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NATURAL SODA

2011 Plan of Operation

Oil Shale Research, Development and Demonstration (RD&D)
Tract COC 74299

Prepared for:

Natural Soda Holdings, Inc.

Piceance Creek Basin
Rio Blanco County, Colorado

Prepared by:

Daub & Associates, Inc.
Grand Junction, Colorado

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List of Abbreviations

ºC	degrees Celsius
ºF	degrees Fahrenheit
APEN	Air Pollution Emission Notice
Bbls	barrels
BLM	Bureau of Land Management
BMP	Best Management Practices
BTEX	benzene, toluene, ethylbenzene and xylene
CBL	cement bond log
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Regulations
CIBP	cast iron bridge plug
CO	carbon monoxide
CO_2	carbon dioxide
COD	chemical oxygen demand
DHB	down hole burner
DSA	Dissolution Surface Aquifer
DVPW	Deep Vertical Production Well
EPA	Environmental Protection Agency
Gpt	gallons per ton
HSE	Health, Safety and Environmental
LI	Leached Interval
MAIP	maximum allowable injection pressure
Mbbls	million barrels
$NaAl(CO_3)(OH)_2$	dawsonite
$NaAlO_2$	sodium aluminate
NaCl	halite
$NaHCO_3$	nahcolite
NO_X	nitrogen oxide (NO and NO_2)
NSHI	Natural Soda Holdings, Inc.
NSI	Natural Soda, Inc.
OSR	Oil Shale Reactor
PCB	Piceance Creek Basin
PLS	Pure Live Seed

List of Abbreviations (Continued)

PRL	Preference Right of Lease
RBC	Rio Blanco County
RD&D	Research, Development and Demonstration
SO_X	sulfur oxide (SO_2 and SO_3)
SWMP	Storm Water Management Plan
TDS	total dissolved solids
UIC	Underground Injection Control
UL	Underwriters Laboratories
USDW	Underground Source of Drinking Water
USGS	United States Geological Survey
VOC	Volatile Organic Compounds
WRFO	White River Field Office
Wt%	weight percent or percent by weight

EXECUTIVE SUMMARY

Natural Soda Holdings, Inc. (NSHI), in conjunction with its wholly owned subsidiary Natural Soda, Inc. (NSI), has successfully operated a sodium bicarbonate (nahcolite) mining operation in the Piceance Creek Basin in northwestern Colorado for over 18 years. NSI's solution mining technique is a proven method for economically extracting nahcolite with minimal environmental impact. NSHI's strategy is to incorporate NSI's expertise in solution mining with a new innovative in-situ method for extracting kerogen from oil shale to commercially develop the oil shale resources within the proposed 160 acre lease area. Following the acceptance of NSHI's nomination for an oil shale research, development and demonstration (RD&D) lease by the Bureau of Land Management (BLM), NSHI has developed this Plan of Operation which discusses details surrounding the implementation of NSHI's oil shale research project.

The NSHI proposed RD&D lease, when granted by the BLM, will consist of 160 acres and will be situated between the Stake Springs and Ryan Gulch drainages, encompassing Lots 1, 2, 3, and 4 in the N ½ of the N ½ of Section 35, T1S, R98W, 6th Principal Meridian, Rio Blanco County, Colorado. Meeker, Colorado, lies approximately 41 miles to the northeast. Surface elevation on the lease ranges from approximately 6,650 to 6,770 feet (Figure 1-1); topography is characterized by shallow alluvial valleys and broad soil-covered ridges and mesas. Pinyon, juniper and sagebrush are the dominant vegetative cover.

NSHI's process for extracting kerogen from the Green River Formation oil shale utilizes 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. This process is derived from research conducted at Monash University in Australia to enhance the liquefaction of low rank coals, such as Victorian brown coal, which have similar reactive chemical bonds and structural features to those found in oil shale kerogens. Research is on-going at Monash University on samples of oil shale from the Piceance Creek basin to guide the process development and includes similar work undertaken since 2010 of core samples (12H-C) from NSI's ongoing sodium mining operations.

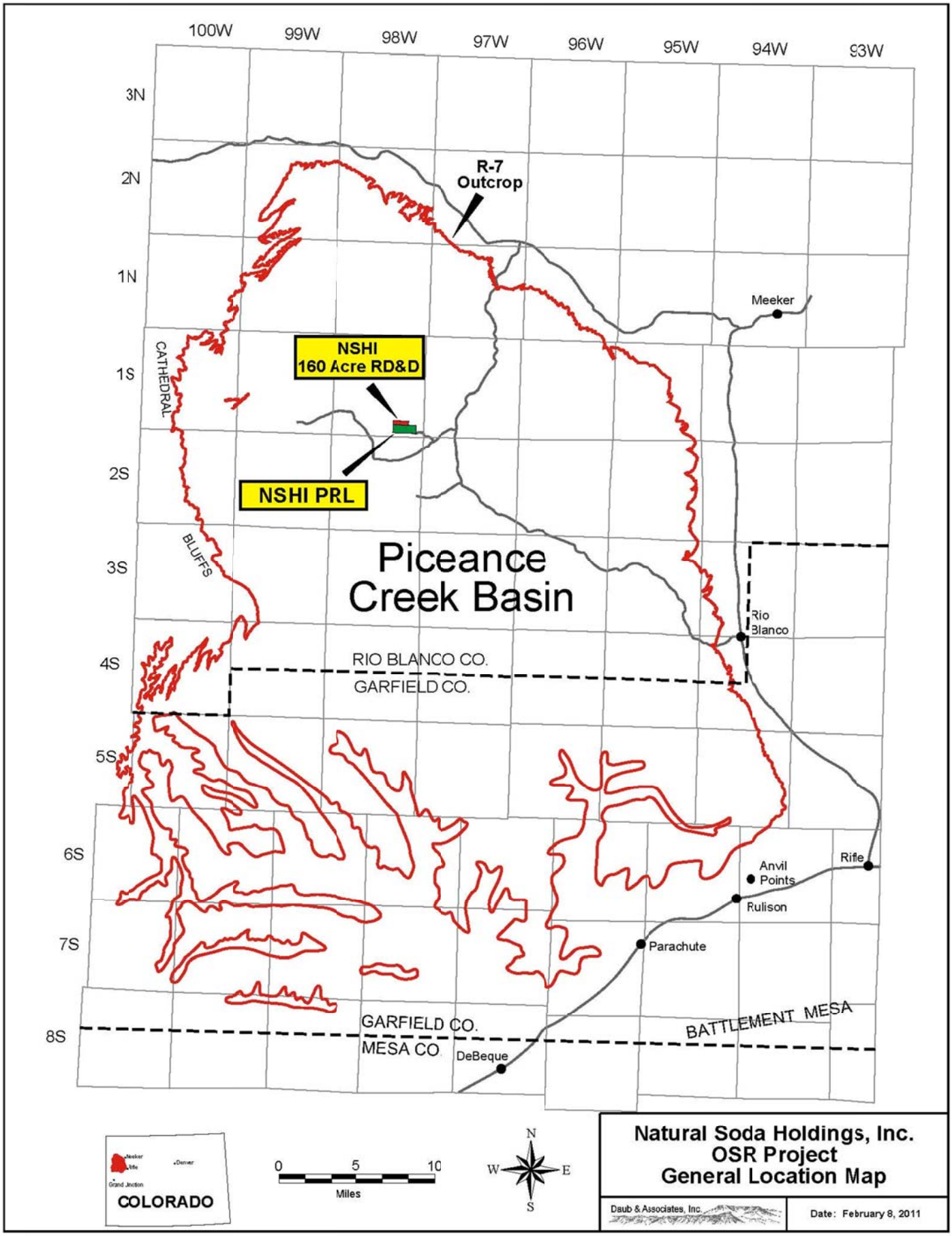

Figure 1–1. General location map for the NSHI 160 acre nominated RD&D and PRL Leases.

Naturally occurring dawsonite ($NaAlCO_3(OH)_2$) within the Saline Zone of the Piceance Creek Basin is chemically similar to sodium aluminate ($NaAlO_2$) and nahcolite ($NaHCO_3$, naturally occurring sodium bicarbonate). Both sodium bicarbonate and sodium aluminate are known to catalyze the liquid forming reactions of Victorian brown coal in the presence of carbon monoxide and water. The presence of fine-grained highly dispersed dawsonite, which decomposes at the reaction temperature in the range of kerogen decomposition together with sodium bicarbonate offer the opportunity to develop an in situ kerogen liquefaction reaction.

The scale and scope of NSHI's research and development project is largely dependent upon the initial success and continued success of the leaching and chemical conversion technology to be employed by NSHI for the recovery of shale oil. NSHI intends to initially drill and complete a single Oil Shale Reactor (OSR) production well to test the effectiveness of their leaching and chemical conversion technology on a small scale. A 40-foot (plus or minus) reactor interval at the base of the Saline Zone has been 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 will be selected for subsequent testing. This technique will utilize best management practices by testing multiple intervals in a single production hole. Should the NSHI leaching and chemical conversion process prove successful on the RD&D production well, additional production and associated monitoring wells will be constructed on the NSHI nominated RD&D Lease for continued testing and expansion of technology development prior to commercial production.

The leaching and chemical conversion process that will be used by NSHI to recover shale oil from oil shale will utilize the abundance of saline minerals, predominantly nahcolite and to a lesser extent dawsonite, for both the generation of porosity and permeability and to potentially catalyze, the chemical conversion reaction. The hot water sodium bicarbonate leaching will not produce a cavity, but rather an interval with small, intermittent vugs. Nahcolite produced during operations of the pilot well will be treated in NSI's existing sodium bicarbonate processing facility. Nahcolite solutions not rich enough for processing will be added to NSI's barren liquor stream, reducing waste stream footprints and further utilizing resources. The development activities are to take place low in the Saline Zone which is devoid of any water and acts as a highly confined interval, avoiding complications associated with groundwater and highly fractured rock.

The goal of this program is to produce an amount of shale oil by NSHI's process to define the parameters, and economics required for a commercial operation.

The major attributes of the NSHI in-situ plan of operation are:

1. Improved resource utilization of the nahcolite because the nahcolite will be solution mined prior to extracting the shale oil.

2. The NSHI plan results in limited surface disturbance because of the utilization of the NSI existing infrastructure, i.e. roads, water, electricity, natural gas, well pads, etc.

3. Plan limits carbon footprint because of limited decomposition of nahcolite, and use of natural gas as a heating medium.

4. The existing NSI mine plan including the comprehensive monitoring plan consists of processes and facilities which can be used to support the operations.

5. The NSHI technology will be advanced in stages, based upon the success of each previous discrete stage. This limits environmental impacts if technology cannot be proven successful in the intervening stages.

SECTION 1.0 GENERAL INFORMATION

1.1. Operator Name and Contact Information

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SECTION 2.0 Surface and Mineral Ownership

The United States federal government owns and manages both the surface and mineral rights to the proposed NSHI 160 acre RD&D lease, which is managed by the BLM.

SECTION 3.0 Setting

3.1. Detailed Geologic Condition within the Lease Tract

The NSHI nominated 160 acre RD&D Lease is located in the north-central portion of the Piceance Creek Basin near the depositional center and center of saline mineral deposits within the Eocene-aged Green River Formation (Figure 1-1). The Piceance Creek Basin contains the largest concentration of oil shale reserves in the world and has been the subject of numerous major oil shale research and development projects over the past 75 years.

3.1.1. General Stratigraphy

The Uinta Formation, along with a tongue of Green River Formation (Thirteenmile Creek), dominates surface outcrops on the Lease. The Uinta Formation consists predominantly of fluvial sandstones, with occasional interbedded siltstones and marlstones. The Uinta Formation has an average thickness of approximately 1,200 feet in the Lease area. Included in this sequence are three tongues of Green River Formation. The Uinta Formation rests conformably on the R-8 Zone of the Parachute Creek Member of the Green River Formation.

The Green River Formation, a thick lacustrine unit deposited in ancient Lake Uinta, contains important oil shale and saline mineral deposits in the Piceance Creek Basin. In the Lease area, the Green River Formation is greater than 3,900 feet thick and is overlain by the Uinta Formation (Eocene) and underlain by the Wasatch and Fort Union Formations (Eocene-Paleocene). The Parachute Creek Member of the Green River Formation is the principal resource interval for both oil shale and saline minerals. It averages about 1,700 feet thick in the Lease area and consists primarily of oil shale, marlstone, leached oil shale and saline oil shale (Figure 3-1).

The Parachute Creek Member of the Green River Formation consists of 13 zones that are differentiated by average oil shale grade, and have been divided into two categories: rich and lean. There are 7 thick, rich oil shale zones (R-8, R-7, R-6, R-5, R-4, R-3, and R-2 Zones) separated by 6 thinner, lean oil shale zones (A-Groove, B-Groove, L-5, L-4, L-3, and L-2 Zones). Average oil shale grade varies substantially between rich (on average 20-30 gpt and up to 80 gpt) and lean (on average 10-15 gpt) zones, as well as between individual rich zones and individual lean zones.

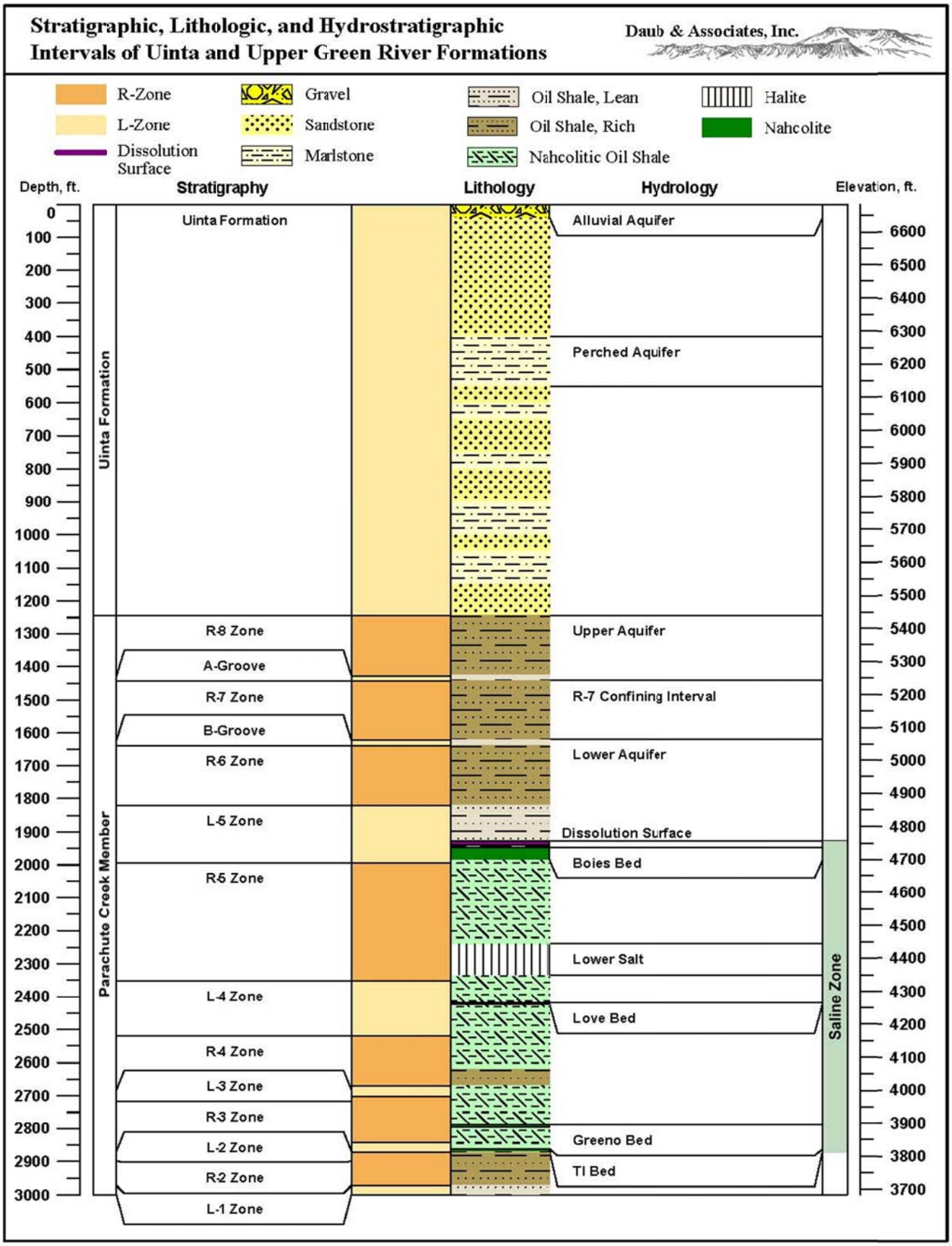


Figure 3–1. General Stratigraphic, Lithologic and Hydrostratigraphic column of the Uinta and Upper Green River Formations. NSHI Nominated Lease Area.

Thin volcanic ash (tuff) deposits are common in the uppermost five units of the Parachute Creek Member. Saline minerals in saline oil shale include nahcolite ($NaHCO_3$), dawsonite ($NaAl(CO_3)(OH)_2$) and halite (NaCl). In the area of the NSHI nominated 160 acre Lease, saline oil shale is located only in the lower part of the Parachute Creek Member in the R-2, L-2, R-3, L-3, R-4, L-4, R-5 and L-5 oil shale stratigraphic zones. This interval, known as the Saline Zone, ranges in thickness from approximately 950 to 1,000 feet in the Lease area. Oil shale resources for the Saline Zone under the Lease are approximately 300 million barrels (Johnson and others, 2009). At the current time, NSHI is targeting only the oil shales within the Saline Zone for potential commercial oil shale production.

The Saline Zone is overlain by an approximately 600-foot thick sequence of oil shale known as the Leached Zone. This interval, which usually includes part of the L-5 Zone and all of the R-6 Zone, B-Groove, R-7 Zone, A-Groove, and part of the R-8 Zone, once contained numerous horizons of stratiform nahcolite and halite and nonstratified nahcolite (in oil shale). Circulating groundwater in the geologic past dissolved the saline minerals and produced numerous dissolution vugs, cavities, breccias and rubble, as well as the subsidence features within the Leached Zone. The Leached Zone is characterized by thin oil shale horizons containing numerous dissolution features interbedded with massive oil shales containing joints and partings.

Lithologies above the Saline Zone contain numerous fractures. Most are associated with the Leached Zone and were produced by a combination of local and regional tectonism along with the imprint of the dissolution of saline minerals. Lithologies in the Saline Zone have far fewer fractures relative to the rest of the Parachute Creek Member and Uinta Formation. Most open fractures in the Saline Zone have been healed by secondary precipitation of calcite or saline minerals, mainly white crystalline nahcolite. Some fractures in the L-3 and L-2 zones have infillings of organic matter.

The Garden Gulch Member of the Green River Formation underlies the Saline Zone, and consists of highly fissile clay-rich oil shales and claystones. In the vicinity of the Lease, the Garden Gulch Member is approximately 500 feet thick.

In summary, the NSHI nominated 160 acre RD&D Lease has the following geological characteristics:

- A uniform and predictable stratigraphic framework within the Uinta Formation and Parachute Creek Member of the Green River Formation.
- Abundant resources of oil shale, nahcolite and dawsonite. Numerous mappable nahcolite beds exist in the Saline Zone.
- A structure characterized by a broad, shallow basin. Fractures and dissolution features are very common in rocks above the Saline Zone.
- A gentle surface topography conducive to continual development of the property.

- A dry, confined interval within the Saline Zone that is devoid of water and highly competent.

3.2. Detailed Hydrologic Condition within the Lease Tract

The climate of the Lease area is semi-arid, with annual precipitation of approximately 15 inches at 6,800 feet (Ege et al, 1978). Precipitation generally occurs as snow from November to March and as rain during the remainder of the year. Annual potential evapotranspiration for horizontal surfaces is about 43 inches at 6,800 feet. The NSHI nominated 160 acre RD&D Lease is located between the Stake Springs and Ryan Gulch drainages and is part of the Yellow Creek hydrologic basin (Figure 3-2). The primary source of streamflow to the Ryan Gulch and Stake Springs drainages is alluvial groundwater discharge. The primary flow periods include runoff from snowmelt beginning in March and continuing through June or July. Streamflow for the remainder of the year is maintained almost totally by groundwater discharge with approximately 80 percent of streamflow in the basin being supplied by groundwater (Weeks et al, 1974).

Water quality in the Yellow Creek drainage can be classified as a mixed bicarbonate type in the upper reaches and sodium bicarbonate type in the lower reaches. Generally, total dissolved solids (TDS) range from 797 mg/l in the Corral Gulch near Rangely, Colorado to more than 2,700 mg/l at the mouth of Yellow Creek. Irrigation return flows, evapotranspiration and groundwater discharge from the Uinta and Green River Formations (saline minerals) are the main cause of the water quality degradation in Yellow Creek. However, due to the low acreage irrigated in Yellow Creek, irrigation return flows have only a small effect. As is typical, water quality varies substantially with streamflow. During high runoff periods (snowmelt) TDS concentrations are typically at their lowest levels.

The increase in TDS concentration during low flow periods is a good indication that groundwater is discharging into surface streams. Groundwater in the Uinta and Green River Formations generally contains high concentrations of sodium, bicarbonate, chloride and fluoride.

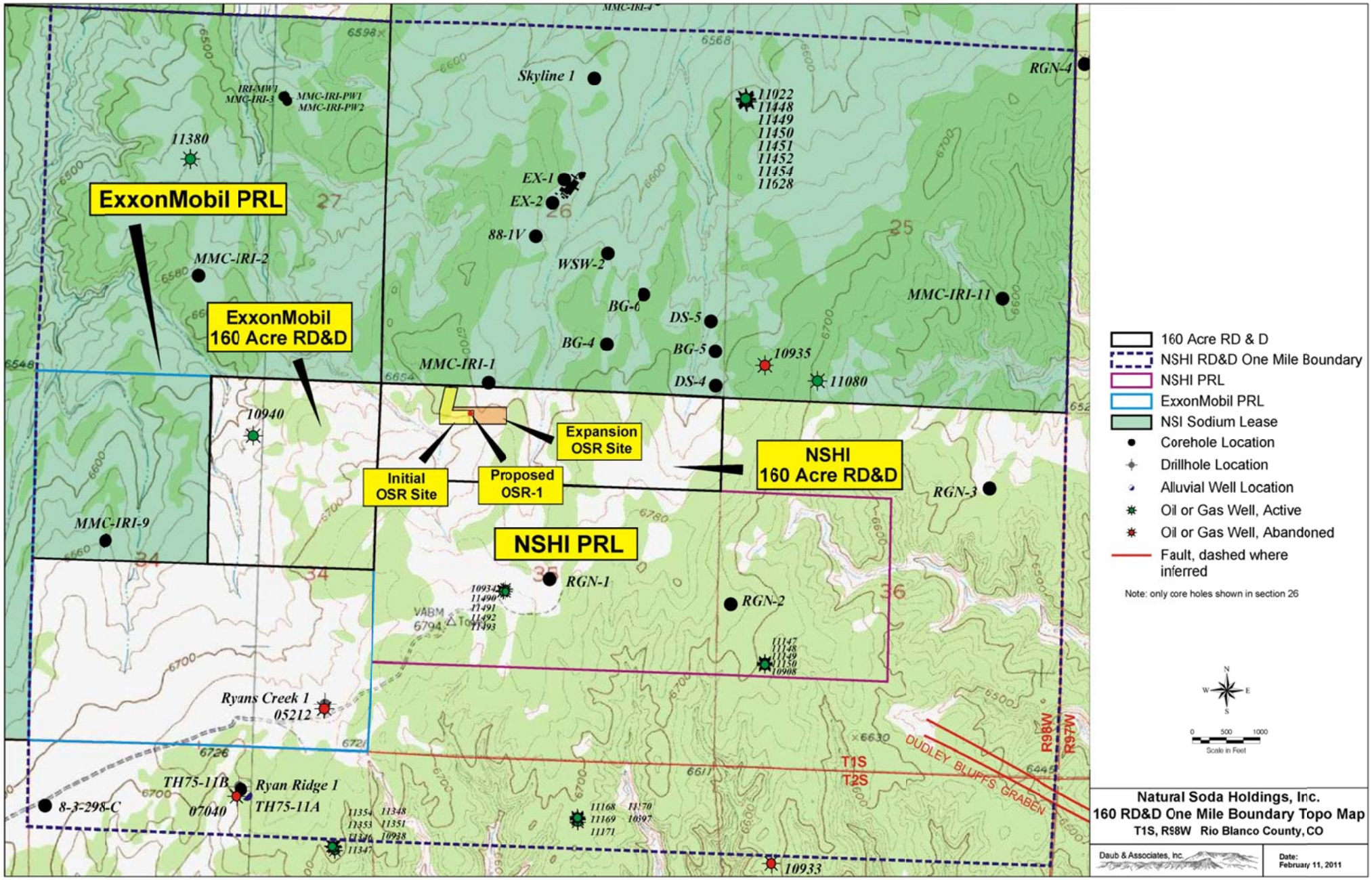


Figure 3–2. Topographic Map of the NSHI nominated 160 acre RD&D Lease Area.

3.2.1. General Aquifer System Characteristics

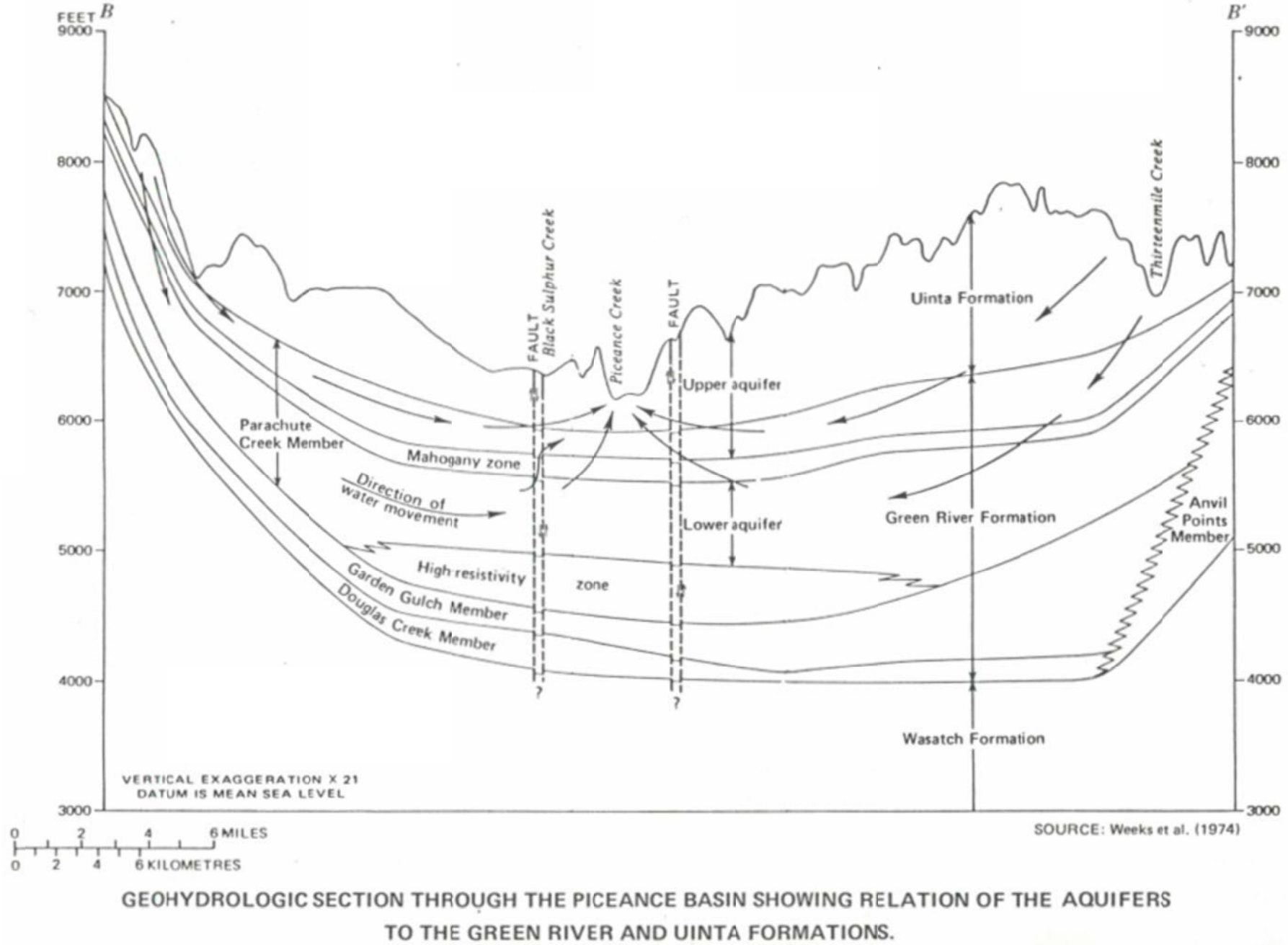
The principal water-bearing zones are located in the Uinta and Green River Formations and in the alluvium of stream valley bottoms. The aquifer system in the NSHI nominated Lease consists of four aquifers. These are known from shallowest to deepest as the Perched Aquifer, A-Groove Aquifer, B-Groove Aquifer and Dissolution Surface Aquifer. Historically, the Perched Aquifer and A-Groove Aquifer were grouped into what was known as the "Upper Aquifer," while the B-Groove and Dissolution Surface Aquifers were grouped into what was known as the "Lower Aquifer." The A-Groove and B-Groove Aquifers are separated by a leaky semi-confining oil shale-rich layer called the Mahogany Zone (R-7 Zone) (Daub et al, 1985). Similarly, the B-Groove and Dissolution Surface Aquifers are separated by a leaky semi-confining oil shale-rich layer called the R-6 zone. A cross-sectional profile of the water-bearing zones is presented in Figure 3-3.

Recharge to the aquifer system occurs principally from snowmelt during the spring. Weeks et al, (1974) suggested that recharge to the aquifer system is probably most effective in the areas of the basin above 7,000 feet elevation, where about 65 percent of the total volume of November to March precipitation occurs. During the summer months, most rainfall is lost as direct runoff or goes to meet the soil moisture deficiency and is subsequently evapotranspired.

During spring snowmelt, water is released slowly, especially on the north facing slopes, allowing ample opportunity for the melt to infiltrate the soil, increase soil moisture content to field capacity and percolate into the saturated zone.

In the recharge areas, water from the A-Groove Aquifer moves downward through the Mahogany Zone to recharge the B-Groove Aquifer. A minor amount of water moves downward through the R-6 zone to recharge the Dissolution Surface Aquifer. Generally groundwater in the A-Groove and B-Groove Aquifers flows from the recharge areas at the basin margins toward the north-central part of the basin.

In discharge areas, water moves upward from the B-Groove and Dissolution Surface Aquifers through the R-6 and Mahogany Zones to the A-Groove Aquifer. Water is discharged from the A-Groove Aquifer to the alluvium through valley floors and by springs along the valley walls. Groundwater flows through the alluvium to the streams and is lost from the basin by evapotranspiration and discharge to Piceance Creek and Yellow Creek.



GEOHYDROLOGIC SECTION THROUGH THE PICEANCE BASIN SHOWING RELATION OF THE AQUIFERS TO THE GREEN RIVER AND UINTA FORMATIONS.

Figure 3–3. West-east geohydrologic section through the Piceance Creek Basin showing the location of the historic Aquifers with respect to the Green River and Uinta Formations.

The alluvial aquifers are limited to the valley bottoms along the major creeks. Although not continuous throughout the basin, the alluvial deposits can provide significant sources of groundwater particularly in major stream valleys. Generally, the aquifers are less than 0.5 mile in width and the alluvium less than 140 feet thick. Saturated thickness of the alluvium in Yellow Creek has been reported to be up to 100 feet.

The degree of saturation within the alluvium is highly variable and dependent on seasonal recharge from precipitation, snowmelt runoff and discharge from underlying bedrock aquifers. Generally, the alluvial aquifer is under unconfined conditions. However, locally semi-confined conditions could exist depending on the occurrence of clay beds.

Groundwater movement generally parallels the direction of streamflow in the alluvial valleys. Discharge from the alluvial system occurs in springs along valley bottoms, from withdrawals for domestic and irrigation usage, and predominantly directly to streams during low flow periods (November through February) where streamflow is almost wholly derived from groundwater discharge.

3.2.2. Individual Aquifer Systems

In the area of the NSHI nominated Lease, the bedrock aquifer system is comprised of three major aquifers, the A-Groove, B-Groove and Dissolution Surface Aquifers. Additionally, a Perched Aquifer exists in the upper Uinta Formation (Figure 3-4). The Perched, A-Groove and B-Groove Aquifers are considered to be underground sources of drinking water (USDW), while the Dissolution Surface Aquifer is not considered to be a USDW.

3.2.2.1. Perched Aquifer

The Perched Aquifer is locally present in the Lease area due to the presence of the Thirteenmile Creek tongue of the Green River Formation within the permeable sandstones of the Uinta Formation. The Thirteenmile Creek tongue consists of largely impermeable oil shale units, and groundwater is encountered in the Uinta Formation sandstones that immediately overlie the Thirteenmile Creek tongue. This aquifer is up to 20 feet thick, and is encountered at a depth of approximately 530 feet on the Lease.

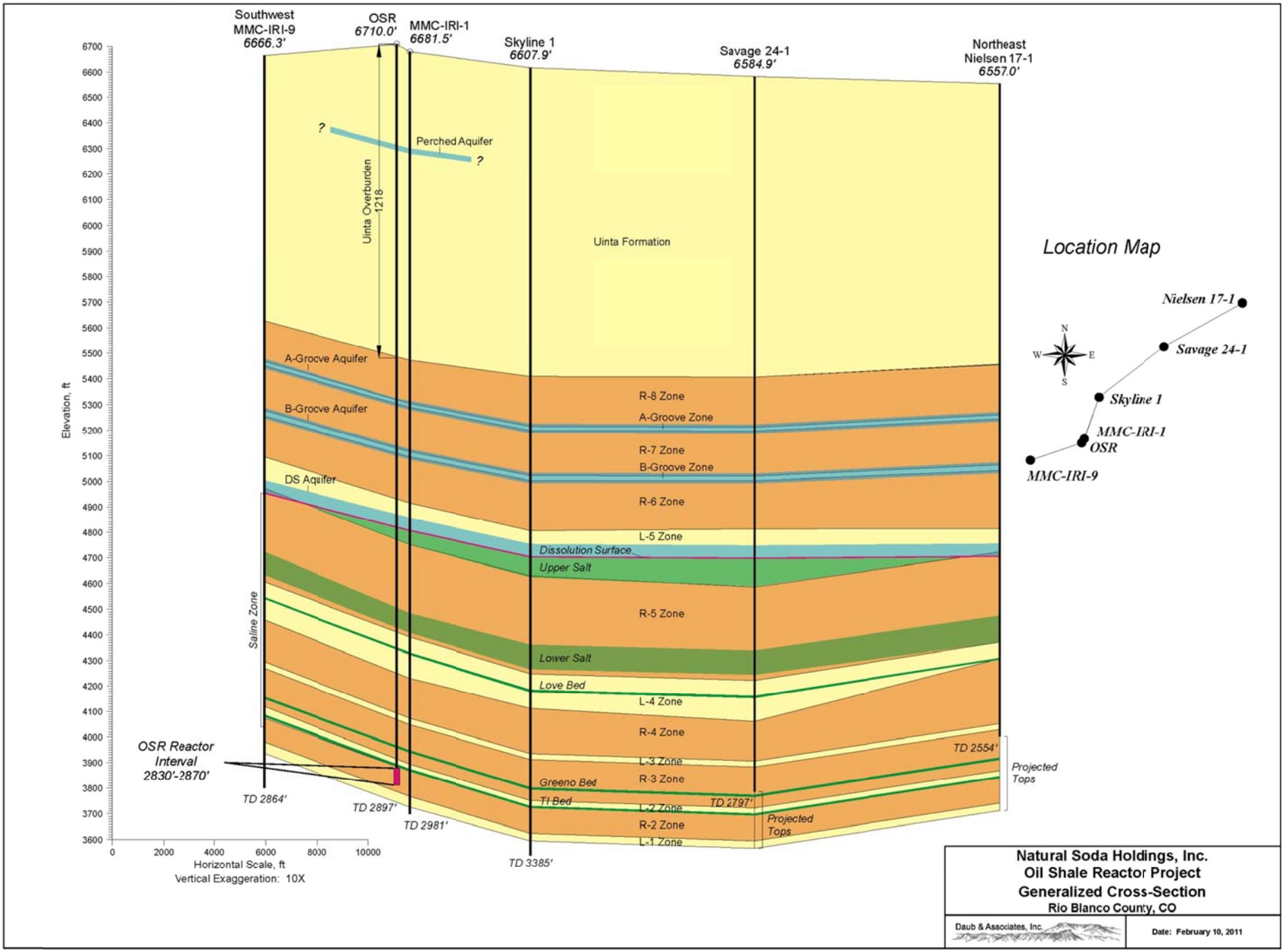


Figure 3–4. Cross-section showing the water bearing zones in the vicinity of the NSHI nominated 160 acre RD&D Lease.

3.2.2.2. A-Groove Aquifer

The A-Groove Aquifer consists of fractured lean oil shale and marlstone of the Parachute Creek Member located immediately above the Mahogany Zone. The permeability of the aquifer is due to primary matrix porosity and secondary fracture porosity. The A-Groove Aquifer is encountered at approximately 1,375 feet below ground surface on the Lease in the Parachute Creek Member of the Green River Formation just above the Mahogany Zone. It is generally between 15 and 20 feet thick.

3.2.2.3. B-Groove Aquifer

The B-Groove Aquifer consists of lean fractured oil shale and marlstone of the Parachute Creek Member underlying the Mahogany Zone. The B-Groove Aquifer occurs approximately 1,565 feet below ground surface in the area of the NSHI Lease. It is generally between 18 and 25 feet thick.

3.2.2.4. Dissolution Surface Aquifer

The Dissolution Surface Aquifer is present approximately 50 to 70 feet immediately above the top of the Saline Zone. In the vicinity of the NSHI Lease, the Dissolution Surface Aquifer is found in the lean, fractured, brecciated, and rubblized oil shales and marlstones of the upper L-5 stratigraphic zone. Due to the proximity of the Dissolution Surface, solution features such as vugs, voids and pits are common characteristics of the matrix material. The Dissolution Surface Aquifer occurs approximately 1,875 feet below the ground surface in the area of the NSHI lease.

3.3. Resource Calculation

3.3.1. Oil Shale

The USGS completed an assessment of the in-place oil shale resources of the Piceance Creek Basin in 2009 (Johnson and others, 2009). According to this assessment, Township 1 South, Range 98 West contains approximately 45,790.89 million barrels of oil in the Saline Zone (between the L-5 Zone and the R-2 Zone). Compensating for geographic setting of the Lease within Township 1 South, Range 98 West, the Saline Zone within the NSHI nominated 160 acre Lease is estimated to contain approximately 304.02 Mbbl (1.9 million barrels/acre) of oil.

In the immediate area of the NSHI OSR well, analytical data of core samples are available from the MMC-IRI-1 core hole which is located approximately 500 feet north of the OSR. Analysis of core samples from the Saline Zone in MMC-IRI-1 indicated average concentrations of 22.2 gallons per ton of oil, 35.4 wt% nahcolite and 5.3 wt% dawsonite.

3.3.2. Nahcolite

The USGS completed an assessment of the in-place nahcolite resources of the Piceance Creek Basin in 2009 (Brownfield and others, 2009). According to this assessment, Township 1 South, Range 98 West contains approximately 12.9 billion short tons of nahcolite in the Saline Zone. Compensating for geographic setting of

the Lease within Township 1 South, Range 98 West, the Saline Zone within the NSHI nominated 160 acre Lease is estimated to contain approximately 89.8 million short tons of nahcolite.

3.3.3. Dawsonite

Beard et al (1974) compiled an estimate of in-place dawsonite resources in the Piceance Creek Basin. According to this assessment, the NSHI Lease falls within a region where dawsonite concentrations are approximately 120 million tons per square mile. It is thus determined that there are approximately 30 million tons of dawsonite underlying the NSHI nominated 160 acre RD&D Lease.

3.4. Location and Design

The nominated RD&D Lease area abuts the southern boundary of NSI's federal sodium lease area and existing nahcolite well field and runs east to Rio Blanco County Road 31 which accesses NSI's sodium bicarbonate plant (Figure 3-5). The access road runs immediately outside the eastern boundary of the Lease area. The Lease contains unpaved two tracks, which will provide access to the research area and reduce environmental impact. The Lease area does not cover private lands and has no water rights associated with it. There are no defined animal trails and no gas wells. The area is largely flat with low level undulations, so the creation of new access tracks will not create a significant environmental disturbance.

Utilities required for the NSHI OSR project will be natural gas, electric, water and sodium solution water. All utilities will largely utilize existing NSI infrastructure. NSI's existing facilities will be used for processing sodium bicarbonate produced by the OSR. A proposed utility map is provided in Figure 3-6.

3.4.1. Proposed Roads

Existing roads on and accessing the NSHI nominated Lease will be utilized, to minimize surface disturbance and continue the use of best management practices. A total of 2 roads are proposed to be constructed for initial research and development operations. Additional roads may be constructed in the future, coincident with project expansion.

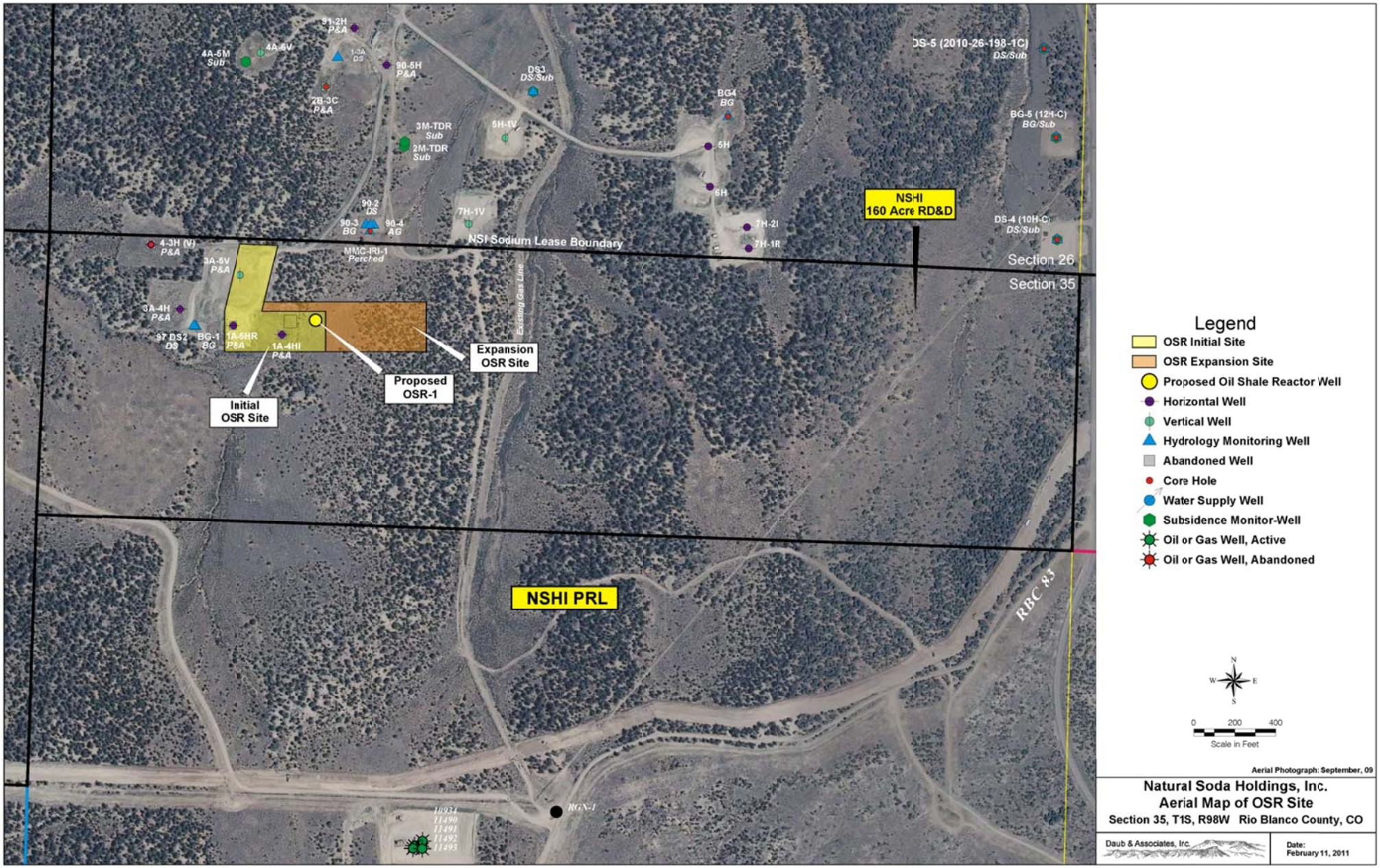


Figure 3–5. Aerial map of the NSHI nominated 160 acre RD&D Lease.

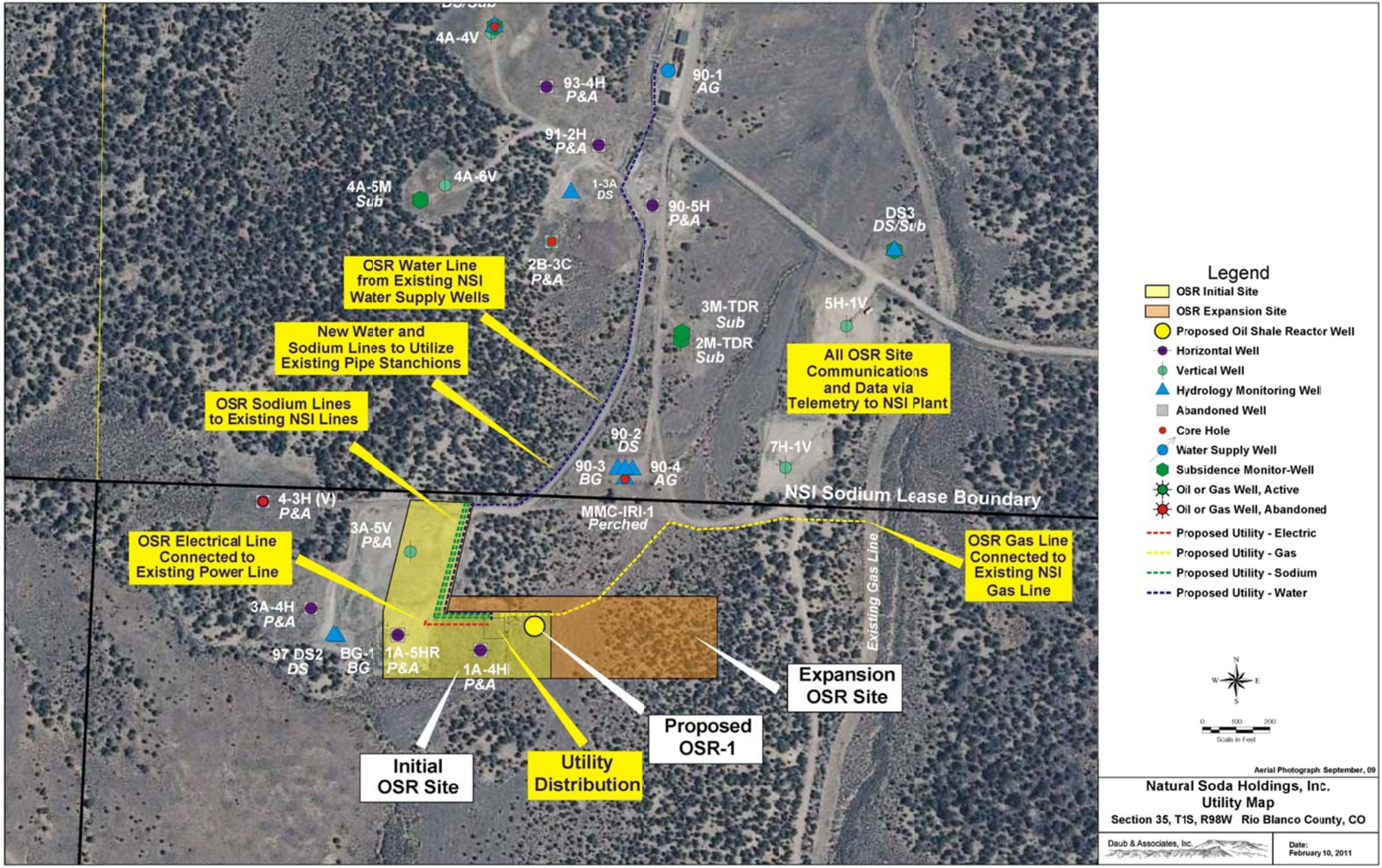


Figure 3–6. Proposed utility map for the NSHI nominated 160 acre RD&D Lease.

3.4.2. Well Pads

A single well pad will be constructed for initial research and development operations, utilizing an area already disturbed and cleared for environmental purposes (Figure 3-6). Additional well pads will be constructed with future project expansion in the area indicated in Figure 3-6.

3.4.3. Ponds

Due to the proximity of the NSI process pond, no new ponds will be constructed. The NSI process pond may be utilized for the disposal of OSR well sodium carbonate-rich waste water, when and if necessary.

3.4.4. Power Lines

Existing power lines on the Lease will not be affected by the initial research and development operations. However, NSI's existing power lines will need to be extended approximately 200 feet in order to bring power to the OSR well area. This will require an extension of NSI's existing power line.

3.4.5. Pits

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

3.4.6. Monitor Wells

Existing NSI upgradient and downgradient monitoring wells will be used to monitor groundwater conditions at the OSR Site. The existing upgradient monitoring wells to be used will be the BG-1 to monitor the B-Groove Aquifer and the 97 DS-2 to monitor the Dissolution Surface Aquifer. The existing downgradient monitoring wells to be used will be the: MMC-IRI-1 to monitor the Perched Aquifer; 90-4 to monitor the A-Groove Aquifer; 90-3 to monitor the B-Groove Aquifer; and the 90-2 to monitor the Dissolution Surface Aquifer. Existing historical baseline groundwater data are already available for these wells. One new monitoring well will be installed to monitor the Dissolution Surface Aquifer. This well will be located approximately 200-300 feet from the OSR well, downgradient to the east-northeast of the OSR. Thus, a total of 7 monitoring wells will be employed to monitor groundwater conditions at the OSR facility.

3.4.7. Storage Tanks

A single temporary storage tank will be brought to the pad to store water required for the drilling of the OSR well. This storage tank will be removed after the well has been drilled and completed. The volume of storage tanks and their location will be agreed upon with the governing regulatory authorities responsible for issuing construction/installation and operations permits. The initial agreed upon storage volume will reflect the stage and nature of the progression of the project towards potential commercial production. The tanks used for the OSR will range from 1,000

– 10,000 gallon capacity. Proposed storage tank volumes and locations are indicated on Figure 3-7. Please see Section 3.6.4. for a listing of additional proposed equipment.

3.4.8. Surface Structures/Facilities

Figure 3-7 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 will be constructed, tested and labelled in accordance with Underwriters Laboratories specifications for aboveground storage of flammable and combustible liquids, UL-142. The tanks will be equipped with the option to be blanketed with an inert gas such as nitrogen or carbon dioxide. Tanks will be installed on-site in conjunction with appropriate secondary containment (vertical dykes or other such similar approved containment systems) to prevent spills, contain possible leaks, and protect the environment. Best management practices will be employed to ensure all surface facilities are safe, secure and operate properly and to minimize adverse impacts to the environment.

Surface facilities shall be designed, built, monitored and operated in accordance with industry best practice to ensure the surrounding environment is protected in accordance with the BLM and EPA Regulations and applicable mining, environmental and other laws related to aboveground storage tanks for petroleum and chemical products.

3.4.9. Stack Parameters and Air Emissions

Phase 1 sodium solution mining will be a closed loop system; air emissions will be minor. NSHI's oil recovery system air emissions are also anticipated to be very minor, given the limited scope of the system. In the commercial phase of development, NSHI proposes to recapture and recycle hydrocarbons and CO_2 within the sodium bicarbonate and oil production processes. In-situ and preheating requirements and equipment are currently under development. If a surface heater is considered, NSHI proposes the use of a low-NOx boiler for the generation of the required steam. Emissions from the boiler will include: NOx and CO, with lesser amounts of particulates, VOC and SOx also being produced. The initial fuel source for a proposed boiler is anticipated to be natural gas; however, as the kerogen conversion process begins to produce recoverable hydrocarbons, NSHI would like to replace the natural gas with these produced fuels. If the boiler system is fired with produced gas or oil, NSHI will appropriately scrub these waste streams prior to usage to assure that emissions are below acceptable emission levels.

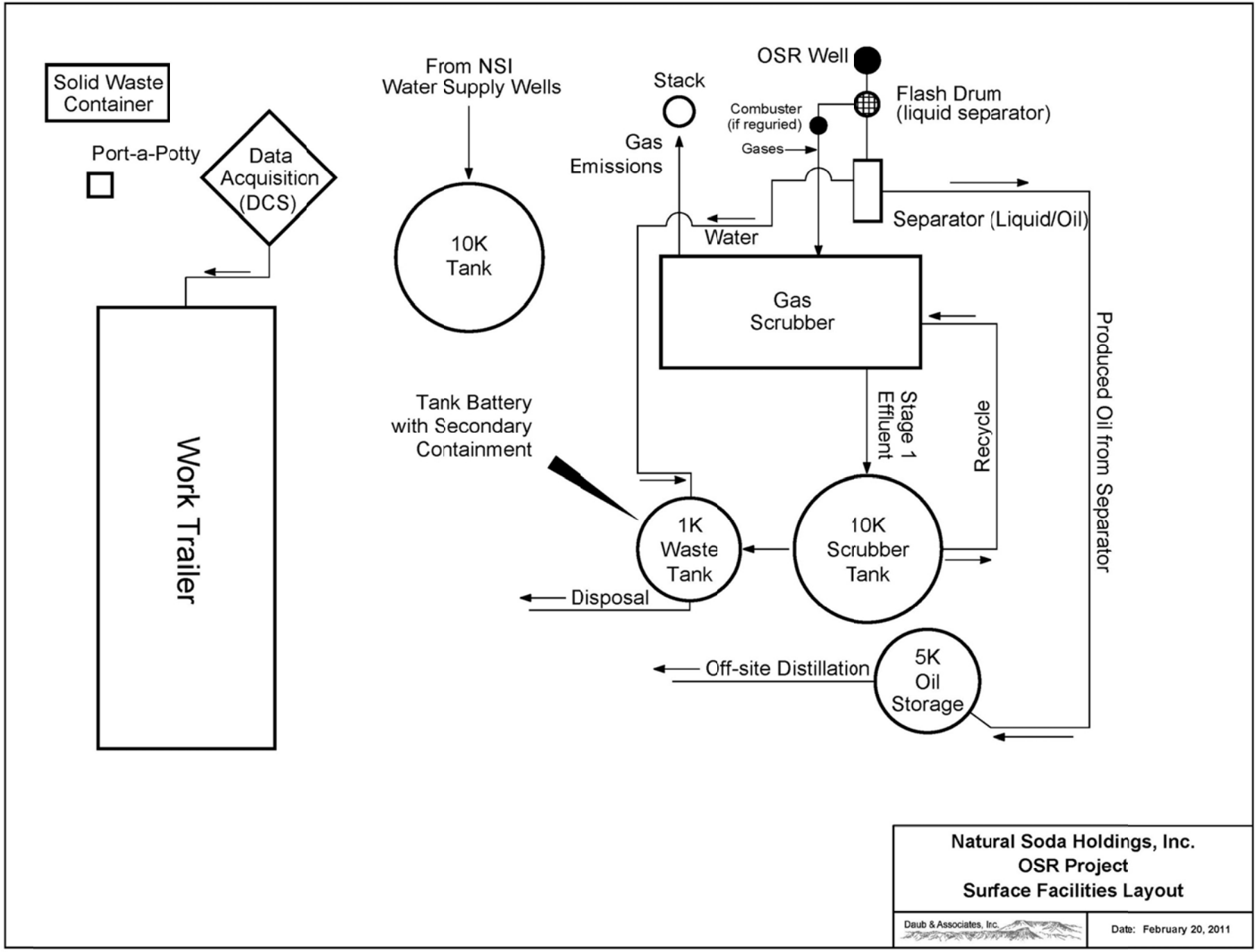


Figure 3–7. NSHI O.S.R. Project Surface Facilities Layout.

3.4.10. General Layout and Total Disturbance

The total anticipated disturbance of the surface for the entire research project, including the drilling and completion of the OSR well and monitoring well, as well as the subsequent heating and oil extraction, is approximately 4.5 acres initially. Contingent upon the success of the initial OSR operation, an additional 3-4 acres may be considered for additional testing. Total disturbance is anticipated to be less than 10 acres. The majority of this acreage has already been disturbed by well pad construction from NSI's current operation and is in a partial reclamation phase.

3.5. Access and Right of Way

Access to the RD&D project site will be via the paved Piceance Creek Road (Rio Blanco County (RBC) Road 5) and RBC Road 24, and then via RBC Road 31 which is immediately adjacent to the eastern boundary of the 160 acre nominated RD&D Lease. In order to reduce environmental impact, existing roads will be utilized wherever possible. If additional roads are deemed necessary, a 10 foot wide access road would be constructed following approval of the BLM. Proposed access and utilities are shown in Figure 3-6.

3.5.1. Electrical Power

The existing electrical power line that cuts across the western portion of the proposed 160 acre Lease will provide electrical power to the OSR facility. Approximately 200 feet of new power lines will be required to bring power to the OSR well.

3.5.2. Natural Gas

The NSI natural gas pipeline supplying the existing sodium bicarbonate production facility bisects the Lease area and will provide natural gas to the NSHI OSR Site.

3.5.3. Water

Proposed water and sodium solution lines supplying the OSR facility will originate from existing NSI operations. Water used during drilling operations of the OSR will be trucked or piped to the site from the existing NSI 90-1 and/or WSW-2 water wells.

3.5.4. Communications

A telemetry (DCS) system will provide communications and data medium between the OSR on site work trailer and the NSI production plant.

3.6. Development Sequence

The NSHI plan to commercially produce shale oil using the in situ chemical conversion process will involve seven primary stages. These are:

1. Drilling and completion of the initial RD&D production well

2. Development of a reactor chamber by leaching nahcolite from the initial production well

3. Design and construction of surface RD&D processing facilities

4. Installation of heating elements and recovery infrastructure

5. Commencement of operation of RD&D facilities

6. Expansion and replication

7. Plugging, abandonment, and reclamation of deactivated wells and infrastructures

The first five stages listed above apply immediately to the material contained within this Plan of Operation. The sixth stage, expansion and replication, is expected to take place utilizing the same technology and methodology as for the OSR as outlined in this Plan of Operation. Should the technology and methodology be unsuccessful in any area, appropriate modifications will be made prior to and during the expansion and replication stage.

The following is a brief description of the sequence of development NSHI intends to use in order to recover shale oil from oil shale.

3.6.1. Phase 1: Pre-Conversion Leaching

The first phase in the development of shale oil will 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. The sodium bicarbonate-enriched brine will be processed in the existing NSI sodium bicarbonate production facility.

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

Following nahcolite extraction, the LI will be dewatered in preparation of the second phase of the process. A pump and screen will be lowered into the LI and all liquids will be pumped to the surface for recovery/disposal. A diagram of the well completion technique for solution operations is shown in Figure 3-8.

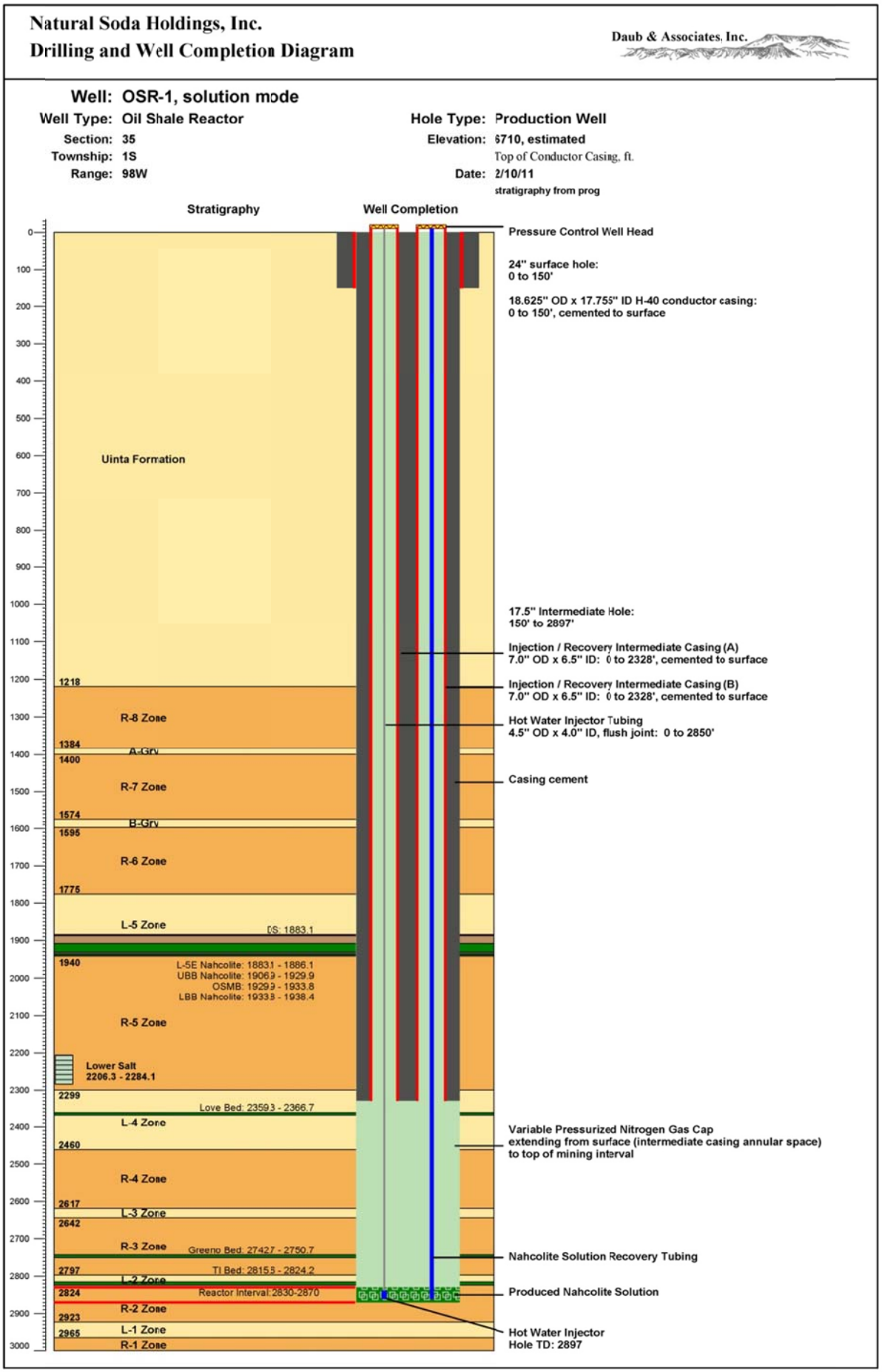


Figure 3–8. Well completion diagram of the OSR during the solution mode phase.

3.6.2. Phase 2: Oil Shale Liquefaction

The second phase in the development of the shale oil will be to use NSHI's chemical conversion technology to liquefy the kerogen in the oil shale. The OSR well will utilize a conventional completion technique (Figure 3-9) which will comply with appropriate Environmental Protection Agency (EPA) Underground Injection Control (UIC) regulations. The well completion will 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 temperature. Optionally, the well design will also enable water, carbon monoxide and potentially hydrogen and catalysts to be pumped into the reactor LI. The gasses and water will be heated to approximately 300 - 350 degrees Centigrade (572°-662°F) to liquefy the kerogen. The well head will also be equipped with a pressure control system to maintain pressure as high as possible without approaching 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.

It is uncertain whether mixing will be required to ensure that the liquefaction reaction is not constrained by mass transfer issues. Experience suggests that thermal currents set up by heating the reactor LI will supply adequate mixing. The water and gases that are injected into the LI may be pre-heated prior to injection. They will act as heat transfer agents in the reactor LI. The reactor LI should ensure that there is no significant physical compression or distortion of the in situ heating device.

As the liquefaction reaction progresses, water, oil, sodium salts and aluminium salts will be released from the reactor walls along with the oil shale that had been liberated in the establishment of the LI. The products will 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 will 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 are to be developed as part of optimizing the product mix.

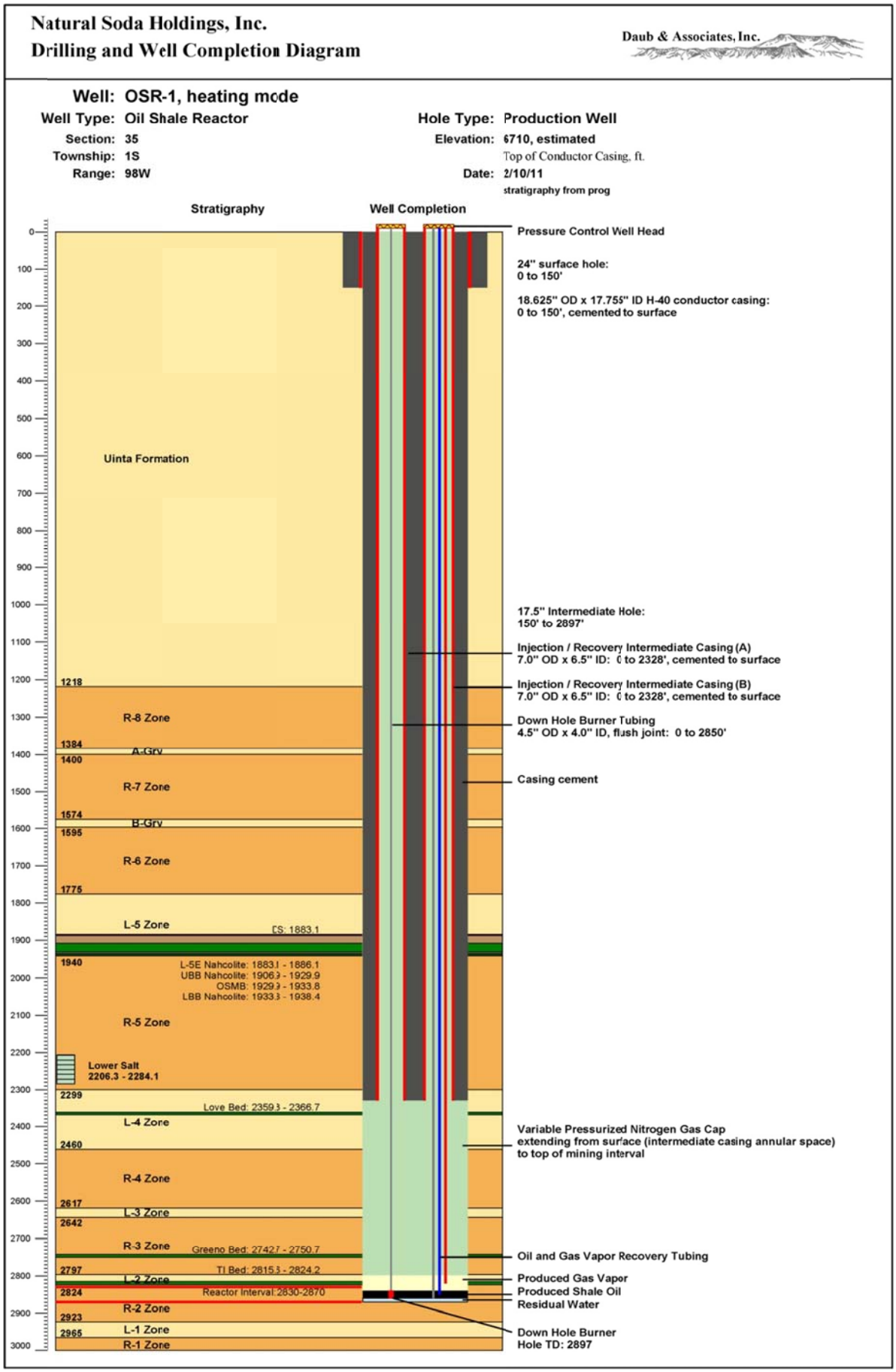


Figure 3–9. Well completion diagram of the OSR during the Kerogen conversion and shale oil production phase.

3.6.3. Phase 3: Shale Oil Extraction

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

The products will 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 will 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 will be self-limiting and there will be an economic life for each well.

At least 10 barrels of product oil will be isolated under an atmosphere of nitrogen in drums and shipped to a petroleum analysis laboratory where its components and overall market value will be determined. Analyses on the oil will include viscosity, trace element analysis and various spectroscopic techniques including infrared, nuclear magnetic resonance and mass spectrometry. The crude shale oil will be distilled into conventional fractions and the amounts of each fraction noted. Elemental analysis and several spectroscopic techniques will be used to characterize all of the fractions obtained by distillation. Research and motor octane blending numbers will be determined for the naphtha fractions and cetane numbers determined for the distillate fractions. Gas oils and vacuum gas oils will be tested for their performance in simulated catalytic cracking, and the vacuum bottoms tested for their performance in coking operations. Several fractions will be tested for their performance in hydrotreating operations and the hydrotreated products will be evaluated as blending stocks for gasoline, diesel and jet fuels. These and other tests will allow the valuation of the product oil.

3.6.4. Equipment List

The equipment involved in the construction and development of the OSR well includes:

- Down Hole Burner
- Surface Boiler (If needed)
- Various Instrumentation with Telemetry Capability
- Down Hole Pump
- Various Surface Transfer Pumps
- Flash Drum and liquid-oil separator
- Reactor off-gas combustor (If needed)
- Reactor off-gas Scrubber
- Shale Oil Storage Tank

- Scrubber and Scrubber Water Tank
- Waste Water Tank
- Water Supply Tank
- Instrument/Electrical Enclosure
- Gas/Liquid Sampling Equipment
- Office/Work Trailer
- Port-a-potty
- Waste/Trash Container

3.6.5. Estimated Production Rate

The NSHI Plan of Operation calls for a 40-foot thick reactor interval to be initially leached of saline minerals to generate porosity and permeability for enhanced shale oil recovery during the chemical conversion process. Shale oil and gas production will be induced by the liquefaction of kerogen through a chemical combination of carbon monoxide, hot water, and a sodium aluminate promoter at elevated temperature. 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. An estimate of oil production rate during the sustained production period is given by the following equation:

Oil Production Rate = (Oil Shale Grade) * (Recovery Efficiency of Shale Oil) * (Affected Volume) * (Percentage of Affected Volume Recoverable) * (Conversion Rate) * (Conversion Efficiency) * (Recovery Efficiency of Pump)

At this time laboratory experiments are being conducted to help define some of these variables. The RD&D project is designed to determine rates of production and resource recovery factors which will ultimately lead to an economic oil shale recovery process.

3.6.6. Estimated Resource Recovery Factors

At this time, laboratory experiments are aimed at defining some of the parameters needed to determine recovery factors and rates of production.

3.7. Construction

3.7.1. Number and Location of Employees

NSHI's nominated oil shale lease tract is in the Piceance Creek Basin of Colorado in an unincorporated area of Rio Blanco County. The Lease area is very sparsely populated, and no towns are present within a 40 mile radius of the Lease. A man camp is not anticipated to be constructed at any time during drilling or production operations. As such, contracted workers and NSHI employees during both phases will have to commute to the Lease area from Rangely, Meeker, Rifle, Parachute, Silt and/or Grand Junction, Colorado, as is currently done by NSI employees who work at the 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 NSI 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 will be developed on or near the NSHI Lease or on NSI's sodium leases.

3.7.1.1. Construction

An estimated 10 to 20 employees and/or contractors will be required during the drilling and construction operations of the initial production hole. These employees/contractors will work 12-hour shifts, working both day and night so as to sustain a 24-hour operation. The work will be conducted in the northwestern section of the NSHI nominated 160 acre RD&D Lease, in the area indicated in Figure 3-6. The number of employees/contractors working on the project at any given time will fluctuate, depending on the amount and type of work being done.

3.7.1.2. Operations

During production operations, an estimated 5 to 10 employees/contractors will be required to sustain the development and recovery of the shale oil from the production hole. These employees/contractors will work 12-hour shifts, working both day and night so as to maintain a 24-hour operation. The majority of the work will be conducted in the same area as for the drilling and construction phase, though some existing employees will be utilized at the NSI processing plant, involved in the processing of leached nahcolite from the production hole.

3.7.2. Timing

3.7.2.1. Dates of Construction

The drilling of the initial production hole is anticipated to commence as early as 2012 and no later than 2014, contingent upon timely permitting events. Surface facilities will be constructed/brought to the site after the hole has been completed.

3.7.2.1.1. Traffic Amount and Type

Due to the commuting requirement, the majority of the traffic will be from Rifle, Colorado to the Lease 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 will increase by less than 20 vehicles per day. Carpooling will be utilized whenever possible to minimize road traffic and decrease potential safety hazards.

3.7.2.2. Dates of Operation

Production operations are anticipated to begin approximately three months after the completion of the initial production hole, dependent upon timely permitting activities, 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.

3.7.2.2.1. Traffic Amount and Type

Traffic is expected to be similar to that experienced during drilling and construction operations, and will increase in proportion to the scale of the project and potential future expansion. The traffic will be almost exclusively truck traffic, including drilling rigs, water trucks, trash trucks and four-wheel drive work trucks.

3.8. Trash and Waste

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

3.8.1. Type of Materials Produced

During the drilling phase, wastes will be produced in the form of rotary drill cuttings and drilling fluid, both of which are considered non-hazardous materials. During the production phase, wastes will be produced in the form of spent oil shale and waste water from the production well. The water will be analyzed for potential contaminants (by-products). The spent oil shale is not considered to be hazardous. Waste water and solids may be disposed of in-situ or at an acceptable off site disposal facility depending upon composition and analysis.

3.8.2. Containment / Disposal

At the conclusion of drilling operations, the drilling fluids and mud pit fluids will be trucked off-site for disposal at an appropriate disposal facility by a contracted fluid disposal company. Waste water resulting from the chemical breakdown of the oil shale will be recaptured and recirculated as a best management practice 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 will be trucked off-site for disposal at an appropriate disposal facility by a contracted fluid disposal company. Off gases will be captured and directed through an on-site scrubber. The captured wastes from the scrubber will be contained in a 1,000 gallon waste tank.

The in situ process will leave the spent oil shale within the confined oilshale 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.

3.9. Existing/Abandoned Mines and Oil & Gas Wells

3.9.1. Mines

There are no mines on the proposed NSHI 160 acre RD&D Lease, either existing or abandoned. NSI is currently maintaining a solution mining operation in the Upper Salt immediately below the Dissolution Surface in an approximately 30-foot thick nahcolite horizon on their sodium lease immediately to the north of the NSHI Lease. Five horizontal well surface locations that were used as part of the NSI solution mining operations are present on the NSHI Lease, all of these wells have been plugged and abandoned.

3.9.2. Wells

Seven NSI wells are currently present on the nominated RD&D lease, five of which are plugged and abandoned and two of which are currently being used as groundwater monitoring wells. NSI has an additional 44 wells, 12 of which have been plugged and abandoned, within a mile of the perimeter of the nominated RD&D lease outline. A total of 33 natural gas wells are present within a mile of the perimeter of the Lease, 3 that are currently plugged and abandoned and 30 that are active (Table 3-1). Twenty-two oil shale core holes, 8 of which have been plugged and abandoned, are located within a mile of the perimeter of the Lease (Figure 3-10).

3.10. Oil Shale Structure

3.10.1. Geologic Structure

Structurally, the north-central Piceance Creek Basin consists of a series of northwest-southeast trending anticlines and synclines which are superimposed on the overall basinal setting. None of these structures crosses the nominated RD&D Lease area. Bedding on the Lease is flat-lying to gently dipping to the northeast between 1.0° and 2.5°.

Wel Name	Company	Status	Twsp	Rge	Sec	Latitude	Longitude	Elevation
30-4 FEDERAL	Caerus Washco LLC	Abandon Location	1S	97W	30	39.933060997	108.319966987	6310.0
RGN-4	Ryan Gulch Nahcolite	P&A	1S	97W	30	39.941085247	108.332671669	6707.4
14-25-198 FEDERAL RGU	Williams	Abandon Location	1S	98W	25	39.928610010	108.349139985	6730.0
11022	Williams	Active	1S	98W	25	39.939121005	108.350513998	6608.0
11080	Williams	Active	1S	98W	25	39.928059005	108.346293987	6684.0
10H-I	NSI	Active	1S	98W	25	39.927867829	108.349719846	6724.6
10H-R	NSI	Active	1S	98W	25	39.928400092	108.349547099	6724.6
11H-1	NSI	Active	1S	98W	25	39.928561854	108.349538868	6724.6
11H-R	NSI	Active	1S	98W	25	39.929094334	108.349366198	6725.9
MMC-IRI-11	Multi Mineral Corporation	Active	1S	98W	25	39.931580209	108.336655596	6613.6
I-3A	NSI	Active	1S	98W	26	39.929883109	108.364430331	6687.2
2A-2V	NSI	P&A	1S	98W	26	39.932120175	108.363338240	6673.9
2B-3C	NSI	P&A	1S	98W	26	39.929482029	108.364617427	6692.6
2M-TDR	NSI	Active	1S	98W	26	39.928707694	108.363203358	6677.8
3M-TDR	NSI	Active	1S	98W	26	39.928767153	108.363197004	6677.9
4-2V	NSI	P&A	1S	98W	26	39.934877329	108.363276446	6680.4
4A-1V	NSI	Active	1S	98W	26	39.931226494	108.365308549	6696.6
4A-4V	NSI	P&A	1S	98W	26	39.931173071	108.365341698	6696.1
4A-5M	NSI	Active	1S	98W	26	39.929785709	108.366029176	6705.9
4A-6V	NSI	P&A	1S	98W	26	39.929911318	108.365775113	6705.0
5H	NSI	Inactive	1S	98W	26	39.928840894	108.357872460	6688.4
5H-1V	NSI	Inactive	1S	98W	26	39.928864592	108.361450196	6671.7
6H	NSI	Inactive	1S	98W	26	39.928292498	108.357820351	6695.4
7HR	NSI	Active	1S	98W	26	39.927481895	108.357111106	6708.8
7H-1B	NSI	Inactive	1S	98W	26	39.927687478	108.362042871	6686.0
7H-I	NSI	Active	1S	98W	26	39.927764815	108.357153701	6707.7
88-1V	NSI	Active	1S	98W	26	39.933480607	108.361461162	6650.0
89-1	NSI	Active	1S	98W	26	39.934790190	108.360475796	6631.7
89-2	NSI	Active	1S	98W	26	39.934743748	108.360300875	6628.9
89-3	NSI	Active	1S	98W	26	39.934932018	108.360521524	6633.6
90-1	NSI	Active	1S	98W	26	39.930914786	108.363431665	6671.9
90-2	NSI	Active	1S	98W	26	39.927630175	108.363763577	6691.2
90-3	NSI	Active	1S	98W	26	39.927631768	108.363841988	6692.3
90-4	NSI	Active	1S	98W	26	39.927627096	108.363686352	6690.3
90-5	NSI	P&A	1S	98W	26	39.929803047	108.363552063	6675.5
91-1V	NSI	P&A	1S	98W	26	39.933956672	108.362043212	6652.5
91-2H	NSI	P&A	1S	98W	26	39.930284626	108.364156020	6683.8
93-2M	NSI	P&A	1S	98W	26	39.933325433	108.362404676	6659.3
93-3V	NSI	P&A	1S	98W	26	39.934433832	108.362651825	6663.5
93-4H	NSI	P&A	1S	98W	26	39.930749406	108.364726349	6695.5
94-1M	NSI	Active	1S	98W	26	39.935685298	108.361915504	6661.9
BG-4	NSI	Active	1S	98W	26	39.929250705	108.357546625	6680.4
BG-5 (12H-C)	NSI	Active	1S	98W	26	39.929110777	108.351765842	6683.4
BG-6 (2010-26-198-6C)	NSI	Active	1S	98W	26	39.931274001	108.355642983	6659.5
DS-3	NSI	Active	1S	98W	26	39.929501272	108.360974631	6663.7
DS-4 (10H-C)	NSI	Active	1S	98W	26	39.927733902	108.351691761	6699.0
DS-5 (2010-26-198-1C)	NSI	Active	1S	98W	26	39.930307226	108.352048413	6657.1
EX-1	NSI	P&A	1S	98W	26	39.935787659	108.360060221	6631.5
EX-2	NSI	Active	1S	98W	26	39.934829690	108.360641542	6634.5
MMC-IRI-1	Multi Mineral Corporation	Active	1S	98W	26	39.927552392	108.363761241	6681.5
Skyline 1	Sindair	P&A	1S	98W	26	39.939868160	108.358653440	6607.9
WSW-2 (2010-26-198-2C)	NSI	Active	1S	98W	26	39.932885306	108.357646105	6639.9
FEDERAL RGU 432-27-198	Williams	Active	1S	98W	27	39.936125695	108.379917016	6560.0
IR-MW1	Industrial Resources, Inc.	Active	1S	98W	27	39.938694576	108.374281584	6517.6

Table 3–1. List of wells within a one mile perimeter of the NSHI Nominated RD&D Lease.

Wel Name	Company	Status	Twsp	Rge	Sec	Latitude	Longitude	Elevation
MMC-IRI-2	Multi Mineral Corporation	Active	1S	98W	27	39.931445041	108.379288827	6573.6
MMC-IRI-3	Multi Mineral Corporation	Active	1S	98W	27	39.938729177	108.375063027	6520.1
MMC-IRI-PW1	Multi Mineral Corporation	Active	1S	98W	27	39.938766751	108.374347922	6518.5
MMC-IRI-PW2	Multi Mineral Corporation	Active	1S	98W	27	39.938585629	108.374208382	6519.6
68-30-198-L4	Shell	Active	1S	98W	30	39.932846455	108.427813716	6380.0
10940	Williams	Active	1S	98W	34	39.925136000	108.376079989	6622.0
Ryans Creek 1	Ohio Oil	Inactive	1S	98W	34	39.914310988	108.371888996	6732.0
MMC-IRI-9	Multi Mineral Corporation	Active	1S	98W	34	39.920732290	108.383765363	6666.3
23-35-198 FEDERAL RGU	Williams	Active	1S	98W	35	39.919332006	108.362492987	6780.0
1A-4HI	NSI	P&A	1S	98W	35	39.926109311	108.365242536	6702.5
1A-5HR	NSI	P&A	1S	98W	35	39.926212241	108.366115190	6699.9
3A-4H	NSI	P&A	1S	98W	35	39.926409471	108.367053491	6691.9
3A-5V	NSI	P&A	1S	98W	35	39.926897785	108.366011335	6712.2
4-3H	NSI	P&A	1S	98W	35	39.927271722	108.367596733	6692.1
97 DS2	NSI	Active	1S	98W	35	39.926190196	108.366804472	6691.0
EG-1	NSI	Active	1S	98W	35	39.926182184	108.366768853	6691.3
RGN-1	Ryan Gulch Nahcolite	P&A	1S	98W	35	39.919782629	108.360163683	6757.1
RGN-2	Ryan Gulch Nahcolite	P&A	1S	98W	36	39.919021580	108.350535513	6726.0
RGN-3	Ryan Gulch Nahcolite	P&A	1S	98W	36	39.923982683	108.337016876	6588.5
44-1-298 FEDERAL RGU	Williams	Active	2S	98W	1	39.901000994	108.336162013	6282.0
12-1-298 FEDERAL RGU	Williams	Abandon Location	2S	98W	1	39.908719992	108.347950014	6624.0
31-2-298 FEDERAL RGU	Williams	Active	2S	98W	2	39.910100991	108.358277991	6696.0
341-2-298 FEDERAL RGU	Williams	Active	2S	98W	2	39.910322998	108.358307009	6690.0
441-2-298 FEDERAL RGU	Williams	Active	2S	98W	2	39.910281989	108.358295983	6690.0
442-2-298 RYAN GULCH UNIT	Williams	Location	2S	98W	2	39.910202003	108.358273981	6690.0
42-2-298 FEDERAL RGU	Williams	Active	2S	98W	2	39.910241996	108.358285000	6690.0
1 FEDERAL C-012396 298-2	Rio Blanco Natural Gas Co	Inactive	2S	98W	2	39.904871013	108.358798007	6652.0
42-3-298 FEDERAL RGU	Williams	Active	2S	98W	3	39.908659009	108.371094002	6701.0
Ryan Ridge 1	Humble	P&A	2S	98W	3	39.910701013	108.376388994	6691.0
8-3-298-C	Shell	P&A	2S	98W	3	39.910062648	108.386500921	6708.7
TH75-11A	USGS	Active	2S	98W	3	39.910767932	108.375153740	6706.0
TH75-11B	USGS	Active	2S	98W	3	39.911123432	108.375618293	6706.2
FEDERAL RGU #13-36-198	Williams	Active	1S	98W	36	39.916717000	108.348652001	6680.0
FEDERAL RGU #43-35-198	Williams	Active	1S	98W	36	39.916737999	108.348646992	6679.0
FEDERAL RGU #44-35-198	Williams	Active	1S	98W	36	39.916615004	108.348646996	6679.0
FEDERAL RGU #343-35-198	Williams	Active	1S	98W	36	39.916696991	108.348646993	6679.0
FEDERAL RGU #344-35-198	Williams	Active	1S	98W	36	39.916656011	108.348646995	6679.0
FEDERAL RGU #411-25-198	Williams	Active	1S	98W	25	39.939200003	108.350545986	6607.0
FEDERAL RGU #341-26-198	Williams	Active	1S	98W	25	39.939231006	108.350593988	6607.0
FEDERAL RGU #342-26-198	Williams	Active	1S	98W	25	39.939133012	108.350555997	6607.0
FEDERAL RGU #541-26-198	Williams	Active	1S	98W	25	39.939191992	108.350580013	6607.0
FEDERAL RGU #414-24-1	Williams	Active	1S	98W	25	39.939257015	108.350572988	6607.0
FEDERAL RGU #544-23-198	Williams	Active	1S	98W	25	39.939271010	108.350609004	6607.0
FEDERAL RGU #322-35-198	Williams	Active	1S	98W	35	39.919263991	108.362627006	6778.0
FEDERAL RGU #412-35-198	Williams	Active	1S	98W	35	39.919229011	108.362653006	6778.0
FEDERAL RGU #522-35-198	Williams	Active	1S	98W	35	39.919227991	108.362545985	6778.0
FEDERAL RGU #532-35-198	Williams	Active	1S	98W	35	39.919227989	108.362493012	6778.0
FEDERAL RGU #41-26-198	Williams	Active	1S	98W	25	39.939250996	108.350601995	6608.0

Table 3-1. List of wells within a one mile perimeter of the NSHI Nominated RD&D Lease (Continued).

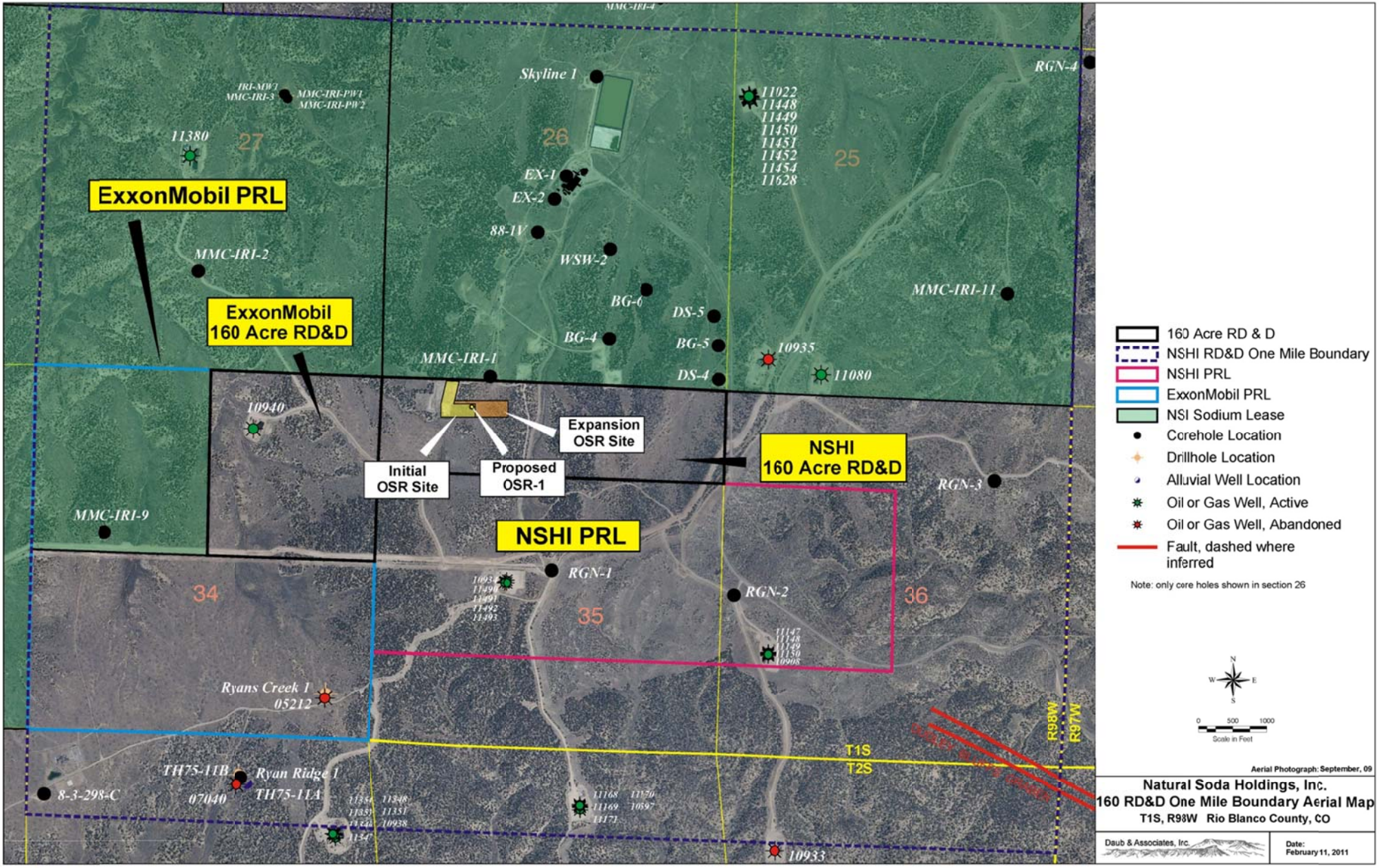


Figure 3–10. Aerial map showing wells within a one mile perimeter of the NSHI nominated RD&D Lease.

The Dudley Bluffs Graben is a northwest to southeast trending fault system originating at the Piceance Creek Dome about 10 miles southeast of the nominated RD&D Lease. As the Dudley Bluffs Graben approaches the Lease it loses surficial definition and intensity (Figure 3-11). It is doubtful that this feature will have a significant impact to oil shale operations on the nominated RD&D Lease.

The nominated RD&D Lease is located near the depositional center of the basin, and contains some of the thickest and richest oil shale deposits in the entire basin. The proposed OSR reactor interval to be developed is the uppermost 40 feet of the R-2 Zone, which is anticipated to contain a well laminated to blebby, moderately rich to rich oil shale containing occasional nahcolite aggregates, nodules and thin nahcolite interbeds. A structure contour map of the top of the R-2 Zone in the vicinity of the NSHI nominated 160 acre RD&D Lease can be seen in Figure 3-12. The lithologic units and features contained within each stratigraphic zone can be easily correlated from one part of the basin to another. This is especially true over short lateral distances. Due to the proximity of the NSI plant and associated sodium bicarbonate production wells, NSHI has sound stratigraphic control over the stratigraphic tops of the Parachute Creek Member in the vicinity of the 160 acre RD&D Lease.

3.10.2. Overburden Cross-Section

This part of the Piceance Creek Basin also contains some of the thickest overburden deposits of the Uinta Formation overlying the Parachute Creek Member of the Green River Formation. The Uinta Formation overburden on the Lease is anticipated to be approximately 1,200 feet thick. An overburden cross-section in the vicinity of the Lease can be seen in Figure 3-4.

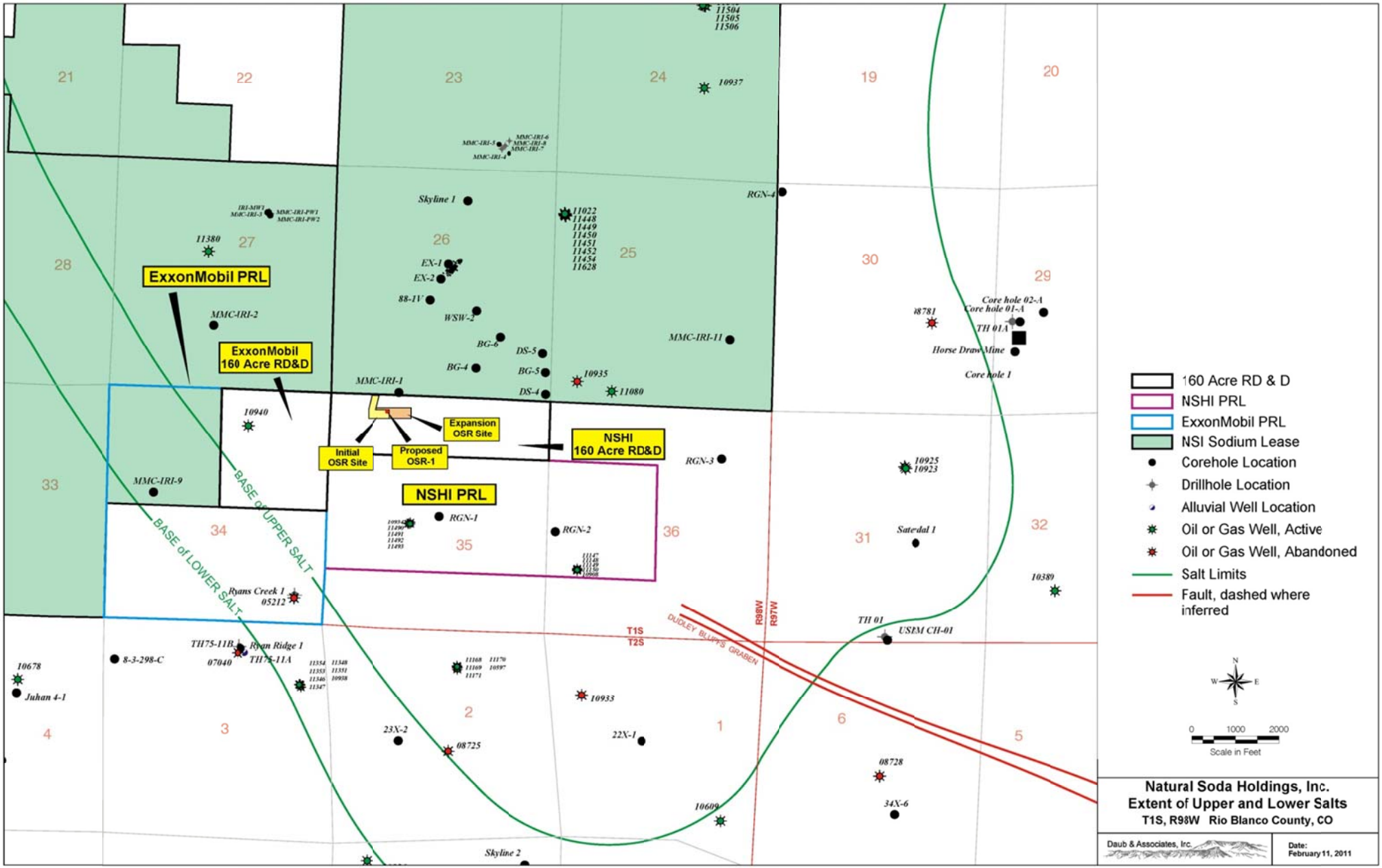


Figure 3–11. Map showing the extent of the Dudley Bluffs Graben and Upper and Lower Salts in the vicinity of the NSHI Nominated RD&D Lease.

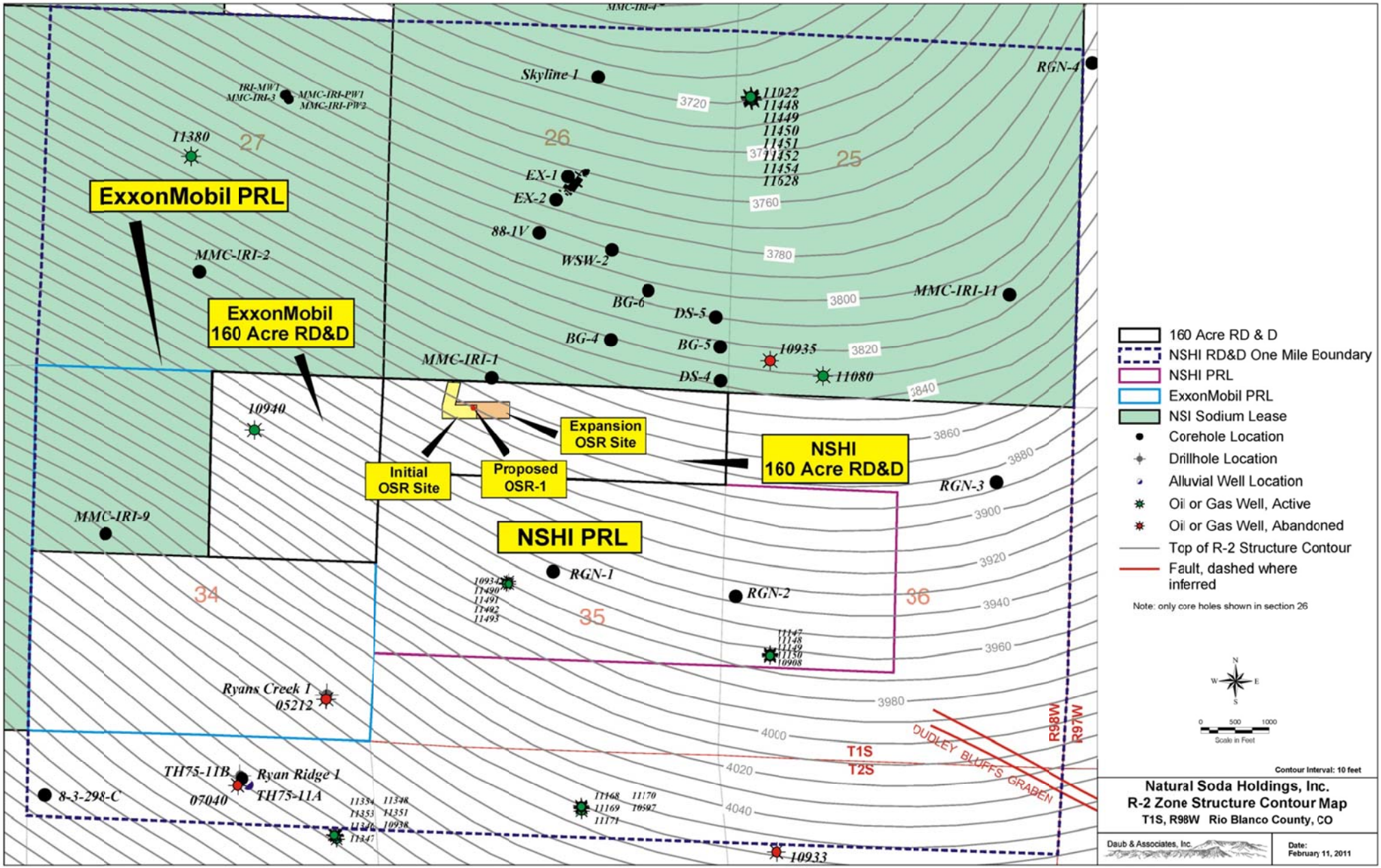


Figure 3–12. R-2 Zone top structure contour map in the vicinity of the NSHI Nominated RD&D Lease.

SECTION 4.0 DRILL PLAN

4.1. Estimated Geologic Tops and Markers

The estimated tops of the stratigraphic zones and nahcolite marker beds based upon an average ground level elevation of 6710 feet above mean sea level are displayed in Table 4-1.

The top of the Saline Zone is expected to coincide with the Dissolution Surface at a depth of approximately 1883 feet. The TI nahcolite bed is anticipated to be present between the depths of 2815.6 feet and 2824.2 feet. The top of the R-2 Zone is expected to be at a depth of approximately 2824 feet. The OSR reactor interval is to be between the depths of 2830 and 2870 feet.

4.2. Detailed Stratigraphy and Hydrostratigraphy

4.2.1. Detailed Stratigraphy

The upper contact of the Saline Zone is marked by a Dissolution Surface (see Figure 3-4) which represents the lowermost penetration of circulating groundwater into the Parachute Creek Member. Where the Saline Zone reaches its maximum thickness (near the Lease), the Dissolution Surface is positioned stratigraphically about 110 feet above the contact between the L-5 and R-5 oil shale zones. Laterally from this location the Dissolution Surface progressively penetrates deeper into the Parachute Creek Member, reducing the Saline Zone in thickness until it becomes nonexistent. The present-day extent of the Saline Zone (Figure 4-1) is a result of natural subsurface dissolution processes operating since the Eocene Epoch.

Natural Soda Holdings, Inc.
160 Acre RD&D Program

Stratigraphic and Hydrostratigraphic Prognosis Tops

Well Number: OSR-1
Section: 35
Township: 1S
Range: 98W
GL Elev, ft: 6710

Date: 2/8/2011

		Stratigraphic Intercept	Prog Depth, ft	Prog Elevation, ft	Hydro-stratigraphic Intercept	Prog Top Depth, ft	Prog Bottom, Depth, ft
		Green River Tongue	566.5	6143.5	Perched Aquifer	397.0	417.0
		Uinta Formation	nd		A-Groove Aquifer	1373.5	1410.1
		Transition Zone	nd		B-Groove Aquifer	1564.4	1604.5
Green River Formation	Parachute Creek Member	R-8 Zone	1217.5	5492.5	DS Aquifer	1833.1	1883.1
		A-Groove	1383.5	5326.5			
		R-7 Zone (Mahogany Zone)	1400.1	5309.9			
		B-Groove	1574.4	5135.6			
		R-6 Zone	1594.5	5115.5			
		L-5 Zone	1775.3	4934.7			
		R-5 Zone	1940.3	4769.7			
		L-4 Zone	2298.7	4411.3			
		R-4 Zone	2459.6	4250.4			
		L-3 Zone	2617.1	4092.9			
		R-3 Zone	2641.5	4068.5			
		L-2 Zone	2796.8	3913.2			
		R-2 Zone	2824.2	3885.8			
	Garden Gulch	L-1 Zone (Blue Marker)	2923.2	3786.8			
		R-1 Zone	2964.5	3745.5			
		L-0 Zone	nd	nd			
		R-0 Zone (Orange Marker)	nd	nd			

Saline Mineral Interval	Prog Top Depth, ft	Prog Bottom, Depth, ft	Prog Top Elevation, ft	Prog Bottom, Elevation, ft	Prog Thickness, ft
First Water	nd	na	nd	na	na
Top Mahogany Bed	1446.3	na	5263.7		na
Dissolution Surface	1883.1	na	4826.9		na
First Nahcolite	nd	nd	nd		nd
Partially Leached Interval	nd	nd	nd		nd
Saline Zone Interval	1883.1	2871.4	4826.9	3838.6	988.3
L5-E Bed - Nahcolitic	1883.1	1886.1	4826.9	4823.9	3.0
L5-E Bed - Halitic	na	na	na	na	na
L-5 B&C Bed	1886.1	1906.9	4823.9	4803.1	20.8
Upper Boies Bed - Nahcolitic	1906.9	1929.9	4803.1	4780.1	23.0
Upper Boies Bed - Halitic	na	na	na	na	na
Oil Shale Marker Bed	1929.9	1933.8	4780.1	4776.2	3.9
Lower Boies Bed - Nahcolitic	1933.8	1938.4	4776.2	4771.6	4.6
Lower Boies Bed - Halitic	na	na	na	na	na
Lower Salt	2206.3	2284.1	4503.7	4425.9	77.8
Love Nahcolite Bed	2359.3	2366.7	4350.7	4343.3	7.4
Greeno Nahcolite Bed	2742.7	2750.7	3967.3	3959.3	8.0
TI Nahcolite Bed	2815.6	2824.2	3894.4	3885.8	8.6

Table 4–1. Prognosis stratigraphic and Hydrostratigraphic tops for the OSR well.

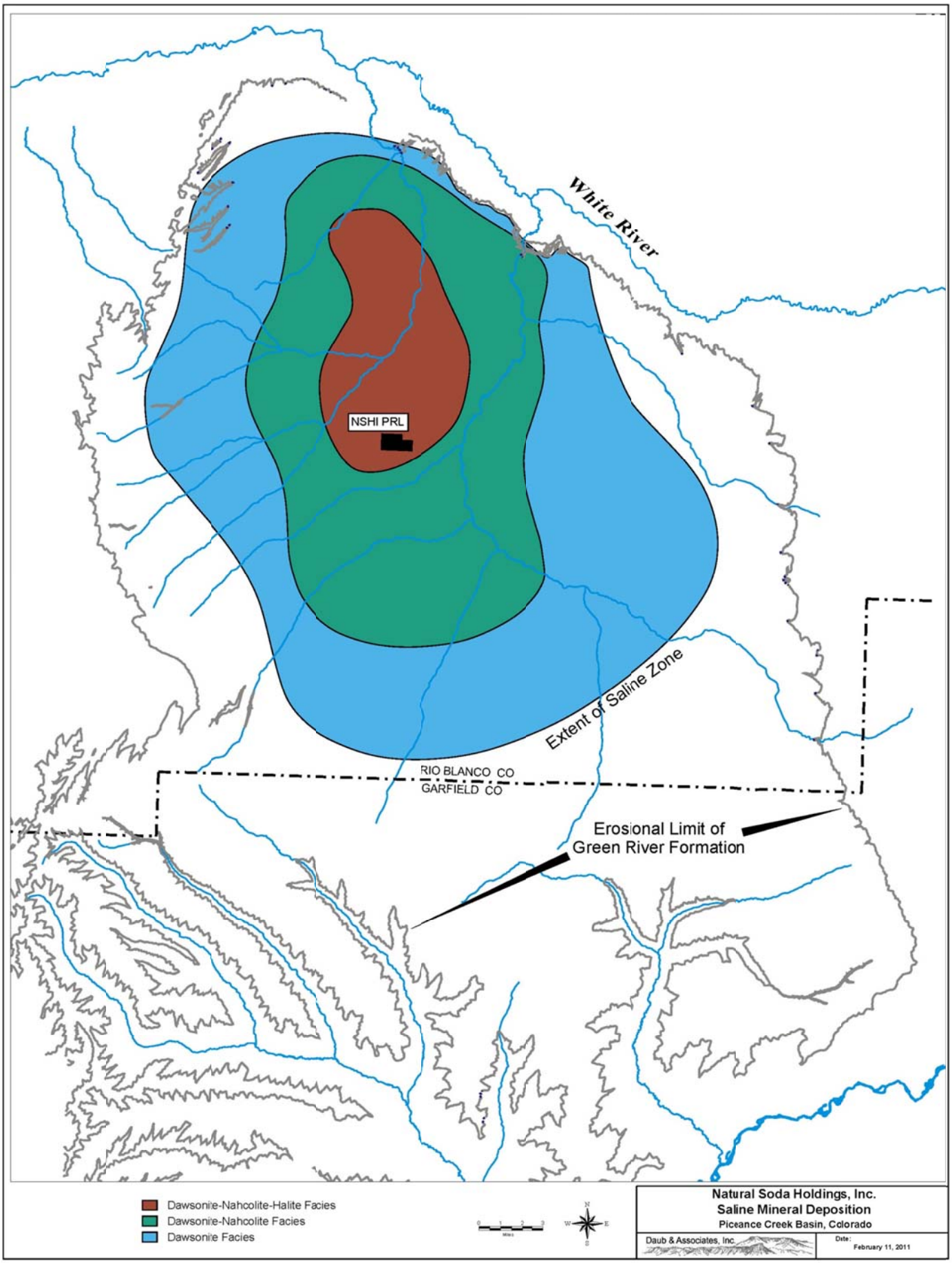


Figure 4–1. Extent of the saline zone in the Piceance Creek Basin.

Above the Dissolution Surface, rocks of the Parachute Creek Member are generally disturbed. The intensity of disruption is directly proportional to the former abundance of saline minerals in the oil shale host rock. High concentrations of saline minerals are now represented by dissolution features, rubble and collapse breccias. Removal of the saline minerals also produced subsidence in overlying oil shales, thus creating numerous joints and partings. The most intense interval of dissolution disturbance in the Parachute Creek Member occurs between the R-7 (Mahogany Zone) and the R-5 Zone. Where the Saline Zone is thick, the Leached Zone (Dissolution Surface to uppermost vug or dissolution feature) has a minimum thickness of about 600 feet. As the Dissolution Surface penetrates further into the section, the Leached Zone becomes proportionally thicker. It should be noted that evidence for leaching of saline minerals is also present above the Mahogany Zone. The lower Mahogany Zone, A-Groove and parts of the R-8 Zone all have dissolution features (Daub and others, 1985; Trudell and others, 1970, 1974).

Because the Dissolution Surface represents the deepest extent of groundwater penetration, rocks in the Saline Zone below the Dissolution Surface are dry, generally very competent, and largely devoid of fractures. Significant quantities of nahcolite are present below the Dissolution Surface in the form of nodules and aggregates, thin interbeds, and thick beds.

The most important bedded (stratiform) nahcolite horizons in descending order are the Boies Bed, a 30 to 32-foot thick seam of crystalline nahcolite in the lower L-5 Zone; the Love Bed, an interbedded series of microcrystalline nahcolite seams and oil shale beds (6 to 7 feet thick) in the L-4 Zone; the Greeno Bed, a 7 to 8-foot thick horizon in the R-3 Zone consisting of densely disseminated nahcolite crystals in an oil shale matrix; and the TI Bed, a 7 to 8 foot-thick bed in the L-2 Zone that closely resembles the Greeno Bed in texture, composition, and thickness. Typically, the average nahcolite content in these high-grade beds exceeds 65 weight percent. These units are easily identifiable and are therefore considered good marker beds.

Dawsonite generally becomes common within the R-5 Zone and is present in the stratigraphic units below the R-5 Zone. Minor amounts of free oil and methane are anticipated to be encountered in the Saline Zone lithologic units, though not in enough quantity so as to be commercially developed. However, any methane or natural gas encountered in the subsurface either by way of degassing or via the subsurface heating process will be captured and utilized in the production of carbon monoxide or hydrogen, or utilized for heating water and other processing constituents.

Halite in the Saline Zone is not found below the R-5 oil shale zone. It is primarily concentrated in two major horizons, one at the base of the L-5 zone, called the Upper Salt (containing the Boies Bed), and the second within the R-5 oil shale zone, the Lower Salt. Other horizons of halite occur between the two massive salts but they are subordinate in thickness. Within the Upper and Lower Salts, halite is usually interbedded with thin horizons of nahcolitic oil shale, nahcolite and halitic nahcolite.

Though halite is present in the Boies Bed on the NSI leases immediately to the north of the NSHI nominated 160 acre RD&D Lease, the lateral extent of the halite facies

in the Boies Bed is not expected to encompass any part of the 160 acre RD&D Lease. Halite is present in the Lower Salt as part of an approximately 100-foot thick nahcolitic halite interval within the R-5 Zone, and acts as an excellent confining interval (see Figure 3-11).

The NSHI research project intends to produce initially approximately 100 barrels of oil from a 40-foot thick interval of oil shale in the uppermost R-2 Zone beginning approximately 6 feet below the bottom of the TI nahcolite bed.

4.2.2. Detailed Hydrostratigraphy

Groundwater is expected to be encountered in the Perched, A-Groove, B-Groove, and Dissolution Surface Aquifers at the depths listed in Table 4-1. However, since the OSR interval is between the depths of 2830 and 2870 feet, no groundwater is anticipated to be encountered nor is there any potential for existing groundwater to be adversely affected by the initial development operations because approximately 1,000 feet of dry confining interval exists between the top of the OSR and groundwater occurrences. In addition, to preclude any contamination the hole will be cased and cemented from near the top of the reactor interval to ground level.

4.3. Description of Geological Formations to be Developed

4.3.1. Geologic Description

The R-2 Zone characteristically consists of moderately rich to rich oil shale with occasional aggregates, nodules and interbeds of nahcolite in the upper half of the R-2 Zone. The base of the Saline Zone in the vicinity of the lease is found at a depth of approximately 2860 feet, located near the middle of the R-2 Zone. The proposed reactor interval for the NSHI research project is between the depths of 2830 and 2870 feet, which will encompass the lowermost 40 feet of the Saline Zone (see Figure 3-9). The top of this interval is approximately 6 feet below the base of the 8.6 foot thick TI nahcolite bed found in the lowermost L-2 Zone.

Based upon analytical data from the MMC-IRI-1 well located immediately adjacent to the NSHI nominated 160 acre RD&D lease, the R-2 Zone reactor interval in the Lease area is expected to average approximately 30 gallons of oil per ton of oil shale. Additionally, nahcolite in the reactor interval is anticipated to average 17% by weight, and dawsonite is expected to average 4% by weight.

Because the reactor interval is at the base of the Saline Zone, there will be an impermeable, competent overlying confining interval of as much as 950 feet of solid rock. No subsidence or groundwater contamination resulting from the solution mining and oil recovery activities is anticipated.

4.3.2. Temperatures of Heating Technology

The reactor interval will be used to first solution mine nahcolite to create a prescribed void space in the oil shale. Appropriate equipment will be inserted and carbon monoxide, hydrogen and water will be generated downhole by burning natural gas to produce supercritical (or near supercritical) water at temperatures in the range of 300 – 350 degrees Centigrade (572 - 662 degrees Fahrenheit).

Optionally down hole heaters may be inserted and these gasses may be preheated at the surface and injected.

4.4. Circulation Medium to Heat Oil Shale

A down hole burner (DHB) will be installed in the 4.5 in. casing down to the top of the OSR reactor interval. Heating will be initiated from the top of the reactor interval downward. The injection side tubing will be closed by packing it off at the surface and/or with an inert gas. The DHB will have temperature thermocouples and pressure sensors attached to monitor the reactor interval and sections above the reactor interval. The 7 in. reactor interval extractor tubing will have an adequate pressure control regulator at the surface well head.

Fresh water will be pumped downhole to the DHB located in the reactor interval. The combination of high temperature and hydrostatic pressure of the overlying water column will make the water reach a supercritical or near supercritical state. Partial oxidation of natural gas will generate carbon monoxide, hydrogen and water which along with sodium aluminate will enhance the liquefaction of kerogen from oil shale. The heated, supercritical or near supercritical CO/water/hydrogen atmosphere will remain downhole as conversion takes place. After the water has been heated and given the necessary time for conversion, the water will be pumped to the surface along with the shale oil and any dissolved constituents. At the surface, the water will go through a separation system whereby coarse inorganic materials will be removed and the filtered water recycled through the system to be pumped back downhole to be reheated. Circulation water deemed to be too unfit for reuse will be removed from the water circulation system. Shale oil received at the surface will be stored in on-site storage tanks for forthcoming transport to an off-site analytical facility. Any gases produced from the conversion process will be run through a scrubber and either vented or combusted.

4.5. Type/Characteristics of Proposed Circulation Medium During Drilling

4.5.1. Type and Weight of Mud/Drilling Fluids

The drilling of the OSR well and monitoring well will be conducted using a combination of an air mist and/or mud drilling medium. This medium has provided for the successful drilling of the numerous wells on the NSI sodium leases, and is expected to be satisfactory for the drilling of the wells on the NSHI nominated 160 acre RD&D Lease. The mud will be a bentonite-based fluid with polymer (Pol-E-Flake) added to maintain a density between 9.0 and 9.5 lb/gal. Circulation will be normal, and any lost circulation zones will be remedied by flushing the hole with lost circulation material in the form of sawdust, shredded paper, walnut hulls, Diamond Seal or similar materials. It is anticipated that less than 100 bbls of water will be used daily during the drilling operations. The water to be used in drilling operations is to be taken from one or both of NSI's water supply wells, 90-1 and WSW-2.

4.6. Fracturing Methods

NSHI will not employ any fracturing methods or propellants in the OSR well drilling or production operations. However, minor fracturing within the OSR as a result of thermal expansion of the oil shale during the heating of the water is expected.

4.7. Hole Pressures

4.7.1. Expected Bottom Hole Pressures

The pressure induced formation fracture gradient (FG) for the area and interval of the OSR is 0.9 to 1.0 psi/ft. The top of the OSR interval is anticipated to be approximately 2,830 feet. The formation fracture pressure (FP) at that depth is given by the equation:

FP = FG * (depth to top of reactor interval)

A conservative formation fracture pressure at 2,830 feet is therefore equal to 0.9 psi/ft * 2,830 feet or 2,547 psi. Downhole pressures of less than 2,547 psi are not expected to fracture the formation. The formation will be cased from surface to top of the reactor interval.

The hydrostatic pressure (HP) component of wellbore/reactor fluids is given by the equation:

HP = D x FW x 0.052

Where:

- HP = Hydrostatic Pressure in pounds per square Inch (psi)
- D = Depth in feet
- FW = Fluid Weight in pounds per gallon (lb/gal)
- 0.052 = unit conversion factor

Drilling mud is anticipated to be among the heavier fluids with a weight of between 9.0 and 9.5 lb/gal (ppg). The hydrostatic pressure of heavier drilling mud at the top of the anticipated OSR interval will be approximately:

2,830 ft. * 9.5 ppg * 0.052 = 1,398 psi

The maximum allowable injection pressure (MAIP) of an injected fluid is limited by the equation:

MAIP = (formation fracture pressure at the top of the reactor interval) – (hydrostatic pressure)

or by the similar equation:

MAIP = [FG – (0.433 * SG)] * (depth to top of reactor interval)

A fluid with the weight of drilling mud could be injected at a pressure of up to or less than 1,149 psi without fracturing the formation (2,547 psi -1,398 psi = 1,149 psi). Fluids weighing less, i.e. water or solvents may be injected at correspondingly higher pressures.

The injection of gases into a dry hole is limited by the formation fracture pressure of 2,547 psi. Gases added to a reactor containing injected fluids are limited to a maximum pressure of 2,547 psi if allowed to displace any fluids, i.e. opening the system to allow fluid displacement. In a closed system containing injected fluids gas injection would be limited by the MAIP. Expected downhole pressures, expressed as the total of hydrostatic pressure (if any) and injection pressure, will be less than 2,547 psi to avoid pressure induced formation fracturing.

4.7.2. Pressure Control Equipment

Automatic and manual pressure control valves, gauges, monitoring and recording equipment will be installed to ensure control and compliance of the OSR pressures.

Though minor pressure variations are anticipated, these variations are not expected to be considerably above normal bottom hole pressures and at no time expected to be above the formation fracture pressure.

4.8. Well Identification

4.8.1. Disposal, Injection, and Production

No disposal wells are planned. Initially, for phase 1 a single OSR well will be constructed which will act as both an injection well (for the leaching phase) and the production well (for the recovery of shale oil during the production phase).

4.8.2. Casing Specifications

The OSR well is anticipated to use 18 5/8 inch carbon steel conductor casing to a depth of approximately 150 feet. The well will use 7 inch permanent (intermediate) casing and 4 1/2 in. tubulars, which will 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 will be used in the annulus of the 7 in. casings.

4.8.3. Well Life

The OSR well is expected to produce shale oil from multiple reactor intervals within the Saline Zone. After the appropriate amount of shale oil has been produced at a particular reactor interval, the DHB and production material will be removed from the hole and a new reactor interval will be identified, leached and produced from an area higher up in the stratigraphic section. The old/spent well will be plugged and abandoned following production from the multiple intervals in the Saline Zone, or at a time when the well is deemed uneconomic.

4.9. Cement

The OSR well will utilize high-temperature Class G cement with silica flour and spherical glass beads formulated to withstand high temperatures. The Class G cement will be used on both the conductor and intermediate casing strings. Cement will be circulated to the surface in both casing strings. The monitoring wells will use Portland Type I/II cement with 2% calcium chloride on both the conductor and intermediate casing strings. Cement will be circulated to the surface on all monitoring well holes. Specific cement formulations will 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.

SECTION 5.0 ENVIRONMENTAL

5.1. Water Rights

NSI owns and controls significant absolute and conditional water rights in northwest Colorado which are sufficient to solution mine nahcolite on the NSI sodium lease and develop the OSR project on the NSHI nominated160 acre RD&D Lease.

Natural Soda, Inc., a wholly owned subsidiary of Natural Soda Holdings, Inc., is the owner of several direct flow and storage water rights that divert out of the White River, Piceance Creek and Yellow Creek and well water rights that divert water from aquifers tributary to the surface streams. The water rights are part of an integrated system of a water supply for various uses associated with NSI's sodium leases and other natural resource development.

Under Colorado law, the withdrawal of water through a water production well or wells requires the replacement of depletions to stream systems caused by the withdrawal of the water from the aquifer. In compliance with Colorado law, NSI, or its predecessors, obtained and has operated a judicially approved "plan for augmentation" to replace the stream depletions associated with water well production. Pursuant to a decree entered by the District Court in and for Water Division No. 5 in Case No. 88CW420 on August 13, 1991, the District Court approved a plan for augmentation for the sodium mining operations and other natural resource development operations. The plan for augmentation provides for the construction of such wells as are required by NSI for the mining operations, and for the replacement of depletions associated with such well operation. The water produced pursuant to the construction and operation of the groundwater wells will provide water supplies for the RD&D nominated lease operations.

Natural Soda owns several water rights that are useable for the replacement of stream depletions associated with the operation of the water production wells. Included within the water rights are several "senior" ditch water rights. The significance of the "senior" status is that under Colorado law, the right to withdraw water from the surface streams is based on seniority. As a result, a senior water right is entitled to divert water prior to a junior water right.

NSI's current sodium bicarbonate production is in excess of 100,000 short tons per year, which has required a water supply of approximately 115 acre feet of water per year. The withdrawal of the water supply requires the replacement of water depletions to stream systems, and the replacement obligation is currently less than two and one-half (2.5) acre feet of water per year. As of 2010, the calculated maximum annual replacement of depletions associated with past pumping of the water well is approximately 7 acre feet over the next approximately 250 years.

The senior ditch water rights owned by NSI are among the most senior water rights in the Piceance Creek Basin, and the water rights produce approximately 270 acre feet of fully consumable water each year, which will allow for water well pumping and supply of approximately 3100 acre feet of water per year. In addition, NSI owns other water rights that divert out of the White River that are anticipated to produce in

excess of 79,000 acre feet of fully consumable water per year. The water rights owned by NSI will provide adequate water for the RD&D nominated lease operations, and no further approvals will be required from the Colorado District Courts.

The NSI 90-1 and WSW-2 water supply wells will be the source of water for the OSR project. These wells will be used to supply the water for the drilling, leaching and production operations.

5.1.1. Estimate of Quantity of Water to be Used

The majority of water to be used will be during the drilling of the OSR well and monitor well. NSHI's RD&D project anticipates using less that 100 bbl per day for 15 to 30 days of drilling and approximately 10 bbl per day once operations commence. This water usage is expected to total to less than 1 acre foot per year.

5.1.2. Types of Products and By-Products Produced and Their Storage/Disposal

The NSHI production process is in-situ and, for much of the process, a closed-loop system, therefore the amount and type of by-products are limited as are associated environmental impacts. The OSR project is also a very small-scale project, anticipating a total production of 100 barrels of shale oil over the life of the initial RD&D project. The shale oil will be stored in on-site storage tanks until it can be transferred to a local analytical facility. Minor amounts of solids produced as a result of the kerogen conversion process will be brought to the surface and temporarily stored in waste tanks. As a utilization of a best management practice, most of the circulation water used in the conversion process will be recycled. Spent circulation water will be removed from the OSR, as necessary, and stored in an on-site waste water tank prior to disposition. This unrecyclable waste water from the conversion process is expected to be limited to less than 10 barrels per day. As a best management practice, NSHI would like create a slurry comprised of the solids which were brought to surface as a by-product of the kerogen conversion process and the spent circulation water. This slurry would then be pumped into an exhausted OSR interval. Should this process prove unfeasible, the solid and liquid waste by-products will be removed and disposed of at an appropriate off-site solid waste and/or liquid disposal facility by a contracted waste disposal company in a timely manner.

5.1.3. Potential Pollutants of Surface Water and Ground Water

Any waste water that meets the qualifications of NSI's existing process evaporation/storage pond will be transferred to this lined pond. Because the OSR interval is located below the Dissolution Surface, no pollutants from the conversion process are anticipated to affect either surface water or groundwater.

5.2. Spill Prevention

5.2.1. Control and Countermeasures

All storage tanks and roll-off bins located on-site will have secondary containments. These secondary containments will be checked daily for possible pollutants. Accumulated precipitation within the secondary containments will be removed as necessary.

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. 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 also be disposed of in a like manner.

Any spill to the ground surface will be immediately remediated using NSI's in-place guidelines for spill remediation. A spill will indefinitely shut down drilling or production operations until the spill has been appropriately remediated. Notifications of a spill will be sent to the appropriate local, state and federal regulatory agencies.

5.3. Groundwater Remediation Plan

5.3.1. Specific Plan for Prevention of Groundwater Contamination

Appropriate high grade specialty alloy, casing grades and thicknesses will be used for the 7 inch casing. Groundwater contamination will be prevented by cementing the OSR production casing string from the top of the reactor interval (located near the base of the Saline Zone) to the surface with thermal cement. Additionally, the 950 feet of groundwater-free Saline Zone above the proposed reactor interval will ensure that the production activities will not affect any aquifers underlying the NSHI nominated 160 acre RD&D Lease. The monitoring well to be drilled will be cased and cemented to the surface. This will result in the isolation of the aquifers and prevention of aquifer cross-mixing or comingling. This monitoring well, in conjunction with the existing NSI monitoring wells to be utilized for NSHI OSR monitoring purposes, will provide both upgradient and downgradient groundwater monitoring. All wells will have cement bond logs run in them to verify that a quality cement bond exists between the aquifer systems. Remedial cement jobs will be conducted on wells, as necessary. The aquifers will be isolated by competent annular cement seals.

Should groundwater contamination from the NSHI 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.

5.4. Storm Water Management Plan

Site facilities are currently undergoing preliminary design. As these facility plans advance, NSHI 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.

The plan will include a site description and detailed site map. All erosion and sediment control Best Management Practices (BMPs) that will be employed at the site, including structural site management practices, interim and permanent stabilization practices and materials handling procedures, will be described. BMPs for controlling sediment sources will be given greater emphasis than those designed to handle sediments after release.

After developing the SWMP, NSHI will submit the required Stormwater Construction Permit Application to CDPHE at least ten days prior to the anticipated start of construction.

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.

After construction has been completed and final stabilization of the site has been achieved, NSHI will provide CDPHE with a stormwater permit inactivation notice.

If necessary, a SWMP for the operating facility will be developed and implemented.

Storm water produced fluid on the NSHI site will be collected into appropriate catchments. Storm water collected within NSHI surface equipment containment will be promptly removed to NSI's 7 acre waste water evaporation pond.

5.5. Best Management Practices (BMPs)

5.5.1. Fire Prevention Control

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. A water truck from NSI's nearby plant will be made available. Halon extinguishers will be available, as required, in instrumentation and electrical areas. Extra fire extinguishers located in the NSI plant will be brought to the NSHI Lease to have on-site during drilling and production operations. Additionally, the close proximity of the NSI plant and attendant resources will be available to enhance the NSHI firefighting capabilities.

Fire prevention for the NSHI 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 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. Produced

shale oil, motor oil, flammable liquids and grease shall be kept in containers provided for them. The containers will be labeled as to their contents.

The first concern during a fire is the safety of the employees and others on site. If a fire starts there are at least two options, depending on the size of a fire:

1. The fire may be controlled with a fire extinguisher

2. 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 need to be provided to the first responders. If necessary, locate and evacuate all other persons from potentially dangerous situations.

5.5.2. Soil Erosion

Soil erosion control practices that will be implemented on the NSHI nominated Lease are contained within the NSI SWMP. If it is deemed necessary to modify the SWMP in any way, a revised SWMP will be directly submitted to the CDPHE.

5.5.3. Subsidence

Subsidence monitoring wells in the area of the NSI mining operations do not show any subsidence of the ground surface. The proposed NSHI OSR interval is thinner, will affect a much smaller area and is as much as 1000 feet deeper than the NSI solution mined nahcolite production cavities. Therefore, no surficial or subsurface subsidence is anticipated. As such, NSHI will not need to drill a subsidence monitoring well for its production operations. Only approximately 20% of the material in the OSR interval will be removed. The remaining 80% will occupy the OSR interval and no subsurface subsidence is anticipated.

5.5.4. Pollution of Water

5.5.4.1. Surface Water

No perennial surface water has been identified on or adjacent to the NSHI nominated 160 acre RD&D Lease, therefore there is no nearby surface water to contaminate. During the construction phase, surface disturbance including cuts, fills, and grading could increase the potential for sedimentation in nearby ephemeral drainages. Streams which drain through the Lease area are intermittent and usually have less than 2 square miles of drainage area above the project site. A sedimentation pond and runoff diversion ditches will be placed at strategic locations to minimize runoff and sediment contributions from construction areas, pursuant to the construction phase SWMP.

5.5.4.2. Ground Water

Contamination of the ground water aquifer systems is not anticipated due to the production interval being located and encased so deep within the Saline Zone. Using both currently existing upgradient and downgradient NSI monitoring wells and

the early warning monitoring well to be constructed by NSHI, the aquifer systems will be sampled on a quarterly basis. Appropriate corrective action will take place if a problem is identified.

Saline liquids produced by the drilling operations with conductivity values greater than 5,000 µmhos/cm will be removed and placed in the existing NSI lined evaporation/process ponds near the NSI plant site. The ponds, which contain high TDS water, have a dual liner system that incorporates a drain blanket with a leakage detection system. Consequently, no impacts to ground water quality from the evaporation/process ponds are expected.

5.5.5. Air Pollution

Air pollution from production processes is expected to be minimal and below all minimum regulatory compliance levels, because no permanent RD&D facilities are currently planned to be constructed on the NSHI nominated Lease and due to the very small-scale nature of the project (100 bbl production). NSHI intends to rigorously monitor air emissions to gather data for use in planning commercial operations and future air pollution emission permitting. Once the equipment that will be used on site has been fully specified, NSHI 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 NSHI 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 the NSHI Lease, permits will be filed and APENs submitted to the CDPHE in accordance with existing regulations.

5.5.6. Damage to Surrounding Fish, Wildlife, and Natural Resources

Because the OSR well is to be located on a portion of the NSHI nominated Lease that has already been disturbed via previous NSI drilling activities, a biological and cultural assessment of the land has already been conducted and approved for drilling activities. As such, no land-clearing or land-disturbing activities will take place during the OSR operations.

The lack of perennial surface waters indicate that damage to fish populations will be nonexistent. The small footprint (less than 10 acres) of the OSR site on previously disturbed land ensures that disturbance or damage to wildlife populations and other natural resources will be minimal.

Subsurface activities of the production operations will result in an approximately 40 to 50 foot tall by 20 foot wide by 20 foot long zone of porous and permeable, chemically retorted oil shale. The influence of this zone will be restricted to the immediately proximal unretorted oil shale, and is not expected to exhibit detrimental effects either at the surface or at substantial lateral distance from the well.

5.5.7. Hazards

5.5.7.1. Public Health and Safety

The activities to be conducted during the drilling and production of the pilot hole and monitoring wells will not substantially nor detrimentally affect public health and safety, given the minor scope of the project and its location in a sparsely populated region of Colorado.

NSHI or NSI employees and contractors working on the project will be required to follow NSI's existing Health, Safety and Environmental (HSE) program.

5.6. Monitoring Plan

5.6.1. Development Process

A quarterly report documenting any drilling and production activities conducted on the NSHI 160 acre nominated RD&D Lease will be submitted to the Bureau of Land Management (BLM). The report will detail both the activities conducted in the quarter as well as an outline of impending activities in the upcoming quarter. Quarterly activity reports will be submitted to the BLM as long as any drilling or production activities are being conducted on the NSHI nominated RD&D Lease.

5.6.2. Surface and Groundwater

Due to the lack of any nearby surface water and depth of production operations, surface waters are not anticipated to be affected. Groundwater quality will be analyzed quarterly in the existing upgradient and downgradient NSI monitoring wells and the monitoring well to be constructed by NSHI. These wells will be analyzed for key constituents including: alkalinity, total dissolved solids, pH, organics, conductivity and VOCs. A complete analyte list can be found in Table 5-1.

5.6.3. Air Emissions and Quality

Monitoring of air emissions and quality is not anticipated to be required for the OSR project, as the process itself and materials needed to conduct the production operations will not produce enough air pollutants to require regulation. Air emission and quality monitoring will commence if and when it is warranted by the growth of production operations on the NSHI nominated Lease. Disturbed ground and roadways will be watered to minimize fugitive dust.

5.6.4. Noise Abatement Procedures and Equipment

Due to the isolated location of the NSHI nominated RD&D Lease and the small scale nature of the project noise pollution is not considered to be a factor. Individuals working on or around any potentially harmful noise-generating equipment on the Lease will be required to wear ear protection while in the vicinity of such equipment while it is in operation.

Analyte List		
Field Measurements:		
pH	Conductivity	Temperature
Major Analytes:		
TDS	Alkalinity	Sodium
Silica	pH	Chloride
Potassium	Bicarbonate	Magnesium
Fluoride	Conductivity	Carbonate
Calcium	Sulfate	Boron
Strontium	Hardness	VOCs
BTEX		
Minor Analytes:		
Arsenic	Aluminum	Cadmium
COD	Manganese	Selenium
Barium	SAR in water	Chromium
Nickel	Copper	Lead
Ammonia	Molybdenum	Mercury
Vanadium	Cation-Anion Balance	Beryllium
Bromide	Zinc	Lithium
Iron	Total Phosphorus	Nitrate as N
Nitrate/Nitrite as N	Nitrogen, total	Kjeldahl Nitrogen
Nitrate as N		

Table 5–1. Analyte list for NSHI's quarterly water sampling program.

SECTION 6.0 RECLAMATION PLAN

The proposed post-production land use is designed to be consistent with the current land use. The current land use is primarily limited to livestock grazing and wildlife habitat with its associated hunting activities. The proposed post-production land use likewise will be livestock grazing and wildlife habitat. The reclamation plan has been designed so that post-production land use goals are met. This is achieved by ensuring that a permanent vegetative cover is established which meets or exceeds the BLM White River Field Office (WRFO) success criteria. The OSR site is anticipated to be relatively small in area. Efforts will be made to ensure that the disturbance will be kept to a minimum. NSHI's reclamation efforts will be consistent with BLM guidelines.

6.1. Measures for Surface Reclamation

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

The BLM WRFO Reclamation Coordinator will be notified via email or by phone 24 hours prior to beginning any BLM approved construction-related activities, regardless of size that result in disturbance of surface soils.

A portion of the reclamation strategy embodies a concept that is very common with salt dome usage, in that used production intervals associated with shale oil production may be used for storing shale oil process tailings. At the end of oil production, all remaining process tailings will be slurried with waste water and re-injected into the spent OSR interval. As there is a net removal of material during the formation of the LI in the form of nahcolite and kerogen, the proportion of process tailings is projected to be quite small. The process tailings are likely to be restricted to clays which have minimal commercial value, but given they originated from the LI they are non-polluting.

The initial RD&D phase will utilize NSI's water management facilities for water storage and evaporation. NSHI does not anticipate significant environmental impacts for water, air and/or the land.

6.1.1. Site-Specific Reclamation Procedures

Site-specific reclamation procedures are identified in this section for the two types of reclamation activities that will occur on the project area. These two types include 1) the reclamation activities that will follow construction and those routine disturbances associated with the well field operations (interim reclamation), and 2) those reclamation activities that will be associated with the cessation of production

operations (final reclamation). Many of the specific, routine reclamation procedures associated with each of these two types of activities are identical and will be discussed in tandem. Some of the activities that will be associated with final decommissioning of the production operations are different from those routine reclamation activities and will be discussed separately.

6.1.1.1. Topsoil Handling Procedures

The WRFO Reclamation Coordinator will be notified via email or by phone 24 hours prior to beginning any BLM approved construction-related activities, regardless of size, that result in disturbance of surface soils. Handling of topsoil during production operations involves several different activities. These activities include the removal of vegetation, topsoil stripping, stockpiling and replacement of the topsoil onto the areas to be ultimately reclaimed. Prior to construction or any production activities, the vegetation in the area must be cleared, and the soil grubbed to a depth of one foot. If less than one foot of soil is present, the entire soil present should be grubbed. The topsoil will then be removed to the extent possible. Suitable soil materials will be scraped from all the areas to be disturbed and stockpiled.

Surfaces of topsoil stockpiles will be stabilized and protected from wind and water erosion by seeding as soon as possible, i.e. spring or fall. The total seeding rate will be 12 to 15 lbs of pure live seed (PLS) per acre for a drilled rate, and 24 to 30 lbs per acre for a broadcasted rate. An established grass and forb cover will be adequate to protect topsoil stockpiles from erosion until the soil is needed for reclamation. In cases when topsoil handling sequencing does not allow stabilization by vegetation methods, topsoil stockpiles may be stabilized by application of a chemical dust suppressant. Topsoil will be spread as evenly as possible over the graded surfaces.

Where feasible, topsoil will be removed from areas that are being stripped and will be directly applied to well sites or other disturbed areas, rather than stockpiling the material. Limitations that will influence the use of this technique include such factors as the haul distance and sequencing of reclamation. The potential benefits of this reclamation technique are well documented and include maintained topsoil fertility and preserved seed source. Reclamation is often more successful when topsoil is directly applied than when the topsoil is stockpiled.

After production activities are completed and the area is graded, the topsoil will be taken from the stockpiles and spread as evenly as practicable over the disturbed area. This area will then be prepared for seeding.

6.1.1.2. Grading

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. Best management practices for erosion control measures such as contour furrowing, installing water bars, etc., will be used where necessary to ensure that slope and soil erosion are kept to a minimum. Surface drainage patterns will be re-established to pre-production conditions.

In certain areas, future production wells may be located where slopes are greater than 3:1. In these cases special precautions will be taken to minimize erosion, both during and after operation of these portions of the well field. Water bars and ditches will be used during operation to minimize potential adverse erosion impacts. Reclamation of these areas will incorporate water bars and contour furrowing to aid in erosion control.

6.1.1.3. Surface Preparation

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. The purpose is to leave an uneven, erosion-resistant surface which will aid water infiltration and enhance germination and establishment of seeded and planted species. Any existing vegetation piles will be removed.

6.1.1.4. Seeding Procedure

The seed mix application rates and seeding techniques are based on reclamation experience in the area, as well as on consideration of local environmental conditions of soil, slopes, elevation, and precipitation. Use of this seed mixture will result in a rapidly established, diverse, and effective vegetative cover capable of self-regeneration. The seed mixture is shown in Table 6-1. For short-term stockpiles or other areas, an interim seed mixture will be utilized (Table 6-2).

RECLAMATION SEED SPECIES LIST		
Species	Variety	Pounds Pure Live Seed/Acre
Grasses		
Thickspike	Critana	0.5
Streambank	Sodar	0.5
Western wheatgrass	Arriba	1.0
Pubescent	Luna	0.5
Basin wildrye	Magnar	0.5
Russian wildrye	Vinall	0.5
Green needlegrass	Common	2.0
Orchardgrass	Paiute	0.25
Forbs		
Lewis flax	Appar	0.2
Cicer milkvetch	Monarch*	0.5
Alfalfa	50% Ladak*	0.75
	50% Nomad*	0.75
Small burnet	Delar	1.0
Shrubs		
Fourwing saltbush	Rincon (dewinged)	1.5
Winterfat		0.5
Antelope bitterbrush		1.0
* preinoculated	**Total**	**11.1**

Table 6–1. Reclamation seed species list.

INTERIM SEED SPECIES LIST		
Species	Variety	Pounds Pure Live Seed/Acre
Grasses		
Pubescent wheatgrass	Luna	4
Thickspike wheatgrass	Critana	2
Forb		
Alfalfa	Ladak*	2
*preinoculated		

Table 6–2. Interim seed species list for reclamation.

The availability of seed will determine the ultimate seed mixture and variety of seed used. If a variety of seed is not available, additional seed from one of the seeds listed in Table 6-2 will be substituted so that the final seeding rate is 12 to 15 lbs pure live seed (PLS) per acre.

Topsoil stockpiles or other areas which require short-term vegetative stabilization, normally less than three years, will be seeded with this seed mixture. Seeding will be conducted as soon as possible (spring or fall) following disturbance to enhance viability of stockpiled topsoil, to increase the stabilization of the disturbed area, and to reduce potential erosion problems.

Although seeding can occur on the site nearly any time between snowmelt and ground freezing, the optimum time for seeding is during the fall. Accordingly, the seed mixture will be seeded between the time the first killing frost occurs usually sometime in September and when the ground freezes usually sometime in November. The scheduling of revegetation in this manner will allow the seeds to germinate and become established early in the spring when soil moisture is optimum. However, it may be necessary to seed at other times in some instances to either establish a ground cover to prevent soil erosion or to re-seed an area in the event of failed seedling establishment. In these events, seeding may occur during the spring (April-May).

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.

Following seeding, straw or native pasture hay will be applied as a mulch at a rate of approximately 2 tons per acres. If hydromulch 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.

Seeding will occur as necessary as the project progresses.

6.1.1.5. Fertilizer

The use of a sufficient topsoil material that is high in organic matter and contains the naturally occurring microorganism populations and necessary trace elements required for revegetation is more important than the application of fertilizers. However, soils that are stored for even relatively short periods of time lose their fertility and may need to be amended with fertilizers. Soil fertility in the project area appears to be adequate for reclamation purposes.

Generally, fertilizer application with precipitation of less than 12 inches per year yields very poor results. Furthermore, application of nitrogen fertilizer with inadequate spring moisture may have a depressing effect on grasses. If deemed necessary in the project area, an application of 800 lbs/acre of 5-10-5 fertilizer is expected to produce positive results. This fertilizer rate is typically used for cultivation of dry land wheat. Fertilizer will only be utilized if deemed necessary and after the third growing season.

6.2. Ensure Compliance with Established Requirements

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: (1) 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; (2) disturbances resulting from flow line installations are reclaimed to the extent that they are reasonably capable of supporting the pre-disturbance land use; (3) a Sundry Notice has been submitted describing the final reclamation procedures and any mitigation measures associated with final reclamation; and (4) a final reclamation inspection has been completed by the BLM and/or DRMS and there are no outstanding BLM and/or DRMS compliance issues.

6.3. Reclamation Schedule

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 project area will be completed during the first fall following production shut-down; seeding will occur according to the procedures described above. Monitoring activities associated with ground water quality (monitoring wells) will continue for 3 years after production operations cease. The monitoring of revegetation success will continue until bond release.

6.4. Reclamation Monitoring

The State of Colorado and BLM require reclaimed lands to be revegetated in a manner that establishes a diverse, effective, and long-lasting vegetation cover that is equal or nearly so to the natural vegetation of the surrounding areas. The vegetative cover should be as defined by the range/ecological site description or by the seed mix applied. It should also be self-sustaining and of a density sufficient enough to control erosion and non-native weed encroachment. In order to ensure that this

requirement is fulfilled, monitoring will be required to assess the success of revegetation efforts.

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. Additionally, the monitoring program will be implemented by qualified personnel with both practical field experience and knowledge of reclamation practices. Monitoring will continue until bond release.

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.

6.5. Contingency Plans

Correction procedures for unsuccessful reclamation are necessary in the event that revegetation attempts fail. The currently established NSI 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.

BLM requirements also state that contingency plans be included in the reclamation plan to protect the environment and human welfare from such catastrophes as flooding, fires, massive slope failures, or explosions resulting from production operations. Flooding is extremely unlikely to occur at the project site, because the proposed production plan involves solution mining and chemical conversion of oil shale. No slopes of any significance are present on the project site, so massive slope failure does not apply. Prevention of fires and explosions resulting from production operations was addressed in Section 5.5.1.

SECTION 7.0 ABANDONMENT PLAN

Plugging and abandonment will occur if a well is deemed unusable for future use as a monitor or production well. This plugging and abandonment plan may be modified based on site conditions at the time of abandonment.

7.1. Proposed Well Abandonment

Production and monitoring wells associated with the well field will be plugged and abandoned in accordance with procedures described herein and permit stipulations. At the completion of RD&D, pilot, semi-works and/or commercial production operations, all surface facilities will be dismantled. Areas previously occupied by these facilities, and any remaining areas associated with the well field will be reclaimed and revegetated according to procedures described in this section.

7.1.1. Procedures

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 will be removed from the wellbore. A bridge plug may be set near the top of the OSR interval. The residual brine will be left in the OSR interval and will 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 will be plugged and abandoned in compliance with all regulatory requirements. Core holes will be plugged and abandoned or converted to monitoring wells per BLM specification. Some of the NSHI monitor wells may be maintained to provide additional ground water monitoring for the NSI sodium operations.

NSHI will cement the well to surface after borehole preparation is complete. As a minimum, the following plugs will be required (per NSI EPA UIC Class III Area Permit): 1) a cast iron bridge plug (CIBP) will be placed at the base of the production casing, and the interval from the top of the CIBP to the Dissolution Surface will be cemented; 2) cement the entire Dissolution Surface Aquifer interval plus fifty feet above; 3) the entire B-Groove Aquifer interval must be plugged, and the plug must extend fifty feet above and below the aquifer; 4) the entire A-Groove Aquifer interval must be plugged, and the plug must extend fifty feet above and below the aquifer; and 5) the final plug must extend from the surface to 165' below ground level. The intervals between the cement plugs will be filled with a bentonite based plugging mud and/or cement. Other cement plugs or revised plugging procedures may be required based on CBL analyses and casing recovery results. Any remaining casing will be cut off and removed to a depth of 2 feet below grade. An appropriate surface location marker will be installed at grade. The well abandonment will conform to 40CFR §146.10 and BLM requirements.

7.1.2. Removal of Surface Structures

Any surface facilities present at the cessation of production operations will be dismantled and either salvaged or removed for disposal. Concrete foundations and

road pavement will be broken up and buried on-site at least three feet below final grade. The natural gas and water pipelines will be disconnected and purged; they will be left in place because these areas will have already been reclaimed and revegetated.

Surface infrastructure such as buildings, tanks, foundations and associated structures that cannot be used by NSI's sodium bicarbonate facility will be removed from the site and the site re-contoured and revegetated. It is estimated that the cost for final reclamation and abandonment would be approximately $5,400/acre based on bonding for the NSI facilities.

SECTION 8.0 REFERENCES CITED

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