance Creek watershed, an area of 589,825 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 15,810 acres (2.6 percent). Disturbance from foreseeable actions is estimated to be 3,447 additional acres (0.7 percent) (**Table 3.3**). The increased human activity within the 320 acres of both lease tracts from RD&D activities combined with ongoing oil and gas, nahcolite extraction, livestock grazing, and recreation (hunting) would incrementally add to the risk for accidental fire and increase the presence of facilities that would cause an aggressive fire-fighting response to both accidental fires and wildfires. The increased human presence and activity would not alter the existing planned response of suppression for lands occupied by the two lease tracts.

3.14.3 Environmental Consequences of the No Action Alternative

Direct, indirect, and cumulative effects would not occur should the No Action Alternative be selected.

3.14.4 Proposed Mitigation

None.

3.15 Forest Management

3.15.1 Affected Environment

Pinyon-juniper (PJ) forest is common on the nominated EM and NS RD&D lease tracts, with over 50 percent of the landscape being dominated by forest. The forest is comprised of pinyon (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*). Some relatively immature stands are co-dominant with sagebrush, while more mature stands generally have sparser understories (see Vegetation section). . Old-growth forests and woodlands stands differ in their characteristics from earlier stages of stand development and can in part be characterized by large size and

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accumulation of mass in the upper branches. Other differences include a variety of characteristics such as tree size, accumulations of large dead woody material, number of canopy layers, species composition, and ecosystem function (USFS 1993). The USFS defines old-growth forest as ecosystems distinguished by old trees and related structural features (USFS 1992). BLM has interpreted this definition to mean old-growth is typically distinguished by the following (BLM 2005):

1. Large-size trees of specific species,
2. Wide variation in age classes and stocking levels,
3. Accumulations of large-size dead standing and fallen trees,
4. Decadence in the form of broken or deformed tops and boles,
5. Multiple canopy layers,
6. Canopy interspaces and understory patchiness.

NS Lease Tract: PJ forest comprises 55.5 percent of the NS lease tract. Within this tract's forests, five stands of old-growth were observed in 2011. A single large tree could be considered a stand. Pinyon pine was the dominant species in all stands observed, with few old-growth juniper trees located (**Table 3.28**). The extent to which these patches of forest would be impacted will depend on the exact location of infrastructure.

Table 3.28 Old Growth Forest Observed within the NS RD&D Lease Tract in 2011

Species	Understory	Max Diameter (in.)	Max Height (ft.)	Area (ac.)
Pinyon	grass	27	25	<0.5
Pinyon	shrub	25	32	0.5-1
Pinyon	shrub	25	45	2-5
Pinyon	grass	28	30	<0.5
Pinyon	shrub	26	40	2-5

EM Lease Tract: PJ forest comprises 60.8 percent of the EM lease tract. Within this tract's forests, four stands of old-growth were observed in 2011. Pinyon pine and juniper were co-dominant in all stands observed (**Table 3.29**). The extent to which these patches of forest would be impacted will depend on the exact location of infrastructure.

Table 3.29 Old Growth Forest Observed within the EM RD&D Lease Tract in 2011.

Species	Understory	Max Diameter (in.)	Max Height (ft.)	Area (ac.)
Pinyon and Juniper	shrub	25	30	1-2
Pinyon and Juniper	grass	28	40	5-10
Pinyon and Juniper	grass	23	30	1-2
Pinyon and Juniper	forbs	33	30	2-5

3.15.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: The description of project effects relating to forest management applies equally to both lease tracts.

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The description of project effects relating to forest management applies equally to both lease tracts. Areas where vegetation is removed would be reverted to an early succession stage following development/reclamation (see Vegetation section). The general trend of succession in PJ ecosystems is described in the Vegetation section. It is expected that PJ saplings would begin to establish on reclaimed surfaces within 15-25 years and would develop to a mature stage within 75-200 years for pinyon pine and 80 to 100 years for juniper (Buttery and Gillam 1983). Old growth may take up to 300 years to establish (Erdman 1970). Recent studies have found that trees aged at over 400 years are common in many PJ stands (Eisenhart 2004, Floyd et al. 2004).

The loss of PJ woodland due to project-related activities would adversely affect habitat for wildlife that prefer mature/old growth forest. Nesting habitat for accipiters would be particularly impacted, and would remain impacted until mature/old growth forest had regenerated. Some species such as mule deer may benefit from thinning of forest, due to the increase in herbaceous growth during early successional stages. Livestock may also benefit from removal of pinyon-juniper. Wildlife and livestock aside, the impacts to the trees and the community age structure must also be considered an effect. The clearing of forested land will have an obvious negative impact for the trees removed, as well as for the understory plant community. The loss of large trees may also be considered an economic loss for forestry.NSO buffers for raptors (see Special Status Animals Section) would provide some degree of protection for mature/old growth PJ forest.

Erosion potential would increase in areas where forests were removed or thinned, particularly on steep slopes where the roots may increase stability; however, the application of interim and/or final reclamation measures to disturbed lands would stabilize existing and replaced soil cover and would provide a stabilized medium in which PJ could begin to invade and restore forest cover to the extent environmental conditions allow. Old growth stands and individuals would be avoided where possible to maintain these components of the lease tracts' forest to provide a source of seed for the continuance of PJ in the area and optimum forest habitat for other plant and animal species.

Cumulative Effects: The CEAA is CPW Game Management Unit 22, an area of 632,894 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 16,771 acres (2.6 percent). Disturbance from foreseeable actions is estimated to be 3,632 additional acres (0.6 percent) (**Table 3.3**). Removal of PJ forest in the 320 acres of the NS and EM lease tracts would incrementally add to existing disturbed/reclaimed areas described in the Vegetation section. Within the CEAA are approximately 337,000 acres of PJ forest (CDWR 2011). In addition to net loss of forest, the effects of fragmentation are important to consider as development increases. Removal or thinning of PJ forest leads to increased edge effects, and a loss of continuous core forest habitat.

3.15.3 Environmental Consequences of the No Action Alternative

In the event that the EM and NS lease tracts are not approved, no direct, indirect or cumulative impacts associated with the proposed actions would occur.

3.15.4 Proposed Mitigation

Mitigation measures applicable to both tracts include:

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FRST-1 - In accordance with the 1997 White River RMP/ROD, all trees removed in the process of construction shall be purchased from the BLM. Prior to any surface disturbing activities, the operator must purchase and obtain a commercial vegetative materials removal permit from the WRFO-BLM. Once it is known where the infrastructure will be constructed, the amount of cords per acre to be removed must be determined and WRFO must be notified. This volume will be used to charge the applicant for the vegetative materials removed. Trees should first be used in reclamation efforts and then any excess material made available for firewood or other uses.

FRST-2 - Woody material smaller than 4 inches in diameter will be chipped and stockpiled for later use in reclamation. Woods chips can be incorporated into the topsoil layer to add an organic component to the soil to aid in reclamation success.

FRST-3 - Woody materials, not used for woods chips, required for reclamation shall be removed in whole with limbs intact and shall be stockpiled along the margins of the authorized use area separate from the topsoil piles. Once the disturbance has been recontoured and reseeded, stockpiled woody material shall be scattered across the reclaimed area where the material originated. Redistribution of woody debris will not exceed 20-30 percent ground cover. Limbed material shall be scattered across reclaimed areas in a manner that avoids the development of a mulch layer that suppresses growth or reproduction of desirable vegetation. Woody material will be distributed in such a way to avoid large concentrations of heavy fuels and to effectively deter vehicle use.

FRST-4 - Trees that must be removed for construction and are not required for reclamation shall be cut down to a stump height of 6 inches or less prior to other heavy equipment operation. These trees shall be cut in four foot lengths (down to 4 inches diameter) and placed in manageable stacks immediately adjacent to a public road to facilitate removal for company use or removal by the public.

In addition to these mitigations, reclamation guidance as indicated in the Vegetation and Invasive Species sections would also apply here.

3.16 Rangeland Management

3.16.1 Affected Environment

The description of rangeland management applies equally to both lease tracts.

Livestock grazing and wildlife habitat are currently the predominant land uses within the nominated lease tracts, although oil and gas development has occurred and will likely continue in the area and solution mining activities occur immediately to the north. Grazing allotments are areas of land where livestock operators are permitted to graze livestock and generally consist of federal rangelands; they may also include intermingled parcels of fee or state lands. The BLM stipulates the type and number of livestock and period of use for each allotment. The nominated lease tracts are located mostly in the Upper Yellow Creek pasture and to a minor extent, the Ryan pasture of the Square S Allotment (#06027). Two projections of the allotment extend to the southwest to the edge of the Cathedral Bluffs, along the north side of Black Sulphur Creek and along the upslope tributaries to the stream in Stake Springs Draw. The total allotment consists of 75,739 acres, including 64,050 federal acres, 9,437 State of Colorado acres, and 2,252 private acres. Use is multi-seasonal and entirely restricted to cattle grazing (BLM 2012b).

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Rangeland improvement project 0204420, the Yellow Creek pipeline lateral, traverses through the northwest quarter of Section 35. Additionally, the pasture division fence between the Upper Yellow Creek pasture and the Ryan pasture traverses the SE of the NW quarter of section 35. These both of these projects are critical elements of the overall livestock management in this area. Their functionality must be maintained throughout the life of these projects.

Rangeland carrying capacity is typically estimated on the basis of the Animal Unit Month (AUM). The AUM is defined as the amount of forage needed by an "animal unit" grazing for one month. The animal unit in turn is defined as one mature 1,000-pound cow and her suckling calf (43 CFR 4130.8-1 (c)). Assuming that such a cow nursing her calf will consume about 26 pounds of dry matter per day as forage, combined with a factor for tramping and waste of about 25 percent, results in an estimate of about 1,000 pounds of dry matter from forage to supply one AUM.

All WRFO grazing allotments have been placed in one of three management categories that define the intensity of management: (1) improve, (2) custodial and (3) maintain. These categories broadly define rangeland management objectives in response to an analysis of an allotment's resource characteristics, potential, opportunities, and needs. The Square S allotment has been placed in an improve category and an allotment management plan (AMP) has been implemented to further this goal. Current permittees are Mantle Ranch (#0501432) and LOV Ranch (#0504241). Permitted livestock levels for the affected use areas within these allotments are indicated in **Table 3.30**.

Table 3.30 Grazing Allotment Covering the Nominated Lease Tracts

Allotment	Authorization Number	Livestock Number	Livestock Type	Period of Use	Authorized Use (AUMs)
06027 Square S	0501432	190	Cattle	04/15-06/15	256
		250	Cattle	10/02-10/21	108
		140	Cattle	07/16-10/01	237
		80	Cattle	11/30-4/30	264
		46	Cattle	04/15-7/15	92
		75	Cattle	05/01-07/15	124
	0504241	300	Cattle	10/16-12/15	578
		100	Cattle	03/01-05/15	240
		100	Cattle	12/16-02/28	237
		500	Cattle	05/16-06/10	410
		600	Cattle	06/11-07/30	178

Source: BLM 2012b

3.16.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: Livestock grazing during the authorized periods of use would continue throughout the duration of the projects. The primary impact to the grazing resource would be short-term loss of available forage as a result of construction and production-related disturbance. There would be some long-term loss due to physical structures replacing the pre-disturbance vegetation. Currently, the Square S allotment public lands have 3,522 AUMs permitted for 64,050 acres of public land, a stocking ratio of an average 18.2 acres per AUM. However it should be noted that both lease tracts are located on a ridge crest which avoids rugged terrain which would be less accessible to livestock. The nominated lease tracts thus

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represent forage areas that are probably more accessible to livestock. In addition to direct forage loss, livestock are likely to avoid grazing areas in proximity to active construction and drilling activities.

Some of the projected forage loss would likely not occur as successful reclaimed sites in other projects in the area have been shown to out-produce later-seral undisturbed vegetative cover, especially in mature PJ and sagebrush dominated sites—both in total available biomass and forage quality. Improved range carrying capacity on reclaimed lands has been observed in lands immediately to the east where PJ has been cleared for pipeline and power line ROWs as well as by the outcome of past BLM PJ reduction actions (BLM 2012c).

NS Lease Tract: Short-term and long-term disturbance associated with implementation of the proposed action would result in the long-term loss of less than ½ AUM. The disturbance would occur at the start of the project and would mostly remain for the life-of-project.

EM Lease Tract: Short-term disturbance of the EM nominated lease tract would result in temporary loss of up to 6.2 AUMs. The exact maximum loss at any one time is uncertain, depending on the development schedule, number of phases of the project implemented, and reclamation rates. Implementation of the proposed action could last for up to 15 years and reclamation could require additional years. Long-term disturbance would result in a loss of up to approximately three AUMs. The maximum loss at any one time would depend on the schedule, number or phases of the project implemented, and reclamation rates.

Cumulative Effects: The CEAA is the Square S Allotment, an area of 79,550 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 2,445 acres (3.0 percent). Disturbance from foreseeable actions is estimated to be 709 additional acres (0.9 percent) (**Table 3.3**). Implementation of either of the proposed actions would incrementally result in additional disturbance of up to approximately 120 acres to regional range proportional to the direct and indirect effects of each project.

3.16.3 Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the proposed projects would be denied, no direct, indirect, or cumulative project-related forage loss would occur and there would be no project related impacts to rangeland. Impacts to range would result from continuation of existing management actions on the public lands.

3.16.4 Proposed Mitigation

Mitigation measures applicable to both lease tracts include:

RANG-1 - Project proponents must repair or replace to BLM specifications any livestock control facilities and/or rangeland improvements (e.g., fences, waterlines ponds, water tanks, etc.) impacted during this operation. Measures will be taken to maintain the function of these projects throughout construction and the life of these projects (i.e., temporary fences during specific construction activities to prevent livestock drift between pastures until permanent fences can be reconstructed).

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3.17 Realty Authorizations

3.17.1 Affected Environment

The description of realty authorizations applies equally to both lease tracts.

The nominated lease tracts are situated in an area which has historically been leased and developed extensively for oil and gas. A number of roads, pipelines, and other linear facilities have been developed in existing ROWs within the lease tracts. A review of the BLM LR2000 website and the BLM Master Title Plat for Township 1S, Range 98W indicates existing ROWs located within the nominated lease tracts which are listed in **Table 3.31**.

Table 3.31 Existing Rights-of-Way within the Nominated Lease Tracts

Serial Number	Type	Grantee	Length (mis.)	Width (ft.)	Tracts Crossed
COC 040613	O&G Facilities	Natural Soda Inc.	2.0	50	NS
COC 050047	Power Line	White River Electric	7.4	25	NS
COC 050065	Telephone Line	Qwest Corp.	2.2	10	NS
COC 053195	Roads	Rio Blanco County	3.2	100	NS
COC 057625	Roads	Natural Soda Inc.	0.1	150	NS
COC 067991	O&G Pipelines	Bargath LLC	69.0	30	NS, EM
COC 069548	O&G Pipelines	Enterprise Products	33.7	Varies	NS
COC 073180	Water Pipelines	Williams Production	10.3	15	NS, EM
COC 073830	Roads	Rio Blanco County	0.8	Varies	NS
COC 073844	O&G Pipelines	Bargath LLC	13.0	50	EM
COC 073845	Water Pipelines	Williams Production	12.6	15	EM

Source: BLM 2012, BLM 2012a

3.17.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: Implementation of the proposed actions could result in the necessity for obtaining federal ROW grants.

NS Lease Tract: The proposed action would include a utility corridor of above ground pipelines installed on supports. The utility corridor pipelines would connect to an existing above ground pipeline corridor which approaches the NS lease tract. A federal ROW would be required for the short off-lease connection between the proposed action utility corridor and the existing pipelines. A federal ROW would be required for the off-lease portion of an existing road from Rio Blanco County Road 31 to the NS lease tract. The off-lease road access would be approximately 0.75 mile long. Other linear facilities, including electrical power lines and a natural gas supply pipeline, would be contained within the nominated lease tract and no ROW grant would be required. The current project layout would not result in any NS linear facilities crossing existing federal ROWs.

EM Lease Tract: The proposed action would require a federal ROW grant for road access to the nominated lease tract. There are two likely approaches for this access, but the final selection has not been made at the time of this analysis. The surface disturbance table has accounted for the

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maximum off-lease disturbance for this analysis. The ROW grant would be obtained prior to authorization of construction activities. Electrical power for the proposed action would require a connection to an existing White River Electric Association (WREA) power line running along the southern border of the lease tract.

Natural gas for powering equipment is expected to be largely supplied as a byproduct of the pyrolysis activities. Additional gas could be supplied from storage gas trucked to the location or from a connection to the local gas sales line. In the latter case, a federal ROW would be required for the off-lease portion of the pipeline route. Should EM decide to pursue this option, a ROW application would be submitted at that time, and such a pipeline does not constitute a portion of the proposed action.

Cumulative Effects: The CEAA is the combined Yellow Creek-Piceance Creek watershed, an area of 589,825 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 15,810 acres (2.6 percent). Disturbance from foreseeable actions is estimated to be 3,447 additional acres (0.7 percent) (**Table 3.3**). Implementation of either of the proposed actions on 320 acres of the proposed lease tracts would incrementally result in additional effects to acreage contained within federal ROW grants in the CEAA.

3.17.3 Environmental Consequences of the No Action Alternative

Under the No Action Alternative, the proposed projects would be denied, no direct, indirect, or cumulative project-related effects would occur. Additional realty actions would result from continuation of existing management actions on the public lands.

3.17.4 Proposed Mitigation

Mitigation measures applicable to both lease tracts include:

REAL-1 - If installation of linear facilities results in crossing existing federal ROWs, the applicant will coordinate activities with the ROW holder(s).

REAL-2 - ROW application(s) will be submitted for any off-lease facilities and/or access roads. WREA will submit a ROW application for installation of power lines crossing BLM lands.

3.18 Recreation

3.18.1 Affected Environment

The description of existing recreational opportunities applies equally to both lease tracts.

The two adjacent nominated lease tracts are located on federal lands administered by the BLM's WRFO and also on lands designated as the White River Extensive Recreation Management Area (ERMA). BLM manages the ERMA to provide for unstructured recreation activities such as hunting, dispersed camping, hiking, horseback riding, wildlife viewing and off-highway vehicle (OHV) use. There are no developed recreational facilities on BLM-administered lands in or near the lease tracts. Recreation on public land is dispersed and takes place in an unstructured setting with few restrictions. BLM management is limited to custodial action whose objective is to maintain and protect recreation opportunity, given the allocation of other resources to development (BLM 1997).

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Within and in the vicinity of the lease tracts, regulated seasonal big game hunting is the predominate dispersed recreational activity. Game Management Unit 22 encompasses the two lease tracts and supports annual fall hunting of mule deer, elk, and bear (CDOW 2011a). Seasons for muzzle loading rifle and rifle are set annually from mid September to the end of December in Unit 22.

The principal Recreational Opportunity Spectrum (ROS) class specified within the two nominated lease tracts is Semi-primitive Motorized (SPM); this class is typically characterized by a natural appearing environment with few administrative controls and low interaction among users (but evidence of other users may be present)(BLM 2009). Roaded Natural (RN) class lands, characterized by less naturalness and increased contact with other users, occupies a minor peripheral position of approximately eight acres in the southeast corner of NS' nominated lease tract. SPM lands dominate the uplands above and between the Yellow Creek and Ryan Gulch/Piceance Creek valleys.

BLM-administered lands in the project area are designated as limited for OHV travel and restricted temporally due to seasonal conditions (10/1 – 4/30) and restricted spatially to existing roads, trails, and ways.

3.18.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: For the alternating period of construction, including drilling and completions, and production operations over the proposed 15-year RD&D period, dispersed recreational opportunities would likely be affected within portions of the two lease tracts where vehicle traffic, construction equipment activity, well drilling and completion activities are present. Traffic, noise, human activity, and dust would increase particularly during periods of construction and drilling/completions and could diminish or alter recreational experiences. Other ongoing oil and gas field and transportation (pipeline) development and nahcolite mining has and continues to provide a baseline of traffic, noise, human activity, and dust within the lease tracts and in adjacent lands. Most interaction between recreationists and RD&D personnel would occur on the existing roads, trails, and ways and on newly constructed roads where recreationists are using roads to access desirable areas, particularly hunters during the fall hunting seasons for big game species. During construction activity, most recreationists would likely seek areas away from the immediate vicinities of construction where the dispersed recreation opportunities are present and do not conflict with the RD&D projects. During less intense periods of production operations most recreationists would likely still seek areas away from reduced but still present activity, although the motivation to go elsewhere would likely be reduced in comparison to the response during periods of construction.

Should construction operations, or to a lesser extent production operations, overlap with big game hunting seasons, the RD&D activities could temporarily displace target species to adjacent habitat either within or outside of the lease tracts, but away from the areas of activity. Since hunting relies on the presence of game species and the ability of the hunters to close on the animals, hunters generally prefer relatively quiet settings. Actions disturbing the natural setting, beyond the presence of the hunters themselves, could disrupt hunting in the vicinity of the lease tracts. Although such disturbance would adversely affect the hunting experience at that location and possibly for some portion of the surrounding area, hunters may be able to find relatively undisturbed settings within their permitted hunt unit on adjacent public lands.

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For lands within and in the vicinity of the project area classified as SPM of the ROS classes, the classification of these lands could change to RN.

NS Lease Tract: During the 15-year life-of-project, both interim and final reclamation of disturbance associated with access roads, well and process pads, and pipelines would reduce the extent of disturbance to 6.8 acres from 7.3 acres of total project disturbance. Over the 15-year life-of-project, the character of the remaining disturbed and active areas of the NHG Project would generally remain less attractive to recreational users seeking relative quiet and separation from other human activity; however, the limited extent of actual disturbance and activity within the 160 acre lease tract would likely have minimal effect on recreational activities within the lease tract.

EM Lease Tract: During the 15-year life-of-project, both interim and final reclamation of disturbance associated with access roads, well and process pads, and pipelines would reduce the extent of disturbance to 52.3 acres (47 percent) of the 112.7-acre total project disturbance. Over the 15-year life-of-project, the character of the remaining disturbed and active areas of the NHG Project would generally remain less attractive to recreational users seeking relative quiet and separation from other human activity, and recreational opportunities would likely be limited within the approximately 160-acre lease tract.

Cumulative Effects: The CEAA is CPW Game Management Unit 22, an area of 632,894 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 16,771 acres (2.6 percent). Disturbance from foreseeable actions is estimated to be 3,632 additional acres (0.6 percent) (**Table 3.3**). Implementation of either NS' proposed project or EM' proposed project would incrementally result in a decrease in recreational attractiveness and opportunity within the 320 acres of the proposed lease tracts for the 15-year life-of-projects.

3.18.3 Environmental Consequences of the No Action Alternative

Direct, indirect, and cumulative effects to recreation would not occur should the proposed action for either RD&D project not be approved.

3.18.4 Proposed Mitigation

None.

3.19 Access And Transportation

3.19.1 Affected Environment

A network of county, BLM, and oil and gas roads provide access to and within the adjacent RD&D lease tracts located in Sections 34 and 35, T1S, R98W (**Attachment 1**). These roads range in surface material from paved, to gravel, to maintained native materials, and to two-track native materials.

Principal county roads providing access to the combined RD&D lease tracts area include:

RBC 5	Piceance Creek Road
RBC 24	Ryan Gulch Road
RBC 31	Natec Road
RBC 3	Bar D Mesa Road

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Primary access to the combined lease tracts area is the Piceance Creek Road, Rio Blanco County Road (RBC) 5. RBC 5 can be reached from 1) Colorado State Highway 64, an east – west arterial two-lane highway located north of the project area that connects the cities of Meeker, CO and Rangely, CO; and 2) Colorado State Highway 13, a north – south arterial two-lane highway located east of the project area that connects the cities of Meeker, CO and Rifle, CO. Direct access to the combined, adjacent lease tracts area would be from RBC 5 via the Ryan Gulch Road (RBC 24) and Natec Road (RBC 31). RBC 5 is the major thoroughfare in and out of the Piceance Basin for oil and gas development, sodium production, ranching/residential, and recreational activities. Like RBC 5, county roads 24 and 31are paved county-maintained access roads used principally by sodium production operators, oil and gas operators, grazers, and recreationists, primarily during big game fall hunting seasons. RBC 31 crosses RBC 83 just outside the NS lease tract at its southeast corner. From this crossing, access into NS' lease tract follows RBC 31 to the NS plant and from the plant south on gravel, native-surface, and two-track roads to and into the NS lease tract (**Attachment 1**). Access into the EM lease tract follows graveled RBC 83 approximately 0.5 mile southwest of the junction with RBC 31 to a turnoff onto the graveled oil and gas road into Williams well 31-34-198 location and other well locations. This deviation onto the oil and gas road is located near the center of Section 35, T1S, R98W.

The above roads plus open BLM/oil and gas roads support traffic for a full range of uses: residential/ranching, recreational, BLM – management operations, federal grazing permittees, and oil and gas field development (including new wells, pipelines, and gas treatment and compression facilities) and ongoing operations and maintenance of existing facilities. The most current traffic counts for all county roads listed above with the exception of RBC 83 are presented in **Table 3.32**. Traffic counts have not been recorded for RBC 83.

Table 3.32 County Road Traffic within the Project Area*

Road	Mile Post	Mo.	Year	Date Range	Total Days	Total	ADT	Weekday Ave.
5	1.0	April - May	2011	28 - 16	18	17,453	970	1,113
	26 (South of RBC 24)	April	2011	12 - 18	7	4,274	611	697
	28 (North of RBC 24)	April	2011	12 - 18	7	3,313	473	549
	40	April	2011	12 - 18	6	2,941	490	590
24	0	April	2011	12 - 18	7	2,703	386	436
31	0	April	2011	20-26	7	2,428	347	376

* Rio Blanco County Road and Bridge Department, 2011.

NS Lease Tract: As introduced above, access into NS' lease tract would result from use of existing roads all the way to NS' lease tract boundary after leaving RBC 83 and continuing on RBC 31 north approximately 0.7 mile to NS' sodium bicarbonate processing plant in the NENW of Sec. 26, T1S, R98W (**Attachment 1**). At this point, access to the lease tract would follow existing roads from the plant to the south and the lease tract boundary. At the boundary a new access road would be constructed into the OSR and Centralized Processing Facility pad.

EM Lease Tract: As introduced above, access into EM's lease tract would result from one of two possible routes or a combination of both after leaving RBC 83 near the center of Section 35, T1S, R98W (**Attachment 1**). The first route would follow the oil and gas road from RBC 83

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west approximately 0.3 mile to where the existing access road turns to the north-northwest, crosses a reclaimed pipeline ROW, and continues approximately 0.4 mile to where the existing road crosses into the EM lease tract.

The second and shortest route would again follow the first route to the point of crossing the reclaimed pipeline ROW. At this point, the route would deviate to the west from the existing oil and gas road along the northern edge of the east-west reclaimed pipeline ROW where the route would result in the construction of access road and within the previously disturbed, but now reclaimed pipeline ROW for approximately 0.2 mile to a point where the route crosses into the EM lease tract. The route would continue west along the reclaimed pipeline ROW within the lease tract boundary for a remaining 0.4 mile (a total of 0.6 mile along the reclaimed pipeline ROW) to a point where the route would turn north into the lease tract and EM's proposed operational areas. The reclaimed pipeline ROW mostly parallels and is adjacent to and is within the southern boundary of EM's lease tract. This route would result in new road construction for approximately 0.2 mile off lease within the reclaimed pipeline ROW and 0.4 mile of new road construction along the reclaimed pipeline ROW within EM's lease tract.

From either or both points of entrance into the lease tract, additional roads would be constructed to reach well and production pads and ancillary facilities.

3.19.2 Environmental Consequences of the Proposed Action

Direct and Indirect Effects: To access the proposed facilities for both RD&D projects, new or improved access road would be constructed and maintained for the life-of-project. All roads would be constructed and surfaced with native materials with the addition of aggregate, where necessary, to provide year-round vehicle access to construction and/or operational personnel.

NS Lease Tract: During an initial three month period of construction activity and for the remaining life-of-project production operations, vehicle trips per day in and out of the lease tract is not expected to exceed 40 for all vehicle types. Nearly all of the maximum 20 employees and contractors would travel daily between area residences (Rifle, Meeker, and Rangely areas), hotels, and motels via RBC 31, RBC 24, and RBC 5.

For the life-of-project, connecting roads, RBC 31, RBC 24, and RBC 5 could see an increase in trips which together would total approximately 40 vehicle trips (20 roundtrips) per day. RBC 5 would receive all 40 trips per day however the trips would likely be split between use of western/northern portion of RBC 5 (north of RBC 24) that connects to State Highway 64 (Rangely and Meeker) (25 percent) and use of the southern-eastern portion of RBC 5 (south of RBC 24) that connects to State Highway 13 (Meeker, Rifle)(75 percent).

Based on average daily trips (ADT) in 2011 reported by Rio Blanco County for RBC 5 in **Table 3.29**, the added trips for the life-of-project period, assuming a split of 25 percent and 75 percent, trips on RBC 5 from State Highways 64 and 13, respectively, would increase the ADT approximately 2.0 percent from 490 to 500 north of RBC 24 and 3.1 percent from 970 to 1,000 south of RBC 24. Access to the adjacent lease tracts from RBC 5 up segments of RBC 24 and RBC 31 over the life-of-project would increase the ADT approximately 10.4 percent from 386 to 426 for RBC 24 and 11.5 percent from 347 to 387 ADT for RBC 31.

The increased traffic would proportionally result in an increased rate of state, county, and BLM road deterioration and need for maintenance. Increased dust levels, principally from used segments of RBC 31 and from the new and upgraded road segments could also result from the

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increased project-related traffic. Increased traffic may also proportionally increase the accident rate. However, NS, as a long-term active operator in the area, including having substantial lease holdings in the vicinity of the adjacent oil shale RD&D lease tracts, would continue to work with the State, the BLM, and Rio Blanco County with regards to road maintenance and road safety. NS participates in applying dust controls as defined in cooperative agreements. NS would continue to assume their appropriate participation in supporting the county with road use and safety issues.

EM Lease Tract: During the extended periods of construction and drilling for the four phases of activity, as many as 30 vehicles would be used on a daily basis to provide transportation within and outside of the Project for an estimated 120 personnel. An estimated 90 vehicle trips would occur daily during construction activities for all phases. Nearly all of the estimated 120 employees and contractors would travel daily between area residences (Rifle, Meeker, and Rangely areas), hotels, and motels via RBC 83, RBC 31, RBC 24, and RBC 5.

During subsequent periods of production operations, employee and contractor numbers and associated vehicles would drop to about 20 workers associated with Phase II, Phase III, and Phase IV production operations. Vehicles would drop to about five to 10 with an estimated 30 trips per day.

For extended periods during the 15-year life-of-project, connecting roads, RBC 83, RBC 31, RBC 24, and RBC 5 could see an increase of approximately 90 trips representing 45 roundtrips in and out of the lease tract. RBC 5 would receive all 90 trips per day; however, the trips would likely be equally split between use of western/northern portion of RBC 5 (north of RBC 24) that connects to State Highway 64 (Rangely and Meeker) (50 percent) and use of the southern-eastern portion of RBC 5 (south of RBC 24) that connects to State Highway 13 (Meeker, Rifle)(50 percent).

Based on average daily traffic (ADT) trips in 2011 reported by Rio Blanco County for RBC 5 in **Table 3.31**, the added trips for the extended periods of construction, assuming a split of 50 percent and 50 percent for trips on RBC 5 from State Highways 64 and 13, respectively, would increase the ADT approximately 9.2 percent from 490 to 535 north of RBC 24 and 4.6 percent from 970 to 1,015 south of RBC 24. Access to the adjacent lease tracts from RBC 5 up segments of RBC 24 and RBC 31 for extended periods of the 15-year life-of-project would increase the ADT approximately 23.3 percent from 386 to 476 for RBC 24 and 26.0 percent from 347 to 437 ADT for RBC 31. The 90 daily trips would also be added to traffic load for the short segment of RBC 83.

The increased traffic would proportionally result in an increased rate of state, county, and BLM road deterioration and need for maintenance. Increased dust levels, principally from used segments of RBC 31, RBC 83, and from the new and upgraded road segments could also result from increased project-related traffic. Increased traffic may also proportionally increase the accident rate. However, EM, as a long-term active operator in the area, including having substantial lease holdings in the vicinity of the adjacent oil shale RD&D lease tracts, would continue to work with the State, BLM, and Rio Blanco County with regards to road maintenance and road safety. EM participates in applying dust controls as defined in cooperative agreements. EM would continue to assume their appropriate participation in supporting the county with road use and safety issues.

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Cumulative Effects: The CEAA is the combined Yellow Creek-Piceance Creek watershed, an area of 589,825 acres. Past and present analyzed surface disturbing activities within the CEAA are estimated to equal 15,810 acres (2.6 percent). Disturbance from foreseeable actions is estimated to be 3,447 additional acres (0.7 percent) (**Table 3.3**). Implementation of either NS' proposed project or EM's proposed project would incrementally result in increased traffic loads for approximately 2,100 miles of State, BLM, and county roads within the CEAA, proportional to the effects of each project.

3.19.3 Environmental Consequences of the No Action Alternativ

Direct, indirect, and cumulative effects would not occur should the proposed action for either RD&D project not be approved.

3.19.4 Proposed Mitigation

None.

4 CONSULTATION AND COORDINATION

Federally threatened and endangered species are managed under the authority of the Endangered Species Act (ESA) (PL 93-205, as amended). Section 7 of the ESA directs federal department and agencies to ensure actions authorized, funded, or carried out by them are not likely to jeopardize the continued existence of threatened or endangered species or result in the destruction or adverse modification of their critical habitats (16 USC 1536). A BA is required under section 7(c) of the ESA, to fulfill consultation requirement set forth in section 7(a)(2) of the ESA, if Federally-listed species or designated critical habitats may be present in the area affected by any "major construction activity." "Major construction activities" are considered to be Federal actions significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4321 *et seq*.). Proposed and candidate species are also discussed. The contents of the BA are at the discretion of the federal agency and depend on the nature of the federal action (50 CFR 402.12(f)). The BAs prepared for these projects have been submitted to the FWS for review by BLM on April 19, 2012.

Section 106 of the National Historic Preservation Act (NHPA) (Public Law 89-665; 16 U.S.C. 470 *et seq)* requires that federal agencies consider how their undertakings could affect historic properties, i.e., those included in or eligible for inclusion in the NRHP. The Section 106 process includes five steps involving identification of potentially eligible properties and assessment of potential impacts, and consultation between the agency and the State Historic Preservation Officer (SHPO). Inventories and evaluations of historic properties potentially affected by these projects have been prepared and submitted to the Colorado Office of Archaeology and Historic Preservation (the Colorado SHPO office) by BLM on October 16, 2011.

4.1 Tribes, Individuals, Organizations, Or Agencies Consulted

Name	Organization	Subject
Chick, Nancy	Colorado Dept. Public Health and Environment	Ambient criteria pollutant concentrations, Rio Blanco Co.
	Colorado Division of Water Resources	GIS data downloads

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Name	Organization	Subject
	Colorado Dept. Public Health and Environment Air Pollution Control Division	Air quality data report; PSD Class II areas protected as Class I for sulfur dioxide online map
	Colorado Dept. Public Health and Environment Air Quality Control Commission	Report to the Public 2009-2010
	Colorado Dept. Public Health and Environment Water Quality Control Commission	305(b) Report 2010 update
	Colorado Division of Water Resources	Rio Blanco Co. well data; GIS data downloads
de Vergie, Bill (Scoping letter)	Colorado Division of Parks and Wildlife	Colorado Vegetation Project GIS data; Colorado Hunting Planner 2011-2012; Colorado Herpetofaunal Atlas; Scoping comments
Nichols, Edward - SHPO	Colorado Office of Archaeology and Historic Preservation	NHPA Section 106 consultation
	Colorado Oil and Gas Conservation Commission	Online oil and gas database
	Colorado State University	Interagency Monitoring of Protected Visual Environments online data
	Colorado Weed Management Association	Noxious Weeds of Colorado online data
	Energy Information Agency	Online data regarding greenhouse gases and climate change
	U.S. Environmental Protection Agency	Air quality data for Rio Blanco and Garfield counties; National Ambient Air Quality Standards; RCRA compliance data
Sharp, Charles	U.S. Fish and Wildlife Service	ESA Section 7 consultation
	U.S. Forest Service	Colorado Class I Areas under Clean Air Act online map
	U.S. Geological Survey	Assessment of Undiscovered Oil and Gas Resources Uinta-Piceance province; National Water Information System online data
la Jeunesse, Mike	Eastern Shoshone Tribe	Cultural resources consultation request
Cuch, Irene	Ute Indian Tribe	Cultural resources consultation request
Hayes, Gary	Ute Mountain Ute Tribe	Cultural resources consultation request
Casias, Pearl	Southern Ute Tribe	Cultural resources consultation request
Volante, Ashley	ExxonMobil Production	Raw ozone monitor data from Colorado Dept. Public Health and Environment Air Pollution Control Division
	Western Regional Climate Center	Online climate data

4.2 Interdisciplinary Review

Petros Environmental Group, Inc., an environmental consulting firm, with the guidance, participation, and independent evaluation of the BLM prepared this document. The BLM, in accordance with 40 CFR 1506.5 (a) and (c), is in agreement with the findings of the analysis and approves and takes responsibility for the scope and content of this document.

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BLM Oversight				
Name	**Title**	**Area of Responsibility**	**Initial Review**	**Final Review**
Paul Daggett	Mining Engineer	Project Lead – Document Preparer, Geology and Minerals, Hazardous or Solid Wastes	02/28/2012	05/17/2012
Bob Lange	Hydrologist	Surface and Ground Water Quality; Floodplains, Hydrology, and Water Rights; Soils	02/24/2012	03/27/2012
Melissa Hovey	Air Resource Specialist (BLM Colorado State Office)	Air Quality	3/27/2012	
Zoe Miller	Ecologist	Areas of Critical Environmental Concern; Special Status Plant Species; Forest Management	2/9/2012	03/27/2012
Kristin Bowen	Archaeologist	Cultural Resources; Native American Religious Concerns; Paleontological Resources	2/2/2012	04/05/2012
Mary Taylor	Rangeland Management Specialist	Invasive, Non-Native Species; Vegetation; Rangeland Management; Prime and Unique Farmlands	2/22/2012	03/28/2012
Ed Hollowed	Wildlife Biologist	Migratory Birds; Special Status Animal Species; Terrestrial and Aquatic Wildlife; Wetlands and Riparian Zones	2/23/2012	03/26/2012
Chad Schneckenburger	Outdoor Recreation Planner	Wilderness; Visual Resources; Access and Transportation; Recreation; Scenic Byways;	02/02/2012	03/28/2012
Kyle Frary	Fuels Specialist	Fire Management	02/02/2012	03/26/2012
Stacey Burkel	Realty Specialist	Realty	02/23/2012	03/27/2012
Melissa J. Kindall	Range Technician	Wild Horse Management	02/06/2012	03/26/2012
David Epstein	Economist	Environmental Justice; Social and Economic Conditions		03/28/2012
Heather Sauls	Planning & Environmental Coordinator	NEPA Compliance;		05/17/2012

Name	Title	Area of Responsibility
Petros Environmental Group, Inc.		

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Name	Title	Area of Responsibility
Richard Bell	NEPA Specialist, Soils Scientist	Soils, Visual Resources; Fire Management; Recreation, Access and Transportation
Joe Fetzer	Geologist	Air Quality; Geology and Minerals; Surface and Ground Water Quality; Cultural Resources, Paleontological Resources; Realty Authorizations; Rangeland Management
Hayden-Wing Associates, LLC		
Jennifer Hess	Wildlife Biologist	Terrestrial Wildlife; Migratory Birds; Special Status Animals
Lisa Foy Martin	Senior Scientist	Invasive Species; Vegetation; Forest Management
Jeff Winstead	Project Manager	Biological Sciences Oversight
Matt Dzialak	Senior Scientist	Terrestrial Wildlife

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6 ACRONYMS AND GLOSSARY

6.1 List of Acronyms

Acronym	Meaning
ACDFs	applicant-committed design features
ACEC	Area of Critical Environmental Concern
AQI	Air Quality Index
AQRV	air quality-related values
AUM	animal unit month
bbl	barrel
BLM	U.S. Bureau of Land Management
BMPs	best management practices
BOPD	barrels of oil per day
BWPD	barrels of water per day
CAAQS	Colorado Ambient Air Quality Standards
CAQCC	Colorado Air Quality Control Commission
CASTNET	Clean Air Status and Trends Network
CBL	cement bond log
CDPHE	Colorado Department of Health and Environment
CEQ	Council on Environmental Quality
CIBP	cast iron bridge plug
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COAs	conditions of approval
CWMA	Colorado Weed Management Association
DOI	U.S. Department of Energy
EA	Environmental Assessment
EM	ExxonMobil Exploration Company
EPA	U.S. Environmental Protection Agency
ERMA	Extensive Recreation Management Area
ESA	Endangered Species Act
DVPW	deep vertical production well
FLPMA	Federal Land Policy and Management Act
FR	Federal Register
ft^3/sec	cubic feet per second
FWS	U.S. Fish and Wildlife Service
GHG	greenhouse gas
HAPs	hazardous air pollutants
H_2S	hydrogen sulfide
HMA	herd management area
IMPROVE	Interagency Monitoring of Protected Visual Environments
LI	leached interval
$\mu g/m^3$	micrograms per cubic meter
Mscfd	thousand standard cubic feet per day
MMscfd	million standard cubic feet per day
MOU	Memorandum of Understanding
MW	megawatt
NAAQS	National Ambient Air Quality Standards
NADAP	National Atmospheric Deposition Program
NEPA	National Environmental Policy Act
NH_3	ammonia
NHPA	National Historic Preservation Act
NO_2	nitrogen dioxide

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Acronym	Meaning
NO_3	nitrate
NOx	nitrogen oxides
NS	Natural Soda Holdings, Inc.
O_3	ozone
OHV	off-highway vehicle
OSR	oil shale reactor
PDP	Piceance Development Project
PEIS	Programmatic Environmental Impact Statement
PFYC	Potential Fossil Yield Classification System
PJ	pinyon-juniper
$PM_{2.5}$	particulate matter less than 2.5 microns diameter
PM_{10}	particulate matter less than 10 microns diameter
POO	plan of operations
ppb	parts per billion
ppm	parts per million
PSD	prevention of significant deterioration
RD&D	research, development, and demonstration
RMP	Resource Management Plan
ROD	Record of Decision
ROS	Recreation Opportunity Spectrum
ROW	right-of-way
SHPO	State Historic Preservation Officer
SO_2	sulfur dioxide
SPCC	spill prevention, control, and countermeasure
SWMP	stormwater management plan
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TPY	tons per year
TVD	true vertical depth
UIC	underground injection control
USDW	underground source of drinking water
USFS	U.S. Forest Service
VOCs	volatile organic compounds
WREA	White River Energy Association
WRFO	White River Field Office
WSA	Wilderness Study Area

6.2 Glossary of Selected Terms

A-Groove aquifer - A Green River Formation aquifer located stratigraphically above the oil shale-rich Mahogany Zone.

B-Groove aquifer - A Green River Formation aquifer located stratigrahically below the oil shale rich Mahogany Zone.

Bentonite - A type of clay which expands under absorption of water to form a gel and which is a common component of drilling fluids.

Cast iron bridge plug - A downhole tool that is located and set to isolate the lower part of the wellbore. Bridge plugs may be permanent or retrievable, enabling the lower wellbore to be permanently sealed from production or temporarily isolated from a treatment conducted on an upper zone.

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Dissolution Surface aquifer - A Green River Formation aquifer located stratigraphically above the Saline Zone of the Parachute Creek Member.

Geophone - A type of specialty microphone used for recording seismic energy. In the current project, downhole geophones would be used to monitor placement of electrical oil shale heating elements.

Heater element - An electrically conductive nonhazardous material, such as a mixture of calcined coke and cement, that is injected into hydraulically-created fractures and solidifies. Under application of electric current, the conductive material heats to temperatures which should be sufficient to liquefy the kerogen contained in adjacent oil shale.

Kerogen - A solid, bituminous substance found in rocks termed "oil shales" which can be processed in various ways to yield a liquid similar to crude oil.

Seismic Project - A method of visualizing the subsurface geology of an area by recording the reflection or refraction of sound waves generated at or near the surface and developing an interpretive image.

Supercritical water - Water under specific pressure and temperature conditions such that distinct liquid and gaseous phases do not exist.

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7 ATTACHMENTS

Attachment 1 - Maps of the Two Nominated Lease Tracts

Attachment 2 - Stratigraphic and Hydrologic Chart

Appendix A - Natural Soda Applicant-committed Design Features

Appendix B - ExxonMobil Applicant-committed Design Features

Appendix C - Natural Soda BLM Identified Mitigations and BMPs

Appendix D -ExxonMobil BLM Identified Mitigations and BMPs

Appendix E - Natural Soda Process Details for Air Emissions

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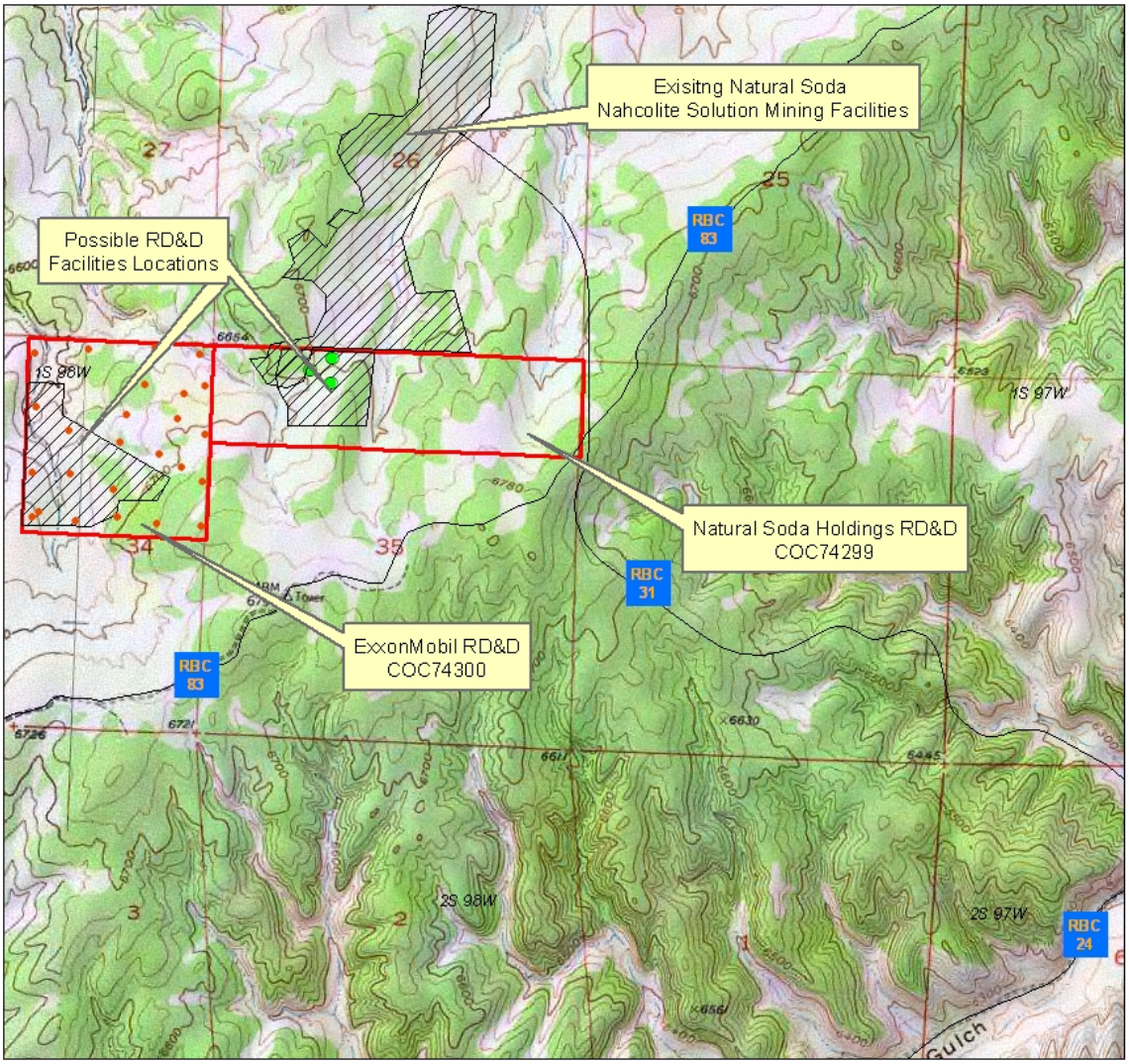
7.1 Maps and Charts

PRELIMINARY

Insert Attachment 1a

DOI-BLM-CO-110-2011-0177-EA
Second Round Oil Shale Research, Development, and Demonstration (RD&D)



T. 1 S. , R. 98 W., 6th P.M.
Sections 34 and 35

05/14/2012

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Sources:
BLM, USGS, CDOW, etc.

Disclaimer:
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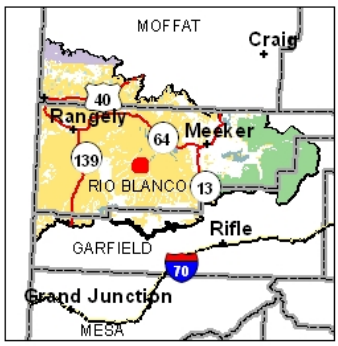
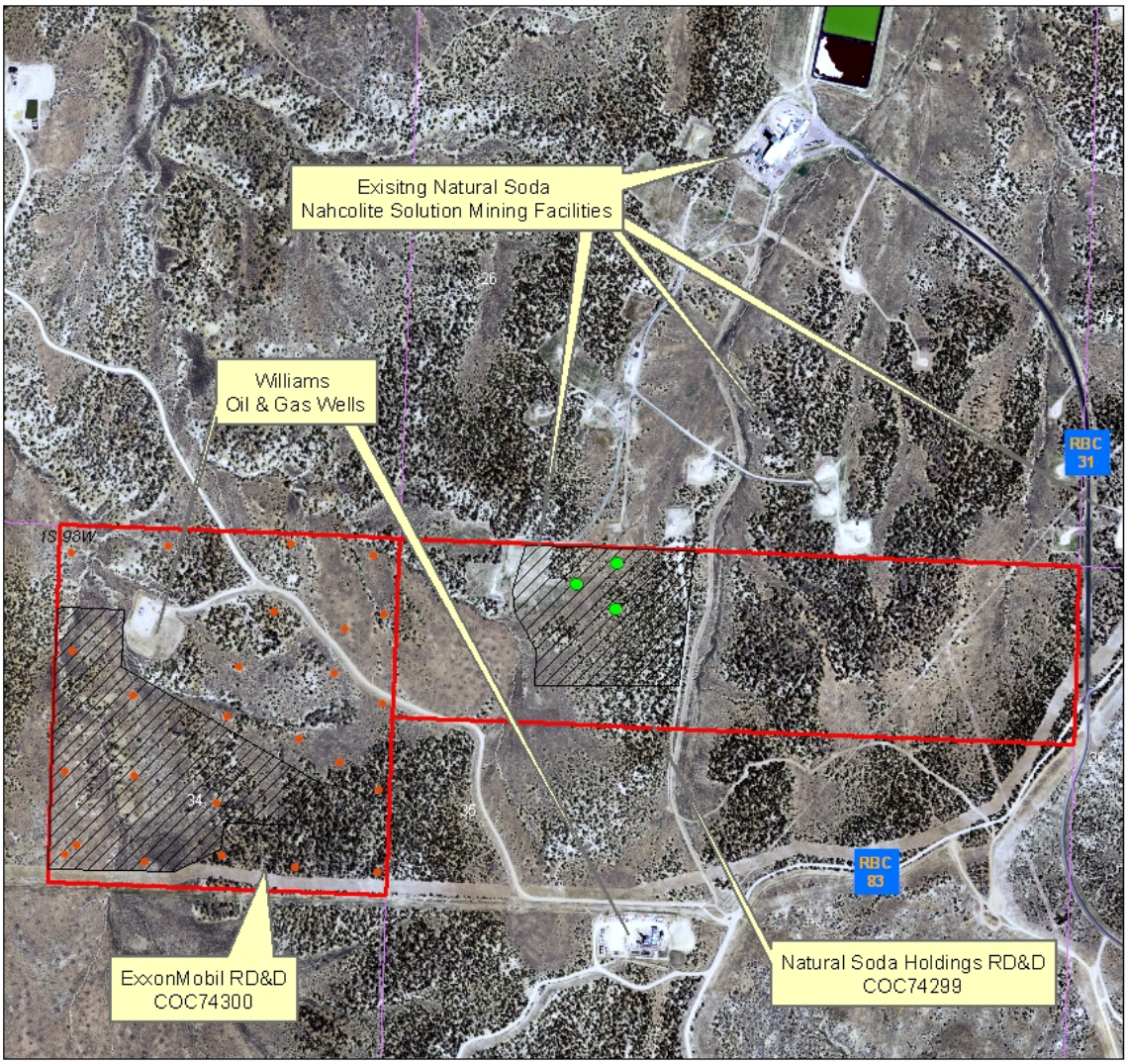


Attachment 1b

DOI-BLM-CO-110-2011-0177-EA
Second Round Oil Shale Research, Development, and Demonstration (RD&D)



T. 1 S. , R. 98 W., 6th P.M.
Sections 34 and 35

- core/monitoring well
- reactor well
- Section

05/14/2012

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Feet

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Sources:
BLM, USGS, CDOW, etc.

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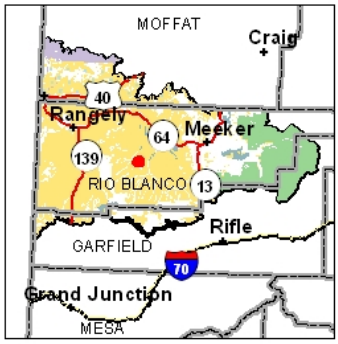

7.2 Appendix A: Natural Soda Applicant-committed Design Features

NS will apply the following mitigation measures as part of implementing their Proposed Action:

Spill Prevention Control and Countermeasures (SPCC)

1. All storage tanks and roll-off bins located on-site will have secondary containments with capacity sufficient to contain the volume of the largest tank plus sufficient freeboard to contain precipitation, per *Gold Book* recommendations (BLM and USFS 2007). These secondary containments will be checked daily for possible pollutants. Accumulated precipitation within the secondary containments will be removed as necessary.
2. In the event of a leak from a storage tank to a secondary containment, the material in the leaky storage tank will be immediately and completely removed from the tank, and the storage tank repaired as soon as possible.
3. The removed material will either be transferred to another on-site storage tank, or transported to an appropriate off-site disposal facility. Material contained within the secondary containments will be disposed of in a like manner.
4. Any spill to the ground surface will be immediately remediated using NS' in-place guidelines for spill remediation. A spill will indefinitely shut down drilling or production operations until the spill has been appropriately remediated.
5. Notifications of a spill will be sent to the appropriate local, state and federal regulatory agencies as required by applicable reporting requirement regulations.

Ground water Monitoring and Response

6. Consistent with BMP's, NS plans to use existing wells monitoring aquifers above the Saline Zone which will minimize additional disturbance and maximize the use of existing infrastructure.
7. The aquifers penetrated by all monitor wells will be isolated by competent annular cement seals.
8. Ground water quality will be analyzed quarterly in the existing NS monitoring wells. These wells will be analyzed for key constituents including: alkalinity, total dissolved solids, pH, organics, conductivity and VOCs. Monitoring activities associated with ground water quality (monitoring wells) will continue for three years after production operations cease.
9. Should ground water contamination from the NS OSR production activities be noted in the monitoring wells, production will be halted and appropriate remediation measures taken. Remediation measures may include secondary cement jobs, cement squeeze jobs, casing liners, casing replacement, or plugging and abandonment.

Surface Water Monitoring and Response

10. NS will develop a Stormwater Management Plan (SWMP) that conforms to the requirements established by the Colorado Department of Public Health and Environment (CDPHE) for compliance with Colorado's General Permit for Stormwater Discharges Associated with Construction Activities.

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11. Implementation of the SWMP will commence with initiation of construction. The construction process will be carefully monitored, and any needed changes to the SWMP will be identified, incorporated into a revised SWMP and fully implemented.
12. After construction has been completed and final stabilization of the site has been achieved, NS will provide CDPHE with a stormwater permit inactivation notice.
13. If necessary, a SWMP for the operating facility will be developed and implemented.
14. Stormwater produced fluid on the NS site will be collected into appropriate catchments. Stormwater collected within NS surface equipment containment will be promptly removed to NS' seven acre waste water evaporation pond.

Fire Prevention and Control

15. Fire extinguishers will be conveniently located throughout the OSR site for accessibility and rapid attack on a fire. Clear access to fire extinguishers will be maintained. Portable, dry chemical extinguishers with A, B and C ratings are utilized and work for most types of fire. At a minimum, these fire extinguishers will be checked annually for condition and charge. Water extinguishment works well for most solid flammable fuels, such as structure fires, and for cooling structures during brush fires, but should not be used on an electrical fire. Halon extinguishers will be available, as required, in instrumentation and electrical areas. Extra fire extinguishers located in the NS plant will be brought to the NS lease tract to have on-site during drilling and production operations.
16. A water truck from NS' nearby plant will be made available. Additionally, the close proximity of the NSI plant and attendant resources will be available to enhance the NS firefighting capabilities.
17. Fire prevention for the NS nominated Lease will consist of controlling the supply of flammable and combustible materials as well as any possible sources of ignition. The dry terrain on the lease tract is a potential source of combustion and caution must be used in extinguishing smoking materials in the area. Designated smoking areas will be established and equipped with appropriate disposal containers.
18. Produced kerogen oil, motor oil, flammable liquids and grease shall be kept in containers provided for them. The containers will be labeled as to their contents.
19. The first concern during a fire is the safety of the employees and others on site. If a fire starts, depending on the size of a fire, it will be controlled with a fire extinguisher. If the fire is large enough that the fire extinguisher is inadequate, the employees and any other persons will leave the area and initiate a fire response team from Meeker immediately. Information regarding the facility's name, the location of the fire, and the type of fire will be provided to the first responders.
20. NS will notify Craig Interagency Dispatch (970-826-5037) in the event of any fire within or in the vicinity of the proposed EM Oil Shale RD&D Lease Tract.
21. The reporting party will inform the dispatch center of the location of the fire, size, status, smoke color, aspect, fuel type and contact information.

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22. The reporting party or a representative will remain nearby in order to make contact with incoming fire resources to expedite actions taken towards an appropriate management response.
23. The applicant and contractors will not engage in any fire suppression activities outside the approved project area. Accidental ignitions caused by welding, cutting, grinding, etc. will be suppressed by the applicant only if employee safety is not compromised and if the fire can be safely contained using hand tools and portable hand pumps. If chemical fire extinguishers are used, the applicant will notify incoming fire resources of the extinguisher type and the location of use.
24. Natural ignitions caused by lightning will be managed by federal fire personnel. If a natural ignition occurs within the approved project area, the fire may be initially contained by the applicant only if employee safety is not compromised. The use of heavy equipment for fire suppression is prohibited, unless authorized by the Field Office Manager. Moreover, removal of slash and woody debris associated with the proposed action shall follow mitigations as authorized.

Air Pollution Prevention, Monitoring, and Mitigation

25. NS intends to rigorously monitor air emissions. ASTM standard techniques will be used to sample air emissions and an approved outside laboratory will perform the gas analysis. Data obtained will be used for planning commercial operations and future air pollution emission permitting.
26. Once the equipment that will be used on site has been fully specified, NS will determine whether an Air Pollution Emission Notice (APEN) must be prepared and submitted to the CDPHE Air Pollution Control Division. This will involve evaluating the planned NS process and operations, identifying relevant regulated air pollutants, determining whether the sources are subject to Maximum Achievable Control Technology Requirements, identifying exempt sources, calculating uncontrolled actual emissions, and making a determination as to whether an APEN is required. If so, the APEN will be prepared and submitted to CDPHE. Should future facilities be constructed on an approved NS RD&D lease, permits will be filed and APENs submitted to the CDPHE in accordance with existing regulations.

Noise Abatement

27. Individuals working on or around any potentially harmful noise-generating equipment on the approved lease tract will be required to wear ear protection while in the vicinity of such equipment while it is in operation.

Reclamation

28. Topsoil will be salvaged, stockpiled and protected where necessary, and redistributed evenly and directly where feasible.
29. In preparation for reclamation, all disturbed areas will be graded to slopes consistent with the surrounding area. Grading will also be done in a manner so as to control erosion and siltation of the affected and unaffected lands. BMPs for erosion control measures such as contour furrowing, installing water bars, etc., will be used where necessary to ensure that

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slope and soil erosion are kept to a minimum. Surface drainage patterns will be re-established to pre-production conditions.

30. Where necessary, heavily compacted surfaces will be ripped prior to receiving a topsoil cover from the topsoil stockpiles. Surface tillage and seedbed preparation will consist of a light or shallow tillage operation using a combination of disk harrow and spike-tooth harrow. The final tillage treatment will be performed by a shallow chisel plow on a level contour, or by using an imprinter or rangeland pitter, where necessary, depending upon soil conditions. Any existing vegetation piles will be removed.
31. The seed mix application rates and seeding techniques are based on reclamation experience in the area and WRFO reclamation guidance, as well as on consideration of local environmental conditions of soil, slopes, elevation, and precipitation. Use of a BLM-approved seed mixture will result in a rapidly established, diverse, and effective vegetative cover capable of self-regeneration. For short-term stockpiles or other areas, a BLM approved interim seed mixture will be utilized.
32. The seed mixture will be placed by either a drill seeder or by broadcast seeding. The use of a drill seeder necessitates having slopes less than 3:1 (33 percent). Drill rows will be 20 to 25 centimeters apart. If the seed is broadcast, the amount of seed indicated will be doubled.
33. Following seeding, certified weed-free straw or native pasture hay will be applied at a mulch rate of approximately two tons per acre. If hydro-mulch is used, the rate will be ¾ - 1 ton per acre. Straw or hay mulch will be mechanically crimped using a straight running disc on 10-inch centers. Normally, irrigation will not be required to establish a good stand of vegetation, provided that seeding occurs at appropriate timing. Any prohibited noxious weeds that may appear in the reclaimed area will be controlled, as necessary, by chemical and/or mechanical means.
34. The bonding of disturbed lands (financial assurance) will ensure compliance with established requirements. Successful reclamation of the well site and access road will be considered completed when:
    a. reclamation has been performed according to BLM and DRMS requirements, and the total cover of live perennial vegetation, excluding noxious weeds, provides sufficient soil erosion control as determined by botanical study and the regulatory agencies through a visual appraisal per BLM monitoring requirements;
    b. disturbances resulting from flow line installations have been reclaimed to the extent that they are reasonably capable of supporting the pre-disturbance land use;
    c. a Sundry Notice has been submitted describing the final reclamation procedures and any mitigation measures associated with final reclamation; and
    d. a final reclamation inspection has been completed by the BLM and/or DRMS and there are no outstanding BLM and/or DRMS compliance issues.
35. Following the cessation of production activities, the removal of surface facilities will require approximately six months and take place between the spring and fall seasons. Revegetation of the affected portions of the lease tract will be completed during the first

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fall following production shut-down; seeding will occur according to the procedures described above. The monitoring of revegetation success will continue until bond release.

36. The monitoring program will evaluate the success of any reclamation effort and will provide recognition of any problem areas. Vegetation transects will be sampled each year at the peak of the growing season. Initially (years 1-2), cover and production are sampled. In year 2 or 3, depending on growth rate, the amount of vegetative cover, production, and plant composition will be determined as a minimum. Following sampling, appropriate mitigation measures will be identified, and any problems will be rectified. Monitoring will continue until bond release.
37. In the event that seeding is unsuccessful, potential causes for the failure will be evaluated. The soils may be tested for toxic, sodic, pH, or other conditions that may prohibit successful revegetation. Depending upon the results of this testing, the soils may be removed, covered with more suitable material, or amended to provide a more favorable growth medium.
38. The currently established NS environmental monitoring programs for vegetation and wildlife will be used to evaluate the effectiveness of revegetation, and of the impact of mining and reclamation on the wildlife populations.

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7.3 Appendix B: ExxonMobil Applicant-committed Design Features

EM will apply the following mitigation measures as part of implementing their Proposed Action:

Spill Prevention Control and Countermeasures (SPCC)

1. A site-specific SPCC Plan will be created for surface facilities and a copy provided to BLM. Substances that pose a risk of harm to human health or the environment shall be stored in appropriate containers.
2. Fluids that pose a risk of harm to human health or the environment, including but not limited to produced water, shall be stored in appropriate containers and in secondary containment systems at 110% of the largest vessel's capacity. Secondary fluid containment systems shall be lined with a minimum 24-mil impermeable liner.

Ground water Monitoring and Response

3. Ground water monitoring will take place quarterly beginning 15 months prior to the start of pyrolysis operations and extend through a period of two years after the pilot is completed. A complete list of constituents for ground water monitoring is provided in **Table B-1**.
4. Ground water monitoring well samples would be collected on a quarterly basis and analyzed by a Colorado state-certified laboratory. Analytical results would be recorded and reported to the appropriate agencies at an agreed upon format and frequency.

Table B-1. Ground water Monitoring Analytes

Constituents	Units	Constituents	Units
Field Measurements		Trace Constituents – Inorganic (Lab)	
pH		Arsenic	mg/L
Temperature	°C	Boron	mg/L
Dissolved Oxygen	mg/L	Chromium, Hexavalent	mg/L
Turbidity	ntu	Chromium, Total	mg/L
Conductivity[1]	µmho/cm	Iron	mg/L
Arsenic[2]	mg/L	Lead	mg/L
Ammonia[1]	mg/L	Lithium	mg/L
COD[1]	mg/L	Molybdenum	mg/L
General Water Quality (Lab)		Nickel	mg/L
Alkalinity (as $CaCO_3$)	mg/L	Potassium	mg/L
Hardness (as $CaCO_3$)	mg/L	Selenium	mg/L
TDS	mg/L	Sodium	mg/L
TOC	mg/L	Strontium	mg/L
Calcium	mg/L	Zinc	mg/L
Ammonia	mg/L	Trace Constituents – Organic (Lab)	
TKN	mg/L	Benzene	Pg/L
Bicarbonate	mg/L	Toluene	Pg/L
Fluoride	mg/L	Ethylbenzene	Pg/L
Chloride	mg/L	Xylenes	Pg/L
Phosphate	mg/L	TPH	mg/L
Sulfate	mg/L	Phenols	mg/L
Sulfide	mg/L		

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1. EM commits to remediation of any ground water contamination resulting from RD&D activities. The degree and level of such contamination, if any, cannot be predicted at this time. EM will develop a remediation plan in conjunction with BLM and other regulatory agencies, as appropriate.

Surface Water Monitoring and Response

2. A comprehensive Surface Water Monitoring Plan will be developed prior to the start of operations (and in parallel to the development of the Ground water Monitoring Program) to detect potential contaminants migrating from the pyrolysis zone.
3. Surface water analytes monitored will be substantially the same as those indicated in **Table B-1**.

Waste Water

4. During the early research stage, the volume of wastewater produced will be relatively small and is planned to be managed by removing H2S, and trucking the resulting produced water for appropriate off-site disposal. Such water handling operations will comply with state and local regulations and permits.
5. During later research stages, some or all of the wastewater may first be treated for reuse by skid-mounted facilities.
6. For commercial development, EM proposes to treat wastewater streams and recycle them for various process needs.

Fire Prevention and Control

7. EM will notify Craig Interagency Dispatch (970-826-5037) in the event of any fire within or in the vicinity of the proposed EM Oil Shale RD&D Lease Tract.
8. The reporting party will inform the dispatch center of the location of the fire, size, status, smoke color, aspect, fuel type and contact information.
9. The reporting party or a representative will remain nearby in order to make contact with incoming fire resources to expedite actions taken towards an appropriate management response.
10. The applicant and contractors will not engage in any fire suppression activities outside the approved project area. Accidental ignitions caused by welding, cutting, grinding, etc. will be suppressed by the applicant only if employee safety is not compromised and if the fire can be safely contained using hand tools and portable hand pumps. If chemical fire extinguishers are used, the applicant will notify incoming fire resources of the extinguisher type and the location of use.
11. Natural ignitions caused by lightning will be managed by federal fire personnel. If a natural ignition occurs within the approved project area, the fire may be initially contained by the applicant only if employee safety is not compromised. The use of heavy equipment for fire suppression is prohibited, unless authorized by the Field Office Manager. Moreover, removal of slash and woody debris associated with the proposed action shall follow mitigations as authorized.

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Air Pollution Prevention, Monitoring, and Mitigation -

12. Sources of air emissions will be evaluated, and best available control technologies (BACT) will be used as prescribed by regulations, to reduce their impact on air quality.
13. Vehicles and construction equipment will be equipped with emission controls to reduce fugitive hydrocarbon emissions (uncombusted fuel) and particulate matter.
14. Onsite incineration will be performed to mitigate generation of CO and NO_x. It is expected that sulfur containing compounds and hydrocarbons will be retained within the process system, and only flared in emergency situations.
15. Potential mitigation measures to be applied to control dust include maintaining appropriate speed limits, road cleaning and/or resurfacing for paved roads, and water spraying or use of other approved dust suppressants on unpaved roads.

Noise Abatement

16. Process facility compressors and pumps will be electric motor-driven to mitigate noise. Portable generators, if needed, will have noise control equipment installed to meet noise requirements at the lease boundary.
17. Normal construction equipment will be used for surface disturbance. Drill rigs, that will be used to drill appraisal wells, monitor wells, production wells, and observation holes will meet current noise abatement regulations.

Soil Stabilization/Erosion Control and Interim and Final Reclamation

18. Should erosion features (i.e., riling, gullying, piping and mass wasting on the surface disturbance or adjacent to the surface disturbance) occur as a result of RD&D activity, they will be addressed immediately upon observation, by first contacting the Authorized Officer and then submitting a plan to assure successful soil stabilization with best management practices (BMPs) to address erosion problems.
19. EM will:
    a. locate culverts or drainage dips in such a manner to avoid discharge onto unstable terrain such as headwalls or slumps;
    b. provide adequate spacing to avoid the accumulation of water in ditches or road surfaces;
    c. install culverts with adequate armoring of inlet and outlet;
    d. patrol areas susceptible to road or watershed damage during periods of high runoff; and
    e. keep road inlet and outlet ditches, catch basins, and culverts free of obstructions, particularly before and during spring run-off.
    f. Culverts and waterbars will be installed according to BLM Manual 9113 standards and sized for the 10-year storm event with no static head, and to pass a 25-year event without failing. BMPs associated with stormwater management/erosion control will be applied to the site during construction and drilling/ completion operations. Wattles may be used for perimeter runoff control around the location and stockpiles

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Best Available Control Technologies Application

20. EM will employ, maintain, and periodically update to the best available technology(s) prescribed by regulations aimed at reducing emissions, fresh water use and hazardous material utilization, production and releases through all phases of development and production.

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7.4 Appendix C: Natural Soda BLM-Identified Mitigations and BMPs

Table C-1. BLM-Identified Mitigations

Resource	Mitigation
AIR-1	The Applicant shall employ dust suppression techniques (i.e., freshwater use) whenever there is a visible dust trail behind service vehicles. Any technique other than the use of freshwater as a dust suppressant on BLM lands will require prior written approval from BLM.
GEOL-1	The use of Natural Soda's facilities/ponds should only be for the processing of nahcolite as approved in NSI's 2010 Mine Plan during the development of the OSR.
SOIL-1	All new infrastructure and well pads on either lease tract will be located on old disturbance to the maximum extent possible to avoid additional disturbances in the project area.
SOIL-2	NS will apply committed actions in its Plan of Operations (POO) and in its Proposed Action for achieving interim reclamation on existing facilities when any new disturbance or infrastructure is planned.
SOIL-3	Salvaged topsoil will be respread during interim reclamation on stable cut and fill slopes and other areas. Topsoil will not be stored in piles during the interim reclamation.
SOIL-4	Excess salvaged topsoil will be placed in shallow stockpiles adjacent to construction zones and operational facilities to support and maintain those characteristics of topsoil that will aid in future reclamation and revegetation efforts.
SOIL-5	All new roads and existing access roads that will routinely be used more than 4 times a month for RD&D operations or are observed to have ruts more than three inches deep will be crowned and ditched according to BLM Manual section 9113 standards and surfaced for all-weather use. Surfacing must in include at least six inches of compacted aggregate that can be composed of different gravel sizes and road base as appropriate for the soils and topography. Road design should allow for travel on the roads with service vehicles when soils are saturated.
SOIL-6	Gully crossings within both lease tracts will conform to BLM Manual 9112 standards and be stable without erosion for 10 year storm events and not fail with 25-year storm events.
SOIL-7	An impervious liner with a thickness of at least 24 mils will be required for any secondary containment structures or pits that contain liquids to be installed for new facilities or used for drilling.
WATR-1	Wellpad storage tanks will be surrounded by an impermeable secondary containment structure capable of containing 110 percent of the contents of the largest tank.

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Resource	Mitigation
VEG-1	Cut trees with a chain saw and/or mechanical shears and cutting brush with a hydro-axe or similar equipment as close to the ground as possible (six inches or less).
VEG-2	Leave stumps and root balls in place except in areas requiring topsoiling, or as necessary to create a safe and level workspace.
VEG-3	Shred or chip brush and salvage with topsoil.
VEG-4	Salvage and replace topsoil to preserve and replace existing seed banks and return organic matter needed for seed establishment to the soil. Protect and preserve topsoil as outlined in the Soils Section.
VEG-5	Restore pre-construction contours, drainage patterns, and topsoil.
VEG-6	Prepare a seedbed (scarifying, tilling, harrowing, or roughening) prior to seeding where needed to improve revegetation potential.
VEG-7	Install and maintain erosion control measures until vegetation becomes established sufficiently to stabilize disturbed soils. All materials will be certified weed-free.
VEG-8	Seeding methods should be drill seeding to ensure proper seed placement (broadcast seeding will be used only in areas where steep slopes make drill seeding impossible, and seeding rates will be doubled). Recommend seeding between September 1 and March 15.
VEG-9	Complete drill and/or broadcast seeding prior to redistribution of woody material .
INVA-1	Project proponents will provide BLM with weed management plans to address treatment from pre-disturbance, the life of the project, and through final abandonment including a summary of methods used to monitor, treat, and report the presence of noxious or undesirable invasive weeds within the project area and surrounding area (i.e., within 200 feet of areas of direct use).
INVA-2	Revegetate disturbed areas with approved, weed free seed mixes. To reduce the need for repeated bare ground herbicide treatments around facilities, apply alternative methods such as gravel, weed barrier fabric, or low-growing, disturbance-tolerant herbaceous vegetation as approved by the BLM.
INVA-3	Conduct pre-construction field surveys prior to construction to identify existing noxious weed infestations within the lease tracts.
INVA-4	Require vehicles and equipment to arrive at the work site clean, power-washed, and free of soil and vegetative debris capable of transporting weed seeds or other propagules.
SSAN-1	Construction or forest clearing activity is prohibited between February 1-August 15, inclusive, is unless a survey indicates that no functional raptor nest sites would be impacted by these activities. No surface occupancy will be allowed within ¼ mile of a goshawk nest [NSO-02] or within 1/8 mile of other raptor species nests [NSO-03].

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Resource	Mitigation
SSAN-2	Raptor surveys consistent with the most-current WRFO raptor nest survey protocols will be conducted prior to construction periods during the nesting season. If an active nest is located appropriate WRFO timing stipulations will be applied. A ½-mile timing limitation buffer will be applied to active goshawk nests [TL-01] and a ¼-mile timing limitation buffer will be applied to other active raptor nests [TL-04].
MIGR-1	For all non-raptor migratory birds, ground or vegetation disturbing activity will be avoided to the extent possible during the nesting season (May 15 – July 15).
MIGR-2	To prevent raptor electrocutions when constructing powerlines, provide adequate clearances to accommodate a large bird between energized and/or grounded parts. It is recommended to use 60 inches of horizontal separation and 48 inches of vertical separation. If adequate clearances cannot be accomplished, covering or insulating phases or grounds is recommended. In addition, perch inhibitors may be used where clearances or cover cannot be used.
WILD-1	Seed disturbed areas with native seed mixes as discussed in the Vegetation section. Detected weeds or invasive species would be controlled using herbicides and methods approved by WRFO and the RMP. BLM would identify particular seed mixes for seeding portions of the pipeline ROWs where big game forage is to be optimized. Strategic use of reclamation fencing would be required when and where necessary to achieve desired reclamation response (e.g., establishment of desired reclamation components).
WILD-2	Provide all drivers with information and possible training describing the types of wildlife species in the area that are susceptible to vehicular collisions to reduce the potential for vehicle/big-game or vehicle/raptor collisions. Identify seasonal periods where reduced vehicle speeds would be implemented as a means to reduce potential for vehicle/wildlife collisions.
WILD-3	Prevent accidental entries or inability of exit of temporary open excavations by wildlife, stock, and public by covering, fencing, sloping or flagging these areas.
WILD-4	The operator shall prevent migratory bird access to facilities that store or are expected to store fluids which may pose a risk to such birds (e.g., drowning, toxicity, compromised insulation). Features that prevent access to such fluids must be in place and functional at all times until such facilities are removed or incapable of storing fluids. All lethal and non-lethal events that involve migratory birds inadvertently gaining access to fluids will be reported to the USFWS Special Agent in Grand Junction, Colorado (970-257-0795).

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Resource	Mitigation
WILD-5	Consistent with the 1997 White River RMP and CPW's 2008 "Actions to Minimize Adverse Impacts to Wildlife Resources", vegetation clearing and high intensity construction operations would not be allowed on big game severe winter ranges from January 1 to April 30 on any of the lease tracts (involves all acreage of each lease tract) [TL-08]. Exceptions and modifications may be granted by the WRFO Field Office Manager consistent with those provisions provided for in the 1997 White River RMP.
CULT-1	The operator/holder/applicant is responsible for informing all persons who are associated with the project that they will be subject to prosecution for knowingly disturbing archaeological sites or for collecting artifacts.
CULT-2	If any archaeological materials are discovered as a result of operations under this authorization, activity in the vicinity of the discovery will cease, and the BLM WRFO Archaeologist will be notified immediately. Work may not resume at that location until approved by the AO. The operator/holder/applicant will make every effort to protect the site from further impacts including looting, erosion, or other human or natural damage until BLM determines a treatment approach, and the treatment is completed. Unless previously determined in treatment plans or agreements, BLM will evaluate the cultural resources and, in consultation with the State Historic Preservation Office (SHPO), select the appropriate mitigation option within 48 hours of the discovery. The operator/holder/applicant, under guidance of the BLM, will implement the mitigation in a timely manner. The process will be fully documented in reports, site forms, maps, drawings, and photographs. The BLM will forward documentation to the SHPO for review and concurrence.
CULT-3	Pursuant to 43 CFR 10.4(g), the operator/holder/permittee/applicant must notify the AO, by telephone and written confirmation, immediately upon the discovery of human remains, funerary items, sacred objects, or objects of cultural patrimony. Further, pursuant to 43 CFR 10.4(c) and (d), the operator/holder/permittee/applicant must stop activities in the vicinity of the discovery and protect it for 30 days or until notified to proceed by the AO.
CULT-4	No new surface disturbance is permitted within T 1S, R 98W, Sec 35 NENE of Lot 4, and T 1S, R 98W, Sec 35 N1/2NW of Lot 3.
PALE-1	A paleontological monitor will be present prior to and during any excavation into bedrock of the Uinta Formation, at the direction of the BLM.
PALE-2	The operator/holder/ is responsible for informing all persons who are associated with the project operations that they will be subject to prosecution for disturbing or collecting vertebrate fossils, collecting large amounts of petrified wood (over 25lbs./day, up to 250lbs./year), or collecting fossils for commercial purposes on public lands.

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Resource	Mitigation
PALE-3	If any paleontological resources are discovered as a result of operations under this authorization, Applicants or any of their agents must stop work immediately at that site, immediately contact the BLM Paleontology Coordinator, and make every effort to protect the site from further impacts, including looting, erosion, or other human or natural damage. Work may not resume at that location until approved by the AO. The BLM or designated paleontologist will evaluate the discovery and take action to protect or remove the resource within 10 working days. Within 10 working days, the operator will be allowed to continue construction through the site, or will be given the choice of either (a) following the Paleontology Coordinator's instructions for stabilizing the fossil resource in place and avoiding further disturbance to the fossil resource, or (b) following the Paleontology Coordinator's instructions for mitigating impacts to the fossil resource prior to continuing construction through the project area.
VIS-1	In consultation with the BLM WRFO Visual Resource Specialist, all above ground facilities will be painted a color selected from the BLM Standard Environmental Color Chart CC-001: June 2008 to blend with the surrounding landscape.
FRST-1	In accordance with the 1997 White River RMP/ROD, all trees removed in the process of construction shall be purchased from the BLM. Prior to any surface disturbing activities, the operator must purchase and obtain a commercial vegetative materials removal permit from the WRFO-BLM. Once it is known where the infrastructure will be constructed, the amount of cords per acre to be removed must be determined and WRFO must be notified. This volume will be used to charge the applicant for the vegetative materials removed. Trees should first be used in reclamation efforts and then any excess material made available for firewood or other uses.
FRST-2	Woody material smaller than 4 inches in diameter will be chipped and stockpiled for later use in reclamation. Woods chips can be incorporated into the topsoil layer to add an organic component to the soil to aid in reclamation success.
FRST-3	Woody materials, not used for woods chips, required for reclamation shall be removed in whole with limbs intact and shall be stockpiled along the margins of the authorized use area separate from the topsoil piles. Once the disturbance has been recontoured and reseeded, stockpiled woody material shall be scattered across the reclaimed area where the material originated. Redistribution of woody debris will not exceed 20-30 percent ground cover. Limbed material shall be scattered across reclaimed areas in a manner that avoids the development of a mulch layer that suppresses growth or reproduction of desirable vegetation. Woody material will be distributed in such a way to avoid large concentrations of heavy fuels and to effectively deter vehicle use.

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Resource	Mitigation
FRST-4	Trees that must be removed for construction and are not required for reclamation shall be cut down to a stump height of 6 inches or less prior to other heavy equipment operation. These trees shall be cut in four foot lengths (down to 4 inches diameter) and placed in manageable stacks immediately adjacent to a public road to facilitate removal for company use or removal by the public.
RANG-1	Project proponents must repair or replace to BLM specifications any livestock control facilities and/or rangeland improvements (e.g., fences, waterlines ponds, water tanks, etc.) impacted during this operation. Measures will be taken to maintain the function of these projects throughout construction and the life of these projects (i.e., temporary fences during specific construction activities to prevent livestock drift between pastures until permanent fences can be reconstructed).
REAL-1	If installation of linear facilities results in crossing existing federal ROWs, the applicant will coordinate activities with the ROW holder(s).
REAL-2	ROW application(s) will be submitted for any off-lease facilities and/or access roads. WREA will submit a ROW application for installation of power lines crossing BLM lands.

Table C-2. BLM BMPs

Resource	Best Management Practice
VEG-B1	Minimize vegetation removal to the extent necessary to allow for safe and efficient construction activities.
INVA-B1	Keep all disturbed areas as free of noxious weeds and undesirable species as practicable during drilling, production, and reclamation operations. Diffuse knapweed should be monitored particularly closely. Ensure that weed treatments are conducted in an effective manner compatible with approved seed mixes.

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7.5 Appendix D: ExxonMobil BLM-Identified Mitigations and BMPs

Table D-1. BLM-Identified Mitigations

Resource	Mitigation
AIR-1	The Applicant shall employ dust suppression techniques (i.e., freshwater use) whenever there is a visible dust trail behind service vehicles. Any technique other than the use of freshwater as a dust suppressant on BLM lands will require prior written approval from BLM.
GEOL-2	To limit interference with the use of Willliams' existing well pad RGU 31-34-198 EM shall contact Williams prior to commencement of construction activities associated with the RD&D lease tract.
SOIL-1	All new infrastructure and well pads on either lease tract will be located on old disturbance to the maximum extent possible to avoid additional disturbances in the project area.
SOIL-2	EM will apply committed actions in their respective Plan of Operations (POOs) and in their respective Proposed Actions for achieving interim reclamation on existing facilities when any new disturbance or infrastructure is planned.
SOIL-3	Salvaged topsoil will be respread during interim reclamation on stable cut and fill slopes and other areas. Topsoil will not be stored in piles during the interim reclamation.
SOIL-4	Excess salvaged topsoil will be placed in shallow stockpiles adjacent to construction zones and operational facilities to support and maintain those characteristics of topsoil that will aid in future reclamation and revegetation efforts.
SOIL-5	All new roads and existing access roads that will routinely be used more than 4 times a month for RD&D operations or are observed to have ruts more than three inches deep will be crowned and ditched according to BLM Manual section 9113 standards and surfaced for all-weather use. Surfacing must in include at least six inches of compacted aggregate that can be composed of different gravel sizes and road base as appropriate for the soils and topography. Road design should allow for travel on the roads with service vehicles when soils are saturated.
SOIL-6	Gully crossings within both lease tracts will conform to BLM Manual 9112 standards and be stable without erosion for 10 year storm events and not fail with 25-year storm events.
SOIL-7	An impervious liner with a thickness of at least 24 mils will be required for any secondary containment structures or pits that contain liquids to be installed for new facilities or used for drilling.
WATR-1	Wellpad storage tanks will be surrounded by an impermeable secondary containment structure capable of containing 110 percent of the contents of the largest tank.

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Resource	Mitigation
VEG-1	Cut trees with a chain saw and/or mechanical shears and cutting brush with a hydro-axe or similar equipment as close to the ground as possible (six inches or less).
VEG-2	Leave stumps and root balls in place except in areas requiring topsoiling, or as necessary to create a safe and level workspace.
VEG-3	Shred or chip brush and salvage with topsoil.
VEG-4	Salvage and replace topsoil to preserve and replace existing seed banks and return organic matter needed for seed establishment to the soil. Protect and preserve topsoil as outlined in the Soils Section.
VEG-5	Restore pre-construction contours, drainage patterns, and topsoil.
VEG-6	Prepare a seedbed (scarifying, tilling, harrowing, or roughening) prior to seeding where needed to improve revegetation potential.
VEG-7	Install and maintain erosion control measures until vegetation becomes established sufficiently to stabilize disturbed soils. All materials will be certified weed-free.
VEG-8	Seeding methods should be drill seeding to ensure proper seed placement (broadcast seeding will be used only in areas where steep slopes make drill seeding impossible, and seeding rates will be doubled). Recommend seeding between September 1 and March 15.
VEG-9	Complete drill and/or broadcast seeding prior to redistribution of woody material .
INVA-1	Project proponents will provide BLM with weed management plans to address treatment from pre-disturbance, the life of the project, and through final abandonment including a summary of methods used to monitor, treat, and report the presence of noxious or undesirable invasive weeds within the project area and surrounding area (i.e., within 200 feet of areas of direct use).
INVA-2	Revegetate disturbed areas with approved, weed free seed mixes. To reduce the need for repeated bare ground herbicide treatments around facilities, apply alternative methods such as gravel, weed barrier fabric, or low-growing, disturbance-tolerant herbaceous vegetation as approved by the BLM.
INVA-3	Conduct pre-construction field surveys prior to construction to identify existing noxious weed infestations within the lease tracts.
INVA-4	Require vehicles and equipment to arrive at the work site clean, power-washed, and free of soil and vegetative debris capable of transporting weed seeds or other propagules.
SSAN-1	Construction or forest clearing activity is prohibited between February 1-August 15, inclusive, unless a survey indicates that no functional raptor nest sites would be impacted by these activities. No surface occupancy will be allowed within ¼ mile of a goshawk nest [NSO-02] or within 1/8 mile of other raptor species nests [NSO-03].

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Resource	Mitigation
SSAN-2	Raptor surveys consistent with the most-current WRFO raptor nest survey protocols will be conducted prior to construction periods during the nesting season. If an active nest is located appropriate WRFO timing stipulations will be applied. A ½-mile timing limitation buffer will be applied to active goshawk nests [TL-01] and a ¼-mile timing limitation buffer will be applied to other active raptor nests [TL-04].
MIGR-1	For all non-raptor migratory birds, ground or vegetation disturbing activity will be avoided to the extent possible during the nesting season (May 15 – July 15).
MIGR-2	To prevent raptor electrocutions when constructing powerlines, provide adequate clearances to accommodate a large bird between energized and/or grounded parts. It is recommended to use 60 inches of horizontal separation and 48 inches of vertical separation. If adequate clearances cannot be accomplished, covering or insulating phases or grounds is recommended. In addition, perch inhibitors may be used where clearances or cover cannot be used.
WILD-1	Seed disturbed areas with native seed mixes as discussed in the Vegetation section. Detected weeds or invasive species would be controlled using herbicides and methods approved by WRFO and the RMP. BLM would identify particular seed mixes for seeding portions of the pipeline ROWs where big game forage is to be optimized. Strategic use of reclamation fencing would be required when and where necessary to achieve desired reclamation response (e.g., establishment of desired reclamation components).
WILD-2	Provide all drivers with information and possible training describing the types of wildlife species in the area that are susceptible to vehicular collisions to reduce the potential for vehicle/big-game or vehicle/raptor collisions. Identify seasonal periods where reduced vehicle speeds would be implemented as a means to reduce potential for vehicle/wildlife collisions.
WILD-3	Prevent accidental entries or inability of exit of temporary open excavations by wildlife, stock, and public by covering, fencing, sloping or flagging these areas.
WILD-4	The operator shall prevent migratory bird access to facilities that store or are expected to store fluids which may pose a risk to such birds (e.g., drowning, toxicity, compromised insulation). Features that prevent access to such fluids must be in place and functional at all times until such facilities are removed or incapable of storing fluids. All lethal and non-lethal events that involve migratory birds inadvertently gaining access to fluids will be reported to the USFWS Special Agent in Grand Junction, Colorado (970-257-0795).

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Resource	Mitigation
WILD-5	Consistent with the 1997 White River RMP and CPW's 2008 "Actions to Minimize Adverse Impacts to Wildlife Resources", vegetation clearing and high intensity construction operations would not be allowed on big game severe winter ranges from January 1 to April 30 on any of the lease tracts (involves all acreage of each lease tract) [TL-08]. Exceptions and modifications may be granted by the WRFO Field Office Manager consistent with those provisions provided for in the 1997 White River RMP.
CULT-1	The operator/holder/applicant is responsible for informing all persons who are associated with the project that they will be subject to prosecution for knowingly disturbing archaeological sites or for collecting artifacts.
CULT-2	If any archaeological materials are discovered as a result of operations under this authorization, activity in the vicinity of the discovery will cease, and the BLM WRFO Archaeologist will be notified immediately. Work may not resume at that location until approved by the AO. The operator/holder/applicant will make every effort to protect the site from further impacts including looting, erosion, or other human or natural damage until BLM determines a treatment approach, and the treatment is completed. Unless previously determined in treatment plans or agreements, BLM will evaluate the cultural resources and, in consultation with the State Historic Preservation Office (SHPO), select the appropriate mitigation option within 48 hours of the discovery. The operator/holder/applicant, under guidance of the BLM, will implement the mitigation in a timely manner. The process will be fully documented in reports, site forms, maps, drawings, and photographs. The BLM will forward documentation to the SHPO for review and concurrence.
CULT-3	Pursuant to 43 CFR 10.4(g), the operator or lessee must notify the AO, by telephone and written confirmation, immediately upon the discovery of human remains, funerary items, sacred objects, or objects of cultural patrimony. Further, pursuant to 43 CFR 10.4(c) and (d), the operator or lessee must stop activities in the vicinity of the discovery and protect it for 30 days or until notified to proceed by the AO.
PALE-1	A paleontological monitor will be present prior to and during any excavation into bedrock of the Uinta Formation, at the direction of the BLM.
PALE-2	The lessee is responsible for informing all persons who are associated with the project operations that they will be subject to prosecution for disturbing or collecting vertebrate fossils, collecting large amounts of petrified wood (over 25lbs./day, up to 250lbs./year), or collecting fossils for commercial purposes on public lands.

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Resource	Mitigation
PALE-3	If any paleontological resources are discovered as a result of operations under this authorization, lessees/operators or any of their agents must stop work immediately at that site, immediately contact the BLM Paleontology Coordinator, and make every effort to protect the site from further impacts, including looting, erosion, or other human or natural damage. Work may not resume at that location until approved by the AO. The BLM or designated paleontologist will evaluate the discovery and take action to protect or remove the resource within 10 working days. Within 10 working days, the operator will be allowed to continue construction through the site, or will be given the choice of either (a) following the Paleontology Coordinator's instructions for stabilizing the fossil resource in place and avoiding further disturbance to the fossil resource, or (b) following the Paleontology Coordinator's instructions for mitigating impacts to the fossil resource prior to continuing construction through the project area.
VIS-1	In consultation with the BLM WRFO Visual Resource Specialist, all above ground facilities will be painted a color selected from the BLM Standard Environmental Color Chart CC-001: June 2008 to blend with the surrounding landscape.
FRST-1	In accordance with the 1997 White River RMP/ROD, all trees removed in the process of construction shall be purchased from the BLM. Prior to any surface disturbing activities, the operator must purchase and obtain a commercial vegetative materials removal permit from the WRFO-BLM. Once it is known where the infrastructure will be constructed, the amount of cords per acre to be removed must be determined and WRFO must be notified. This volume will be used to charge the applicant for the vegetative materials removed. Trees should first be used in reclamation efforts and then any excess material made available for firewood or other uses.
FRST-2	Woody material smaller than 4 inches in diameter will be chipped and stockpiled for later use in reclamation. Woods chips can be incorporated into the topsoil layer to add an organic component to the soil to aid in reclamation success.
FRST-3	Woody materials, not used for woods chips, required for reclamation shall be removed in whole with limbs intact and shall be stockpiled along the margins of the authorized use area separate from the topsoil piles. Once the disturbance has been recontoured and reseeded, stockpiled woody material shall be scattered across the reclaimed area where the material originated. Redistribution of woody debris will not exceed 20-30 percent ground cover. Limbed material shall be scattered across reclaimed areas in a manner that avoids the development of a mulch layer that suppresses growth or reproduction of desirable vegetation. Woody material will be distributed in such a way to avoid large concentrations of heavy fuels and to effectively deter vehicle use.

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Resource	Mitigation
FRST-4	Trees that must be removed for construction and are not required for reclamation shall be cut down to a stump height of 6 inches or less prior to other heavy equipment operation. These trees shall be cut in four foot lengths (down to 4 inches diameter) and placed in manageable stacks immediately adjacent to a public road to facilitate removal for company use or removal by the public.
RANG-1	Project proponents must repair or replace to BLM specifications any livestock control facilities and/or rangeland improvements (e.g., fences, waterlines ponds, water tanks, etc.) impacted during this operation. Measures will be taken to maintain the function of these projects throughout construction and the life of these projects (i.e., temporary fences during specific construction activities to prevent livestock drift between pastures until permanent fences can be reconstructed).
REAL-1	If installation of linear facilities results in crossing existing federal ROWs, the applicant will coordinate activities with the ROW holder(s).
REAL-2	ROW application(s) will be submitted for any off-lease facilities and/or access roads. WREA will submit a ROW application for installation of power lines crossing BLM lands.

Table D-2. BLM BMPs

Resource	Best Management Practice
VEG-B1	Minimize vegetation removal to the extent necessary to allow for safe and efficient construction activities.
INVA-B1	Keep all disturbed areas as free of noxious weeds and undesirable species as practicable during drilling, production, and reclamation operations. Diffuse knapweed should be monitored particularly closely. Ensure that weed treatments are conducted in an effective manner compatible with approved seed mixes.
INVA-B2	Consult with BLM and local weed agencies to develop treatment strategies for noxious weed infestations identified during surveys.

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7.6 Appendix E: Natural Soda Process Details for Air Emissions

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7.7 Appendix E: Natural Soda Process Details for Air Emissions

The following are clarifications of NS emissions and processes provided by Compliance Partners, Inc. These clarifications are a result of conversation held between Compliance Partners Inc. and NS for air emission claculations..

Detail and quantification of emissions from gas venting during drilling and completion operations

The wells that will be drilled for this project will not be conventional oil and gas wells in that there will be no oil or gas present at the time the wells will be completed. The wells will be drilled into a formation that will be solution-mined to prepare a *reaction chamber* where the conversion of the kerogen rock will occur. The presence of oil or gas will only occur once this conversion commences. As such, there will be no gas venting during drilling and completion activities.

Detail and calculations on emissions during Phase I—nacholite solution mining

The solution mining activity during Phase I will simply displace solution mining volumes from existing operations. No increase above current emission levels is anticipated during this phase. Emissions due to surface support activities of the new well(s) has been accounted for in the current emission inventory.

Changes to Emissions at the adjoining sodium bicarbonate facility

Emissions from existing Natural Soda operations will not be affected by the activities associated with the RD&D project

Detail for Phase II liquefaction process, including indirect emissions from natural gas demand/combustion for downhole burner

The objective of downhole combustion is to produce CO that will be a reactant for the liquefaction process. As such, combustion will occur in an oxygen-starved environment to partially oxidize the methane in the natural gas. The sulfur, volatile carbon and nitrogen in the kerogen rock will ultimately oxidize to SO_2, CO_2 and NO_X. Any gas produced will ultimately feed to a thermal oxidizer on the surface, and emissions from this unit are quantified in the attachment.

Emissions from gas injection pumps

The compressors that will inject natural gas downhole will be electrically-driven and no emissions will occur from these units.

Gas venting during liquefaction process

No gas will be *vented* during the liquefaction process. Any gas produced during this phase of the process that is brought to the surface will first feed to a thermal oxidizer and then to a caustic scrubber.

The liquefaction process will occur in zones of approximately 40 vertical feet each comprised of approximately 280 tons of kerogen rock that may be available for liquefaction. Gas produced during liquefaction will be comprised of the volatile material, sulfur and nitrogen that are in the native material. The volatile material content of the kerogen rock is estimated to be 2 weight

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percent with an average molecular weight of 37 lb/mole and an average carbon count of 2.5. The sulfur and nitrogen content are each also estimated at 2 weight percent.

The volatile constituents released during liquefaction will be combusted by the downhole burner if/when produced forming CO_2 and H_2O. Gaseous sulfur compounds formed during liquefaction will also be combusted and will ultimately be oxidized to SO_2. It is estimated that 85 percent of the nitrogen in the native material will be converted to ammonia. Up to 95 percent of the ammonia formed will be combusted and ultimately oxidized to NO_X. The total volume of gases produced during liquefaction is calculated to be approximately 338.6 Mscf per interval.

A total of about 1.31 MMscf of natural gas will be supplied to the downhole burner per liquefaction zone. This gas will be completely oxidized to CO_2 and H_2O. The total volume of gas produced as a result of this combustion is estimated to be 3.93 MMscf, which is more than 10 times the amount that will be produced from the native material during liquefaction. We therefore estimate a total gas volume of 4.27 MMscf per interval.

Detail on Phase III extraction process, including emissions from flash drum and separation process or stabilization

The purpose of the flash drum is to affect three-phase separation; gas, oil and water. Any gas that exits the flash drum will be fed to the thermal oxidizer where it will be oxidized to CO_2 and H_2O. The oil will be sent to atmospheric storage tanks. Emissions from these tanks were quantified. We do not anticipate emissions of regulated air pollutants from the produced water storage tanks.

Detail on scrubber and calculated emissions from this source or combustor

Produced gas will pass through a two phase separator to remove any entrained liquid and then to a caustic scrubber. An aqueous solution of sodium hydroxide (NaOH) will be circulated counter-currently to the gas that will absorb reduced sulfur compounds that will remain in the spent liquor as a sodium salt.

As discussed above, the total amount of sulfur anticipated in the kerogen rock is 2 weight percent. Each interval is estimated to contain approximately 280 tons of native material that may be available for liquefaction. As such, up to 5.6 tons of sulfur may gasify in each interval produced. Approximately 11.2 tons per interval of SO_2 may be produced.

The expected sulfur removal rate is at least 80 percent. Our original emission inventory did not assume any sulfur removal and presented an uncontrolled emission rate of SO_2. The controlled emission rate calculated on the above basis is estimated at 2.2 tons per 40-foot interval.

Detail on the potential for H_2S emissions, emission controls, sulfur recovery, other sulfur compounds.

Information relating to the control of sulfur compound emissions was provided above. There is very little potential for emissions of H_2S. Any H_2S formed during liquefaction will be oxidized to SO_2 by the downhole burner. Any trace amounts of H_2S that may be present in gas brought to the surface will be oxidized to SO_2 by the thermal oxidizer.

Emissions from scrubber and waste tank

The scrubber and waste tank will store primarily spent scrubber aqueous liquor and produced water. There is negligible potential for emissions from these vessels.

Produced water sent to existing Natural Soda evaporation pond

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The produced water will be sent to third-party disposal facilities and not to existing Natural Soda ponds.

Disposition of produced gas

The gas produced from the wells will be 99+ percent CO_2 and water and of no value. It will be combusted at a thermal oxidizer to ensure complete oxidation of all sulfur compounds to SO_2, and then be fed to a caustic scrubber to remove the SO_2. The exhaust from the scrubber will be nearly completely comprised of CO_2 and water with trace amounts of NO_X and CO that will primarily form in the thermal oxidizer.

Surface boiler, transfer inject pumps, process equipment heaters

There will be no fuel burning equipment located at the surface, and all pumps will be electrically driven

Estimated GHGs from all activities, especially for the downhole burner.

The greenhouse gas emissions were estimated for all combustion-related surface equipment like vehicle engines. Greenhouse gas emissions due to gas produced during liquefaction and the downhole burner were also estimated in our original inventory, but greenhouse gas emissions due to the thermal oxidizer may not have been fully vetted. These emission estimates have been corrected in the revised emissions inventory and the accompanying attachment.

Produced Gas and Thermal Oxidizer Emissions Estimate

I have reviewed the material balance basis for the gas that will be produced during liquefaction and have revised a few of the calculations that Natural Soda provided to better reflect how the produced gas will be treated once it is brought to the surface. These calculations assume that 2 percent of the material liquefied will be volatile material (hydrocarbon vapors) and that they will be nearly all combusted by the downhole burner if/when produced. The CO_2 calculations were also revised to reflect that all of this material will be oxidized to CO_2 whether it is combusted downhole or at the surface.

I understand that the downhole reaction will produce ammonia, and this ammonia will be oxidized by the downhole burner. This oxidation will produce NO_X. The calculations provided by Natural Soda assumed that 80 percent of the nitrogen will convert to ammonia. Ultimately, all the nitrogen that is freed up during the reaction downhole will be oxidized, either by the downhole burner or the surface thermal oxidizer. As such, the NO_X emissions are much higher than was previously estimated. A revised emission estimate for the produced gas/thermal oxidizer is attached.

Sincerely,

COMPLIANCE PARTNERS, INC.

Gary McFaddin

Gary McFaddin, P.E.

Principal

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Produced Gas and Thermal Oxidizer Emissions Estimates

Gases Formed During Liquefaction	Wt %	ton/Interval	Constituent at Surface	scf/Interval	Uncontrolled ton/Interval	Controlled Total Tons
Volatile	2	5.6	CO2	286811	16.6	249.7
			H2O	114725		
Sulfur	2	5.6	SO2	132650	11.2	33.6
Nitrogen	2	4.8	NOX	244834	14.9	234.6
			NH3	34868	0.8	0.0
Down Hole Fuel Gas			CO2	1307784	75.9	1138.7
			H2O	2615569		
TO Supplemental Fuel (to achieve 300 Btu/scf)			CO2	2186419	126.9	1903.7
			H2O	4372838		
			NOX		0.1	1.7
TO Temp Maintenance			CO		0.6	9.4
			NOX			5.5
			CO			30.0
			CO2			9898.6
Emissions Summary						
NOX					15.5	241.8
CO					0.6	39.4
SO2					11.2	33.6
CO2					219.5	13190.8

The duration of each phase of the project is unknown. A conservative estimate of annual emissions is developed by averaging the project 10-year total emissions over an 8-year period

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8 Finding of No Significant Impact (FONSI)

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Finding of No Significant Impact (FONSI)

U.S. Department of the Interior

Bureau of Land Management

White River Field Office

220 E Market St

Meeker, CO 81641

Finding of No Significant Impact (FONSI)

DOI-BLM-CO-110-2011-0177-EA

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BACKGROUND

As provided for by Federal Register notice 74 FR 56867-56869 (November 3, 2009), the BLM solicited nominations for a second round of parcels to be leased for research, development, and demonstration (RD&D) of shale oil recovery technologies as authorized in Energy Policy Act of 2005, Public Law 109-58, §369(c), which codified procedures for leasing the public lands for oil shale RD&D projects.

Natural Soda holdings Inc. (NS) and ExxonMobil Exploration Company (EM) submitted nominations which were warranted for further consideration by the Colorado State Office of the Bureau of Land Management (BLM) for a RD&D Oil Shale Lease and any supporting rights-of-way pursuant to the BLM's authority to lease Federal lands for oil shale development under section 21 of the Mineral Leasing Act, 30 U.S.C. 241. The Proposed Action includes the construction, operation, and maintenance of oil shale research facilities located in the Piceance Creek Basin approximately 36 miles southwest of Meeker, Colorado.

As a result of further consideration of nominations, the Bureau of Land Management (BLM), White River Field Office (WRFO) conducted an environmental analysis (DOI-BLM-CO-110-2011-0177-EA) for a Proposed Action and Alternatives related to the leasing of two 160-acre tracts of land administered by the BLM for the purpose of exploring the economic viability of shale oil extraction, and to conduct research on modern technologies as a means to extract the liquid fuels from oil shale in an environmentally responsible manner. BLM has determined that the proposed Oil Shale Research, Development and Demonstration (RD&D) projects will have no significant impact on health or the human environment.

NS and EM have proposed research projects to evaluate the feasibility and commercial viability of in-situ oil shale development geologically located in an area association with sodium minerals. The intent of this proposal is to achieve a "proof of concept". That is, while laboratory experiments and theoretical calculations indicate that various in-situ methodologies are viable commercial options, none have been thoroughly field tested to evaluate their practical application. The Proposed Action provides the opportunity to apply those specific technologies under field conditions. The project results will advance our knowledge of these methodologies regardless of whether or not they prove to be commercially viable.

The proponents' research will gather additional data on recovery of oil and gas from oil shale deposits with high concentration of sodium minerals using conventional drilling methods, controlled fracturing, and heating technologies to convert kerogen to oil and gas.

The intent of the NS proposal is to prove an in-situ development and production method that initially recovers the sodium resource (nahcolite - sodium bicarbonate) followed by liquefying the kerogen left in place with the use of down hole burners.

The intent of EM proposal is to create an in-situ electrical resistive heating element by filling controlled horizontal fractures with nonhazardous conductive material. This methodology utilizes horizontal and vertical wells to control the horizontal fracture network, and to contain the process within a vertically and horizontally limited production interval. EM would demonstrate the availability of the sodium resources for future recovery upon completion of the hydro carbon removal from the oil shale,

The BLM has concluded that analyzing the proposed recovery processes is warranted and may advance knowledge regarding the commercial viability of in-situ technologies for hydrocarbon recovery from oil shale.

In addition to the Proposed Action, the BLM has analyzed the environmental impacts of the Proposed Action with Mitigation measures applied to the project design. The analysis assesses the environmental consequences of the Proposed Action, enumerates alternative mitigation actions, and evaluates the consequences of the mitigation. The mitigation measures, in addition to the project design features of the Proposed Action, are intended to reduce the impacts to human health and environment and to minimize surface use conflicts. A summary of the applicant committed design features (ACDF) associated with the Proposed Action is provided in appendices A and B of the EA. Additional BLM mitigations associated with the alternative mitigation actions, is provided in Appendices C and D of the EA.

The BLM proposes leasing two a 160-acre tract located approximately 36 miles southwest of Meeker, Colorado, and requiring the applicant to submit, as a standard lease term, a Plan of Development for an oil shale research, development, and demonstration project. The tracts are adjacent to each other and are situated on a ridge between Ryan Gulch and Yellow Creek at elevations ranging from 6,600 to 6,760 feet.

FINDING OF NO SIGNFICANT IMPACT

Based on the analysis of potential environmental impacts contained in the attached environmental assessment, and considering the significance criteria in 40 CFR 1508.27, I have determined that the Proposed Action with Mitigation will not have a significant effect on the human environment. An environmental impact statement is therefore not required.

Context

The projects are site-specific actions directly involving up to 120 acres of surface disturbance within 320 acres of land administered by the BLM and. While the technology advanced by the EM and NS oil shale RD&D projects could have national. regiona1, and state-wide importance for their contribution to unlocking significant shale oil resources that could help to supply the Nation's future domestic energy needs, these projects, in and of their self, are not likely to produce oil in quantities that would contribute to domestic supplies.

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The primary human influences on the project area are oil and gas development, historic oil shale and current oil shale RD&D, nahcolite mining, and livestock grazing. Existing environmental conditions in the project area reflect changes based on past projects and activities. The project area is rural and relatively undeveloped but is experiencing growth related to energy development.

Intensity

The following discussion is organized around the 10 Significance Criteria described at 40 CFR 1508.27. The following have been considered in evaluating intensity for this Proposed Action:

1. Impacts that may be both beneficial and adverse. The beneficial effects of the proposed RD&D projects include the advancement of innovative technologies to explore and develop the abundant oil shale resources within the Piceance Creek Basin to meet the needs of our nation's future energy requirements. Opting for a small-scale, staged approach to oil shale development provides an opportunity to prove the concept of the technologies involved so as to ensure operation at economic and environmentally acceptable levels before expansion of the RD&D leases to commercial operations can be authorized on public lands. The proposed RD&D projects could add to the collective knowledge regarding the viability of an un-tested technology for use in oil shale development on a commercial scale.

The in-situ (in-place) technologies proposed would not permanently modify the land surface, and if the RD&D efforts prove to be sub-economic, the project would be more easily dismantled and lands could be more easily reclaimed with minimal adverse environmental impact.

Adverse effects include the potential for impacts to air, soils, vegetation, water resources, wildlife, recreation, and visual resources that would occur during construction and operation of the Proposed Action with Mitigation.

2. The degree to which the Proposed Action affects public health or safety.

The design features, environmental commitments, permit requirements, and industry specifications and regulations included in the Proposed Action with Mitigation for the construction, operation, and maintenance of the oil shale RD&D facilities together with supporting access, utility rights-of-way, and lease issuance achieves the balance of resource protection and beneficial uses of the human environment envisioned by the National Environmental Policy Act. In contrast to oil shale development ventures prior to 2007, the small-scale RD&D program would have minimal impacts on the socio-economic infrastructure of local communities. Environmental commitments, and mitigation measures described in this EA, would minimize any public safety effects during project construction and operation.

3. Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas. There are no known park lands, prime farmlands, wild and scenic rivers or ecologically critical areas in the project area. As described in the EA, impacts to wetlands resulting from water usage for the projects would be minimal due to source location and the relatively low water demand of the projects. As results of cultural surveys of the EM lease tract no National Register of Historic Places (NRHP) eligible sites have been located within the EM lease tract. The NS lease tract contains one site determined as Officially Needs Data by the Colorado Office of Archaeology and Historic Preservation (OAHP) due to its potential for buried cultural deposits. The Proposed Action with Mitigation provides protection of the site located on

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the NS lease by a requirement applying a No Surface Occupancy (NSO) on an area that includes a 100 meter buffer of the site. In addition, the Proposed Action with Mitigation contains requirements and contingencies in the event that previously unknown cultural resources are identified.

4. Degree to which the possible effects on the quality of the human environment are likely to be highly controversial. Public input regarding the Proposed Action with Mitigation has been solicited throughout the RD&D planning process. Public involvement included open house forums that provided opportunities for the public to view the technologies proposed and to interact with industry representatives about the proposed oil shale leases and activities. Letters for comments were sent to 12 different local, state and federal agencies.

During the public scoping period six written comments were received: four from members of the general public, one from environmental advocacy groups and one from Colorado Parks and Wildlife (CPW). Concerns were raised about impacts to surface and ground water resources, air quality, wilderness values, and wildlife resources. These impacts have been reduced or minimized through the implementation of mitigation measures. Other comments included; inefficient process design of the proposed technologies, oil and gas leasing and operations, the ongoing oil shale Programmatic Environmental Impact Statement (PEIS), resource recovery, and support for a third round of RD&D leasing.

Based on the number and content of the comments received from the public, the effects of the RD&D program on the quality of the human environment are not considered highly controversial. However, the past oil shale boom and bust cycles, most recently the bust of May 2, 1983 which resulted in significant adverse impact to the social and economic stability of western Colorado, increase the likelihood that a high level of public interest in the implementation and demonstration of feasibility associated with the RD&D leases can be expected.

5. Degree to which the possible effects on the quality of the human environment are highly uncertain or involve unique or unknown risk. The projects utilize conventional drilling techniques, and modified fracturing and heating technologies to convert kerogen to oil and gas. Anticipated effects on the quality of the human environment as a result of the proposed technology have been thoroughly identified, analyzed, and mitigated to an insignificant level. Due to the nature of the RD&D program, some degree of uncertainty is to he expected. The small-scale approach of initiating research on 160 acre parcels reduces risk by providing an opportunity to field test operations at environmentally acceptable level of risk. The technologies proposed would disturb up to a total of 120 surface acres for both projects. ExxonMobil and Natural Soda will develop various response and mitigation plans as part of their approved Plan of Development.

No highly uncertain or unknown risks to the human environment were identified during the analysis of the Proposed Action.

6. Degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.

The Proposed Actions are site-specific actions directly involving 320 acres of land administered by the BLM. ExxonMobil and Natural Soda Holdings., Inc. have applied for leases to be issued for a term of ten years with the option for an extension not to exceed five years upon

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demonstration of the satisfaction of the Authorized Officer that a process leading to production in commercial quantities is being diligently pursued. The leases are subject to conversion to a twenty-year lease upon documenting to the satisfaction of the Authorized Officer that it has produced commercial quantities of shale oil from the lease. The Lessee has the exclusive right to convert the research and development lease acreage to a commercial lease and acquire any or all portions of the remaining preference lease area up to a total of 640 contiguous acres each. Additional NEPA analysis would be required prior to commercial development of the preference lease acreage.

The demonstration of the feasibility of the proposed technologies could result in increased interest in using BLM-administered lands for energy production. However, this action does not represent a decision in principle about a future consideration.

The BLM will base future decisions with respect to land use planning for a commercial leasing of oil shale and tar sands resources on public lands within each of the states of Colorado, Utah, and Wyoming on the "*Resource Management Plan (RMP) Amendments and PElS for the Allocation of Oil Shale and Tar Sands Resources on Lands Administered by the BLM in Colorado, Utah, and Wyoming*" when final. Those decisions will be made independently of this action, except insofar as results of the proposed EM and NS projects may add to our information about in-situ technology.

7. Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. The study area for cumulative impacts is the area within CPW's Game Management Unit (GMU) 22 managed by the BLM WRFO. Of the 632,894 acres of land within GMU 22, the surface of 444,758 acres is managed by the BLM. Estimates of the total past, present, and foreseeable future surface disturbance from oil and gas development and oil shale and nahcolite mining are estimated to equate to 3.2 percent of GMU 22. The 120 acres of surface disturbance associated with these two projects equate to 0.6 percent of all past, present, and future proposed actions, and 0.03 percent of GMU 22 managed by BLM WRFO.

The Proposed Action with Mitigation would not individually have a significant impact on any natural resource within the Piceance Creek Basin or within the communities of the region. However, cumulative impacts to natural resources could occur as the Proposed Action with Mitigation operates in conjunction with other past, present, or reasonably foreseeable future actions, such as the expanding oil and gas production operations in northwestern Colorado. These impacts would be long term, but not permanent, wou1d occur over a relatively small percentage of land when compared to the overall size of GMU22 and would not result in significant impact to any areas of historic, cultural, or biological importance. Monitoring, pollution prevention and permitting requirements further alleviate the possibility of any significant cumulative impacts associated with the RD&D projects.

8. The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed on the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources. As mention above, results of cultural surveys of the EM lease tract identified no sites eligible for National Register of Historic Places (NRHP) within the EM lease tract. The NS lease tract contains one site determined as Officially Needs Data by the Colorado Office of Archaeology and Historic Preservation (OAHP) due to its of its potential for buried cultural deposits. The Proposed Action with Mitigation provides protection of the site located on the NS lease by a requirement applying a No Surface Occupancy

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(NSO) on an area that includes a 100 meter buffer of the site. In addition, the Proposed Action with Mitigation contains requirements and contingencies in the event that previously unknown cultural resources are identified.

9. The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act (ESA) of 1973. The third party contractor for the BLM prepared a Biological Assessment (BA) in compliance with Section 7(c) of the Endangered Species Act (ESA) and submitted to the BA to USFWS in April 2012 to commence formal consultation of the potential impacts to federally listed, proposed, and candidate endangered and threatened species and addressed water depleting activities associated with the projects. Cumulative water depletions from the Colorado River Basin are considered likely to jeopardize the continued existence of the Colorado pikeminnow, as well as downstream populations of humpback chub, bonytail, and razorback sucker and result in the destruction or adverse modification of their critical habitat. The results of the BA are as follows:

- The projects will involve depletions to the Upper Colorado River system and therefore will adversely affect bonytail, Colorado pikeminnow, humpback chub, and razor back sucker. Water depletions of up to 11.7 acre feet (less than 1acre foot for NS and a maximum of 10.7 acre feet for EM) per year from local water sources would occur from the proposed projects.
- The projects may affect, but are not likely to adversely effect greater sage-grouse, Dudley Bluffs twinpod, and Dudley Bluffs bladderpod.
- The projects are expected to have no effect on black-footed ferret, Canada lynx, North American wolverine, Mexican spotted owl, yellow billed cuckoo, Graham's beardtongue, Ute ladies- tresses, and White River beardtongue.

BLM anticipates USFWS Biological Opinion (BO) will be in concurrence with the BA and will implement their recommendations in the final EA.

10. Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment. To the best of my knowledge the Proposed Action does not violate or threaten violation of any federal, state, local, or tribal law or requirement imposed for the protection of the environment. Federal, state, local and tribal interests were given the opportunity to participate in the environmental analysis process.

Based on the above analysis of the context and intensity of potential impacts resulting from the Proposed Action with Mitigation, BLM has determined that the proposed oil shale RD&D projects will have no significant impact on health or the human environment.

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