



# Department of Environmental Quality

*To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.*



Matthew H. Mead, Governor

Todd Parfitt, Director

July 8, 2014

**RE: Response to Public Comments: Groundwater re-classification and proposed aquifer exemption - Line Energy Underground Coal Gasification (UCG) Research and Development (R&D) Gasifier 6 Project, Campbell County, Wyoming**

Dear Concerned Citizen,

Please accept my appreciation for your attending and providing public comment at the Wyoming Department of Environmental Quality's (DEQ) public hearing in Wright, WY on March 26, 2014 regarding the Water Quality Division's (WQD) re-classification of groundwater and proposed aquifer exemption associated with the Linc Energy's UCG Gasifier 6 Project. It is obvious that the protection of groundwater is an important issue to you and others who rely upon this resource for their livelihood; it is an equally important issue to this agency, as well. Please know that your comments were given careful and deliberate attention by the DEQ.

The WQD's role in this process is to determine whether 1) the proposed horizontal and vertical extent of the proposed exempted area of the Wyodak aquifer associated with the project can be re-classified as a Class V (Mineral Commercial) Groundwater of State for the purpose of mineral production, and 2) the proposed area to be exempted (by the US Environmental Protection Agency (EPA)) as an Underground Source of Drinking Water (USDW) satisfies the federal requirements for exemption (see Response to Comments: Topic 1). It is important to note that Land Quality Division's issuance of a Research and Development License to Linc Energy for this project considered and requires, among other things: hydrostatic control in order to maintain all potential contaminants within the burn cavity and to prevent contamination of overlying or underlying aquifers; groundwater restoration to achieve pre-operation baseline groundwater conditions, and; pre- and post-restoration groundwater monitoring. Additional similar projects proposed by Linc Energy will require both an additional permit from LQD, an additional aquifer exemption (when injection into a USDW is involved), and additional opportunity for public comment.

The department has developed and is providing its responses (attached) to comments that are related, either directly or indirectly, to WQD's re-classification of groundwater and proposed aquifer exemption. These responses have been categorized into topics that were common to several commenters. Comments that did not relate to the re-classification of groundwater and proposed aquifer exemption were not addressed.

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In consideration of the above, and upon careful review of the comments received the WQD finds no basis to modify its determination that re-classification of the proposed exempted area is consistent with the regulatory definition of Class V (Mineral Commercial) groundwater, and that the proposed exempted area satisfies the federal requirements for exemption. Consequently, WQD has requested that EPA proceed with its review and approval of the proposed aquifer exemption. It is our understanding that EPA's decision should be forthcoming in approximately 20 days. Upon receipt, EPA's response letter will be posted to WQD's webpage (below).

A copy of the comments, responses to comments, and WQD's submittal to EPA of these and other materials related to its groundwater re-classification and proposed aquifer exemption for this project are posted on WQD's 'Current Events' webpage at <http://deq.state.wy.us/wqd/events/index.asp>. A copy of the public hearing transcript is available for review at WDEQ's offices in Cheyenne and Sheridan, or may be obtained from Wyoming Reporting Service (1-800-444-2826).

Again, I would like to thank you for your time to attend the public hearing in Wright and for your written and oral comments on WQD's groundwater reclassification and proposed aquifer exemption.

Sincerely,



Kevin Frederick, Administrator  
Water Quality Division

KF/rm/14-0594

Attachment: Response to Comments

cc: Todd Parfitt, Director  
Nancy Nuttbrock, Administrator, WDEQ Land Quality Division  
Mark Thiesse, Manager, Groundwater Section  
Don Fischer, WQD, Sheridan  
Jeremiah Williamson, Asst. Attorney General, WY Attorney General's Office  
Brian Deurloo, General Manager, Linc Energy Operations, PO Box 789, Glenrock, WY 82637  
Douglas Minter, Acting Chief, UIC Unit, EPA Region 8, Denver, CO 80202



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**Wyoming Department of Environmental Quality  
Water Quality Division/Groundwater Section  
Underground Injection Control Program  
Review Comments: Plans/Specifications/Proposals/Reports**

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**Project Type:** Response to Public Comments: Statement of Basis, Wyodak Coal Aquifer Exemption

**Facility Name:** Underground Coal Gasification R&D License Application

**Facility Operator:** Linc Energy Wyoming

**Facility Location:** Campbell County, Wyoming NW1/4, Section 36, Township 44 North, Range 74 West

**Date:** June 24, 2014

**INTRODUCTION:** The Wyoming Department of Environmental Quality, (WDEQ) Water Quality Division (WQD) conducted a public hearing in Wright, WY on March 26, 2014 to collect public comments on the "Statement of Basis, Wyodak Coal Aquifer Exemption" (License Application Section 13.14 Appendix D-12) that was submitted to the US Environmental Protection Agency (EPA) for approval. The WQD responses to the oral and written public comments that were received by the department are addressed below. The WQD responses have been grouped into major topics based upon the environmental concerns presented.

**Topic 1: Pre-Mining Groundwater Quality:**

**Example of Comments:**

*"DEQ failed to consider groundwater quality before making a decision."*

*"DEQ's groundwater classification process is not clear."*

*"And then I was confused as to the exemption and the requirements after reclamation that they'll reclaim to the same class prior. Does that mean that they reclaim to the class that's been exempted?"*

*"Water is currently used as stock wells proximal to project".*

## **WDEQ Response to Comments on Pre-Mining Groundwater Quality:**

40 CFR §146.4, Criteria for Exempted Aquifers states: “An aquifer or a portion thereof which meets the criteria for an “underground source of drinking water” in §146.3 may be determined under §144.7 of this chapter to be an “exempted aquifer” for Class I-V wells if it meets the criteria in paragraphs (a) through (c) of this section. Class VI wells must meet the criteria under paragraph (d) of this section:

(a) It does not currently serve as a source of drinking water; and

(b) It cannot now and will not in the future serve as a source of drinking water because:

(1) It is mineral, hydrocarbon or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible.

The licensee has met the requirements of the state regulations for a mineral commercial groundwater reclassification and the WDEQ has submitted the request for the aquifer exemption to EPA for approval. Based on the groundwater data submitted to date, the pre-discharge use suitability of the groundwater has been determined by WDEQ to be Class III (livestock use). This classification is based upon the WDEQ groundwater classification process stated in Wyoming Water Quality Rules and Regulations (WQRR) Chapter 8, Section 4. The groundwater was then re-classified to Class V (mineral commercial) based upon data submitted in the license application and applicable state and federal regulations and guidance.

In accordance with WQRR, Chapter 8, Groundwaters of the State are classified in order to apply standards to protect water quality. The groundwater classifications are Class I (domestic use), Class II (agricultural), Class III (livestock), Class IV (industrial), Class V (mineral or hydrocarbon commercial), and Class VI (unsuitable for use).

No domestic water supply wells are located within ¼ mile of the proposed aquifer exemption boundary. No water supply wells are located within the aquifer exemption boundary.

Even though the aquifer may be exempted by the EPA, state regulations, specifically WQRR Chapter 8 Section 4(d)(viii)(B), require restoration of the groundwater: “A discharge into a Class V (Mineral Commercial) Groundwater of the State shall be for the purpose of mineral production and shall not result in the degradation or pollution of the associated or other groundwater and, at a minimum, be returned to a condition and quality consistent with the pre-discharge use suitability of the water.”

## **Topic 2: Groundwater Monitoring during Operations**

### **Examples of Comments:**

*“Linc has not demonstrated that contamination will remain within the proposed exemption area.”*

*“How do they control excursions?”*

*“Linc’s monitoring plan is insufficient to detect excursions resulting from the proposed UCG process.”*

*"Linc's monitoring program does not include a broad enough list of parameters."*

*"Linc and WDEQ's proposed groundwater monitoring plan is too limited."*

*"Linc's proposed groundwater monitoring plan does not consider dangerous contaminants likely to be mobilized by the UCG process, including carcinogens such as benzene and polycyclic aromatic hydrocarbons (PAH)."*

### **WDEQ Response to Comments on Groundwater Monitoring during Operations:**

A total of 20 trend wells and 17 excursion wells will be used to monitor the groundwater. Overburden and underburden trend wells are located immediately surrounding the cavities to ensure horizontal and vertical groundwater movement is consistently towards the gasifier and to identify excursions. The WDEQ has determined that the Groundwater Monitoring Program described in the Statement of Basis, Wyodak Coal Aquifer Exemption will provide protection of the underground source of drinking water.

The primary focus of the monitoring plan is to monitor potentiometric levels, temperature and specific conductance in the Wyodak, overburden, and underburden trend wells to ensure horizontal and vertical groundwater movement is consistently towards the gasifier and to quickly identify excursions should they occur.

In the case that potentiometric data or conductivity data indicate the possibility of an excursion, during the operational or decommissioning phase, a groundwater sampling program will be initiated. The possibility of an excursion will be determined on the basis of one or more of the following conditions:

- 1) If a cavity-directed hydraulic gradient is not maintained in the Wyodak aquifer or anomalous heads are observed in Overburden or Underburden aquifers during gasifier operation;
- 2) If down-hole conductivity instrumentation in a trend well detects a change in conductivity greater than 80 umhos/cm over a 24-hour period; and,
- 3) If water temperature increases by more than 1 degree C over a 24-hour period.

If any of these conditions is met in one or more trend or excursion wells, groundwater samples will be collected from the closest two excursion wells in the same aquifer of the suspected excursion within two days following receipt of the in-situ detection. The samples will be analyzed for the four upper control limit parameters: phenol, ammonia, conductivity and benzene.

The process is discussed on pages 13.14-19 through 22 of the Statement of Basis, Wyodak Coal Aquifer Exemption.

### **Topic 3: Long Term Contamination Potential**

#### **Examples of Comments:**

*"Historically, the UCG resulted in long-term aquifer contamination and Linc, specifically, has been unable to demonstrate successful decommissioning after operations cease, especially at the scale required for commercial operations."*

*"Why not wait until the process in Australia is done? Linc has a pilot project in Australia and should demonstrate successful aquifer cleanup and decommissioning."*

*"In your response to comments, please explain why the WQD believes that Linc's project proposal will be different than past UCG projects that have contaminated groundwater."*

*"If you believe Linc's project will not contaminate groundwater, please explain the justification for this opinion, especially given the experimental nature of Linc's project and findings of the ISP report related to Linc's and other companies' projects in Australia."*

#### **WDEQ Response to Comments: Long Term Contamination Potential:**

Based on WDEQ's evaluation of the technical provisions within the Linc license application, the WDEQ found the operational controls to be sufficient to protect the underground source of drinking water outside the proposed exempted area and restore groundwater after operations cease within the proposed exempted area in accordance with Water Quality Rules and Regulations. Hydraulic containment of the project is discussed in the Statement of Basis, Section 13.14.7.2.3 and the Groundwater Monitoring Plan is discussed in Section 13.14.7.2.4. Groundwater restoration of the project is found in Section 17.2 of the license application.

#### **Topic 4: Decommissioning of the Burn Cavity**

##### **Examples of Comments:**

*"While Linc claims that its project here in Wyoming will be successful because it plans to use a clean-up process modeled after the Rocky Mountain ICRIP cavity decommissioning process, there is very little public information available about the Rocky Mountain 1 project. In your response to comments, please fully explain the following: 1) Decommissioning process used by Rocky Mountain 1 and why it was allegedly more successful than any other UCG test project, including Linc's Australia projects. 2) Please also explain the similarities and differences between Linc's proposed project here and the Rocky Mountain 1 project, including characteristics such as coal quality, depth, formation thickness, overburden and underburden thickness, availability of fresh water and saturation of the coal seam, and monitoring and regulatory requirements. 3) Please also explain whether the Rocky Mountain 1 process is similar or different to any of Linc's decommissioning processes for its projects in other parts of the world, including Australia."*

#### **WDEQ Response to Comments: Decommissioning of the Burn Cavity:**

The specific questions concerning the decommissioning of the burn cavity are not addressed in the Statement of Basis, Wyodak Coal Aquifer Exemption that was submitted to the USEPA and are therefore outside of the purview of the aquifer exemption public hearing process. Section 17.0 of the license application contains the Reclamation Plan.

## **Topic 5: Mineral Commercial Designation of the Aquifer**

### **Examples of Comments:**

*"The formation does not contain commercially producible minerals.....there are no commercially producible minerals in the aquifer which would allow an aquifer exemption.*

*"Linc hasn't shown that commercial quantities of a mineral exist in the Wyodak aquifer."*

### **WDEQ Response to Comments: Mineral Commercial Designation:**

The licensee has met the state and federal rules and regulations administered by WDEQ and EPA for a mineral commercial exemption of an aquifer and has submitted the necessary application materials provided in guidance by WDEQ and EPA (Ref: Guidance for Review and Approval of State UIC Programs and Revisions to Approved State Programs, GWPB Guidance 34).

## **Topic 6: Procedural Concerns about the Aquifer Exemption Action Under State and Federal Regulations**

### **Examples of Comments:**

*"According to EPA's regulations, EPA or delegated state cannot issue an aquifer exemption if the aquifer is currently being used as a drinking water source or has the potential to be used in the future as a drinking water source."*

*"The depth, location, yield, and existing groundwater quality do not prevent it from being a future drinking water source."*

*"The aquifer in question does not legally qualify for exemption and granting such an exemption would violate the Safe Drinking Water Act (SDWA)."*

*"Groundwater is a vital, limited resource in the Powder River Basin and removing protections is not in the public's interest."*

*"The Fort Union is an important and commonly used regional water supply."*

*"the depth, location, yield and existing groundwater quality of the Wyodak aquifer do not prevent it from being a future drinking water source."*

*"It is our understanding that the WQD made its final decision on the aquifer exemption before any public process. To our knowledge, the WQD has not rescinded its August 29, 2013 letter to EPA with plans to issue a new letter reflecting a new or reaffirmed decision, after the public comment period. The fact that the letter was mentioned in WQD's public notice for the hearing implies that the letter is still in effect." ..... "In other words, WQD and EPA, is still violating the rules before today's public hearing and before considering any data or views offered by members of the public during this public comment process."*

## **WDEQ Response to Comments: Procedural Concerns about the Aquifer Exemption Action Under State and Federal Regulations**

A mineral commercial basis for groundwater reclassification and subsequent federal aquifer exemption is not a violation of the SDWA as stated above in 40 CFR §146.4.

The notice of intent to issue the license and aquifer reclassification was published once a week for four consecutive weeks in the Gillette News Record newspaper, beginning on September 6, 2013. The Administrator of the Land Quality Division, Wyoming Department of Environmental Quality accepted objections to the proposed operations for 30 days following the day of last publication. A formal hearing was held before the Wyoming Environmental Quality Council on November 14 and 15, 2013. As stated in the Findings of Fact, Conclusions of Law and Order before the Environmental Quality Council, State of Wyoming, docket No. 13-4804:

No. 23. All notice requirements have been met.

No. 32. Linc Energy's R&D license is complete. The license application complies with all statutory and regulatory requirements.

In addition to this public participation process, the WDEQ held a public hearing in Wright, WY on March 26, 2014 in order to take additional public comments on the Statement of Basis, Wyodak Coal Aquifer Exemption.

The Wyoming WDEQ cannot authorize an aquifer exemption. The aquifer exemption proposal in question is considered a non-substantial revision to the state's program. The authority for approval of non-substantial revisions is delegated to the US EPA Regional Administrator.

### **Topic 7: Protection of Public Water Supply (Town of Wright)**

#### **Examples of Comments:**

*I run the Wright Water and Sewer District for the town of Wright. My concern is just because it's in the Fort Union aquifer. Our wells are drilled at 3,000 feet. Our first screens are at 1200 feet. You're going to 1100 feet, according to what I can see on the thing.... We're only a hundred feet deep to getting our water. So that's one question I'd like answered from the EPA or the WDEQ or both of them."*

### **WDEQ Response to Comments: Protection of Public Water Supply (Town of Wright)**

If approved, the research and development project will be located over ten miles west of the Town of Wright's wellfield in the NW1/4, Section 36, Township 44 North, Range 74 West. The aquifer proposed for exemption is an 80 acre section of the Wyodak coal, which is one of the coal seams in the Tongue River member of the Fort Union formation. The actual cavities to be gasified will cover less than an acre combined. Based on WDEQ's evaluation of the technical provisions within the Linc license application, the WDEQ found the operational controls will provide protection of the underground source of drinking water outside the exempted area and restore groundwater after operations cease inside the exempted area.

## **Topic 8: Precedent for Future Development**

### **Examples of Comments:**

*"Issuing Linc's requested aquifer exemption sets a dangerous precedent for the state's interpretation and implementation of the SDWA"*

### **WDEQ Response to Comment: Precedent for Future Development**

The WDEQ interpretation and implementation of the groundwater reclassification and subsequent aquifer exemption request process is consistent with federal regulations under the Safe Drinking Water Act, federal guidance on aquifer exemptions, and state regulations. While federal and state regulations afford protection for the non-exempted aquifer during and after mining, WDEQ regulations also require restoration of the exempted aquifer to its predischage class of use suitability after mining ceases.

## **Topic 9: General Informational Questions**

### **Examples of Comments:**

*"The aquifer itself, what is the impact area?"*

*"What size of seam are they going into there?"*

*"Are there test monitoring wells proposed?"*

*"Baseline information, is that part of the project?"*

### **WDEQ Response to Comment: General Informational Questions**

If approved, the project will be located over ten miles west of the Town of Wright's wellfield in the NW1/4, Section 36, Township 44 North, Range 74 West. The aquifer proposed for exemption is an 80 acre section of the Wyodak coal, which is one of the coal seams in the Tongue River member of the Fort Union formation. The actual cavities to be gasified will cover less than an acre.

The Wyodak coal seam is from 24 to 30 feet thick in the project area.

A total of 20 trend wells and 17 excursion wells will be used to monitor groundwater in the vicinity of the gasifier.

Background water quality was collected for a full suite of groundwater classification parameters.

## **Topic 10: Stratus Consulting Report**

### **Examples of Comments:**

*There are a number of technical issues with respect to Linc's calculations in the aquifer exemption application and correspondingly, WDEQ's statement of basis. (e.g., hydraulic properties, rising water table, methods used to analyze pump tests, hydraulic communication*

*between aquifers, estimation of yield, water wells into Ft Union could span multiple aquifers (yield question)*

### **WDEQ Response to Comment: Stratus Consulting Report**

The WDEQ/WQD received the memorandum titled “Review of Linc Energy Wyoming’s Proposed Wyodak Coal Aquifer exemption” (Stratus report) during the public hearing held at the Town of Wright Wyoming from the Powder River Basin Resource Council (PRBRC).

In the report, Stratus Consulting reviewed and commented on the geology and hydrogeology of the application. Wyoming Statute § 33-41-102 states: (viii) "Practice of geology before the public" means the performance of geological services or work including consultation, investigation, evaluation, planning, preparation of geologic reports and maps, the inspection of geological work and the responsible supervision of geological services or work, the performance of which is relevant to public welfare or the safeguard of life, health, property and the environment, unless exempt under this act.

Wyoming Statute § 33-41-104 Prohibited Acts and Conduct states:(a) Unless duly licensed in accordance with the provisions of this act, no person in this state shall: (iii) Practice, continue to practice, offer or attempt to practice geology or any subdiscipline or part thereof before the public as defined by this act.

The report by Stratus Consulting was not submitted by a licensed Wyoming Professional Geologist in accordance with state statutes.

The WDEQ/LQD reviewed the Stratus report. Presented below are the comments on the Stratus report findings. The WDEQ/LQD review comments are grouped into four broad categories.

- **Category 1 – Incomplete review:** WDEQ/LQD comments addressing the Stratus report questions that appear to have resulted from the incomplete review conducted by Stratus on the Linc R&D license application.
- **Category 2 – Reasonably Conservative Estimates:** WDEQ/LQD comments that address and clarify the environmentally conservative approach taken by WDEQ in evaluating the proposed aquifer exemption. The general intent of the WDEQ approach is to protect the underground source of drinking water outside the proposed exempted area and restore groundwater after operations cease inside the proposed aquifer exemption area in accordance with WDEQ Rules and Regulations.
- **Category 3 – Gasifier Inward Hydraulic Gradient Control:** WDEQ/LQD comments clarifying the proposed operational and restoration plan presented in the Linc R&D license application.
- **Category 4 – Clarification on the Proposed Aquifer Exemption:** WDEQ/LQD comments clarifying the proposed aquifer exemption area and the criteria it is applied under.

## Category 1: Incomplete review

Page 1 of the Stratus report states “*The Powder River Basin Resource Council (PRBRC) has requested that Stratus Consulting conduct a technical review of the aquifer exemption request, based on a review of the following sections of Linc’s UCG Research and Development (R&D) Permit Application (Linc, 2013):*”

- *Section 13.14, Appendix D-12 – Statement of Basis, Wyodak Coal Aquifer Exemption*
- *Section 13.7 – Geology*
- *Section 13.8 – Hydrology*

*In addition, we have reviewed aquifer exemption-related public comments and Linc’s responses to these comments. We have also cited selected literature, reports, and documents that are relevant to our comments.”*

The Stratus review report does not mention if they reviewed the other critical sections in Linc’s R&D license application. A complete review of the entire Linc R&D license application would have addressed several of the questions raised by the Stratus report. It appears that there are several critical sections that were not reviewed by Stratus including:

- Section 14 - Mineral Extraction Plan
- Section 15 – Research and Reporting
- Section 16 – Determination of Upper Control Limits and
- Section 17 – Reclamation Plan

The review comments 1 through 9 are intended to serve as examples to note where the answer to a question that was raised by the Stratus report exists in Linc’s R&D license application. However, this is not a comprehensive list of questions that were raised in the Stratus report caused by the incomplete nature of the review conducted on the Linc R&D license application.

**Review Comment 1:** Page 3 of the Stratus report under the heading ‘Summary of Key Findings’ states, “*The proposed groundwater monitoring program is too limited [e.g., it does not consider contaminants such as polycyclic aromatic hydrocarbons (PAHs) and benzene, which are likely to be mobilized by the UCG process].”*

Please reference the below sections in the Linc R&D license application for details on the groundwater monitoring program.

- Section 14.3.7.4 - Groundwater Contamination and Parameters Monitored
- Section 14.4 - UCG hydrology
- Section 14.5.2 - Groundwater Monitoring Plan – Excursion and Trend Wells

- Section 16 - Determination of Upper Control Limits
- Section 17.2 - Reclamation Plan – Groundwater Restoration and
- Section 17.8 - Bond Reclamation Procedures and Monitoring

**Review Comment 2:** Page 3 of the Stratus report under the heading ‘Summary of Key Findings’ states, *“Hydraulic communication between the Overburden, Wyodak, and Underburden aquifers exists under current conditions and may become more pronounced as the UCG process proceeds because of the effects of the operations on the local hydrogeologic system.”*

Please reference Section 13.8.2.4.2 on the existing groundwater flow system and Sections 13.8.2.5.1, 13.8.2.5.2, 13.8.2.5.3 and Addendum 13.8-D for the leakage analysis between the different geologic units.

Please reference Sections 14.3, 14.4, 14.5 and 14.6 for the hydraulic controls, monitoring and the operation plan to protect the underground source of drinking water outside the proposed exempted area.

Please reference Section 17.2 on the groundwater restoration plan to restore groundwater after operations cease inside the proposed aquifer exemption area.

**Review Comment 3:** Page 5 of the Stratus report under the heading ‘4 Geology of the Project Area and Relevance to UCG Operations’ states, *“Available borehole logs provide additional information on the degree of heterogeneity within the Tongue River Member in the project area. The Wyodak is described as “24 to 30 feet thick and laterally continuous within the Project Area.” However, Linc also notes that “The exception is within the northeast portion [of] the Project Area where it [is] about 12 feet thick” (Linc, 2013, p. 13.14-4). Based on this existing characterization, the thickness of the Wyodak therefore varies by more than 100% over length scales of less than 1 mile.”*

Please reference Section 14 for the location of the proposed gasifier within the permit area. The proposed gasifier for the Linc R&D license project is not located in the northeast portion of the project.

**Review Comment 4:** Page 12 of the Stratus report under the heading ‘5.4 Groundwater Classification Based on Current and Future Use’ states, *“It is unclear how Linc has estimated the yield of the Wyodak Coal aquifer. The technical basis for this yield is not provided, nor does Linc provide the spatial area of the Wyodak over which they assume this yield applies.”*

Please reference Section 13.8.2.5.2 and Addendum 14-F for the yield estimate of the Wyodak Coal aquifer.

**Review Comment 5:** Page 16 of the Stratus report under the heading ‘6.2.1 Excursion well distance’ states, *“While considering experience and knowledge gained from other sites is good practice, monitoring plans and well configurations should be based on site-specific conditions, including the local hydrogeologic properties and site-specific operating conditions. It is difficult to assess whether the 600-foot distance will be sufficient for this site, based solely on experience at different sites that likely had different hydrogeologic and operating conditions”*

Please reference Addendum 14-F Excursion and Trend Well Placement Evaluation in the Linc R&D license application for a description of the other site-specific conditions considered in addition to the

experience at different UCG sites. In addition to the excursion wells, please note that 20 trend wells will be used to monitor groundwater.

**Review Comment 6:** Page 16 of the Stratus report under the heading '6.2.1 Excursion well distance' states, "*Linc states that they conducted contaminant fate and transport analysis in the Wyodak, Overlying, and Underlying aquifers of chloride and benzene, to assist in determining the size of the exemption area (Linc, 2013, p. 13.14-16). For chloride, they report that a concentration of 25 mg/L chloride (emanating from a continuous 500 mg/L source) is estimated to travel 200 feet from its source in the Wyodak aquifer in 5.8 to 10.8 years; in 31.8 to 187 years in the Overburden aquifer, and 9.4 to 26.2 years in the Underburden aquifer. These results would suggest that the aquifer exemption area will adequately encompass any area that would be contaminated if an excursion were to occur. However, Linc does not provide any information on their calculations, input parameters, nor the values for input parameters. This makes it difficult to assess the reported travel times for contaminants.*"

Please reference Addendum 14-F Excursion and Trend Well Placement Evaluation in the Linc R&D license application for a description on the contaminant fate and transport calculations, input parameters and the results.

**Review Comment 7:** Page 16 of the Stratus report under the heading '6.2.2 Overburden and Underburden excursion wells' states, "*All of the wells that form the excursion well perimeter are screened in the Wyodak. The only excursion wells that are screened in the Overburden and Underburden aquifers are those located to the northwest of the oval. It is unclear why the Overburden and Underburden aquifer excursion wells are only placed in one area of the site.*"

Please note that a total of 20 trend wells and 17 excursion wells will be used to monitor groundwater. In addition to the overburden and underburden excursion wells, there are five overburden trend wells and six underburden trend wells within the excursion well perimeter. The overburden and underburden excursion wells are located downgradient from the proposed gasifier.

Please reference Addendum 14-F Excursion and Trend Well Placement Evaluation in the Linc R&D license application.

**Review Comment 8:** Page 19 of the Stratus report under the heading '6.3 Calculation of Area beyond the Excursion Wells to be Included in the Exemption Areas' states, "*As a result of this anisotropy, flow is unlikely to be radial in this setting. Instead, contaminants may preferentially flow in one direction, and/or follow narrow, fracture-controlled preferential pathways that could pass between excursion wells. Such pathways could allow contaminants to travel much faster and reach much greater distances before detection than would be otherwise predicted assuming homogeneous, isotropic, radial flow. Therefore, Linc's calculations could significantly underestimate the distance a contaminant could travel beyond the excursion wells, prior to being detected at a well.*"

Please reference Section 13.7.4 on the existing groundwater flow regime.

Please reference Section 13.8.2.5 on the aquifer properties and anisotropy

Please reference Addendum 14-F Excursion and Trend Well Placement Evaluation in the Linc R&D license application.

**Review Comment 9:** Page 10 of the Stratus report under the heading ‘5.2.1 Wyodak Hydraulic Properties’ states, *“It does not appear that Linc’s analysis of the aquifer test considered the rising water levels in the Wyodak as these wells recover from CBM depletion. No mention is made of the rising water levels in the sections of the document that describe the pumping tests, although increasing water levels are evident in many observation wells in early monitoring times. For example, water levels in observation well OW-30 were increasing at a rate of approximately 2 ft/day from January 27, 2012 through January 29, 2012, and then they began to decline, probably in response to pumping at TR44 that was initiated on January 27, 2012 (see Linc, 2013, Addendum 13.8-D1). Because analysis of the aquifer testing is based on water level changes in observation wells, ignoring the regional groundwater level rise during the pumping test could cause Linc to inaccurately estimate the transmissivity and hydraulic conductivity of the aquifer. This propagates into the aquifer exemption calculations because the estimated hydraulic conductivity is used to estimate both groundwater flow rates and the distance contaminants can be transported by the groundwater over a given time period.”*

Based on the WDEQ/LQD review of Addendum 13.8-D1, the Stratus report determination, *“water levels in observation well OW-30 were increasing at a rate of approximately 2 ft/day from January 27, 2012 through January 29, 2012”* is not correct. It is not clear how the 2 feet per day recovery rate was calculated by Stratus.

#### **Category 2 – Reasonably Conservative Estimates**

Page 3 of the Stratus report under the heading ‘Summary of Key Findings’ states, *“Significant heterogeneity is present in the Wyodak and surrounding geologic units. This heterogeneity has implications for calculations of groundwater travel times and the size of the aquifer exemption area. Heterogeneity between these units also has implications for hydraulic communication between aquifers, and for Linc’s ability to maintain hydraulic control of UCG operations.”*

Almost all aquifers will exhibit heterogeneity. Therefore, it is reasonable to consider the range of estimated aquifer properties and then apply the aquifer properties that would minimize the aquifer exemption area and maximize the protection of the underground source of drinking water outside the proposed exempted area. In other words, the general intent is to minimize the proposed aquifer exemption area while using the possible range of scientifically credible aquifer properties.

Please reference Section 14, Section 15, Section 16 and Section 17 for the protective measures in place during the operation and restoration of the proposed UCG project.

**Review Comment 10:** Page 10 of the Stratus report under the heading ‘5.2.1 Wyodak Hydraulic Properties’ states, *“Literature studies of the Wyodak aquifer hydraulic properties indicate that the hydraulic conductivity values obtained from the site pumping test are lower than mean values obtained from other aquifer tests. A U.S. Geological Survey report (Bartos and Ogle, 2002) summarized three previous studies that evaluated the hydraulic conductivity of the coal bed aquifers in the PRB using results from hundreds of aquifer tests. All three studies found that the data were logarithmically distributed, with geometric means of 0.5 ft/day (Peacock, 1997); 0.8 ft/day (Martin et al., 1988), and 0.9 ft/day (Rehm et al., 1980). Furthermore, Linc cites regional groundwater studies that indicate that the Anderson Coal aquifer (the coal aquifer is often referred to as the Wyodak-Anderson coal zone) has a hydraulic conductivity of 3 ft/day (Linc, Table 13.8-5). This information suggests that the hydraulic*

*conductivity of the Wyodak aquifer may be an order of magnitude higher than indicated by Linc's analysis of a single pumping test in their proposed demonstration project area. An order of magnitude higher hydraulic conductivity would result in an order of magnitude faster travel time, which means that contaminants could potentially travel much farther than estimated by Linc in their transport analysis for the exemption area"*

- The references listed in the Stratus report summarize the hydraulic conductivities for coals that are typically less than 500 feet deep. The coal seam of interest for the proposed Linc R&D project is about 1,100 feet below land surface.
- It is difficult to make a direct comparison of the different coal seams in the Powder River Basin because of the variations in nomenclature.
- Even when compared against shallower coals, the hydraulic conductivity presented in the Linc Energy R&D license application is within the range of hydraulic conductivities reported for the shallower coal seams.
- Given the differences in the depth of the coal seams and the availability of site-specific test, it is prudent to provide more weightage to the site-specific estimate of the hydraulic conductivity of the coal.
- The arguments presented in the Stratus report are for the application of a higher hydraulic conductivity and faster travel times. Selecting a higher hydraulic conductivity from the range of estimates and applying this higher hydraulic conductivity to the aquifer exemption area estimation will result in an aquifer exemption area bigger than the proposed aquifer exemption area. This is contrary to the WDEQ's environmentally conservative approach to minimize the aquifer exemption area.

**Review Comment 11:** Page 14 of the Stratus report under the heading '6.1 Aquifer(s) included in the Exemption' states, *"Based on our review, the Overburden and possibly the Underburden aquifers should be included in the exemption."*

Please note that including the overburden and underburden will increase the aquifer exemption area. In other words, this will remove the federal protection for the overburden and underburden units.

### **Category 3 – Gasifier Inward Hydraulic Gradient Control**

**Review Comment 12:** Page 2 of the Stratus report under the heading 'Summary of Key Findings' states, *"There are a number of technical issues with respect to the calculation of the aquifer exemption, including:*

- *The aquifer exemption calculations contain inappropriate assumptions for key parameters, including the distance to excursion wells and the hydraulic gradient used to calculate flow velocities.*

- *The aquifer exemption calculations do not sufficiently consider uncertainty. Single values were used in aquifer exemption calculations, ignoring the range of parameter values that would be representative of this natural system.*

Please reference Section 14.3 and 14.4 for the details on the proposed operational and monitoring controls. One of the key requirements of the proposed UCG process is to maintain an inward hydraulic gradient towards the gasifier. The gasifier will act as a groundwater sink during operations and restoration. Please note that the aquifer exemption calculations are carried out with an assumed absence of this inward hydraulic gradient towards the gasifier.

**Review Comment 13:** Page 20 of the Stratus report under the heading ‘6.3.3 Calculation of the distance an excursion could travel from the time of detection until recovery operations begin’ states, “It is not clear why a gradient that was measured during a pumping test was used in a calculation to predict travel distances during the UCG demonstration project. A more appropriate approach would be to predict gradients that would exist during the UCG test and, during cavity flushing, use those gradients in the calculation to predict the distance an excursion might travel during the test.”

Please reference Section 14.3 and 14.4 for the details on the proposed operational and monitoring controls. One of the key requirements of the proposed UCG process is to maintain an inward hydraulic gradient towards the gasifier. The gasifier will act as a groundwater sink during operations and restoration. Therefore, if the operations are conducted according to the proposed operation plan presented by Linc in the R&D license application, the hydraulic gradient will be towards the gasifier and not towards the excursion well ring boundary.

#### **Category 4 – Clarification on the Proposed Aquifer Exemption**

**Review Comment 14:** Page 2 of the Stratus report under the heading ‘Summary of Key Findings’ states, “Linc Energy is requesting an aquifer exemption that would allow them to contaminate groundwater in and around the Wyodak Coal aquifer, which is part of the Fort Union Formation. The Fort Union is an important and commonly used regional water supply aquifer in Wyoming. Linc alleges that the depth, location, low yield, and (or) the existing groundwater quality of the Wyodak aquifer preclude future use as a drinking water supply. We disagree.”

Please note that Linc is applying for aquifer exemption under the criteria “Aquifer is not a source of drinking water and will not serve as a source of drinking water in the future because it is mineral, hydrocarbon, or geothermal energy producing, or can be demonstrated by a permit applicant as a part of a permit application for a class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible.” The arguments presented by Stratus are not the criteria used in this Linc’s proposed aquifer exemption (Please review: Aquifer Exemption Summary Sheet, Don Fischer, WDEQ/WQD, August 28, 2013).

**Review Comment 15:** Page 3 of the Stratus report under the heading ‘Summary of Key Findings’ states, “The aquifer exemption request is unclear about which aquifer is being proposed for exemption, and whether this includes the Wyodak aquifer only, or the Wyodak and Overburden aquifers.”

The proposed aquifer exemption is only for the Wyodak aquifer that is within the proposed aquifer exemption boundary.

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