Red Leaf Resources Southwest #1 Oil Shale Mine
Ground Water Discharge Permit No. UGW470002

Comment Response Summary

Utah Division of Water Quality

December, 2013

I. INTRODUCTION

A. Oil Shale Mining and the Southern Uinta Basin

The Southern Uinta Basin has been a source of potential oil shale mining for decades[1] (Fig. 2). As such, the likelihood of actual commercial operation and production has cycled along with the price of oil on world markets. Red Leaf Resources, Inc. has submitted a ground water discharge application to the Director of the Division of Water Quality (DWQ[2]) for an approximately three-quarter size test capsule or Early Production System (EPS) (site location Fig. 1). While, from the basis of permitting requirements the EPS permit stands alone on its own facts and merits, relative to the potential for full scale operation and production at the Red Leaf site and other commercial operations currently being planned in the oil shale rich areas across the Southern Uinta Basin the permit is not alone. Rather, from the broader basin-wide oil shale mining industry perspective, the Red Leaf EPS permit stands at the threshold of actual commercial production in an area that has seen conventional oil and gas development to be sure (Fig. 3), but thus far has not extended to large scale mining. The DWQ's issuance of a ground water permit for the EPS (UGW 470002) is a milestone of sorts in the investigations, exploration and prior attempts to bring full scale mining to actual fruition. Therefore, it is easy to see how this single permit action holds so much interest and attention. From the perspective of DWQ this is clearly observed in the number of comments submitted.[3] After reviewing the comments, DWQ is satisfied from a substantive perspective that the permit order is properly protective, based on negligible risk to ground water and its present and future beneficial uses.

B. Organization and Nature of Response to Comments

1. Most of the substantive comments (addressing the factual or legal basis under which the permit was issued) were received from Western Resource Advocates (WRA). This Response will address WRA's comments. A separate response will address the other comments.

2.-WRA's comments revolve around the regional flow regime (i.e., the conditions under which ground water-including the surface expressions of such, a.k.a springs- occurs and moves across much of the Southern Uinta Basin) and how these factors relate to the site specific conditions and characterization Red Leaf has performed. A key factor in DWQ's determination that the criteria in Rule 317-6-6.4(A) have been met is that there is no shallow aquifer immediately beneath the mine site, or impairment of present and future beneficial uses of ground water. The water that was found in the wells immediately beneath the mine is static and does not contain sufficiently saturated permeable material to yield usable quantities of water to wells and springs so as to meet the definition of aquifer, and no springs are

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[1] Note that Figure 2 shows the basin wide extent of the naturally occurring oil shale and sands as well as the thickness of the richest [gallons per ton] oil shale across the basin, the thickness of lower yielding, uneconomic, oil shale is much greater)

[2] For convenience, the term DWQ refers to both the Division of Water Quality and its director.

[3] At the close of the comment period (Sept. 27, 2013) DWQ had received approximately 35,000 comments from members or individuals associated with the Natural Resources Defense Council (NRDC) who had each signed what appeared to be a form letter objecting to the issuance of the permit. Other comments, somewhat similar in nature to those of the NRDC, were received as well as several comments that are in support of the mining operation and permit. The unedited comments may be found at: http://www.waterquality.utah.gov/PublicNotices/pnarchive2013.htm#gwp

threatened. Such interstitial water had salinity ranging from a low of 9,000 mg/L to as high as 58,600 mg/L TDS. The regional aquifer located hundreds of feet below the bottom of the mine which is of relatively good quality with a TDS of approximately 700 mg/L or less, is naturally protected by intervening impermeable oil shale. These orders of magnitude differences between the water quality of the water and that of the protected deep aquifer were factored into the DWQ's conclusion that water around and immediately beneath the mine site does not move either horizontally or vertically or appreciably recharge the Douglas Creek aquifer hundreds of feet below, and that present and future beneficial uses of the aquifer are protected.

Primary considerations in permit drafting include: 1) Legal and regulatory requirements; 2) Natural site and regional conditions including, among others, the hydrogeology and climatic conditions; and 3) The mining and oil production operation as proposed by the applicant.

C. Legal and Regulatory Requirements

1. The DWQ under the authority of the Utah Ground Water Quality Protection Rules[4] (Ground Water Rules) issues ground water discharge permits to facilities which have a potential to discharge contaminants to ground water. As defined by the Ground Water Rules, such facilities include mining operations.[5] The Ground Water Rules are based on an anti-degradation strategy for ground water protection as opposed to non-degradation; therefore, discharge of contaminants to ground water may be allowed provided that current and future beneficial uses of the ground water are not impaired and the other requirements of Rule 317-6-6.4.A. are met.[6] Following this strategy, ground water is divided into classes based on its quality[7]; and higher-quality ground water is given greater protection[8] due to the greater potential for beneficial uses.

2. Under Rule 317-6, Red Leaf Resources, Inc. applied for a ground water discharge permit to cover a mining operation consisting, at this time of a single earthen (EPS) capsule for petroleum derived from kerogen from mined oil shale ore. DWQ developed permit conditions consistent with R317-6 and appropriate to the nature of the mined materials, the EPS technology and the hydrogeologic and climatic conditions of the site, to insure that the operation would not contaminate ground water. Although permit conditions require Red Leaf to apply for a major modification of the permit prior to proceeding with further mining, the regulatory, factual and permit conditions for the EPS are independent of further mining; that is, the draft permit and factual basis for the EPS alone meet the protective requirements of Rule 317-6-6.4.A.

3. Under Rule 317-6-6.4A, DWQ may issue a ground water discharge permit if:

1) The applicant demonstrates that the applicable class TDS limits, ground water quality standards protection levels and permit limits established under R317-6-6.4E will be met;
2) The monitoring plan, sampling and reporting requirements are adequate to determine compliance with applicable requirements;

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[4] Utah Admin. Code Rule 317-6
[5] Utah Admin Code Rule 317-6-6.1A
[6] Preamble to the Ground Water Quality Protection Regulations of the State of Utah, sec. 2.1, August, 1989
[7] Utah Admin. Code Rule 317-6-3
[8] Utah Admin. Code Rule 317-6-4

3) The applicant is using best available technology to minimize the discharge of any pollutant; and
4) There is no impairment of present and future beneficial uses of ground water.

4. In summary, Subpart 1 is satisfied because Red Leaf has demonstrated that the water[9] beneath and around the mine is class IV and does not circulate therefore DWQ has determined that the standard for protection under R317-6-4(4.7)[10] is met since there will be no effect on human health or the environment. The class II Douglas Creek aquifer is several hundred feet beneath the mine and isolated from any potential discharges by several zones of low permeability oil shale.

5. Subpart 2's monitoring plan, sampling and reporting requirements are satisfied because Red Leaf has evaluated which contaminants may be leached from spent shale in contact with rainwater or snowmelt. Results of this analysis showed some metals and organic compounds may leach from spent shale, and the leachate will likely have a high pH. These tests showed low levels of total dissolved solids and non-detectable results for most metals and organic compounds. To more fully evaluate which contaminants may be present in leachate, additional analyses are required in the permit, as described in the SOB Part VI. The permit requires that sampling should be representative of the capsule contents and that samples will be analyzed for a specified suite of organic and inorganic parameters. The sampling methods will be determined following Red Leaf's assessment of capsule conditions following cooling.

6. Subpart 3 is satisfied because Red Leaf is using best available technology to minimize the discharge of any pollutant based on the design of three feet of Bentonite Amended Shale (BAS) in the test capsule. Site conditions and what is known about the nature of the potential discharge justify accepting the proposed design for the EPS capsule to be Best Available Technology. DWQ's approval of Red Leaf's design is conservative for these conditions. The permeability of the underlying bedrock is so low that discharge from an unlined, uncapped pile of spent shale would not seep through and impair underlying aquifers of higher quality than the leachate, even if some seepage occurred. Nor does available information suggest that the leachate would threaten beneficial uses, if there were any, of the limited quantities of class IV ground water.

7. Subpart 4 is satisfied because there is no impairment of present and future beneficial uses based on the complete unlikelihood of a discharge ever reaching the Douglas Creek Aquifer and on the lack of any present or future beneficial use of the limited quantity class IV shallow ground water at the mine site.

8. Therefore, DWQ has concluded that the proposed facility meets these conditions so the DWQ may issue the permit. In addition, issuance of the permit is consistent with the purpose of the Ground Water Rules and Utah Water Quality Act to protect ground water quality because Red Leaf's operation is not in a recharge zone and discharges, if any, will not enter the hydrologic cycle. See Utah Code Ann. § 19-5-117(1)(a).

9. The DWQ does not have the discretion to deny a permit for matters not related to protecting waters of the state. Accordingly, only comments related to protection of ground water quality or quality of

[9] Not all subsurface water in the mine area meets the definition of ground water.

[10] Utah Admin. Code R317-6-4(4.7) Class Protection Levels provides "Protection levels for Class IV ground water will be established to protect human health and the environment."

other waters of the state are relevant to whether the DWQ shall: 1) issue the permit; 2) issue with modifications to the draft version, or; 3) deny issuance.

10. Rule 317-6 applies to a wide variety of facilities with varying degrees of potential to discharge contaminants to ground water. Operational and natural site characteristics are relevant to a Rule 317-6 inquiry. The ground water application provisions in Rule 317-6-6.3 provide discretion to DWQ in determining the particular information that must submitted in an application as evidenced by the introductory sentence that provides: "*Unless otherwise determined by the Director [DWQ]*, the application for a permit to discharge wastes or pollutants to ground water shall include the following complete information . . ." (emphasis added).

11. In particular, DWQ issues ground water discharge permits to many facilities that contain water under hydraulic head, i.e. the pressure exerted by water that is proportional to the depth of the water body or the thickness of granular material containing water under saturated conditions. Hydraulic head is the potential driving force of liquids through a liner or other materials that underlie the water body or saturated materials. Many of the monitoring requirements in ground water discharge permits are related to verifying the containment of wastewater under hydraulic head. An important feature of Red Leaf's case is that the Eco-Shale capsule technology does not involve containing water under hydraulic head. While in the long term, a closed capsule may accumulate enough leachate that minor zones of saturation may develop on top of the lower capsule liner, the capsule design provides for drainage of the capsule interior, and significant hydraulic head will not be imposed on the lower liner.

12. Rule 317-6-6.3 lists all informational categories that may be used within the universe of permitted facilities to provide substantial evidence in the administrative record to support a finding that Rule 317-6-6.4.A has been satisfied. In other words, Rule 317-6-6.3 makes the DWQ the gatekeeper in determining what is required to be submitted to meet the requirement of Rule 31—6-6.4.A on a case by case basis, therefore not requiring applicants for a ground water discharge permit to submit information that is not relevant. To be clear, the DWQ's discretion is not without limitation, rather the discretion is exercised based upon appropriate review of the *relevant* scientific, technical, engineering or other facts related to the permit, its processes and site characteristics.

D. Site Conditions

The Ground Water Rules take into account varying climatic and hydrogeologic conditions related to the potential for ground water contamination as well as varying natural ground water quality. In developing permit conditions the Ground Water Rules allow these factors to be taken into account so as not to impose unnecessary conditions on permittees.

1. Climate Conditions at the Red Leaf Site

The Red Leaf site climatic conditions from this site can be summarized as:

a) Arid with less than 10 inches of annual precipitation on average, see page 10 and plate one of Price and Miller.[11] This is a true desert which begins when average precipitation is less than 10 inches.

[11] Department of Natural Resources Technical Publication No. 49, *Hydrologic Reconnaissance of the Uinta Basin, Utah and Colorado*, 1975 by Price and Miller.

b) Infiltration rates are very low. On page 28 of Price and Miller[12] the basin wide estimate is 3% of the average annual precipitation. At the Red Leaf site infiltration is no more than 0.3 inches per year. And, since the estimate is basin wide and refers to the potential for infiltration at high elevations at the southern rim of the basin, the actual infiltration rate at the Red Leaf site is likely even lower than 3%.

c) Evaporation (arid climate) and evapotranspiration rates are high, page 12.[13]

The climatic conditions are an important factor to consider since the operation does not use water in its oil shale retorting (heating) and extraction process, the only available source of water for concern relative to potential contamination is from precipitation falling on the mine site after operations cease.

2. Hydrogeology and Ground Water Occurrence at the Red Leaf Site

a. There are three main, relevant site conditions related to potential ground water contamination in this permit. First, the rocks immediately underlying the capsule construction site are lower-grade oil shale with extremely low permeability. In other words, the shale provides a protective barrier that would prevent discharges, if any, from Red Leaf's operations from impairing ground water. Second, the limited quantities of water encountered in Red Leaf's monitor wells in this geologic unit do not constitute an aquifer as defined under R317-6-1(1.1).[14] In other words, the water flow is small and the water is unusable. Third, the water in the monitoring wells is extremely saline (Class 4, low quality), so discharges, if any, from Red Leaf's operations are unlikely to cause impairment even if there were sufficient quantities of water to be usable.

b. Information on the hydrogeologic characteristics of the site is presented in the SOB Part VII.2. The geologic formation that includes Red Leaf's ore horizons and the rocks overlying and underlying them, the Parachute Creek Member of the Green River Formation (Fig. 4) is described in the geologic literature as having low[15] or minimal permeability.[16] Thus the oil shale of the Parachute Creek[17] member of the Green River formation act as a barrier to ground water flow and is confirmed from information collected by site investigations.[18]

c. As part of the site specific characterization, Red Leaf drilled eleven monitor wells around and beneath the mine site.[19] Water encountered in these wells is highly saline and has a stable isotope composition that is different from precipitation at the site. The most likely source of the salts and saline water, beneath the mine site and within the Parachute Creek Member, and is consistent with all of the data gathered from the Red Leaf site including the much lower salinity and different overall chemical quality of the springs found near the Red Leaf property is described by Holmes and Kimball[20]:

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[12] Department of Natural Resources Technical Publication No. 49, *Hydrologic Reconnaissance of the Uinta Basin, Utah and Colorado*, 1975 by Price and Miller.
[13] Department of Natural Resources Technical Publication No. 49, *Hydrologic Reconnaissance of the Uinta Basin, Utah and Colorado*, 1975 by Price and Miller.
[14] R317-6-1(1.1) states: "Aquifer" means a geologic formation, group of geologic formations or part of a geologic formation that contains sufficiently saturated permeable material to yield usable quantities of water to wells and springs.
[15] Price and Miller, pg. 10 table 1
[16] Holmes and Kimball, pg. 5 table 1
[17] Holmes and Kimball, pg. 6
[18] Attachment A, Norwest Core Review
[19] See Application Fig. 7 & 8, sections 9.5.2 and 9.5.3
[20] Holmes and Kimball, pg. 5-6

> The lacustrine deep-water environment is represented mostly by the Parachute Creek Member, whose beds are marlstone, sandstone, and muddy limestone. The marlstone, which has a large organic content, comprises the "oil shale" of the Green River Formation.
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> After deposition of the organic-rich marlstone, Lake Uinta began to recede. The water became saline and local deposition of evaporate minerals occurred.

(A current day analog of the scenario described by Holmes and Kimball above occurs if one replaces Lake Uinta with Lake Bonneville and the salts now observed in the Great Salt Lake and the strata beneath it replace those in the Parachute Creek Member.)

d. Discharges, if any, to the formation beneath the mine site are highly unlikely to impair ground water for several reasons. First, recovery tests performed on some of the wells drilled by Red Leaf (Fig. 5) revealed that the surrounding rocks have very low hydraulic conductivities, comparable to an engineered clay liner so any discharge would likely be confined. Second, the few springs and seeps in the area (none of them on Red Leaf's property) have significantly lower salinity than the water encountered in Red Leaf's monitor wells. There is no evidence of springs discharging highly saline water chemically comparable to that encountered beneath the mine site. Taken together, these facts indicate that the water around and beneath the mine sit does not circulate Most importantly, these facts indicate that water discharged, if any, to this formation, if any, will not circulate into other aquifers or saturated zones, even if it is under hydraulic head. Furthermore, Appendix J of Red Leaf's permit application indicates that any potential leachate generated by the closed capsule would be of lower salinity than the water contained within the strata beneath the EPS capsule, meaning that the risk of impairment to that water is low.

e. WRA appears to suggest that the Douglas Creek Aquifer may be impaired by a discharge from the EPS capsule. The evidence suggests otherwise because the Douglas Creek Aquifer[21] is contained within the part of the section of the Douglas Creek Member that is predominantly sandstone and hundreds of feet below the bottom of the mine site (Fig. 4). This aquifer is tapped by Red Leaf's water supply well (max est. pump rate 20 gpm, drillers log), which encountered ground water at 630 and 830 feet below ground surface. (SOB Part VII.2) WRA's comments appear to refer to the whole Douglas Creek Member as an aquifer, rather than just the predominantly sandy part of it below the gradational contact with the overlying Parachute Creek Member.

f. At the Red Leaf EPS site, the first sandy bed below the Mahogany oil shale, and beneath the bottom of the mine, was selected as the marker horizon for establishing the bottom depth of the deeper monitor wells in Red Leaf's monitor well drilling program. It was known to be non-water bearing prior to drilling the wells. The wells were intended to assess the B Groove lithologic horizon, which is known to have the characteristics of an aquifer to the east in Colorado. There is no evidence for this bed yielding useful quantities of water to wells or springs, therefore it does not meet the definition of an aquifer in Rule 317-6-1. DWQ personnel, along with the Utah Geological Survey's expert on Uinta Basin stratigraphy, visited the Red Leaf site in July, 2012 and examined the strata between the Mahogany Bed and this uppermost sandy unit.[22] This sandy bed is described in Red Leaf's permit application as "carbonate-cemented sandstone" and in the DWQ report as "silty, sandy carbonate". The carbonate cement

[21] Holmes and Kimball, pg. 5 Table 1

[22] Novak, 2012, Attachment B, and referenced in the SOB

between the sand grains results in a low primary porosity for this bed. Drill cores taken from this bed in the subsurface indicate that it is partially saturated with bitumen, further reducing its porosity.[23] The bed has fine-grained rocks above and below it, which limit potential recharge to it. As the recovery tests show[24] its hydrogeologic properties, and quality of any water it may contain, are likely to be similar to the surrounding oil shales.

E. Nature of the Facility

1. The type of facility being proposed is described in the permit's Statement of Basis (SOB) at III and IV, and in greater detail in Red Leaf's permit application. Crushed oil shale ore will be stacked in a "capsule" that will be surrounded on top, sides and bottom by liners designed for product containment during production. Only one capsule is permitted under this permit, unless modified, and Red Leaf has designated this capsule as the "Early Production System" or EPS capsule. A significant factor limiting the potential for the proposed EPS capsule to cause a discharge of contaminants is the method to be used for retorting the oil shale ore. No water or chemicals will be used in the retorting (heating) process. The contents of the capsule will be heated to approximately 725^{o} F through piping that conducts hot air (Application p. 4). Gases that evolve from the ore during retorting, including water vapor, will be conducted out of the capsule, and liquid hydrocarbons that are liberated from the ore will be collected on a metal pan beneath the ore and likewise conducted out of the capsule. After retorting, the capsule contents will be extremely dry, and because of the insulating properties of rock materials, the capsule will remain hot for a long time. There will be no significant water present in the spent shale after retorting, and any significant liquid hydrocarbons will be removed from the capsule by drainage onto the metal pan. As the capsule cools, any remaining liquid hydrocarbons should solidify.

2. Because the spent shale is dry and does not contain water under saturated conditions that would lead to hydraulic head on the liner, it resembles a landfill much more than a structure designed for containment of wastewater, not a leach pad which is constructed to contain fluids under hydraulic head. The main potential for the capsule to cause a discharge of contaminants will be from precipitation infiltrating into the spent shale and dissolving contaminants out of it. In facilities like this, resembling a landfill, the primary strategy to minimize discharge of contaminants is to install a cap over the waste material to exclude precipitation from infiltrating into the waste, to the greatest extent feasible. Although the permit allows some flexibility in liner design for this prototype capsule, Red Leaf has committed to a liner that is the functional equivalent of three feet of bentonite-amended shale (BAS) having saturated hydraulic conductivity of 1×10^{-7} cm/sec. This exceeds the standards required in many cases where bodies of wastewater several feet deep are impounded on an earthen liner, resulting in a hydraulic head on the liner proportional to the depth of the water. The upper liner will not be subject to a significant hydraulic head. It will be shaped to promote drainage, and vegetation will be established on the reclaimed land surface above the liner, which will promote the removal of soil water by evapotranspiration and minimize the buildup of hydraulic head on the underlying upper BAS liner.

3. Despite these efforts to prevent infiltration of precipitation through the reclaimed surface cover layers and the underlying BAS liner, some small flux of water will likely penetrate these layers and enter the spent shale underneath them. As explained in the SOB Part VIII:

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[23] Attachment A, Norwest Core Review

[24] Fig. 5, Monitoring Well Recovery Tests

Formation of leachate and its discharge to the subsurface would only occur when precipitation infiltrates the vegetative cover and upper BAS liner in sufficient quantities to bring the water content of the near 100-foot thick layer of dry spent shale and the "rind" of insulating waste rock *to field capacity*[25], and then this water breaks through the metal oil collection pan and builds up on the lower BAS liner and breaks through it.

4. Only a small percentage of the precipitation at the site will seep through the cap layers and upper BAS liner. This small flux of water would then have to build up in the spent shale until it reaches field capacity. As described in Appendix L of the permit application[26] a conservative estimate of the time required for the entire EPS capsule to reach field capacity is on the order of hundreds of years. This is not surprising given the dry, post-retorting state of the shale, the low precipitation at the site, the high evaporation rate and the 3 foot cap of 1×10^{-7} cm/sec Bentonite Amended Shale (BAS) in addition to the re-grading, contouring and re-vegetation of the mine site.

5. As permit conditions, Red Leaf will monitor any liquids that drain from the metal pan used to collect liquid hydrocarbons during capsule operation, and also any liquids that collect on the upper surface of the lower BAS liner. Liquids will be conducted out of the capsule to monitor points that will allow these observations. Construction of these monitoring points will allow liquids that may collect on the metal pan and upper surface of the lower BAS liner to be observed, sampled and analyzed from the capsule.

6. Permit conditions must also take into account the nature of the contaminants that may be discharged to ground water. Red Leaf has evaluated which contaminants may be leached from spent shale in contact with rain water or snowmelt using the Synthetic Precipitation Leaching Procedure, as described in the SOB Part V, on samples taken from bench-scale test reactors. Results of this analysis showed some metals and organic compounds may leach from spent shale, and the leachate will likely have a high pH. These tests showed low levels of total dissolved solids and non-detectable results for most metals and organic compounds.

7. To more fully evaluate which contaminants may be present in leachate, additional analyses are required in the permit, as described in the SOB Part VI. The permit requires that sampling should be representative of the capsule contents and that samples will be analyzed for a specified suite of organic and inorganic parameters. The sampling methods will be determined following Red Leaf's assessment of capsule conditions following cooling.

[25] Field capacity refers to the point where the water content of unsaturated materials is high enough to allow gravity drainage from the base of the materials.

[26] Also, Attachment C (Technical Memorandum from R.J. Bayer to Jay Vance *Assessment of the Capacity of the EPS Capsule for Absorption and Retention of HELP-predicted infiltration, May 30, 2013)*

II. DWQ Response to WRA'S Comments

The text of the comments are restated verbatim in italics. Some of the comments are broken into subparts for purposes of the DWQ's response.

Comment 1 (1.1)

The Permit Must Contain a Detailed Sampling and Analysis Monitoring Plan for the Testing of Spent Shale.

In its Statement of Basis, DWQ admits that some hydrocarbon product will remain in the capsule after heating and that this product will likely adhere to rock fragments and the metal collection plan. SOB at 3. Pursuant to R317-6-6.3(F), Red Leaf is required to identify the characteristics of its effluent or leachate. In order to accomplish this, the company has briefly outlined a plan for the sampling and analysis of spent shale taken from within the EPS following cooling of the capsule. Application at 6. Rather than requiring the company to finalize the sampling and analysis plan as part of its permit application, DWQ has chosen to defer this regulatory requirement until some indefinite point in the future. SOB at 3; Permit at 6. By taking this approach, DWQ has chosen to ignore the plain language intent of R317-6-6.3(F) and R317-6-6.4, under which it is necessary to determine whether the spent shale has the potential to cause contamination to local ground water. Instead, DWQ has tied the requirement to report the testing of this material to Red Leaf's theoretical modification of the permit at some indefinite future date. This approach by DWQ violates the requirements outlined in R317-6-6.3 and R317- 6-6.4, deprives the public of the opportunity under R317-6-6.5 to meaningfully comment on how the company intends to meet this regulatory obligation, and completely sidesteps the agency's legal duty to treat this as a single and stand-alone project with potential to impact ground water.

1.1 DWQ Response

The entire Southern Uinta Basin has large amounts of hydrocarbons in the rocks naturally. That some oil may be left after Red Leaf's retorting operations is not so much an admission as an acknowledgement of the facts, and is not of particular concern from a ground water protection standpoint. Residual, naturally occurring hydrocarbons at the site will be substantively no different than other oil and gas operations. No recovery process removes all of the oil. It is of greater significance in the review process that the Red Leaf operation will not use any water or other extractive agents whatsoever, beyond heat. Still, out of an abundance of caution, on the remote possibility that something may not be as the data show currently, Red Leaf will analyze the spent shale as described in the SOB and permit. The sampling and analysis contained in the permit is adequate to determine permit compliance.

The purpose of a Sampling and Analysis Plan (SAP) is to insure that data collected during the time that monitoring is required is consistent over time. An SAP contains methods of sample collection, preservation and transport and analytical methods to be used at the laboratory. An SAP is intended to be used to insure continuity of sampling methods even if different personnel conduct the sampling over time. It can only be changed with approval of the DWQ.

Red Leaf has not yet designed and installed the sample ports to be used for collecting any potential leachate from the EPS capsule's metal collection pan and the top of the lower BAS liner. Since the SAP must include detailed instructions on how to obtain a scientifically valid sample from these ports, that part of the SAP cannot be designated at this time. Also, the full suite of analytical parameters will not be known until Red Leaf completes the spent shale analyses required in the permit. Because of these factors, inherent protection of ground water due to site characteristics, and the very low likelihood of leachate discharge during this permit term, DWQ is satisfied that it is not necessary that a SAP be entirely completed before permit issuance.

DWQ's evaluation of the application and issuance of the permit is compliant with R317-6 because it was based on factual, scientific and technical data. Justification for increasing monitoring or sampling in this case would have to be directly related to the likelihood of a discharge and that the discharge would harm the current and future beneficial uses of ground water at the site as defined under Rule 317-6.

DWQ has used the available operational and site conditions as provided in the ground water discharge application and as described in II and III above, as well as described in the SOB, to determine that the risk to ground water at the site is minimal due to natural conditions and that, given the arid nature of the site location, the time for any infiltration into the capped, graded, re-claimed and re-vegetated EPS is on the order of hundreds of years. Therefore, DWQ has concluded that the sampling and monitoring plan is adequate to determine compliance with permit requirements.

As has been established, site conditions are already naturally highly protective. Water immediately beneath the mine site is not hydraulically connected in a regional flow system and is of very poor quality and chemically very different than water found in the Douglas Creek aquifer hundreds of feet below the mine site and isolated springs found throughout the region, see also response to Lips (8).

Comment 1 cont.(1.2)

In approaching matters in this fashion, the agency has failed to account for the distinct possibility that Red Leaf – for any number of reasons – may choose to forego modification of the permit. Under the current permit provisions, the company would only be obligated to submit a plan for testing the spent shale 90 days before it intends to conduct the testing and would not be obligated to report the results of that testing unless the company decides to move forward with commercial production. Permit at 6. The same is true of the company's evaluation of the upper Bentonite Amended Shale (BAS) liner performance and the hydrologic properties of the spent shale as discussed in detail below. None of these results is required to be reported to DWQ unless and until the company seeks modification of its permit. However, this information is critical to determining to what extent the EPS could contaminate ground water. There is no justification for DWQ to waive these requirements until some uncertain future date. The Ground Water Quality Protection regulations require this information to be included as part of the application and incorporated into the current – rather than for some possible future – permit.

1.2 DWQ Response

Permit Action: Sections I.G.2 and 3 of the permit have been amended to require Red Leaf to submit the results of the testing to DWQ whether or not Red Leaf requests modification.

Comment 1 cont. (1.3)

Further, DWQ is only requiring that the company conduct Synthetic Precipitation Leaching Procedure (SPLP) testing of these materials. Permit at 6. Because the SPLP uses a 20:1 liquid to solid ratio, the results of the test are a highly dilute leachate. Kuipers at 6, attached as Exhibit A.[1] ([1] The Kuipers Report references the Red Leaf Notice of Intent to Commence Large Mining Operation, attached as Exhibit B.) Therefore, the appropriate test is the Meteoric Water Mobility Procedure (MWMP) which provides for the column percolation extraction of mine rock in order to determine the potential for dissolution and mobility of constituents by meteoric water. Id. The extract is then used to determine the final pH and release of certain constituents of the test sample under laboratory conditions. Id. In addition, the Toxic Characteristic Leaching Procedure (TCLP) method may also be appropriate for testing the spent shale. Id. Because the TCLP is designed to determine the mobility of both organic and inorganic analytes, this test may provide essential information in a setting where the identification of gasoline and diesel organics is critical. Id; see also Permit at 6. Ultimately, a full suite of tests including the SPLP, the MWMP and the TCLP should be performed on the spent shale.

Because there is no valid reason for DWQ's decision to waive the requirement that the company submit a sampling and analysis plan as required by R317-6-6.3(F) as part of its application and to defer such a submission until some uncertain future date, and because DWQ is not requiring Red Leaf to conduct an appropriate suite of testing on the spent shale, the agency's action is arbitrary and capricious and a violation of the law.

1.3 DWQ Response

Both the SPLP and the MWMP are water extraction procedures. Neither test mimics the actual generation of leachate that will occur in the closed capsule, where water derived from precipitation will be in contact with spent shale under unsaturated and aerobic conditions for a long time before moisture content of the capsule builds up to field capacity. Neither test will accurately predict the chemistry of future leachate. SPLP extraction and analysis of the extract fluid was intended to identify soluble constituents in the spent shale to insure permit conditions are appropriate for its long-term management. DWQ does not consider additional extraction methods and analyses necessary to meet this goal. However, Red Leaf has agreed to perform both SPLP and MWMP extractions on representative samples of spent shale and mine waste rock, and analyze the extract fluids for the suite of parameters specified in the permit.

TCLP uses an acetic acid extraction that mimics conditions in a municipal landfill, and is used to determine if a particular waste is hazardous under RCRA. Because all available information suggests that the spent shale will be highly alkaline, and because it is not the purpose of Rule 317-6 to define or regulate hazardous waste, it is inappropriate to require TCLP analysis for this permit.

As shown in section I.D.2 above as well as in the SOB, the lack of an aquifer immediately beneath the mine site as well as the low potential for contaminants to reach the much deeper Douglas Creek aquifer (Fig. 4) satisfies DWQ that the monitoring plan and sampling requirements are adequate to determine compliance with applicable requirements.

Permit language has been changed to require Red Leaf to conduct both of the spent shale tests (SPLP and MWMP) and develop a closure and reclamation plan as specified in Part I.G whether or not they intend to go into commercial production. Because samples of the spent shale from the EPS capsule will not be available until after the capsule is heated, it is not possible to conduct the tests or develop a closure and reclamation plan (beyond that required by the Division of Oil, Gas and Mining) before then.

Permit Action: The permit has been modified at Part I.G.2 to require the MWMP extraction and analysis for the same parameters as the SPLP extraction. Other sections of the permit that mention SPLP analysis have been modified to include MWMP.

Permit language has been modified in Parts I.G.2, I.G.3 and I.G.4 to clarify that Red Leaf must complete investigations on spent shale analysis and liner performance after capsule closure, and develop an appropriate reclamation plan whether or not they intend to modify the permit to allow construction of capsules for commercial production.

Comment 2 (2.1)

The Permit Must Contain Provisions Requiring Rigorous Sampling and Analysis Monitoring of Liquid Buildup Within the Capsule.

It is also a violation of the law for DWQ to brush aside Red Leaf's offer to conduct more extensive monitoring of liquid build-up on the top of the BAS near the collection drain trough on the steel floor. Application at 6. This monitoring would involve the collection of liquids in both the monitoring pipes and trench sumps on a weekly basis for a period of up to 2 months following their installation and thereafter on a monthly basis. Id. at 6-7. When liquids are detected in the monitoring pipes or trench sump, that detection would trigger resumption of weekly monitoring until four consecutive weeks have passed without liquid accumulation. Id.

The company then goes on to suggest that semi-annual sampling would replace monthly monitoring when six months have passed without additional liquid accumulation. Id. Rather than requiring this level of monitoring of the discharge, DWQ is content to have the company monitor the drains leading from these points on a semi-annual basis beginning six months after shutdown. SOB at 8.

2.1 DWQ Response

WRA does not distinguish liquid hydrocarbons from liquid water in this comment. The primary purpose of constructing the capsule is to collect liquid hydrocarbons from heated oil shale. It is not DWQ's intention to regulate this production phase, under the assumption that Red Leaf intends to collect all of this product. DWQ does have an interest in understanding the potential for long-term discharge of liquid hydrocarbons from the capsule, to develop appropriate permit conditions for commercial production using the capsule technology. Because of the insulating properties of rock materials, it is expected that the capsule contents will remain hot enough to yield liquid hydrocarbons for a significant period of time following shutdown of the capsule's heating system, during which time hydrocarbon recovery will continue by Red Leaf. For this reason, Red Leaf will not have to report quantities of liquid hydrocarbons discharged from the capsule until six months after shutdown of heating. After six months, semi-annual reporting of quantities of liquid hydrocarbons discharging from the capsule is adequate for DWQ's purpose of evaluating long-term performance of the EPS capsule and to determine with permit requirements.

After retorting of the shale is completed, the EPS capsule will contain a stack of spent shale approximately 100 feet in thickness that will be extremely dry after being heated to over 700° F; it will be capped by a liner that is the functional equivalent of three feet of material with hydraulic conductivity of 1 x 10^{-7} cm/sec (and re-capped after heating operations have concluded with an additional 3 feet if significant cracking is determined to have occurred-see Fig. 6), and significant hydraulic head will not be imposed on the cap. Leachate is unlikely to form before shut down of the capsule heating system, and very likely not for a significant time thereafter, or during the five year term of this permit. There is no necessity for a more frequent monitoring schedule immediately after capsule closure.

Comment 2 cont. (2.2)

Further, instead of having Red Leaf submit a complete monitoring plan of this discharge as required in R317-6-6.3(I), and evaluating that plan as part of the draft permit as required by R317-6-6.4, DWQ intends to allow the company to forego this requirement until some unnamed date in the future. In addition to illegally sidestepping the requirement to outline a thorough monitoring plan as part of this permit, DWQ is also depriving the public of an opportunity to meaningfully comment on this plan as provided for in R317-6-5. Because there is no valid reason for DWQ's decision to waive this requirement until some uncertain future date, the agency's action is arbitrary and capricious and a violation of the law.

2.2 DWQ Response

The purpose of a Sampling and Analysis Plan is to insure that data collected during the time that monitoring is required is consistent over time. The Sampling and Analysis Plan contains methods of sample collection, preservation and transport and analytical methods to be used at the laboratory. The Sampling and Analysis Plan is intended to be used to insure continuity of sampling methods even if different personnel conduct the sampling over time. It can only be changed with approval of the DWQ.

Red Leaf has not yet designed and installed the sample ports to be used for collecting any potential leachate from the EPS capsule's metal collection pan and the top of the lower BAS liner. Since the Sampling and Analysis Plan must include detailed instructions on how to obtain a scientifically valid sample from these ports, that part of the Sampling and Analysis Plan cannot be designated at this time. Also, the full suite of analytical parameters will not be known until Red Leaf completes the spent shale analyses required in the permit. Because of these factors, inherent protection of ground water due to site characteristics, and the very low likelihood of leachate discharge during this permit term, DWQ is satisfied that it is not necessary that a Sampling and Analysis Plan be developed before permit issuance.

DWQ's evaluation of the application and issuance of the permit is compliant with Rule 317-6 because it was based factual, scientific and technical data. Justification for increasing monitoring or sampling in this case would have to be directly related to the likelihood of a discharge and that the discharge would harm the current and future beneficial uses of ground water at the site as defined under Rule 317-6.

DWQ has used the available operational and site conditions as provided in the ground water discharge application and as described in I.D. and I.E. above, as well as described in the SOB, to determine that the risk to ground water at the site is minimal due to natural conditions and that, given the arid nature of the site location, the time for any infiltration into the capped, graded, re-claimed and re-vegetated EPS is on the order of hundreds of years. Therefore, DWQ has concluded that the sampling and monitoring plan is adequate to determine compliance with permit requirements.

Permit Action: Permit language in Part I.E has been clarified to require Red Leaf to remove all liquid hydrocarbons discharged from the capsule's drainage points for as long as the discharge occurs.

Comment 3 (3.1)

The Permit Must Contain Provisions for Monitoring for Liquids Beneath the EPS Capsule.

The permit does not require complete and accurate information that shows that the discharge can be controlled as required by R317-6-6.3(G) and R317-6-6.4. While the company proposed to conduct additional monitoring in the trenches for product and heating pipes beneath the capsule, Application at 43, DWQ is of the opinion that such monitoring is of no value in this situation. As noted by the company, the analysis of water samples from these locations would provide an indication of any possible discharge of petrochemicals from the capsules. Id.

There are several reasons why monitoring beneath the capsule is critical. First, in spite of the fact that no information is presented to the public on the viability of the metal sheet design or any quality assurance/quality control measures which would be used to ensure the proper installation of this equipment, DWQ assumes that the metal sheet designed to collect the fluids and prevent seepage below the sheet will work as advertised. However, the metal sheet pan collection system is novel to this process and it is highly likely that the metal sheet will be affected by the heating and pressurization process, as well as by the weight and settling of the material. Kuipers at 4. These forces will cause warping and weld failures that will result in the sheet allowing solution to pass through the sheet and result in increased reliance on the BAS liner to capture and prevent solution discharge. Id.

3. 1 DWQ Response

Discharge is controlled by site conditions that include the presence of rocks with very low permeability below the capsule and no aquifers for hundreds of feet below the land surface, by the fact that capsule contents are under unsaturated conditions and will not impose significant hydraulic head on the lower liner and bedrock, and by the upper capsule cap that must be the functional equivalent of three feet of material with hydraulic conductivity of 1×10^{-7} cm/sec under permit conditions and which will minimize infiltration of precipitation into the capsule.

Monitoring beneath the capsule is not critical to insure control of discharge, as WRA represents. In the very unlikely event that leachate builds up within the closed capsule, the permit requires monitoring of drainage from the metal pan and the top of the lower BAS liner.

Comment 3 cont. (3.2)

Second, the stability of the backing walls and the integrity of the BAS liner are likely to be adversely affected by the heat and pressure generated within the capsules during the retorting process. Id. Other cover systems such as geomembrane liners and composite liners have been shown to be highly susceptible to conditions such as heating, which has resulted in significant degradation of liner integrity over time. Id. Liner integrity could also be affected by conditions such as the pressure and associated solution contact in the form of retort steam and liquid products. Id. Further wetting and drying of BAS liners can result in material shrinkage and desiccation. Id. Potential chemical alteration by mechanisms such as ion exchange can degrade the liner and compromise the integrity of the BAS. Id. If any of these conditions compromise the BAS liner, both the stability of the EPS and the ability of the liner system to prevent discharge would be adversely affected and it is highly likely that the result would be the release of contaminants from the capsule. Id. While the company claims that the BAS liner will have a uniform hydraulic conductivity of 1x10-7 cm/sec across the entire surface of the capsule, if the permeability is not *uniform because there are defects or cracks in the BAS layer, the seepage of water into the processed ore zone and from within the capsule to the exterior would be several orders of magnitude higher than modeled. Lips at 7, attached as Exhibit C.*

<u>3.2 DWQ Response</u>

Stability of the capsule is important from a safety and operational perspective but not from a ground water quality permitting perspective. Overall stability issues are addressed in more detail in DWQ Response to Kuipers 2 below. As described above, the time frame for any liquid to discharge from the capsule is on the order of hundreds of years. Natural site conditions are already highly protective of the Douglas Creek Aquifer hundreds of feet beneath the mine site. DWQ is generally interested in how the BAS liner performs relative to the conditions noted in the comment but these issues are not relevant to protection of the aquifer at the site or the permitting conditions required under R317-6-6.4A.

<u>Comment 3 cont. (3.3)</u>

Third, while the EPS is being proposed as a zero-discharge operation that will contain primary and secondary containment, Application at 10, only the primary BAS system offers containment and no secondary systems, such as a drainage and capture network below the BAS, have been proposed. Kuipers at 5; Lips at 10-11. Given the likelihood of failure of the BAS, DWQ should only issue a permit for the EPS if it is constructed on a liner system that incorporates a leak detection system, such as a geomembrane liner overlain by a geogrid draining to a collection point. Id.

<u>3.3 DWQ Response</u>

Red Leaf's ground water discharge permit application represented the capsule design as a "zero discharge" facility[27], but from DWQ's perspective, a zero discharge is not necessary for permit issuance because of the site conditions described above. Liners that are mainly intended for product containment provide added protection, but the permit is not based on a zero-discharge design for the EPS capsule which would be an excessive standard in this case. Site conditions and what is known about the nature of the potential discharge justify accepting the proposed design for the EPS capsule to be Best Available Technology. DWQ's approval of Red Leaf's design is conservative for these conditions. The permeability of the underlying bedrock is so low that discharge from an unlined, uncapped pile of spent shale would not seep through and impair underlying aquifers of higher quality than the leachate, even if some seepage occurred. Nor does available information suggest that the leachate would threaten beneficial uses of the limited quantities of highly saline water in those rocks.

<u>Comment 3 cont. (3.4)</u>

Fourth, while the Application states that this is a zero-discharge operation, as noted in detail below the seepage analysis conducted by Red Leaf shows that a significant amount of water from precipitation will infiltrate through the upper BAS layer and, in all probability, through the bottom EPS layer. Lips at 7-9.

[27] This representation may be based on Red Leaf's economic interest in collecting as much of the oil as possible.

3.4 DWQ Response:

This is not a zero-discharge operation from a ground water discharge permit perspective. Nevertheless, Red Leaf is required by the permit to have 3 feet of BAS, or the functional equivalent as a cap. Some water will infiltrate, however it has been conservatively estimated to take hundreds of years to reach a point where the resultant shale will even produce any free draining liquid. The likelihood of any discharge is minimal and the aquifer is hundreds of feet below the bottom of the mine.

Comment 3 cont. (3.5)

Fifth, there is the potential for differential settling over a longer period of time – years versus months – than is predicted. Kuipers at 5. This differential settling would mean that some areas of the capsule would settle more than others, id., and that this settling would likely result in significant gaps in the upper BAS layer that would allow moisture from precipitation to enter the capsule relatively unimpeded. Lips at 7. Because the settling may occur over an extended period of time – in excess of five years and possibly as many as 25 years, id. – DWQ must account for the possibility that the resulting settling of the pile will make long-term effectiveness of the containment questionable and short-term reclamation of the surface difficult. Id. at 7.

Because there is a strong possibility that the BAS liner will fail due to heat and pressure, that the metal sheet could fail to perform as expected, and that differential settling will make the long-term effectiveness of the containment questionable thus allowing a significant amount of precipitation to infiltrate through the upper – and ultimately lower – BAS layers, and because DWQ is not requiring the company to construct the EPS on a liner system that incorporates a leak detection system, the agency's action is arbitrary, capricious and a violation of the law.

3.6 DWQ Response

Red Leaf is required to monitor the settling and overall condition of the initial 3 feet of BAS placed on the EPS capsule. If sufficient cracks or other issues are determined to have potentially compromised the initial cap and the cap cannot be restored to its original condition Red Leaf will place an *additional* BAS or similar to reach a functional 3 foot BAS cap of 1×10^{-7} cm/sec material after heating and settling issues have been resolved.

Permit Action: See permit I.D.2(h) for final top layer requirement.

Comment 4 (4.1)

The Permit Must Require Red Leaf to Excavate the Decommissioned Capsule to Verify Performance of the BAS Layer and Other Critical Components and Must Require the Company to Report the Results of its BAS Testing on a Timely Basis.

In its Application, the company has stated that it is considering alternative design and construction methods for the bottom, side and cover BAS layers. Application at 32. However, the total lack of monitoring on the capsule exterior required in the DWQ permit will not allow the agency to determine whether the BAS layer remains intact across the majority of the capsule surface. As the company admits, "[n]o direct post operational evaluation or monitoring of the basal BAS layer will be performed." Application at 34. This is a fatal flaw in the company's plan and the resulting permit. While the company *is appropriately proposing to construct a prototype of sufficient scale, in order to examine the impacts that the retort process has on the BAS layer and other critical components such as the metal sheet, the company must excavate into the decommissioned capsule. Kuipers at 4. Without such excavation, there is no way for the company or DWQ to properly evaluate the results of the testing process. Id. Because DWQ is not requiring Red Leaf to excavate into the capsule in order to account for the performance of both alternative designs on the bottom and sides of the EPS and critical capsule components, there is no way for DWQ to verify whether the EPS will perform as expected as required by R317-6-6.3(G) and R317-6-6.4. Therefore DWQ's action is arbitrary, capricious and a violation of the law.*

4.1 DWQ Response

Excavation of the decommissioned capsule is not necessary. Ground water is protected by site conditions, not the lower BAS liner, and re-contouring and re-vegetation of the final capsule surface. As explained in Part I.E. (Nature of the Facility) of the introduction to these comment responses, significant hydraulic head will not build up on the lower BAS liner, and there will be no significant force driving fluids through it. The closed capsule will resemble a landfill, and leachate generation will be minimized by the upper BAS liner. The lower BAS liner is not a critical component to insure the conditions for issuing a ground water discharge permit are met. Red Leaf is required to evaluate the condition of the upper BAS cap after capsule compaction, at the most likely places where its integrity may be compromised. If this investigation reveals damage to the BAS cap, Red Leaf is required to maintain a cap with the functional equivalent of three feet of material with hydraulic conductivity of 1×10^{-7} cm/sec. To achieve this requirement a new BAS cap will be added if the integrity of the upper BAS layer cannot be demonstrated by post-closure evaluations (see Fig. 6 and Permit I.D.2(h)).

Comment 5 (5.1)

The Application Fails to Accurately Characterize the Geology and Hydrology in the Area of the Mine.

First, while Red Leaf's Application documents the presence of ground water in the wells drilled at the mine site and emanating from nearby springs, the company does not provide, and DWQ does not require, complete and accurate descriptions of these systems as required by the Ground Water Quality Protection regulations. See R317-6-6.3(E) & (K) and R317-6-6.4. For instance, while the Application indicates that there are layers containing ground water immediately below the mine site, the Application fails to properly document those aquifers. Lips at 4. Specifically, the Application notes the presence of an aquifer as close as 20 feet below the proposed mining operation, but fails to contain an adequately document such things as the quality of the water, the thickness of the aquifer, the direction of flow, porosity, hydraulic conductivity and flow systems characteristics. Id. at 5.

5.1 DWQ Response

The DWQ is satisfied that the characterization of the geology and hydrology in the area sufficiently support the issuance of the permit[28]. This comment cites to Lips at 5, an exhibit in WRA's comments. Lips assumes there are "aquifers" underlying the EPS capsule site at shallow depths.

[28]See discussion in I. Introduction C. Site Conditions, above.

The Application does not "note" the presence of aquifer and there is no support for Lips' statement that there is or may be an aquifer as close as 20 feet below the base of the mine operations. Such statements show a misunderstanding of the nature of the geologic contact between the Parachute Creek Member and the underlying Douglas Creek Member, and confusion of the Douglas Creek Member with the aquifer contained within that member and again as R317-6-1(1.1) states an aquifer may be "….part of a geologic formation that contains sufficiently saturated permeable material to yield usable quantities of water to wells and springs."

In reality, the contact between these two members is gradational, alternations of fine-grained rock deposited in a deeper water environment with coarser-grained rocks deposited in a more shallow water environment. Sandstones deposited in a shallow water environment, subject to waves and currents, may have relatively high permeability and may contain aquifers if they have sufficient pore space between the sand grains, and if there is source for water to recharge into the sandstone. This "primary porosity" may be enhanced by fractures in the rock, termed "secondary porosity". The stratigraphic relationship between the Parachute Creek and Douglas Creek Members is illustrated in detailed measured sections taken at an outcrop of the two members along Evacuation Creek, approximately 19 miles northeast of the Red Leaf site[29]. Details of the stratigraphy will be different between the Evacuation Creek sections and the Red Leaf site, but the larger-scale stratigraphic relationships will be similar. In a gradational sequence such as this, picking a contact between the two members is arbitrary, and there is often no consistent agreement of the contact among geologic workers in the region. The U. S. Geological Survey picks the contact at the first sandy bed below the Mahogany oil shale bed, and this contact was used for the USGS geologic map in Figure 5 of Red Leaf's ground water discharge permit application. The Utah Geological Survey places the contact at the base of the R2 oil shale zone, as shown on Figure 4 of this response. The Douglas Creek Aquifer is contained within the part of the section that is predominantly sandstone. This aquifer is tapped by Red Leaf's water supply well, which encountered ground water at 630 and 830 feet below ground surface. (SOB Part VII.2) WRA's comments appear to refer to the whole Douglas Creek Member (USGS interpretation) as an aquifer, rather than just the predominantly sandy part of it below the gradational contact.

Areas mapped as the upper Douglas Creek Member in Figure 4 of the permit application are in the lower part of the Parachute Creek Member where the depositional environment is beginning to change to one that includes occasional sandstone interbeds, and do not represent the outcrop of the sandstones that form the Douglas Creek aquifer and are not exposed at the project site. The Douglas Creek aquifer is several hundred feet deeper in the section and isolated from these upper sandy beds by several zones of oil shale. Red Leaf's water supply well taps the Douglas Creek aquifer and is over 600 feet below ground surface, much deeper than the upper sandy beds. There is no evidence that the sandy bed below the Mahogany Zone is an aquifer, and significant evidence that it is not. In outcrop (Attachment B, Novak 2012, Photo 5), these upper sandy beds have significant carbonate content and the thinly-bedded

(fissile) appearance indicates a significant content of fine-grained material as well. It is overlain and underlain by oil shales with low permeability that prevents water from recharging into it. Examination of drill cores through this interval show that it is partly saturated with bitumen, further decreasing its porosity and permeability (Attachment A, Memo from Steven Kerr to Jay Vance, November 7, 2013).

[29] (Fig. 4 of this response)

Because the stratigraphic interval below the B Groove is composed primarily of oil shales, which were deposited in an environment similar to the Mahogany Zone and which have similar hydrogeologic properties, there is no reason to suspect any ground water that may occur in these rocks would have significantly better water quality than that observed in the Mahogany Zone.

The site specific data Red Leaf has collected and presented in the ground water discharge permit application is consistent with the geologic literature describing geology and hydrology the Southern and Southeastern Uinta Basin. DWQ has determined that more than adequate information is known about the geology and hydrology of the area such that the EPS operation will have no effect on the class TDS limits or ground water quality standards and that there will be no impairment of present or future beneficial uses of the Douglas Creek Aquifer.

Permit Action: None

Comment 5 cont. (5.2)

Second, while the Application contains a brief description of the October 2012 seep and spring survey, it completely fails to incorporate any of the information contained in the Supplemental Inventory conducted in May 2013. This omission is significant because the 2013 inventory corrected many of the conclusions drawn from the 2012 inventory, noting that "several areas marked as potential seeps were verified to be springs[,]…that seeps inventoried in October 2012 should now be classified as springs in May 2013[, and that] some of the smaller, previously identified individual springs were, in fact, larger springs that were part of gaining/losing systems." 2013 Inventory at 6. Rather than seriously considering the information contained in the 2013 Inventory, DWQ dismissed this information out of hand concluding that "no distinctly new seeps and springs were found in the May 2013 survey" and that the discharge of one of the springs identified in 2012 "appeared slightly higher in May 2013." SOB at 5.

The fact is that the 2013 Inventory documented two springs that showed appreciable amounts of water – .42 gallons per minute permit in one case, and .52 gallons per minute in another – and showed that all of the springs have less than 3,000 mg/l of total dissolved solids and therefore qualify for protection as Class II Drinking Water Quality Ground Water under the regulations. Lips at 5; see also R317-6-3.5 The 2013 Inventory also documented surface flow of up to 3,900 feet which supports vegetation and wildlife. Lips at 5; see also 2013 Inventory at 9-12.

The question left unanswered by both the Application and the SOB is what constitutes the source of the water that feeds these springs and what is the significance of the finding that eight individual springs exist down gradient of the mine site. Specifically, the question of whether those springs could be impacted by the mine must be answered. In spite of that, the Application does not contain any geologic and hydrologic descriptions of the aquifers from which these springs emanate, or the ground water flow direction and aquifer materials. Lips at 5; R317-6- 6.3(E). Rather than require Red Leaf to resubmit the Application in order to properly account for the new information regarding ground water that could be impacted by the mining operation, DWQ merely includes the information in its public notice and makes passing reference to it in the SOB. SOB at 5.

5.2 DWQ Response

The source of the ground water feeding the springs is not the water found in the monitor wells beneath the proposed mining site. For instance, the sandstones that form the Douglas Creek aquifer are not exposed in the area surveyed for springs and seeps, and the personnel from JBR Consultants who conducted the survey followed the Utah Geological Survey interpretation of the Parachute Creek-Douglas Creek contact, thereby designating the bedrock in the area of the springs and seeps to be the Parachute Creek Member.

The permit application, p. 23 states:

> The observed geological occurrence of the single spring and most seeps was discharging or potentially discharging stream bed material, which was comprised of alluvium, residuum or both.

In addition, Red Leaf has demonstrated that such ground water that exists in the Parachute Creek Member (the bedrock in most of the survey area) is highly saline and contained in rocks with very low hydraulic conductivity. The relatively low levels of dissolved solids contained in springs in the survey area are best explained by these springs representing ground water flow from the surficial deposits (Attachment D). Although these deposits have weathered from the Parachute Creek Member, salts have been removed from them by weathering. The levels of dissolved solids in these springs, approximately 3000 mg/l, are a result of this weathering process in action. Seeps found near the mine site and flowing from shale partings in bedrock represent places where ground water from the surficial deposits has penetrated to shallow levels in the upper, weathered portion of the bedrock. As cited above, the low hydraulic conductivity and highly saline water contained deeper in the bedrock are evidence against a ground water flow system that penetrates deep into the bedrock.

Red Leaf's EPS capsule will be built directly on top of un-weathered bedrock at the bottom of a mine pit. Any discharges at the site of the capsule would not affect ground water in the surficial deposits. Monitoring of springs and seeps that issue from the surficial deposits or from weathered bedrock immediately underlying them is not necessary to meet the requirements for permit issuance listed in Rule 317-6-6.4A for the EPS capsule. Similar capsules built at other sites, however, may be in locations where discharges from them could affect ground water in the surficial deposits, and monitoring springs that issue from those deposits may be appropriate in such cases.

Permit Action: None

Comment 5 cont. (5.3)

Third, there is no basis for the statement in the Application and the inventories that "[a]lluvial deposits are minimal in the RLR parcels and are insufficient to meet the state definition of an aquifer." Application at 17. Alluvium is not a condition necessary for the occurrence of ground water, as seen in the fact that there are many productive bedrock aquifers.

5.3 DWQ Response:

Any alluvial aquifers in the project area, if they exist, are not hydraulically connected the waters immediately beneath the mine site. Evidence that the bedrock at the Red Leaf site has very low permeability and not hydraulically connected is the extremely saline water contained in it and the low permeability that was actually measured by Red Leaf's recovery tests in its monitor wells (see Attachment B, Fig. 5 well Recovery Curve and Application Part 9.5.2).

Permit Action: None

Comment 5 cont. (5.4)

Additionally, the importance of recharge to bedrock is emphasized in other sections of the Application, where the Douglas Creek outcrop is identified as an important zone of recharge.

5.4 DWQ Response

Bedrock recharge is important both in the exact manner that it occurs and the magnitude. A good discussion of both of these is provided on page 28 of Price and Miller. This description is consistent with the site specific data Red Leaf has collected and gives the likely location of the recharge of the part of the Douglas Creek Members that constitutes the Douglas Creek Aquifer at the mine site, the Price and Miller study states:

> Because of the predominantly fine-grained nature and low permeability in the recharge area, percolation rates are very slow……Therefore, it is estimated that only about 100,000 acre-feet (123hm^3) or about 3% of the estimated average annual precipitation becomes ground water recharge.

The high quality water in the Douglas Creek Aquifer must come from somewhere and it must be consistent with the other observed data at the mine site and information of the overall flow regime. Simply put, recharge of the Douglas Creek Aquifer (a deeply confined aquifer) does not occur through the bedrock beneath the mine site. None of the evidence supports such a conclusion, rather (Price and Miller, pg. 28):

> Ground water in the Southern Uinta Basin is in a complex system of shallow unconfined, perched, and deep confined aquifers. Shallow unconfined aquifers exist in the principal recharge area, along the southern rim of the Uinta Basin, where they support the flow of many perennial springs such as PR and Marble Springs…….Perched aquifers exist beneath the tablelands between the major streams where they support the flow of small widely scattered intermittent springs such as (D-10-17)12baa-S1 and (D-11-15)15dbb-S1 (table 12).
>
> Deep artesian aquifers in bedrock underlie a major part of the southern Uinta Basin. Such aquifers have been penetrated by a number of oil and gas wells (D-11-24)6dbc-1, which have been converted to stock water wells (table 10).

The foregoing statement from Price and Miller is important because it describes the likely location of the primary recharge area for the deep confined aquifer at the mine site, the Douglas Creek aquifer within the Douglas Creek Member, and that it is along the southern rim of the Uinta Basin. Even along the southern rim of the Uinta Basin, where the elevation and consequently the precipitation is highest and evaporation lowest, the rate of recharge is still low. The small springs observed in the Red Leaf area are as described by Price and Miller, small (flow rates), widely scattered, perched and intermittent. These springs are not part of the regional flow regime and not connected to the much higher salinity water beneath the mine site.

<u>Permit Action:</u> None

Comment 5 cont. (5.5)

Finally, the assertion that alluvial deposits are insufficient and the assertion that marlstone is too impermeable to conduct significant ground water is contradicted by evidence in the record that notes that the B Groove, which is described in the Application as marlstone, is described as a productive aquifer in certain locations.

Fourth, DWQ's assumptions regarding possible impacts of the mine are based on an inaccurate characterization of ground water quality beneath the mine. In the SOB, DWQ makes the statement that ground water in the area of the mine is of such poor quality that it would not be impacted by contaminants from the mine. SOB at 7. However, DWQ has no basis for such an assumption. Lips at 6-7. Specifically, the manner in which Red Leaf conducted the monitoring of its wells does not make it possible to determine whether the water that has been analyzed derives from the aquifer in the Mahogany Zone, or from the aquifer in the sandstone layer a few tens of feet beneath the Mahogany. Id. Because the Application does not contain data related to water quality of the aquifer in the zone immediately beneath the proposed mine site, DWQ is not justified in its conclusion that ground water quality in the area of the mine will not be impacted. In any case, there is nothing in the record to suggest that the ground water beneath the mine contains petrochemicals or other contaminants that would be discharged from the mine and therefore that would not be adversely impacted by the operation of the mine.

Because the permit fails to require Red Leaf to accurately describe the geology and hydrology of the mine site as required in R317-6-6.3(E) & (K) and R317-6-6.4, and to incorporate and explain the results of the 2013 seep and spring inventory, and because DWQ's assumptions regarding possible impacts of the mine area based on an inaccurate characterization of ground water beneath the mine, the agency's action is arbitrary and capricious and a violation of the law.

5.5 DWQ Response:

As described in DWQ's responses above, there is no evidence of such aquifer(s), as defined in Rule 317-6-1, anywhere in the geologic section below the EPS capsule site and above the strata tapped by Red Leaf's water supply well, over 600 feet below ground surface. Rocks of the B Groove and the strata underlying it have low permeability at this site (Novak 2012 and Memo from Steven Kerr to Jay Vance, November 7, 2013). Also, because the B Groove may be an aquifer in another location does not mean it must be one here. Red Leaf conducted substantial investigation to determine the occurrence of water around and beneath the mine site and the evidence clearly shows that at the Red Leaf mine site an aquifer does not exist immediately beneath it including in the B Groove. The core data as shown in attachment B and the recharge of wells beneath around and beneath the mine site prove this. See also I.D.2(a-f) of this response.

DWQ is satisfied that both substantial and adequate site specific investigations have occurred at the Red Leaf mine site to determine proper permit issuance under Rule 317-6-6.4A. This data is consistent with the generally known conditions and the geologic and hydrologic literature. Any claim of insufficiency must show, at a minimum, a clear discrepancy between the site data and the literature that is supported by factual information and evidence as required under Rule 305-7-202(1)(b), not by mere supposition or inference from the small surface expressions of ground water, i.e. springs, that have been objectively and factually proven to be of wholly different quality (TDS, chemical constituents and isotopically) than the water found immediately beneath the mine site. Anything less would allow an unnecessary and undue burden of serial suppositions and subsequent investigations such that no final determination could be made.

<u>Permit Action:</u> None

Comment 6

The Permit Fails to Demonstrate that the Discharge Can be Properly Controlled.

The permit does not require complete and accurate information to show that the discharge can be controlled as required by R317-6-6.3(G) and R317-6-6.4. While the company claims that the mine operation will be a zero-discharge operation, Application at 11, that claim is based on the assumption that the EPS will be constructed with an "impermeable liner," id. at 4, and that water will not enter the hydrocarbon recovery zone of the capsules." Id. at 8. However, the company's own analysis shows that there will be a rate of seepage through the BAS layer of 1,683 gallons per year for a reclaimed capsule, and 73,772 gallons per year for a non-vegetated one. Lips at 7. Of critical importance is that the company performed this analysis assuming that there would be a uniform conductivity of lxlO"7 cm/sec across the entire surface of the capsule. However, if there are defects or cracks in the BAS layer, as discussed above, the seepage of water into the capsule will be several orders of magnitude higher than modeled. Id. Further, seepage through the BAS is likely to be greater than the 1,683 gallons per year figure derived by the 30-year modeling conducted by the company for three reasons. First, the modeling failed to take into account the amount of time that it will take to completely saturate the overlying material. Id. This could take up to 10-15 years, and because the 30-year model failed to factor in this significant element, any results derived from that model are skewed. Id. Second, the model does not take into account the company's plans to regrade the top surface of the EPS. See Application at 8. As noted above, the long-term differential settling that is likely to occur will necessarily increase the amount of water that will penetrate the capsule. Id; see also Kuipers at 7. Third, the modeling also does not factor in the amount of time that will be necessary to establish vegetation at the mine site.

DWQ previously recognized the deficiencies of the modeling, and on February 12, 2012, requested that the company conduct modeling that would: 1) consider long-term performance of the capsule; 2) evaluate the time it would take to reach field capacity; and, 3) evaluate performance of the upper layer where the covering had been removed by erosion. Completeness Review, attached as Exhibit D. Rather than comply with DWQ's request, Red Leaf submitted a technical memorandum that completely fails to address the long-term management of the spent shale, the performance of the bottom BAS, the potential discharge from the EPS, and the point at which the lower portion of the EPS will reach field capacity. See Bayer Technical Memorandum; see also Lips at 8. Further, rather than requiring the company to submit this modeling as part of its Application, DWQ allows Red Leaf to submit a plan on how it intends to conduct such a study 90 days before beginning its testing and permits the company to wait until the theoretical application for a revised permit before requiring Red Leaf to submit this data. Because DWQ is improperly allowing the company to perform the evaluation after the EPS is constructed rather than requiring the company to provide complete and accurate information that shows that the discharge can be controlled, as required by R317-6-6.3(G) and R317-6-6.4, and because it is improperly denying the public a meaningful opportunity to comment on the company's plan to obtain such information, as required by R317-6-5, DWQ's action is arbitrary, capricious and a violation of the law.

6. DWQ Response

Red Leaf's ground water discharge permit application may have represented the capsule design as a "zero discharge" facility but the permit is not based on a zero-discharge design for the EPS capsule. Rather, site conditions and what is known about the nature of the potential discharge justify considering the proposed design for the EPS capsule to be Best Available Technology in this particular case. The permeability of the underlying bedrock is so low that discharge from an unlined, uncapped pile of spent shale would not seep through them and affect underlying aquifers. Liners that are mainly intended for product containment provide even more protection, even if they allow some seepage through them. Nor does available information suggest that the leachate would threaten beneficial uses of the limited quantities of highly saline water in those rocks. Modeling required by the permit is mainly intended to confirm capsule performance and estimate the time it will take for the capsule contents to reach field capacity.

Requirements for studies on the EPS capsule are listed in Part I.G of the ground water discharge permit. Part I.G.3 requires Red Leaf to evaluate the hydraulic conductivity of the upper BAS liner, including sections that were constructed differently or which underwent mechanical strain due to compaction of the underlying oil shale ore during retorting. Red Leaf shall also evaluate hydrologic properties of the spent shale and other components of the EPS capsule in order to model water flow through the capsule using actual measured values for the parameters used by the model and not estimated values. The goal of this modeling will be to estimate the volume of water needed to bring the capsule contents (and contents of future production capsules) to field capacity, and the time needed for this volume of water to infiltrate the capsules in the site's climate.

Taking into account the unknown factors of the new technology and the design of the system, given the conditions of the site, DWQ is satisfied that this permit approval is very conservative. The most important factors regarding protection of ground water in this case are the nature of the facility and the site conditions. The capsule contents will always be under unsaturated conditions and significant hydraulic head will not build up on the lower BAS liner. If some small flux of leachate does bypass the metal collection pan and migrate through the lower BAS liner, rocks underlying the capsule have very low permeability. The first aquifer underlying the site is hundreds of feet below ground surface and is under confined conditions with an upward hydraulic gradient.

The justification for allowing Red Leaf to model liner and capsule performance is that such modeling is not as important as WRA represents because of the site conditions and also that modeling based on hydrologic parameters that are actually measured in a constructed capsule will be superior to using estimated values. It is DWQ's intent to potentially apply the results of this modeling to develop permit conditions when the capsule technology is used further by Red Leaf. In the unlikely event that the modeling and other studies required by this permit reveal that leachate discharge may be a significant threat from capsules of this design, the modeling results will allow DWQ and Red leaf to consider other ways in which it may be managed such as by requiring a more impermeable design for the upper liner cap.

<u>Permit Action:</u> None

<u>Comment 7</u>

The Permit Fails to Require Red Leaf to Monitor Ground Water in the Area of the Mine.

Given that Red Leaf has never constructed its proposed capsules, there is no basis in the record for DWQ to conclude "that construction of the EPS capsule as presented in Red Leafs ground water discharge application will not degrade beneficial uses of ground water." SOB at 7. This is especially true given the admission in the previous sentence that "[t]he issuance of this permit is part of an evaluation phase that will be used to test assumptions and factors related to ground water protection, capsule performance and site conditions that are still not completely known." Id. DWQ assumes that the BAS liner will remain intact after being subjected to extreme heat over an extended period of time. As outlined in detail above, there is no justification for this assumption. Further, DWQ is also unjustified in its assumption that there *is an "unlikely possibility that the capsule would cause a discharge of contaminants to the subsurface," as a basis for concluding that monitoring ground water "would not provide useful information to evaluate Red Leafs compliance with the Ground Water Quality Protection Regulations." SOB at 7.*

Because the Application does not contain complete and accurate information showing that the discharge can be controlled and will not migrate into or adversely affect the quality of waters of the state, as required by R317-6-6.3(G) and R317-6-6.4, the company must conduct monitoring to determine the impact of the mine on ground water resources. Additionally, the ground water permit makes the incorrect statement that "[g]round water monitoring is not feasible at the site due to the impermeability of the shales that underlie it." Permit at 2.

While Red Leaf recognized that a continuous sandstone layer exists under the project area a few tens of feet below the mine, the company did not complete monitor wells that would allow for the sampling and analysis of the water quality in this aquifer. Lips at 9. Because of that, the company must be required to install new monitor wells that will adequately establish baseline conditions of the ground water in this aquifer as required by R317-6-6.3(1) and R317-6- 6.4. Id. Further, DWQ must require that these wells continue to function as monitoring wells once mining operations begin. Lips at 2, 9-11.

Because the company identified eight springs down gradient from the well, DWQ must require the company to explain the significance of these springs, where the water is coming from and whether these waters can be impacted by Red Leafs operation. Id. Further, once mining operations begin, the company must be required to monitor these springs to determine whether they will be impacted from the mine as required by R317-6-6.3(1) and R317-6-6.4. Id. While DWQ recognizes the uncertainties associated with the EPS, SOB at 7, DWQ fails to require the company to submit a sampling and monitoring plan as required by the Ground Water Quality Protection regulations and instead allows the company to submit a sampling and analysis plan at some point in the future. Permit at 6. This action both violates the requirements of R317-6-6.3(G) & (I) and R317-6-6.4, and deprives the public of the opportunity to meaningfully comment on this plan as provided for in R317-6-5 and is therefore arbitrary and capricious and a violation of the law.

7. DWQ Response

The EPS capsule site is not underlain by “aquifers” at shallow depth. The DWQ is satisfied that springs in the vicinity of the EPS capsule site represent a ground water flow system contained in unconsolidated surficial deposits and weathered bedrock. Because the EPS capsule will be constructed on un-weathered bedrock that is physically below these surficial deposits, this flow system could not be impacted by contaminant discharges at the capsule location.

The permit requires source monitoring of any leachate that may collect on the metal pan within the capsule and the upper surface of the lower BAS liner. This would detect any problems with leachate discharge long before there would be a discharge to the subsurface. The rocks underlying the capsule are of very low permeability. The highly saline nature and distinct isotopic composition of ground water observed in these rocks, as well as the very low permeability measured directly in these rocks by recovery testing at Red Leaf’s monitor wells is evidence that it does not circulate, and potential discharge from the capsule would not necessarily report to a monitor well, even if the well was located directly down-gradient from the EPS capsule. In addition, it would be very difficult or impossible to detect the influence of leachate in highly saline ground water containing naturally occurring dissolved hydrocarbons such as that observed in Red Leaf’s monitor wells.

Permit Action: None

Comment 8 (8.1)

The Permit Does Not Contain a Closure and Post-Closure Management Plan as Required by R317-6-6.3(S).

DWQ fails to require the inclusion of a Closure and Post-Closure Management Plan in the permit as required by the Ground Water Quality Protection regulations. See R317-6-6.3(S) and R317-6-6.4. Therefore there are no provisions for operational shut-down and subsequent drain-down and handling of petroleum containing liquids. Such a management plan is especially important in the case of an unplanned mine closure. Kuipers at 6. Various state and federal agencies require that an interim or emergency fluid management plan be part of reclamation and closure plans at mines. Id. If Red Leaf were to abandon the site during operations, it is likely that the State of Utah would have to dispose of significant quantities of process solutions containing deleterious materials. Id.

Because there is no mention of a closure or post-closure plan in either the Application or the Permit, DWQ's failure to address this deficiency was arbitrary and capricious and a violation of the law.

8.1 DWQ Response

Red Leaf is required to complete site reclamation by the Division of Oil, Gas and Mining (DOGM), and a bond has been collected by that agency to insure site reclamation in case of an unplanned mine closure. The DWQ is satisfied given expected capsule performance, spent shale leachate characteristics and site characteristics, that the reclamation required by DOGM is adequate to prevent discharge of contaminants to ground water.

To insure adequate reclamation, as DWQ's knowledge of the Eco-Shale capsule technology grows with the experience of EPS capsule operation and closure, Part I.H.4 of the permit requires Red Leaf to develop reclamation and closure plans that are protective of ground water quality following the investigations into capsule performance and leachate chemistry required in Parts I.H.2 and I.H.3 of the permit.

It should be noted that operation of the EPS capsule will not involve process solutions. Permit conditions were developed under the assumption that Red Leaf would remove all liquid hydrocarbons that drain from the capsule from the site, for as long as they drain from the capsule. Permit language has been modified to require this.

Permit Action: Permit language in Part I.E has been clarified to require Red Leaf to remove all liquid hydrocarbons discharged from the capsule's drainage points for as long as the discharge occurs.

End of DWQ's Responses to WRA's Comments

<u>III</u>
<u>DWQ RESPONSES TO REPORTS ATTACHED AS EXHIBITS TO WRA'S COMMENTS</u>
<u>Excerpts from the reports are restated verbatim in italics.</u>

DWQ Responses to Excerpts from Kuipers Report, Exhibit A to WRA's Comments

<u>Kuipers 1 (Heap Leach)</u>

The EcoshaleTM In-Capsule Technology (hereinafter referenced as "capsule") approach proposed for the project is a new method for the extraction of petroleum containing liquids from oil shale. The capsule method in some respects is comparable to ***heap leaching*** *for gold or copper versus traditionally more energy intensive milling processes**.** Similarly, the capsule approach would utilize sized material placed in a Bentonite Amended Soil (BAS) lined facility (JBR, 2013 p. 4)1 rather than more intensive milling and retorting processes employed in the past and at present in oil shale producing regions such as Estonia. The oil shale capsule approach would then seal the pile and apply heat in order for the pile to act as a retort and mobilize the contained petroleum. Capsules would be located within mined areas and be stacked two high and would be reclaimed by standard techniques following cooling and settling of the capsules.* [Kuipers p.1-2, emphasis added.]

*   *   *

all of which have been shown to be highly important in ***heap leach*** *and other similar designs.* [Kuipers at p.4, emphasis added.]

*   *   *

No provisions for operational shut-down and subsequent drain-down and handling of petroleum containing liquids are contained in reclamation and closure information provided in the Application. This is especially important in the case of an unplanned mine closure. The inclusion of interim fluid management, also referred to as emergency fluid management, is an integral reclamation and closure task common to mine sites recognized by the Office of Surface Mining, Bureau of Land Management, Forest Service and states such as Nevada and Montana. The typical tasks required include management of process solutions upon operator bankruptcy resulting in the abandonment of the site to prevent discharge of those solutions, and involves the cost of manpower, equipment and materials involved in the management of those materials for a minimum of six months and in some cases three years or more.

In the event Red Leaf Resources were to abandon the site during operations it is likely that the State of Utah would have to manage significant quantities of in-process solutions as well as immediate draindown solutions from the capsules. It is also likely that the State would eventually have to dispose of significant quantities of process solutions containing deleterious materials. Both of these tasks could result in significant cost to Utah taxpayers if the interim water management and fluid draindown tasks are not addressed in the reclamation and closure plan and associated costs are not covered by a bond for these activities. [Kuipers at p.6.]

DWQ Response to Kuipers 1 *(Heap Leach)*

If the Red Leaf operation were similar to a heap leach operation, DWQ would share Mr. Kuipers' concerns. DWQ is satisfied that the permit application and other documents in the record demonstrate that it is not, and that such concerns do not apply in this case (Table 1).

Table 1: Operational Comparison of The Red Leaf EcoShale^{tm} EPS process versus Conventional Gold or Copper Heap Leach.

	Red Leaf Operation	**Au or Cu Heap Leach Operation**
Water used in the extraction process, i.e. "process water"	NO	YES
Process Water Ponds needed for Operation, e.g. solution ponds	NO	YES
Any chemicals or additional extractive agents added (which of course themselves could present a contamination concern)	NO	YES
Pregnant Leach Solution (PLS) collection ponds required	NO	YES
Draindown of ore required after operation ceases due to water used in the process	NO	YES
Enhancement of potential contaminant mobilization or migration due to use of water or additional extractive agents	NO	YES
Potential for hydraulic head (contaminant migration driving force) to develop while in operation	NO	YES
Is the ore from which extraction takes place partially saturated before or after operation	NO and NO	NO and YES
Need for double lined ponds with leak detection	NO	YES
Need for any liner beneath or around the extraction ore	NO	YES

Kuipers 2 (Capsule Stability)

The stability analysis performed for Red Leaf was a "preliminary analysis" conducted by Norwest (Norwest, 2011b p. 1)2, and in general all materials that have been reviewed do not appear to contain the level of site-specific technical analysis which should be required of the project proponent in the Ground Water Application. A preliminary analysis uses professional judgment rather than site-specific data and generally relies upon the project proponent to conduct detailed final analysis using site-specific data to verify the results of preliminary analysis. Similarly, model parameters used were assumed and apparently based on experience with similar materials and literature review (Norwest, 2011a p. 2)3 rather than site-specific materials information which would provide much more reliable data. It is not uncommon for plans to require significant changes to the foundation and containment designs over successive design generations to account for site-specific conditions when they are based on preliminary analysis. In order to provide for confident data and analysis the Norwest analysis should have contained more detailed and final analysis based on borings and materials analysis from a variety of samples representative of the actual site conditions.

The BAS and insulating gravel units were not included in the preliminary backing wall stability analysis (Norwest, 2011a p. 2) and should be considered in a more detailed analysis using site specific data. The BAS and insulating gravel units represent potential weak layers in the design. According to the proponent's consultant, the intact strength of the bedrock foundation and risk of planar bedding failures through weak layers would affect the stability of the backing walls impact the integrity of the BAS liner and should be further investigated and include lab testing of actual site materials (Norwest, 2011a p. 4). Planar failures result when a discontinuity dips out of a slope surface such as that of the BAS and insulating gravel layer. For this reason, the information in the NOI should have contained additional investigations related to the site specific materials to be used in creating the BAS and insulating gravel units and their properties and the BAS and insulating gravel units should have been included in the stability analysis.

The stability of the backing walls and the integrity of the BAS liner will be adversely affected by the heat and pressure generated within the capsules during the retorting process and should be evaluated during the EPS testing (Norwest, 2011a p. 4). While no comparable design has been methodically tested for performance under similar conditions, other cover systems such as geomembrane liners and composite liners using soil and geomembrane systems have been shown to be highly susceptible to conditions such as heat resulting in significant degradation of liner integrity over time Liner integrity would similarly likely be affected by other conditions such as the pressure and associated solution contact in the form of retort steam and liquid products. Wetting and drying of BAS liners can result in material shrinkage and desiccation. Potential chemical alteration by mechanisms such as ion exchange could degrade the liner and compromise the integrity of the BAS. If the BAS materials are compromised by any of these processes, the stability of the capsules as well as the integrity of the liner system to prevent discharge would be adversely affected and it is highly likely that this would result in a release of deleterious materials.

While the company is appropriately proposing to construct a prototype EPS at a significant scale, it is not proposing to excavate into the decommissioned EPS capsule in order to examine the impacts that the heating process will have on the BAS materials and on such critical components as the metal sheet that the company plans to use to collect fluids. Without such excavation and examination of the potential degradation of the buffer and liner system and examination of its integrity relative to the EPS test conditions, there is no way for the company or regulatory agencies to properly evaluate the results of the testing process.

DWQ Response to Kuipers 2 (Capsule Stability):

A thorough review of the stability analysis performed by Norwest (Norwest, 2011b) references an Appendix A provided by Intermountain GeoEnvironmental Servies Inc. (IGES). A review of the UGW Permit Application binders show that this Appendix A was inadvertently not provided. This was communicated to Red Leaf and on Nov. 22, 2013 the complete document was received by DWQ. This will replace Appendix B of the UGW Permit Application. The IGES Appendix is a "Summary Report" containing "Data Review and Development of Rockfill Strength Parameters". This included direct shear, unconfined compression and triaxial compression testing of site specific materials.

As described under II(4.1) excavation of the capsule is not necessary and ground water is protected by site conditions.

Kuipers 3 (Process Solution and Post-Retort Draindown and Leachate Collection)

A metal sheet, referred to as the oil collection pan, is proposed above the BAS to collect fluids and prevent seepage together with collection pipes (JBR, 2013 p. 28), however no information is presented to the public as to the viability of the metal liner design and collection pipe system or quality assurance/quality control measures to ensure their proper installation, all of which have been shown to be highly important in heap leach and other similar designs. The metal sheet pan collection approach is novel to the proposed capsule process and has not been used elsewhere to my knowledge. It is highly likely that the metal sheet will be affected by the heating and pressurization process as well as the weight and settling of the material and will cause warping and weld failures in the metal sheet which will result in the sheet allowing solution to pass through the sheet and in turn result in increased reliance on the BAS liner to accomplish capture and to prevent solution discharge.

According to the Bureau of Land Management (FPEIS p. 4-31 to 4-32)5 common impacts from oil shale development include "Spent shale piles and mine tailings that might be sources of contamination for salts, metals, and hydrocarbons for both surface and groundwater" and (DPEIS p. 4-32) "Degradation of groundwater…from contributions of residual hydrocarbons or chemicals from retorted zones after recovery operations have ceased; and, from spent shales replaced in either surface or underground mines." Based on this information the proponent has not adequately identified the spent shale as a potential source of deleterious materials and as a result has not emphasized the proper management of these materials either during operations, in the event of unanticipated closure, during the solution draindown period, or post reclamation.

Given the high likelihood for capsule liner failure as previously described, there is an equally high risk that any solution which escapes from the capsule will contain deleterious constituents. The operation is proposed as a zero-discharge operation that will include primary and secondary containment (JBR, 2013 p. 10). However, other than the primary BAS system no additional secondary containment such as a drainage and capture network below the BAS has been proposed for the EPS. Given the potential likelihood of failure of the BAS, a true zero-discharge design would incorporate an additional redundant liner and leak detection system, such as a geomembrane liner overlain by a geogrid draining to a collection point. In addition, at least one if not more downgradient groundwater monitoring wells should be included in the EPS proposal as an additional measure of BAS system containment.

The proposal relies on "proprietary fabrications" to address BAS seal function (JBR, 2013 p. 30). In a heated and pressurized retort environment this is problematic given the high likelihood of failure that liner seals have exhibited in other similar designs under less onerous conditions. Considerable effort has been required to successfully design and construct liner seals in heap leach processing and other applications which are relatively mundane in comparison to the requirements which will be placed on liner seals in a heated and pressurized retort environment. The liner seals proposed for the capsule design which consists of a pressurized and heated retort application represent a specific design area in this novel approach where there is a high likelihood of failure which would be likely to result in discharge of retort solutions containing deleterious constituents.

Further, there is a significant potential for differential settling within the capsule which would occur over a longer term (e.g. years versus months) than is predicted. Differential settling would result in some areas of the pile settling more than others and is common in similar instances where large amounts of settling relative to the overall material height have been constructed. The EPS proposal will allow for evaluation of settling however the time period over which it may occur could be in excess of five years and take place for potentially 25 years or more.

<u>DWQ Response to *Kuipers 3 (Process Solution and Post-Retort Draindown and Leachate Collection)*</u>

The following is a summary of the EPS capsule system and the safety factors as evaluated by DWQ that have been engineered into that EPS system.

- ET Cover – The ET cover system will be sloped so that any significant rain fall or snow melt will runoff the cover. The precipitation that does not runoff will be taken out of the system through evaporation and transpiration (evapotranspiration).
- Upper BAS Layer – Water that could work its way through the ET cover would then encounter a minimum 3 foot layer of BAS with a permeability of $1x10^{-7}$ cm/sec. This layer is also sloped to carry water away from the EPS capsule. Post-cooling the EPS capsule will be evaluated for settlement, especially differential settlement and if necessary a new 3 foot layer of BAS will be installed as part of the cover system. The EPS capsule will also be drilled and cored to see how the heating may have impacted the BAS layer.
- Spent Shale Retort Material – The heating of the oil shale will initially drive off all the water and then liberate the petroleum liquids drying the oil shale even further. After the capsule is completely cooled any moisture entering the capsule will be drawn into this very dry spent shale and leaching of this material would only take place when the moisture level is above the wilting point of the spent shale. The spent shale will also be analyzed to see if moisture in the system would actually leach any contaminants. Post-cooling the drilling and coring will evaluate the moisture retention and contaminate leach ability of the spent shale.
- Lower BAS Layer – Moisture that would be released from the ore would then encounter the lower BAS layer that again has a permeability of $1x10^{-7}$ cm/sec. Again the post-cooling coring will evaluate the condition of the BAS layer.
- Shale Layers Underneath the EPS Capsule – There are hundreds of feet of low grade oil shale under the EPS capsule that act as an aquiclude.

As shown by the bulleted items above there are numerous safety factors built in to the design of the EPS capsule.

And, as shown in Table 1 above, DWQ believes that the comparison to heap leaching has no merit or relevance to Red Leaf's operation and the conditions at this site. Red Leaf has shown that in the unlikely event that any discharge should occur, it will not be significantly different than what is already present in ground water beneath the site. This is consistent with the fact that Red Leaf is not adding anything whatsoever to the shale, see Table 1 above.

The discussion of "deleterious materials" is misplaced, as no such term is used or defined under R317-6. The appropriate relevant standard is whether an aquifer exits, the class of the water and the associated beneficial uses. Red Leaf has demonstrated satisfactorily that an aquifer does not exist immediately beneath the mine and that potential for contamination at the site is negligible.

Kuipers 4 (Post-Closure Sampling)

According to the draft public notice version of the Statement of Basis, Red Leaf will be required to obtain representative samples of spent shale, including hydrocarbons, and analyzed by the SPLP method. It is widely recognized that the SPLP method (ASTM D6234-98, EPA Method 1312, Standard Test Method for Shake Extraction of Mining Waste by the Synthetic Precipitation Leaching Procedure (SPLP)), which uses a 20:1 liquid to solid ratio, results in a highly dilute leachate. A more appropriate alternative method would be to use the MWMP method (ASTM-E2242-12a, Standard Test Method for Column Percolation Extraction of Mine Rock by the Meteoric Water Mobility Procedure (MWMP)). This test method provides a procedure for the column percolation extraction of mine rock in order to determine the potential for dissolution and mobility of certain constituents by meteoric water. This test method is intended as a means for obtaining an extract from mine rock samples. The extract may be used to estimate the final pH and release of certain constituents of the test sample under the laboratory conditions described in this test method. In addition, testing by the TCLP method (EPA Method 13, Toxic Characteristic Leaching Procedure (TCLP)) may also be appropriate. The TCLP method is used to determine if a waste is hazardous under RCRA. It is intended to simulate municipal landfill containing organic wastes. The TCLP is designed to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes.

Due to the undefined nature of the spent shale oil in terms of regulatory jurisdiction (e.g. RCRA applicability) we recommend that testing be performed on representative samples using SPLP, MWMP and TCLP methods. In addition it is important that separate samples representative of various areas and depths of the EPS be sampled and individually analyzed to determine variability within the EPS. A single representative sample of the EPS would not be representative of the capacity of various parts of the pile to contain and leach significant contaminants.

DWQ Response to Kuipers 4 (Post-Closure Sampling)

DWQ is uncertain that the MWMP provides meaningful additional information relative to this site. However, Red Leaf has agreed to perform it.

Kuipers 5 (Closure and Post Closure Management Plan)

No provisions for operational shut-down and subsequent drain-down and handling of petroleum containing liquids are contained in reclamation and closure information provided in the application. This is especially important in the case of an unplanned mine closure. The inclusion of interim fluid management, also referred to as emergency fluid management, is an integral reclamation and closure task common to mine sites recognized by the Office of Surface Mining, Bureau of Land Management, Forest Service and states such as Nevada and Montana. The typical tasks required include management *of process solutions upon operator bankruptcy resulting in the abandonment of the site to prevent discharge of those solutions, and involves the cost of manpower, equipment and materials involved in the management of those materials for a minimum of six months and in some cases three years or more.*

In the event Red Leaf Resources were to abandon the site during operations it is likely that the State of Utah would have to manage significant quantities of in-process solutions as well as immediate draindown solutions from the capsules. It is also likely that the State would eventually have to dispose of significant quantities of process solutions containing deleterious materials. Both of these tasks could result in significant cost to Utah taxpayers if the interim water management and fluid draindown tasks are not addressed in the reclamation and closure plan and associated costs are not covered by a bond for these activities.

DWQ Response to Kuipers 5 (Closure and Post Closure Management Plan)

Red Leaf is required to complete site reclamation by the Division of Oil, Gas and Mining, and a bond has been collected by that agency to insure site reclamation in case of an unplanned mine closure. Given our understanding of capsule performance, spent shale leachate characteristics and site characteristics at this time, DWQ has concluded that the reclamation required by DOGM is adequate to prevent discharge of contaminants to ground water.

To insure adequate reclamation as DWQ's knowledge of the Eco-Shale capsule technology grows with the experience of EPS capsule operation and closure, Part I.H.4 of the permit requires Red Leaf to develop reclamation plans that are protective of the quality of ground water and other waters of the state following the investigations into capsule performance and leachate chemistry required in Parts I.H.2 and I.H.3 of the permit.

It should be noted that operation of the EPS capsule will not involve process solutions. Permit conditions were developed under the assumption that Red Leaf would remove all liquid hydrocarbons that drain from the capsule from the site, for as long as they drain from the capsule. Permit language has been modified to require this.

Kuipers 6 (Conclusions)

Based on my review the following conclusions can be reached concerning the risks presented by the proposed capsule technology: (1) The new technology has only been demonstrated at a pilot scale and is technically and economically unproven as a commercially viable technology; (2) Given the history of similar endeavors in the mining and oil/gas industry it is highly likely that the project will prove to be uneconomic and could cease operations within 2-3 years of start-up or otherwise during the expected course of operations; (3) Given similar technological developments it is likely that initial efforts to capture and contain liquid petroleum containing products will not be successful as it is highly likely that unexpected forces will be exerted in terms of liquid head or saturation within the pile resulting in the additional potential for loss of liquid products containing deleterious materials outside the capsule, and; (4) The degree to which the retorting process might result in deformation or reaction with the capsule materials as well as the resulting settling of the pile makes long-term effectiveness of the containment questionable and short-term reclamation of the surface of the capsule difficult due to highly uneven surfaces requiring significant re-grading to accomplish positive drainage off the top surface of the reclaimed capsules.

The capsule proposal is without precedence from an engineering standpoint and therefore has inherent risks. It is not known how a three-foot thick bentonite liner will perform under the proposed conditions. We know how a six or twelve inch liner used for heap leaching or municipal waste disposal (e.g. landfill) might behave under much less rigorous conditions and know that failures are typically very site or incident specific. This means reliance on preliminary analysis rather than site-specific data is likely to lead to underestimation of failures, and that processes which exert more demands, such as those involving heat and pressure, would be more likely to result in failures. How a three-foot thick liner used in retort conditions with heat and pressure might behave in terms of fluid containment over the short or long-term, is as much dependent on the oil and gas retorting process, which is also novel in this case, as it is on the novel liner itself in this specific application.

My best professional judgment is that because this is a novel concept involving significant chemical and physical demands upon the proposed BAS containment system there is a high likelihood there will be significant failures resulting in release of deleterious materials. And while construction of the Early Production System could answer many of those questions, the company does not propose to take the necessary step of doing post-decommissioning excavation of the capsule and require installation and monitoring of a secondary leachate collection system in order to allow for direct examination in order to determine how the BAS liner has performed. Without this essential step, there is no assurance that the BAS liner integrity, metal sheet design, seal designs, and post-operation settlement of the EPS will perform to similar expectations in a commercial application. In addition site-specific data should be gathered and used to evaluate stability and other aspects of the proposed design.

DWQ Response to Kuipers 6 (Conclusions)

The conclusions are irrelevant due to site conditions or are unfounded due to an erroneous comparison of Red Leaf's operation to a heap leach facility; see Table 1 above, sections I.D and E and response to comments (Kuipers 1-5 above) and others.

Lips 1

The Utah Ground Water Quality Protection Rules require that an application for a ground water discharge permit contain geologic and hydrologic descriptions including aquifers, ground water flow direction, ground water quality, aquifer material, and well logs (R317-6-6.3 (E)). In addition the rules require a description of the ground water most likely to be affected by the discharge, including water quality information of the receiving ground water prior to discharge, a description of the aquifer in which the ground water occurs, the depth to the ground water, the saturated thickness, flow direction, porosity, hydraulic conductivity, and flow systems characteristics (R317-6-6.3 (K)). Red Leaf's Application does not contain, and the permit does not require, this information. The Application documents the presence of ground water in wells and nearby springs, however, the scant information in the Application fails to provide complete and accurate descriptions required by the Ground Water Protection Rules.

DWQ Response to Lips 1

Please see Section I.C. for DWQ's response.

Lips 2

Sandstone layers in the lower portions of the Parachute Creek Member or the upper portions of the Douglas Creek Member are the layers likely containing ground water immediately below the mine site and would be the first to be impacted by the mining and retorted operations. The Application contains numerous references to the Douglas Creek Member that contains layers of sandstone, or to porous rocks at depths as shallow as 20 to 55 feet below the Mahogany Zone, which indicates that the geologic units potentially containing ground water are close to the bottom of the pits. The Application must, therefore, contain information on aquifers in these layers.

The Application identifies the Douglas Creek at a depth of approximately 55 feet below the Mahogany Zone (Fig. 5). The Texaco Seep Ridge Unit #2 well, less than 2 miles west of the Red Leaf Leases reports the Douglas Creek Member 49 feet below the Mahogany (Application, pg. 13). The Application (Fig. 6) shows sandstone/mudstone in all six drill holes at depths between 20 and 60 feet below the Mahogany Zone. The NOI reports that the first porous unit occurs approximately 50-100 feet below the Mahogany Zone in the Douglas Creek indicating the potential for groundwater in the area of the proposed mine (pg. 42).

The presence of a sandstone layer beneath the project area was confirmed in the fall of 2012 when Red Leaf installed six monitor wells to assess ground water conditions. The Application (pg. 24) states "[E]ach boring was drilled to the unnamed sandstone unit that occurs beneath the B Groove. This unit was selected because it is present beneath the entire project area…" Figure 8 shows that the wells were drilled to depths ranging between 20 and 55 feet below the Mahogany Zone, thus confirming that a continuous sandstone layer is present immediately beneath the zone to be mined.

Most importantly, the Application (pg. 24 and Fig. 8) notes that five of the six monitor wells encountered water in the lower part of the bore holes (one hole was not completed below the Mahogany Zone).

Having identified the presence of an aquifer as close as 20 feet below the proposed mining and retorting operations, the Application should, but does not, contain a description of this aquifer, including water quality information, the saturated thickness, flow direction, porosity, hydraulic conductivity, and flow systems characteristics1.

<u>DWQ Response to Lips 2:</u>

There is no evidence of any aquifers in these sandy layers, nor is there any reason to suspect there may be. Water encountered in the lower parts of the five deep holes was determined to have entered the bore holes from the shallower parts of the wells during or shortly after well completion. Recharge tests from the Mahogany Zone of these wells were attempted, but they failed to recharge after withdrawal of water standing in the well. The completion zones of the five deep wells included the upper part of the sandstone bed mentioned by WRA. As cited above, this sandy layer has low primary porosity and is protected from recharge by fine-grained strata (low-grade oil shale) above and below it. Ground water encountered in Red Leaf's monitor wells is contained within the Parachute Creek Member oil shales, and is highly saline with a different isotopic composition than local precipitation. There is no evidence that this water circulates through the rocks it is contained in. These occurrences of ground water do not represent an aquifer in any sense of the definition.

<u>*Lips 3*</u>

The Application briefly discusses a seep and spring inventory that was conducted in Fall 2012 (pg. 23 and Appendix D). Surprisingly, the Application completely fails to incorporate any information from the Supplemental Seep and Spring Inventory conducted in May 2013. This omission is egregious because the May 2013 inventory in many ways corrected or provided critical information that was missing from the Fall 2012 inventory. For example, the May 2013 inventory noted in the, "several areas marked as potential seeps were verified to be springs[,]…that seeps inventoried in October 2012 should now be classified as springs in May 2013[, and that] some of the smaller, previously identified individual springs were, in fact, larger springs that were part of gaining/losing systems." (May 2013 Inventory, pg. 6).

In fact, the May 2013 inventory documented the presence of numerous springs in the vicinity of the proposed operation. Two of these springs show appreciable amounts of water – Klondike Canyon Spring-01 at 0.42 gallons per minute; Reservoir Canyon-01 at 0.52 gallons per minute – and all of the springs have less than 3,000 mg/l total dissolved solids thus qualifying for protection as Class II Drinking Water Quality Ground Water under the Ground Water Quality Protection Regulations. See R317-6-3.5. The springs identified in May 2013 flowed intermittently at the surface for up to 3,900 feet, supported riparian vegetation, and showed evidence of wildlife use.

The May 2013 inventory failed to document the geologic occurrence for all but one of the springs; rather only noting that each was a spring that issued from "an interface between alluvium and the Parachute Creek Formation [sic].." In fact, three of the springs (Klondike Canyon Spring-01, Reservoir Canyon Spring-02, Reservoir Canyon Spring-03) are in areas mapped as the Douglas Creek Member of the Green River Formation on the geologic map in the Application (Fig. 4).

Regardless of this inaccurate information regarding the correct member of the Green River Formation, the Application does not contain any geologic and hydrologic descriptions of the aquifers from which these springs emit, or the ground water flow direction and aquifer materials. The question left unanswered by both the Application and the SOB is what constitutes the source of the water that feeds *the springs noted in the May 2013 inventory, and what is the significance of the finding that eight individual springs exist down gradient of the mine site. Specifically, the question of whether those springs could be impacted by the mine must be answered. In contrast to this, the SOB fails to discuss or incorporate into the basis for the permit the results of the May 2013 inventory and completely mischaracterizes the importance of the findings, the extent of the water and the level of TDS emanating from the water sources (SOB, pg. 5).*

<u>DWQ Response to Lips 3</u>

The USGS geologic map in Figure 4 of the application designates the contact between the Parachute Creek Member and the Douglas Creek Member as the first sandy bed below the Mahogany Bed oil shale and the B Groove layer. Areas mapped as the upper Douglas Creek Member in Figure 4 are in the lower part of the Parachute Creek Member, as explained above, and do not represent the outcrop of the sandstones that form the Douglas Creek aquifer, which are several hundred feet deeper in the section and isolated from these upper sandy beds by several zones of oil shale. The first aquifer encountered in Red Leaf's water supply well was over 600 feet below ground surface, much deeper than the upper sandy beds.

The sandstones that form the Douglas Creek aquifer do not crop out in the area surveyed for springs and seeps, and the personnel from JBR Consultants who conducted the survey followed the Utah Geological Survey interpretation of the Parachute Creek-Douglas Creek contact, thereby designating the bedrock in the area of the springs and seeps to be the Parachute Creek Member.
The permit application, p. 23 states:

> The observed geological occurrence of the single spring and most seeps was discharging or potentially discharging stream bed material, which was comprised of alluvium, residuum or both.

In addition, Red Leaf has demonstrated that such ground water that exists in the Parachute Creek Member (the bedrock in most of the survey area) is highly saline and contained in rocks with very low hydraulic conductivity. The relatively low levels of dissolved solids contained in springs in the survey area are best explained by these springs representing ground water flow from the surficial deposits. Although these deposits have eroded from the Parachute Creek Member, salts have been removed from them by weathering. The levels of dissolved solids in these springs, approximately 3000 mg/l, are a result of this weathering process. Seeps flowing from shale partings in bedrock represent places where ground water from the surficial deposits has penetrated to shallow levels in the upper, weathered portion of the bedrock. As cited above, the low hydraulic conductivity and highly saline water contained deeper in the bedrock are evidence against a ground water flow system that penetrates deep into the bedrock.

Red Leaf's EPS capsule will be built directly on top of un-weathered bedrock at the bottom of a mine pit. Any discharges at the site of the capsule would not affect ground water in the surficial deposits. Monitoring of springs and seeps that issue from the surficial deposits or from weathered bedrock immediately underlying them is not necessary to meet the requirements for permit issuance from UAC R317-6-6.4A for the EPS capsule.

Lips 4

In the discussion of impacts of leachate being discharged from the capsule, the SOB states "Available information suggests that such leachate would have levels of dissolved contaminants that are comparable to or less than the existing ground water in the underlying rocks." (pg. 7) In essence, DWQ is saying that the basis for the permit is that it doesn't matter if the capsule discharges leachate, because of the poor water quality in the underlying aquifer. This justification for issuing a permit is fundamentally flawed because the water quality data in the Application do not represent the aquifer underlying the mining and retorting operations.

Red Leaf collected samples and analyzed ground water quality from the deep monitor wells (Application, pgs. 25-26). The results of the laboratory analyses indicated that these samples had high total dissolved solids (TDS values between 9,020 mg/l and 58,600 mg/l) and isotopic signatures representing long residence time.

The critical question is which aquifer does this high TDS water represent. Figure 8 of the Application shows the total depth of the monitor wells and information on how the wells were completed, including screened intervals, and zones that were backfilled with sand and bentonite. Sand backfill is extremely porous and will allow any water that flows into the bore hole to flow into the screened interval of the monitor well.

Examination of Figure 8 reveals that all of the deep wells were completed within either the screened interval and/or with sand pack that extended into the Mahogany Zone. Thus, the water samples that were collected and analyzed from these monitoring wells contain water that came from multiple geologic layers and their corresponding aquifers. Unfortunately, because of the way the monitor wells were completed, it is not possible to determine if the high TDS water was from an aquifer in the Mahogany Zone, or from the aquifer in the continuous sandstone layer that is present a few tens of feet below the Mahogany (see discussion above in Section 2.1).

Because Red Leaf did not complete the monitor wells in a manner that isolated the aquifer below the proposed mining and retorting operations, there is no basis for any statements regarding "[t]he existing ground water in the underlying rocks." (SOB, pg. 7). The Application contains no data that represents the water quality of the aquifer in the underlying rocks. Thus, DWQ is not justified in its comparison of water quality in the leachate to water quality that could be impacted– and this cannot be a basis for issuing the permit.

DWQ Response to Lips 4:

Again, this comment wrongly assumes there are "aquifers" underlying the EPS capsule site at shallow depths, when there is no evidence that any aquifers exist above the Douglas Creek aquifer tapped by Red Leaf's water supply well, at depths of 630 and 830 feet below ground surface (SOB, Part III.2). In particular, there is no evidence that the sandy bed below the Mahogany Zone is an aquifer, and significant evidence that it is not. In outcrop (Novak 2012, Photo 5), it has significant carbonate content and its thinly-bedded (fissile) appearance indicates a significant content of fine-grained material and naturally occurring hydrocarbons, i.e. kerogen, as well. It is overlain and underlain by oil shales with low permeability that prevents water from recharging into it. Examination of drill cores through this interval show that it is partly saturated with bitumen, further decreasing its porosity and permeability (Memo from Steven Kerr to Jay Vance, November 7, 2013).

Because the stratigraphic interval below the B Groove is composed primarily of oil shales, which were deposited in an environment similar to the Mahogany Zone and which have similar hydrogeologic properties, there is no reason to suspect any ground water that may occur in these rocks would have significantly better water quality than that observed in the Mahogany Zone.

<u>Lipps 5</u>

The Application states that the mine operation is designed to be a zero-discharge operation (pg. 11). This claim is based on Red Leaf's assumption that the capsules will be constructed with an "impermeable liner" (pg. 4) and that "water will not enter the hydrocarbon recovery zone of the capsules" (pg. 8). The Application further states "the process capsules are designed to prevent both infiltration of precipitation-derived water into them and discharge of fluids from them" (pg.11).

In fact, the seepage analysis conducted by Red Leaf contradicts this assumption and shows that a significant amount of water from precipitation will infiltrate through the upper BAS layer (Appendix K). Red Leaf ran several analyses, including a base case that assumes a vegetated cap as designed; and a case that assumes bare ground, i.e. no vegetation. The results identify a rate of seepage through the upper BAS layer of 1,683 gallons per year per capsule for a reclaimed capsule and 73,772 gallons per year for a non-vegetated capsule.

The analysis performed by the company assumes that there will be a uniform hydraulic conductivity of 1x10-7 cm/sec across the entire surface of the capsule. However, if the permeability isn't uniform because there are defects or cracks in the BAS layer, the seepage of meteoric water into the processed ore zone will be several orders of magnitude higher than modeled.

Further, the 1,683 gallons per year per capsule is the minimum amount of water that could seep through the BAS and this number is likely to be greater for three reasons. First, Red Leaf ran the model for 30 years and reported the average seepage for that time period. However, seepage in the first few years, in layers at depth would be very low to zero. It takes a few, perhaps up to 10-15 years for all the overlying material to reach field capacity and for equilibrium to be reached. At that point the seepage through the BAS would be fairly constant. The normal procedure for reporting seepage results from the HELP model is to only report the values after equilibrium has been reached, not the average for the all the years. Thus, Red Leaf has skewed the results to show a lower seepage through the BAS.

Second, as stated in the Application (pg. 8), the reclaimed surfaces of the capsules will be regraded in order to reduce surface runoff and erosion. This will necessarily increase the amount of precipitation that will infiltrate into the ground and ultimately through the BAS. Red Leaf does not explain how this was accounted for in the HELP model.

Third, the base case assumes that the vegetation has been established. However, it may take a few years for this to occur, and in those years, infiltration will be significantly higher. Red Leaf does not explain how this was accounted for in the HELP model.

In my opinion, the water that infiltrates through the upper BAS layer will also infiltrate into and through the processed ore. Underlying the upper BAS layer will be 13 feet of gravel that Red Leaf has assumed to *have a hydraulic conductivity of 1x10-1 cm/sec. Water will easily run through this layer into the processed ore. The processed ore is assumed to have a hydraulic conductivity of 1x10-4 cm/sec, so water will easily run through this material as well. There is no analysis in the record of the seepage of water into or through the processed ore, nor an evaluation of the seepage of water through the lower BAS layer.*

Red Leaf has clearly demonstrated that the upper BAS layer is not impermeable and that a significant amount of meteoric water will flow through it. Given that the gravel layers and spent ore are several orders of magnitude more permeable, it is axiomatic that water will flow through these layers as well. Any water that accumulates at the base of the capsules will similarly flow through the lower BAS layer, because, like the upper BAS layer, it will not be impermeable.

DWQ recognized that the HELP modeling conducted by Red Leaf was inadequate to answer the questions of how much water will infiltrate into the capsules, and importantly, how much water will percolate through the spent ore and the lower BAS layer. On February 12, 2012, DWQ explicitly stated that the application should provide justification for several model inputs and additional HELP modeling that: 1) considered long term performance of the waste containment (longer than the 30 years evaluated by Red Leaf), 2) evaluated the time for the spent shale to reach field capacity, at which time it could possibly discharge leachate, and 3) evaluated scenarios where the upper BAS layer and capping materials have been removed by erosion.

Red Leaf failed to conduct the analysis that DWQ stated were necessary to address their concerns related to the long-term management of the spent shale. The Application contains no additional HELP modeling performed by Red Leaf. Apparently in an attempt to address these critical issues raised by DWQ, the Application contains a Technical Memorandum from Robert Bayer dated May 30, 2013 (Appendix L). However, this memorandum completely fails to address the long-term management of the spent shale, the performance of the bottom BAS, or discharge of leachate from the capsules. Furthermore, because of fatally flawed assumptions, the memorandum fails to even address its stated objective of determining the time necessary for the lower part of the EPS capsule to reach field capacity, and thus provides no useful information regarding discharge of leachate from the capsule.

In my professional opinion, the performance of the capsule is one of the most critical issues regarding protection of ground water from the proposed Red Leaf operations. It is imperative that the Application provides a thorough and accurate evaluation of the potential for leachate to be discharged from the capsule. This evaluation can be accomplished with modeling that is conducted to the standard of practice for a project of this magnitude and complexity. The Application does not contain such modeling and evaluation, and DWQ has failed to follow through on their original requirement that it does. There is no justification for allowing Red Leaf to perform the modeling and evaluation after the EPS is constructed. As it stands, the Application does not contain, and the permit does not require, complete and accurate information that shows that the discharge can be controlled and will not migrate into or adversely affect the quality of waters of the state as required under R317-6-6.3(G).

DWQ Response to Lips 5:

Red Leaf's ground water discharge permit application may have represented the capsule design as a "zero discharge" facility but the permit is not based on a zero-discharge design for the EPS capsule. Rather, site conditions and what is known about the nature of the potential discharge justify considering the proposed design for the EPS capsule to be Best Available Technology in this particular case. Red

Leaf's design is appropriately protective for these conditions and DWQ's approval of it is conservative, taking into account that there are some unknown factors of the new technology and the anticipated opposition to shale extraction projects. DWQ's request for additional modeling studies was made when Red Leaf was still seeking a ground water discharge permit to cover the entire anticipated mining operation. The current plan to construct a prototype capsule, however, will allow for studies based on actual performance of the capsule and not just modeling based on assumed values for parameters used in the model.

Requirements for studies on the EPS capsule are listed in Part I.G of the ground water discharge permit. Part I.G.3 requires Red Leaf to evaluate the hydraulic conductivity of the upper BAS liner, including sections that were constructed differently or which underwent mechanical strain due to compaction of the underlying oil shale ore during retorting. Red Leaf shall also evaluate hydrologic properties of the spent shale and other components of the EPS capsule in order to model water flow through the capsule using actual measured values for the parameters used by the model and not estimated values. The goal of this modeling will be to estimate the volume of water needed to bring the capsule contents (and contents of future production capsules) to field capacity, and the time needed for this volume of water to infiltrate the capsules in the site's climate.

Again, DWQ is satisfied that the most important factors regarding protection of ground water in this case are the nature of the facility and the site conditions. The capsule contents will always be under unsaturated conditions and significant hydraulic head will not build up on the lower BAS liner. If some small flux of leachate does bypass the metal collection pan and migrate through the lower BAS liner, rocks underlying the capsule have very low permeability. The first aquifer underlying the site is over 600 feet below ground surface and is under confined conditions with an upward hydraulic gradient.

The justification for allowing Red Leaf to model liner and capsule performance is that such modeling is not as important as WRA represents because of the site conditions, and also that modeling based on hydrologic parameters that are actually measured in a constructed capsule will be superior to using estimated values. It is DWQ's intent to apply the results of this modeling to develop permit conditions if the capsule technology is used at other sites in the future.

Lips 6

Because the Application does not contain complete and accurate information showing that the discharge can be controlled and will not migrate into or adversely affect the quality of waters of the state, as required by R317-6-6.3(G), Red Leaf can and should conduct monitoring to determine the impact of the mine on ground water resources. Additionally, the ground water permit makes the incorrect statement that "[g]round water monitoring is not feasible at the site due to the impermeability of the shales that underlie it."

DWQ Response to Lips 6:

Mr. Lips contention that ground water monitoring is necessary or that source monitoring is insufficient at the Red Leaf site is unsupported and without basis. The permit requires source monitoring of any leachate that may collect on the metal pan within the capsule and the upper surface of the lower BAS liner. This source monitoring will detect any problems with leachate discharge long there is a discharge to ground water because of the very low permeability of the rocks underlying the capsule. Ground water monitoring is not necessary because the highly saline nature of ground water observed in these rocks is evidence that it does not circulate and potential discharge from the capsule would not necessarily report to a monitor well. In addition, ground water monitoring would be very unlikely to detect the influence of leachate in highly saline ground water containing dissolved hydrocarbons such as that observed in Red Leaf's monitor wells. Also, the Douglas Creek Aquifer is many hundreds of feet below the mine site, overlain by impervious and uneconomic oil shale, and therefore naturally protected by site conditions. Therefore, requiring source monitoring but not ground water monitoring is rational.

Lips 7

Red Leaf recognized during the drilling of the monitor wells that a continuous sandstone layer exists across the entire project area at a depth of a few tens of feet below the mine. Furthermore, they identified water in the bottom of the drill holes that extended into this layer. Unfortunately, Red Leaf did not complete the monitor wells in a manner that would allow for sampling and analysis of the water quality in this aquifer. Red Leaf should install new monitor wells that collect data that describe hydrologic descriptions including ground water flow direction, ground water quality, aquifer material, water quality information, the saturated thickness, porosity, hydraulic conductivity, and flow systems characteristics of this aquifer. Water quality monitoring in these wells should be used to establish baseline conditions and monitoring should continue as a permit condition.

In addition, because Red Leaf identified eight springs down gradient from the mine site and neither Red Leaf nor DWQ have made any attempt to explain the significance of these springs, where the water is coming from and whether they can be impacted, Red Leaf should monitor these springs to determine whether they will be impacted by the mining operation.

The Application should contain a description of all compliance monitoring points, ground water monitoring to determine ground water flow direction and gradient, and the quality of ground water at the compliance points. These compliance monitoring points should be established and data collected before Red Leaf conducts any mining operations in order to establish background conditions. The Application should also contain a description of: 1) the installation, use and maintenance of monitoring devices; 2) monitoring of the vadose zone; 3) measures to prevent ground water contamination after the cessation of operation, including post- operational monitoring; 4) a description and justification of parameters to be monitored; and 5) quality assurance and control provisions for monitoring data.

DWQ Response to Lips 7:

There is no evidence of any aquifer in the subsurface above the strata tapped by Red Leaf's water supply well, over 600 feet below ground surface. Provisions from R317-6-6.3 that WRA cites here as being necessary for this permit were intended for permitting cases where monitoring an aquifer underlying the permitted facility is the primary means of demonstrating that the conditions in Rule 317-6-6.4A are met. That is not the case for this permit, and the DWQ has discretion to omit these requirements.

Mr. Lips' contention that Red Leaf did not properly complete the deep monitor wells is also without basis. The sandstone bed was known to be non-water bearing prior to well installation based on the results of holes and observations of the drill core. The sandstone bed was selected as an easily identified "marker" to enable each well to be drilled to the same stratigraphic horizon.

Also as presented above, there is no evidence for a deep, regional, bedrock ground water flow system that would be affected by discharge from the EPS capsule. The springs cited by WRA do not discharge highly saline ground water as encountered in Red Leaf's monitor wells. All evidence shows that these springs represent discharge from a shallow system contained in unconsolidated surficial deposits and weathered bedrock. The EPS capsule and any future capsules would be constructed on bedrock at the base of the Mahogany Zone in a mine pit. Any discharge from the capsules would be to bedrock of very low permeability at an elevation below the land surface, and in the case of the EPS capsule at least, such discharge would not affect water in the saturated surficial deposits.

Lips 8

DWQ recognizes that there are uncertainties related to the ground water protection, capsule performance, and site conditions (SOB, pg. 7). Given this uncertainty, it is incredulous that DWQ proposes to issue this permit without a Sampling and Analysis Plan. Rather, DWQ, without explanation or justification, only requires Red Leaf to submit a Sampling and Analysis Plan no later than the date that heating pipes in the capsule are shut down (Permit, pg. 6).

DWQ Response to Lips 8:

The justification for allowing Red Leaf to submit a Sampling and Analysis Plan no later than the date that the heating pipes in the capsule are shut down is that Red Leaf will design and install the sample ports to be used for collecting any potential leachate from the EPS capsule's metal collection pan and the top of the lower BAS liner around the time of capsule closure. They cannot submit a sufficiently detailed Sampling and Analysis Plan that includes proper use of these ports before the detail is known. The delayed submission of the Sampling and Analysis Plan will not compromise the consistency of the monitoring over time. Nor will the delayed submission compromise the continuity of sampling methodology even if different personnel conduct the sampling over time. Moreover, allowing delayed submission of the Sampling and Analysis Plan is administratively efficient because otherwise Red Leaf would likely be required to submit a revised Sampling and Analysis Plan after the necessary detail is known and the revised Sampling and Analysis Plan would then have to be reviewed and approved by the DWQ. Finally, a delayed submission will not be less protective of ground water because the capsule will contain a stack of spent shale approximately 100 feet in thickness that will be extremely dry after being heated to over 700° F, and it will be capped by a liner that is the functional equivalent of three feet of material with hydraulic conductivity of 1×10^{-7} cm/sec. Leachate will not form before shut down of the capsule heating system, and very likely not for a significant time thereafter. For all of these reasons, the delayed submission is reasonable.

Lips 9

The Permit Compliance Monitoring, Reporting Requirements, and Compliance Schedule are incomplete and insufficient to assess impacts from the proposed mining and retorting operation. The purpose of the monitoring and reporting should be to detect problems early and address them with prompt and appropriate actions. First, the monitoring schedule should be modified to reflect monitoring sooner than beginning six months after shutdown of the retorting operations. Second, the monitoring from the tunnels should be initially conducted bi-weekly (not biannually) until it is demonstrated that there is not discharge of leachate from the capsule. Third, monitoring reports should be submitted within 30 days of data collection and laboratory analysis, not semi-annually or annually after the shut down of heating. Fourth, the Permit makes several references to the term of the permit; however, the term of the permit is not established for this EPS capsule. Fifth, DWQ fails to state how any of the data submitted will be analyzed in order to guide decisions as to whether or not to cease operations of the EPS. For example, if monitoring shows that a discharge of leachate is occurring, what will DWQ do?

DWQ Response to Lips 9:

DWQ is satisfied given the nature of the EPS capsule that leachate will not flow from the capsule so soon after shutdown nor in quantities large enough to justify the proposed monitoring schedule. Bringing the capsule contents to field capacity, which would be necessary before there could be discharge of leachate to the monitoring ports, will take a significant amount of time after capsule closure. There is no need for a more frequent monitoring schedule immediately after capsule closure. If, in the future, there is significant discharge of leachate through the monitoring ports, the monitoring frequency could be changed as a minor permit modification, at permit renewal, or as part of a major modification to the permit if Red Leaf decides to go into commercial production. Data submitted for compliance monitoring will not be used to guide decisions on ceasing operations of the EPS because leachate formation and compliance monitoring will only happen after the EPS capsule is shut down. In the unlikely event that the additional data collected as required by this permit reveal that leachate discharge may be a significant threat from capsules of this design, the results will allow DWQ and Red leaf to consider other ways in which it may be managed such as by requiring a more impermeable design for the upper liner cap.

Ground water discharge permits are issued for a five-year term and must be renewed at the end of that term.

Lips 10

The method of recovering hydrocarbons from oil shale described in the Application is a new concept that has never been demonstrated at the scale that Red Leaf proposes. Red Leaf has modified their original Ground Water Discharge Permit Application to only include one test capsule, called the EPS capsule. Among other stated objectives of the EPS, the purpose of this test capsule is to evaluate capsule containment effectiveness (Application, pg. 5). DWQ considers the evaluation of the capsule as the first reason for the basis for permit issuance -"The issuance of this permit is part of an evaluation phase that will be used to test assumptions and factors related to ground water protections, capsule performance and site conditions that are still not completely known." (SOB, pg. 7). Furthermore, the Permit states, "Red Leaf intends to use this EPS capsule to evaluate design features related to waste containment." (Permit, pg.2). In plain language, neither Red Leaf of DWQ knows if the capsule design, particularly the BAS will contain leachate, and if not, what the impacts to ground water will be.
Given this uncertainty, along with the documented presence of ground water immediately beneath the proposed mine, the numerous springs down gradient of the mine, and Red Leaf's modeling results that show that the BAS is no impermeable, it is imperative that this EPS capsule be constructed on a liner system that can effectively contain any leachate that does discharge. DWQ should only issue a permit for this EPS capsule if it is constructed on a liner system that consists of an HDPE (or equivalent) liner and a leak detection and leachate recovery system between the capsule and the HDPE liner. A liner system of this type will provide the best available technology for protecting waters of the state.

In addition, the presence of leachate with this type of liner system will be detected in a time period that will allow DWQ to make informed decisions before permitting a full-sale operation that Red Leaf proposes. While monitoring of ground water in wells and in nearby down-gradient springs is necessary, the time that might be required for leachate to reach these source may be long enough that DWQ would, it no contamination were detected, incorrectly assume that no leachate was discharged. However, the *response time for detecting discharge of leachate could be reduced to a few days or weeks with the use of a HDPE and leak detection and leachate recovery system.*

In my professional opinion, the uncertainty regarding this untested capsule design, and the documented presence of aquifers that are likely to be impacted, required that the PES capsule be constructed on a liner system that is both protective of waters of the state, and provides a reliable means of evaluation the performance of the capsule.

<u>DWQ Response to Lips 10</u>

DWQ is satisfied as to the absence of aquifers at shallow depths under the EPS capsule site, any threat to ground water posed by leachate and also the amount of time required for leachate to form and discharge from the capsule.

Under the permit conditions, Red Leaf will monitor drainage from the metal collection pan within the capsule and from the top of the lower BAS liner. The extremely low probability that leachate would bypass these collection points without being detected and migrate through three feet of liner with hydraulic conductivity of 1×10^{-7} cm/sec while under little or no hydraulic head does not justify requiring construction of a leak detection system. This is particularly the case when bedrock underlying the capsule is fine-grained shales and oil shales with lithology similar to that in the ore zones (Novak 2012), and rocks in the ore zones have hydraulic conductivities, as measured in Red Leaf's recovery tests in its monitor wells, ranging from 1.42×10^{-7} cm/sec to 9.52×10^{-7} cm/sec (Application p. 25).