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Clark Resource Council

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Jim Ruby, Executive Secretary
Environmental Quality Council

Kathy Brown, P.G.
Voluntary Remediation Program
Wyoming Department of Environmental Quality
510 Meadowview Drive
Lander, Wyoming 82520

Re: Report of Investigation and Remedial Alternatives Evaluation – Final – Crosby 25-3 Gas Well Blowout, Park County, Wyoming

Dear Ms. Brown,

On behalf of Clark Resource Council, Powder River Basin Resource Council, EARTHWORKS' Oil and Gas Accountability Project, Western Organization of Resource Councils, and our members, thank you for accepting our comments. We previously provided comments dated December 15, 2008 on the Draft Remedial Alternatives Evaluation. This document provides comments on the more recent final evaluation report referenced above.

1) Primary Objectives and Concerns

Our primary objective in writing these comments is to ensure that the plan be sufficiently protective of the health and safety of residents living in the project area. Our two primary concerns aimed at achieving that objective are:

1) Early warning of potential groundwater contamination in the domestic wells provided by continued monitoring is the most important interim and long term measure to protect the health and safety of residents living in the project area. We recommend that monitoring be continued for a 10 year period, at a minimum, using existing schedule and parameter list for the upper and lower domestic wells and sentinel wells. Our concern is that the plan does not assure that downgradient domestic wells and sentinel well will be monitored in accordance with the existing plan for an appropriate period after remedial actions are implemented.

2) Remedial actions must be implemented in a very timely manner to minimize further spreading of the plume any nearer to the residential area. Our concerns regarding groundwater quality in the residential area are even greater after contamination from the blow-out was recently detected in monitor well 46D located east of Line Creek that indicate the plume is spreading.

3) It is of the utmost importance that the terms and time frame for future monitoring be identified, and a suitable bond or other evidence of financial assurance be secured to ensure that the companies meet their responsibilities to protect human health and the environment by monitoring and remediating the Crosby 25-3 gas well blowout in a timely manner.

Rationale for the first two points include:

1) Terracon estimated that 325,000 to 456,000 gallons per day groundwater seepage rate through the permeable zones in the study area. This is a large volume of water some of which is contaminated. It is probable that some of the contaminated water is migrating in a downstream direction towards the residential area.

2) Geology of the study area is complex. The shallow valley fill aquifer has highly variable transmissivity that indicates likely preferential pathways via channels. The deep bedrock zone has fractures and faults that may be barriers in some areas and preferential pathways in other areas. Due to highly variable geology it is possible that the existing monitor well network may have missed certain preferential pathways and contamination could reach the domestic wells.

2) Groundwater Seepage Volume

This section describes the ground water seepage value and the basis for our concerns that a significant volume of water is moving through the system via groundwater and discharge into Line Creek. It is uncertain as to how much water is moving through preferential pathways in the deep zone.

On page 28 of the ROI/RAE, 14 October 2008, *"The quantity of water in the valley fill aquifer flowing into and out of the monitoring network area was estimated using the results of aquifer testing and static water level mapping. In October 2007 we estimate that about 1.0 to 1.4 acre-feet per day of water in the valley fill aquifer was flowing into the project area from the north and west. About 0.9 to 1.2 acre-feet per day of water is estimated to discharge within the project area to the surface and Line Creek, or be transpired by vegetation. About 0.1 to 0.2 acre-feet per day of water is estimated to flow out of the project area in the valley fill aquifer downstream of the monitoring network."*

On page 40 of ROI/RAE, 7 July 2009, "*The quantity of water in the Valley Fill aquifer flowing into and out of the monitoring network area was estimated using the results of aquifer testing and static water level mapping. During 2008 and 2009, we estimate that about 2.0 to 2.5 acre-feet per day of water was flowing into the project area from the north and west in the Valley Fill aquifer. About 1.2 to 1.8 acre-feet per day of water is estimated to discharge within the project area to the surface and Line Creek, or be transpired by vegetation near the springs. About 0.5 to 0.8 acre-feet per day of water is estimated to discharge within the project area to Line Creek below the Kings Residence. The remaining 0.1 to 0.2 acre-feet per day of water is estimated to flow out of the project area and into Line Creek above Bennett Draw. (See Exhibit 8)."*

Comment: There are 325,851 gallons per acre foot. Converting acre feet to gallons there are approximately 325,000 to 456,000 gallons of groundwater flowing into the project area each day. Approximately 293,000 to 391,000 gallons discharging to Line Creek each day and an additional 32,000 to 64,000 gallons flow out of the project area each day in the valley fill. In addition, Page 30 Section 3.13.3 of the ROI/RAE, 14 October 2008 states that there is an estimated 9,679.067 cubic feet of contaminated water at the site. That is approximately 71,000,000 gallons of contaminated water.

It is not clear as to the fate and transport of COCs if up to 391,000 gallons per day of contaminated groundwater discharging to Line Creek and up to 64,000 gallons per day are migrating through the valley fill. It is uncertain how much water is migrating via preferential pathways in the bedrock. Recent data for monitor well 46D east of Line Creek indicates the plume in the bedrock is spreading.

The large groundwater flux to Line Creek is of concern to downstream domestic wells particularly if Line Creek is a losing stream in the vicinity of these wells. It is possible that some of those wells are screened in sands and gravels adjacent to the stream and water is drawn toward the wells when they are pumped. While we recognize that this migration pathway is a possibility rather than a probability, we conclude that a more thorough evaluation of this exposure pathway risk is necessary to be protective of human health.

The large groundwater flux in the valley fill is also a concern to downgradient domestic wells because some of them are screened in the shallow zone. In addition some private wells are fed by irrigation canals coming directly from the surface waters of Line Creek.

Beaver ponds are present adjacent to Line Creek at locations where contaminates discharge to surface water. These ponds are a logical site for sampling for contaminants. Both soil and water samples should be obtained.

We recommend that groundwater flow maps be prepared that cover the entire study area including the vicinity of the domestic wells. These maps will assist in determination of groundwater flow velocities and losing/gaining characteristics of Line Creek and ultimately evaluate risk to downgradient water well users.

3) Geology

This section describes our understanding of site geology and the basis for our concerns that geology in the study area is complex including the shallow valley fill aquifer with highly variable transmissivity indicating likely preferential pathways in channels; and the deep bedrock zone with fractures and faults that may be barriers in some areas and preferential pathways in other areas. Due to highly variable geology it is possible that the existing monitor well network may have missed certain preferential pathways and contamination could reach domestic wells more quickly than anticipated.

On page 21, *"The results of this sampling event, after sampling the monitoring wells, appeared to indicate that the extent of groundwater impact has been well defined in all directions with respect to the Crosby 25-3 Natural Gas Well pad."*

Previously it was assumed that contaminants were injected by high pressure into the low permeability deep zone; and that future contaminate migration via groundwater was unlikely. Recent detection of benzene in deep zone monitor well 46D east of Line Creek causes uncertainty as to the validity of that site characterization and other subsequent conclusions.

Fort Union Formation: It is likely that contamination movement to the east side of Line Creek is possibly attributable to the bed dip. The dips are very high and contamination is possibly following a single more porous/permeable bed across the creek at that particular drilled depth as that would be the relative strike direction of Fort Union beds. The tear fault that corresponds to "Bennett Draw" is possibly acting as a seal for contamination moving down the drainage. Terracon notes that "Bennett Draw" appears to be limiting the plume.

The structure drilled by Windsor on Line Creek consists of a series of fault blocks. Depending on what strata are juxtaposed by faulting, the faults (and there are many) could be acting as either seals or conduits. Migration potential is also enhanced by associated fracturing of the Fort Union and older formations. Worst case scenario would be more contamination at greater depths that has yet to be discovered by the monitor well drilling program.

Major faults intersecting the surface in the immediate area of the Crosby drill pad are identifiable from "Google" satellite imagery. An example is attached.

Terracon recognizes the extreme bed dips in the Fort Union Formation (Section 3.5.2), the upper part of which has been termed the "bedrock aquifer". The Fort Union Formation and its constituent beds have dips according to the report, ranging from 30 to 60 degrees. However, on the contaminant maps, geologic dip section and groundwater contour maps, dips are not presented and maps are constructed on what appears to be a zero-dipping plane that transgresses a variety of different beds. "Apples and oranges" appear to be mixed together on a single map; correlations are suspect. The maps should represent a single bed or unit representing a single aquifer; instead they seem to represent some slice through a series of different beds down the drainage.

On page 31, *"No evidence of prominent fractures, faults, or shear zones was observed in the borings. In addition, no evidence of faulting was observed in nearby outcrops."* Please refer to Google Earth image submitted with these comments and to all maps and figures submitted in the December 18, 2008 comments. The highly fractured nature of the "bedrock" is easily observed in the Fort Union outcrop near the Crosby pad.

On page 41, *"Bennett Draw appears to 'cut off" the valley fill aquifer at the southern terminus of the project area."* This observation by Terracon is a prime example of why faults should be mapped and considered. See the attached Google Earth photo.

On page 6, "Once the material left the surface casing and entered the bedrock, it either followed existing fractures in the conglomerate bedrock or created new fractures as a result of the high pressures present. The subsurface information appears to suggest that bedding planes of fractures are relatively steeply dipping in the vicinity west of the well head and much shallower, perhaps nearly horizontal in other directions".

Comment: Structural sections showing the bed dips should be included. Bed dips should be available from the actual logging record of the Crosby wells (it is standard operating procedure to obtain dip logs) and should be included and discussed in specific terms relating to potential contaminate pathways along bedding planes or porous/permeable beds.

Recent Valley Fill Deposits: If Line Creek didn't deposit the Recent Valley Fill deposits (Section 3.5.3) then what was responsible for their deposition? Can these deposits be characterized as anatomizing stream channel deposits with braids causing preferential pathways? Can the transmissivity values shown for the Valley Fill Deposits be contoured to reflect channels, i.e. potential pathways?

Hydrogeologic Characterization: If the aquifer tests are conducted in wells that are situated in different stratigraphic beds due to bed dip then how can any assumptions be made as to interconnection of wells in the bedrock or Valley Fill aquifer (Section 3.6.2). Could the extreme differences in transmissivity rates for the Valley Fill Aquifer have anything to do with whether the well is located in an ancestral channel?

Artesian Conditions: On page 14, *"The depth of the wells was adjusted to intercept the shallow water table that is likely overlying the underlying bedrock. A monitoring well was not constructed in boring B-6 due to cement grout flowing out of the borehole as a result of cement squeeze activities being performed on the Crosby 25-3 Natural Gas Well. MW-2 was abandoned the day following completion at the direction of WDEQ due to concerns that the artesian flowing well may impact Line Creek with petroleum hydrocarbons."*

On page 15, *"Monitoring Well MW-2 was abandoned on 30 August 2006 due to artesian flow being observed in the monitoring well. At the direction of WDEQ, the well was abandoned as it appeared that it may have been installed in an impacted groundwater zone and surface water in Line Creek could have been threatened if it was allowed to flow. Abandonment, in this case, consisted of the placement of bentonite chips to the ground surface into the well casing and the severing of the casing at the ground surface."*

Comment: Do these observations of artesian flow indicate the deep zone is interconnected hydraulically to the shallow zone**?** Could confined conditions reduce effectiveness of the remedial alternatives?

4) Improve the Sentinel Well Program

Additional monitoring wells should be installed on the east side of Line Creek to determine the extent of contamination identified in monitor well 46D. Terracon should prepare a sampling and analysis plan for future monitoring wells, including how sites are determined. Windsor must reach surface use agreements with all surface owners whose surface property is disturbed by activities associated with the drilling of monitoring wells, testing, monitoring, and reclamation and remediation of oil and gas operations.

MW 46-S, MW 46-D, and all new and proposed monitor wells should be included and properly identified as sentinel wells and monitored in accordance with the existing sentinel well schedule.

5) Recommended Points of Compliance

On page 99, *"Terracon recommends that initial points of compliance be established at this time. As remedial action progresses at the site Terracon may recommend a change in the points of compliance.*

Comment: Because contamination has been detected in MW-46D, additional points of compliance should also be determined for the east side of Line Creek.

6) Reporting Requirements

It is our understanding that Windsor Energy, LLC did not report the findings of benzene above regulatory limits found in Monitor Well 46D during the June, 2009 testing event to both the Wyoming Department of Environmental Quality and the public until the September 10, 2009 public meeting in Clark. Results from Terracon's water analyses should be posted on a dedicated web site within one week after data validation is completed.

7) WDEQ Groundwater Classification

Section 3.6.6"In accordance with Wyoming Water Quality Rules and Regulations, Chapter 8, the aquifers at the site are a drinking water source and therefore the groundwater at the site, by default, is classified as Class 1 and is required to be cleaned up to drinking water standards. In accordance with the Wyoming Surface Water Classification List, Line Creek, a tributary of the Lower Clarks Fork River in Park County, is classified as Class 2AB surface water."

Comment: This classification should be Class l because of domestic wells downstream.

8) Corrective Action Valley Fill - Monitored Natural Attenuation

On page 91, *"Based on a comparison of technological feasibility, the ability of remedial alternatives to meet ROA, O&M costs, and the precipitous drop of measured COC concentrations the recommended remedy for the Valley Fill aquifer is alternative VF1-Monitored Natural Attenuation."*

Comment: In order for any site to be considered as a candidate for natural attenuation, it is necessary that the process be scientifically documented, which means that if contaminant levels are declining, their decline must also be tied to a mechanism. In order to evaluate this possibility, it is usually necessary to understand the site well enough that evidence of source degradation can be obtained. If the mechanism of degradation is biodegradation, then it is typically required to monitor for parameters that provide evidence that such a process is continuing.

In addition, the EPA has provided guidance with respect to the "appropriateness" of utilizing natural attenuation relative to drinking water sources. While use of natural attenuation can be effective in achieving cleanup goals, it may not be appropriate in situations where there is current

risk to public health, or involves non-industrial areas in which direct human contact with contaminated water or soil is expected to occur more than on a rare occasion.[1] It does not appear that a monitored natural attenuation approach is viable for the site.

Therefore it appears necessary to continue to operate the air sparge system possibly enhanced with iSOC with additional treatment in the source area locations, at a minimum, and/or monitoring for natural attenuation parameters to identify an attenuation mechanism, if any.

9) Corrective Action Valley Fill - Alternative VF3-Enhanced Aerobic Bioremediation Treatment Line

- iSOC case studies at similar sites should be included in the report.
- Has the State of Wyoming ever approved the iSOC alternative previously?
- Have any tests been completed on groundwater samples collected from the existing air sparge system that resulted in any observed enhanced aerobic biodegradation that are applicable to evaluation of iSOC feasibility?
- The report states that indicator parameters and bacteria plate counts will be assessed prior to implementation to determine if iSOC technology is feasible. The report should identify which indicator parameter tests will be run and how those results will be used to evaluate feasibility?
- Does approval of this plan by the State of Wyoming result then in development of a feasibility study workplan for iSOC or will those tests be run immediately after approval?
- The remedial alternatives evaluation does not address COCs in groundwater that have already migrated downgradient of the existing air sparge system.
- The remedial alternatives evaluation does not indicate if the existing air sparge system will continue to be run and/or will it be enhanced using iSOC.
- What tests will be run to assess the performance of iSOC and zone of influence of each injection point?
- Based on a treatment line from MW-20 to MW-8 to MW-23 what is the groundwater flux across this transect and can iSOC treat that volume of water. In development of this alternative were groundwater volumes as high as 325,000 to 456,000 gallons per day considered? Further is the groundwater velocity slow enough that groundwater will have sufficient residence time near the injection points for treatment.
- There is insufficient justification to eliminate treatment at the source, particularly since the source site has benzene concentrations 2 to 3 orders of magnitude larger than the

[1] See, for example, www.epa.gov/swerffrr/documents/petrol.htm; and www.epa.gov/swerffrr/documents/chlorine.htm.

benzene concentrations at the proposed treatment lines. Given the large groundwater flux through the source area it appears prudent to also treat at the source area.

- A more thorough discussion of electrical needs and availability is needed.

10) Corrective Action - Deep Zone

On page 84, *"Due to hydrogeologic conditions in the deeper bedrock zone, many available remedial options are technically and/or financially unfeasible. In response, with concurrence from WDEQ, a selection of different technology pilot studies rather than a remedy for site-wide implementation was agreed upon. Five alternatives were considered to address contaminated groundwater in the bedrock. A summary of estimated costs for implementing pilot studies for the alternatives is provided in Table XIV."*

Comment: CRC has no objection to the pilot tests proposed for the deep zone. CRC suggests that these tests be run in a timely manner given recent results in monitor well 46D located east of Line Creek and the large groundwater volume moving through the system (See Item #2 Groundwater Seepage Budget).

11) Available Electric Power

On page 76, *"Evaluation of alternatives considered not only the cost-effectiveness of the remediation given the confines of the areas limitations, such as available electrical power, but also the balancing criteria established by the WDEQ in Fact Sheet # 21, VRP Remedy Selection."*

Comment: In previous comments, CRC has voiced our concerns over how remediation will take place without industrial capacity for electricity available in the Line Creek drainage. Windsor must fully evaluate this situation, disclose all information to the public, and public input must be given.

12) General Comments

Comments provided below are shown with their associated report section referenced.

On page 5, *"Terracon has been involved with some additional exploration and remedial excavation activities on and around the well pad."*

Comment: Terracon should provide specific documentation for their involvement and additional exploration and remedial excavation activities.

On page 6, *"Based upon the low concentrations reported in samples collected in this area by Mr. Quick, removal activities are not anticipated."*

Comment: Mr. Quick's sample data should be included in the report.

On page 6, *"Based upon our observations, materials released to the surface in this area appear to be limited to natural gas."*

Comment: Terracon's observations should be verified by data and/or sundry reports.

On page 6, "*It appears that weaknesses in the surface casing at a depth ranging from 225 to 250 feet below ground surface became the preferential pathway for the drilling fluids and petroleum condensate. The remainder of the material moving up the well bore was exhausted at the surface through the blooie line.*

Comment: The estimates for volumes released should be included in the report, with the WDEQ estimates being recognized.

2.2 Operational History

On page 7, *"A pipeline was installed along Line Creek and operated until about 1969. Husky Oil purchased the pipeline for salvage, but according to the WOGCC, the right-of-way remains active."*

Comment: Documentation regarding the pipeline and Terracon's explanations should be included in the report.

3.3.6 Pesticides and Herbicides

On page 27, *"No information exists which suggests that pesticides were applied at the site or as part of the drilling process. A biocide identified as Aldacide was used in the drilling mud, the active ingredient of which was a compound called glutaraldehyde. The Remedial Investigation Work Plan – Final dated 1 February 2008 addressed the use of glutaraldehyde and the lack of analytical and regulatory standards."*

Comment: Although there is a lack of analytical and regulatory standards, glutaraldehyde is a constituent that is harmful to human health and the environment, and should be noted as such.

3.3.8 Inorganic Compounds

On Page 28, *"Based upon our review of drilling components used, the materials released into the subsurface, and the availability of regulatory standards, inorganic compounds are not a COC."*

Comment: Please provide full disclosure of all drilling fluid constituents, and their volumes and concentrations used during the drilling of the Crosby 25-3 gas well. Please provide the chemical composition and volumes and concentrations of all fluids and muds used to plug the well during the blowout. The information provided by Windsor Energy for drilling of the Bennett Creek 25-1 gas well included significant amounts of pesticides and other potentially hazardous/toxic chemicals (i.e., styrenes, acrylamides, phenols, etc.) used during drilling. The constituents and

volumes used at the Crosby 25-3 should be disclosed to fully establish that inorganic compounds are not a Contaminate of Concern (COC).

3.8.2 Groundwater

Comment: Is the drawdown and low flow pump rate being measured during groundwater sampling? Field sampling data should be included as an attachment to the report.

3.9.1 Population Distribution

On page 52, *"The Bennett Pad consists solely of a drilling pad and the aforementioned unused well and does not have residential use.*

Comment: Although the water well does not have residential use now, it was drilled and used as a drinking water source for rig hands living on the Bennett Creek Pad. Furthermore, it is drilled into the same aquifer that supplies drinking water to many residents in the Line Creek drainage, and can act as a conduit for contamination into the drinking water aquifer and drinking water wells. The Bennett Creek potable water well is a downstream drinking water well and must continue to be tested under the VRP investigation to protect drinking water and human health.

Thank you again for the opportunity to provide comments. We look forward to your written response to comments and outstanding questions.

Sincerely,

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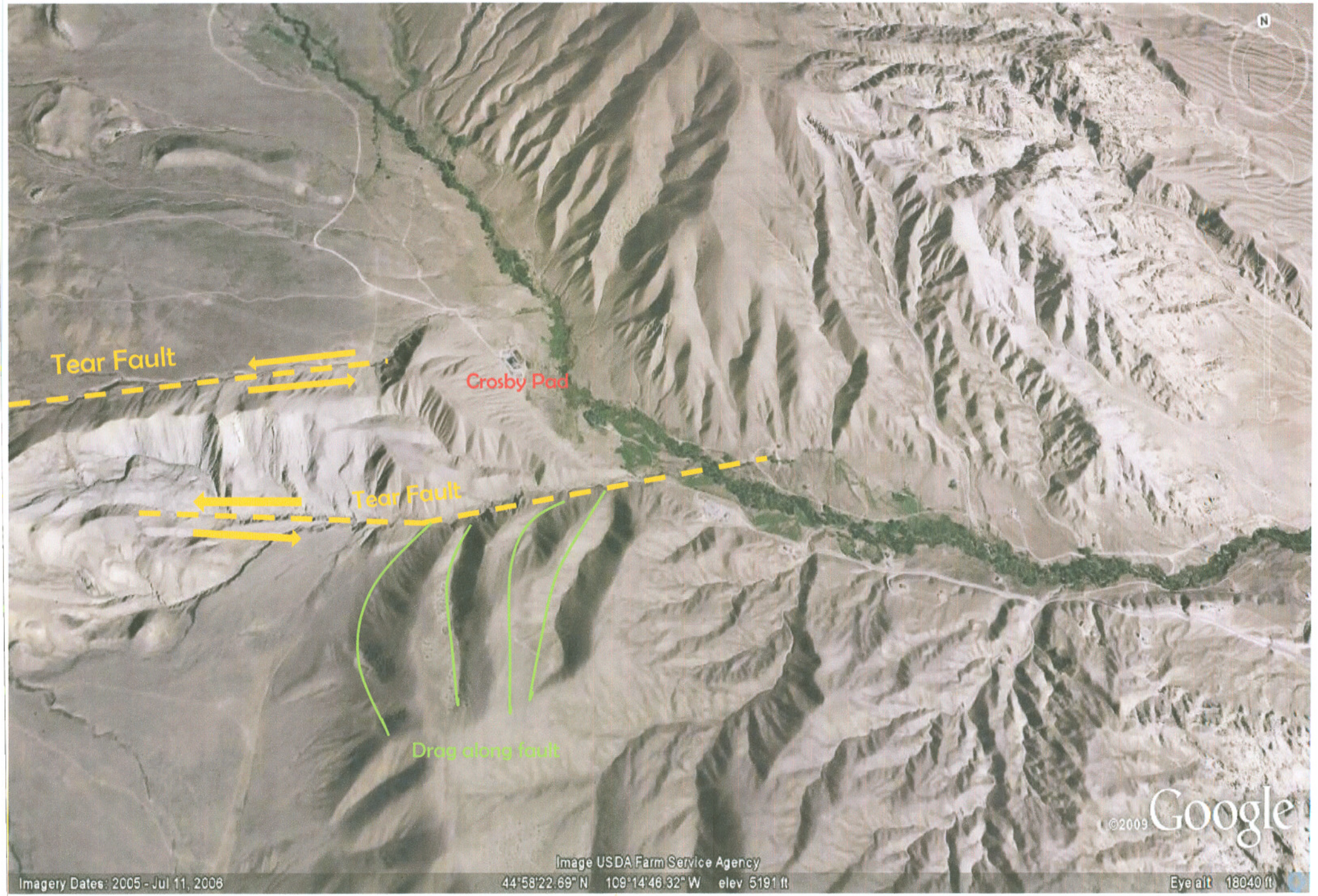
Sent by e-mail
October 15, 2009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