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April 22, 2014

Tom Lancaster
US Nuclear Regulatory Commission
FSME/DWMEP/DURLD/URLB
11545 Rockville Pike, MS T-8F5
Rockville MD, 20852

Additional Information on Niobrara River Fault

Mr. Lancaster,

Here are the materials that were discussed on the conference call March 27, 2014 clarifying the presence of the Niobrara River Fault at the Marsland Expansion Area. Similar materials were submitted via email on April 17, 2014, but were in excess of the file size allowed by NRC email servers. A CD disk with all files and maps is included. Note that due to difficulties plotting Figures 4, 5 and 6, those figures are not included as hard copy at this time. The figures are included as PDF format files on the CD.

If you have any questions, please do not hesitate to call me.

Sincerely,

Wade Beins

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DRAFT

RAI #9 NIOBRARA RIVER FAULT STUDY

Marsland Technical Report Timeline

In May 2012, Crow Butte Resources, Inc. (CBR), d/b/a Cameco Resources – Crow Butte Operation submitted the Technical Report for the Marsland Expansion Area(MEA) located in Dawes County, Nebraska. On July 3, 2013, the Nuclear Regulatory Commission (NRC) Requested Additional Information (RAI) to support the ongoing approval process for the Marsland License. As part of the RAI process, NRC requested clarification concerning the Niobrara River Fault and any other known features in the vicinity of the MEA. This request was made within the context of RAI 9 part b as shown below:

Request for Additional Information #9

RAI 9 Description of Deficiency The information provided in TR Section 2.6 does not meet the applicable requirements of 10 CFR Part 40, using the review procedures in Section 2.6.2 and acceptance criteria in Section 2.6.3 of NUREG-1569.

Basis for Request Staff did not find information that is necessary to allow for an understanding of the project's geologic setting and likely ability of the strata to isolate production fluids consistent with Criteria 1 and 6 in Section 2.6.3 of NUREG-1569. Specifically,

(a) TR Section 2.6 (page 2-216) describes the pre-mining exploratory drilling program, but does not provide the number of drill holes, logging methods, and drill hole abandonment/plugging procedures.

(b) TR Section 2.6.1.3 (page 2-227) does not mention the Niobrara River structural feature in TR Figure 2.6-12 (page 2-313). According to Stout et al. (1971), this structural feature is a fault located south of the MEA site along the Niobrara River.

The Bureau of Reclamation3 indicates that the Nebraska Geological Survey mapped this fault along the length of the river valley at the site of Box Butte Dam.

Request for Additional Information

(a) Please provide information on the pre-mining exploratory boring program (e.g., the number of drill holes, logging methods, and abandonment/plugging procedures).

(b) Please provide information pertaining to Niobrara River structural feature and any other known geological structural features in the vicinity of the MEA.

NRC additional clarification dated October 23, 2013: Within and near the MEA, please further demonstrate the location of the Niobrara River Fault that is proposed by Stout et. al, (1971). This demonstration should include structural contour maps of the tops of the basal Chadron and Upper Chadron. Additionally, please demonstrate (1) the fault's structural form (e.g. fault or fold), (2) the natural confinement of the basal Chadron Sandstone where the Niobrara Structural Feature is located and/or in close proximity to the MEA, (3) whether groundwater in the basal Chadron is leaking through the Niobrara structural feature to the overlying aquifer, and (4) that the structural feature is not a safety concern for Marsland operation.

Cameco Response to NRC for RAI #9

CBR submitted a response to RAI 9 part b in December 2013 as follows:

Cameco Response: In the public meeting dated September 4, 2013, NRC requested additional discussion of Niobrara structural features and provided further clarification in its correspondence dated October 23, 2013.

Please note that Figure 2.6-12 referenced in the NRC comment is now Figure 2.6-16 due to the addition of new figures in Section 2.6. The Niobrara River structural feature has been added the figure.

The Niobrara River Fault as mapped by DeGraw (1971, in Stout et al. [1971]), is located south of the MEA (see Figure 2.6-15). The Stout et al. (1971) publication is a guidebook that was published by the Nebraska Geological Survey and is the likely source of mapping alluded to by Bureau of Reclamation on their Box Butte Dam website (http://www.usbr.gov/projects/Facility.jsp?fac_Name=Box+Butte+Dam).

Additional discussion of the Niobrara River Fault has been added to Section 2.6.1.3 of the report. In summary, DeGraw (1971) does not provide discussion of the data supporting his interpretation of the Niobrara River Fault, nor does he discuss fault offset or formations affected. Structural contour mapping of the Pre-Tertiary surface presented by DeGraw (1969) does not present data that clearly indicate the presence of a fault graben parallel to the Niobrara River. Structural contour maps of the top of the upper Chadron Formation and top of the basal sandstone of the Chadron Formation at MEA are presented as Figures 2.6-11 and 2.6-13, respectively. The Pre-Tertiary surface within the MEA boundary is represented by a structural contour map of the top of the Pierre Shale, which is presented as Figure 2.6-13.

As shown on Figure 2.6-15, the Agate Springs Fault Complex is roughly parallel to the Niobrara River Fault and is within the graben mapped by DeGraw (1971). Approximately 60 feet of throw is observed in Arikaree Group deposits along the Agate Springs Fault (Hunt 1990), but the vertical extent of the fault appears to be unresolved beyond that which can be observed in outcrop. Similar offset of Arikaree Group sediments in the southern MEA is not apparent in data presented in cross-sections (Figures 2.6-3a through 2.6-3n).

Cameco has reviewed subsurface geologic data south of MEA to determine if this feature or related faults (similar to those of the Agate Springs Fault Complex) are located within the southern AOR. Review of subsurface geologic data between the southern MEA and approximately 10 miles south of the Niobrara River indicates that the regional south-southeast sloping Pierre Shale surface continues with no discernible break. Evidence of fault offset of the top of the Pierre Shale or of younger formations in that area is not observed.

As a result, neither Cameco's proprietary data, nor data published by DeGraw (1969, 1971) are sufficient to conclusively determine the nature of the Niobrara River Fault proposed by DeGraw (1971).

As shown in cross-section A-A' (Figure 2.6-3a), the thickness of the confining unit composed of the upper Chadron Formation and middle Chadron Formation overlying the basal sandstone of the Chadron Formation maintains a generally consistent thickness of approximately 700 feet from north-to-south across the MEA. An isopach map of the confining unit is also presented as Figure 2.6-8. In the southernmost MEA (the portion of the MEA closest to the Niobrara River Fault), the confining unit is interpreted to be approximately 650 to 700 feet thick. Local variations in formation thickness observed throughout the MEA are generally attributed to incision during deposition of the overlying Brule Formation. As discussed in Section 2.7.2.3, particle size distribution (i.e. grain size analysis) of six core samples collected from the upper Chadron Formation and middle Chadron Formation indicate estimated hydraulic conductivities that range from 1.7x10-5 to 5.9x10-5 cm/sec.

Groundwater within the basal sandstone of the Chadron Formation has significantly different geochemical characteristics (e.g. TDS, conductivity) than water found within the Arikaree and Brule aquifers. Table 2.9-4 summarizes the results of baseline groundwater sampling from these aquifers. These data do not support a conclusion that the Niobrara River Fault represents a significant preferential flow pathway by which groundwater is currently travelling from the basal sandstone of the Chadron Formation to either the Brule Formation or Arikaree Group.

The structural feature in question (Niobrara River Fault, as proposed by DeGraw [1971]) is not considered to present a concern to MEA operations for the following reasons:

1. Available data do not corroborate the presence of the Niobrara River Fault as mapped by DeGraw (1971).

2. Sufficient evidence does not exist to conclude that the Niobrara River Fault intersects the basal sandstone of the Chadron Formation within the MEA boundary.

3. Pump test data do not indicate hydraulic connectivity between the basal sandstone of the Chadron Formation and overlying aquifers that could potentially exist along the Niobrara River Fault within the MEA boundary.

4. Geochemical characteristics of groundwater collected from the Arikaree Group and Brule Formation are substantially different than for water collected from the basal sandstone of the Chadron Formation, indicating a lack of cross-contamination due to leakage along the Niobrara River Fault within the MEA boundary.

Regional Structure Contour Map – Top of Pierre Shale - Revision

On March 27, 2014, during a conference call between Project Managers for the NRC and CBR, NRC Marsland Project Manager, Tom Lancaster, indicated that efforts to locate additional information about the Niobrara River Fault by NRC staff had been unproductive. In light of the limited information available, Mr. Lancaster requested that CBR make the following revisions to Figure 2.6-14 to assist with NRC assessment of the fault; (1) use contour lines in place of colored contours; (2) Reduce the relative size of the borehole locations shown on the figure; (3) Extend the map further to the east of the MEA if data exists for that area; (4) Correct and/or describe any "bull's-eyes" that may be present in the data; (5) plot on larger paper such as 11'x17', and (6) on a new figure, present a close up of similar information for the southern portion of the Area Of Review (AOR).

Attached with this response is Figure 1 that incorporates the suggested revisions to the Regional Pierre Surface map that will be included in a revised Figure 2.6-14. Figure 1 is marked as a DRAFT at this time and is presented to determine if it meets NRC approval. Likewise, Figure 2 shows similar information for only the southern portion of the AOR and is included to provide greater detail in the vicinity of the MEA.

Both figures depict the Pierre Formation surface topography, Cameco drill hole locations, MEA permit boundary, location of the Niobrara River, and the proposed Niobrara River Fault location as depicted by DeGraw(1971). All drill holes depicted have been completed by Cameco Resources or its predecessors and the depths to the Pierre surface determined from geophysical logs. The regional map utilizes a 15 foot contour interval, and the smaller-scale Southern Area Of Review map uses a 5 foot contour interval. Neither map shows the closely stacked east-west

trending contour intervals that would be expected along the proposed Niobrara River Fault had the Pierre Formation surface been offset due to faulting along the proposed fault.

Request for Additional Cross-Section Data

In addition to the revised Pierre surface maps, Mr. Lancaster also requested that cross-section data extending to the south of the proposed Niobrara River Fault location be presented. CBR geologists have prepared three regional cross-sections that extend from one and a half miles south of the MEA permit boundary (south of the proposed Niobrara River Fault) northward though the Marsland Permit Area, the Crow Butte License Area and the North Trend Permit Area. Figure 3 of this report shows these cross-sections and a map of their location. Each of the three sections, R0, R1 and R2, cross the proposed locations of the Niobrara River Fault, Cochran Arch, Pine Ridge Fault and White River Fault. The principle cross-section, R1-R1' runs from south of the MEA northward through the center of the project along the same transect as A-A' (MEA TR Figure 2.6-3a), and continues to the northwest, intersecting the Crow Butte Project and the North Trend Expansion Area. Sections R0 and R2 are located approximately one mile east and one mile west of R1 respectively. These regional cross-sections would be included as an appendix to the Technical Report.

The cross-sections shown on Figure 3 represent the Mean Sea Level elevation for the stratigraphic picks for the top of the Pierre Formation, top of the basal sands of the Chadron Formation, and a pair of persistent marker beds that are prominent on nearly all of the geophysical logs located south of the Pine Ridge escarpment. The top of each log has been selected based on surveyed ground elevation. The cross-sections are shown both in proportionate scale and with the vertical scale exaggerated 10x to enhance vertical clarity. All depth picks presented on Figure 3 were determined from geophysical log data for each hole. Figures 4, 5 and 6 each depict the respective cross-sections in 10x vertical exaggeration showing the geophysical log along with the corresponding marker horizons.

White River Fault

While this report is primarily a response to NRC's request for additional information about the Niobrara River Fault structure, the regional cross-sections are presented to show the regional geologic structure and to demonstrate the ability to pick out structural features using the available geophysical data. Clearly, all three cross-sections have intersected the White River Fault/Fold in the northern portions of each section. The White River Fault/Fold displays a maximum offset of approximately 470 feet of displacement with the north side downthrown. Close spaced drilling across the fault by CBR shows that the fault is manifested as a significant subsurface fold interpreted to be a deep fault that offsets lower portions of the Pierre and deeper strata and has deformed the overlying portions of the Pierre and younger sediments.

Pine Ridge Fault

In 1969, DeGraw proposed the Pine Ridge Fault on the basis of subsurface data observations and concluded that the normal fault had a north side down displacement of approximately 300 feet. The Pine Ridge Fault should be located between the Crow Butte License Area and the MEA. A review of the cross-sections presented with this report as well as the sections presented in the Three Crow Expansion Area Class III UIC Permit Application and included on Figure 3, do not support evidence for the reported offset of this fault. Swinehart et al. (1985) reported normal faulting along the feature that postdates the Upper Harrison member of the Arikaree Group but does not identify the location of the observed offset. The regional cross-sections do not show evidence of the Pine Ridge Fault as described by DeGraw(1969) and Swinehart(1985).

Cochran Arch

The Cochran Arch as proposed by DeGraw (1969) is located between the MEA and the Crow Butte Licensed Area. This subsurface arch was proposed on the basis of detailed studies of deep oil and gas test hole data collected from Pre-Tertiary sub-surface geology. The axis of the arch is thought to parallel the Pine Ridge Fault, and roughly follows the Pine Ridge escarpment. A review of the cross-sections presented with this report show the location of the proposed arch. Measurements of the regional incline from south to north along the cross-sections average approximately 1.25 degrees. This northward inclination is likely due to regional uplift associated with the Black Hills Uplift. The Cochran Arch as shown on the cross-sections may be interpreted as an east-west trending structural arch with a gentle dipping southern limb, and a sharply-dipping northern limb bounded by the White River Fault/Fold.

Niobrara River Fault

The Niobrara River Fault, as proposed by DeGraw in 1969 and modified in 1971, is a western extension of the Hyannis-North Platte Fault system and was thought to be the northern boundary of a graben which contains the Niobrara River Valley. An unnamed fault is assumed to form the southern boundary of the graben. These faults appear to be generally continuous with the Agate Springs Fault Complex of eastern Sioux County (Hunt 1990). Approximately 60 feet of displacement of Arikaree Group sediments has occurred along one of these faults and similar offset would be expected along the proposed Niobrara Fault.

A review of the cross-sections (Figure 3 through 6) shows little evidence of offset strata within the area identified by DeGraw as the location of the Niobrara River Fault. A comparison of the variations within the Pierre and basal sandstone surfaces show that those variations are not repeated in the overlying marker beds, and thus are interpreted to be the result of weathering and depositional variation. The data presented in this report will be incorporated into the text of the Technical Report and the maps will be included as figures or an additional appendix.

Figure 1

Marsland Pierre Surface Elevation Contour 15' CI-2014

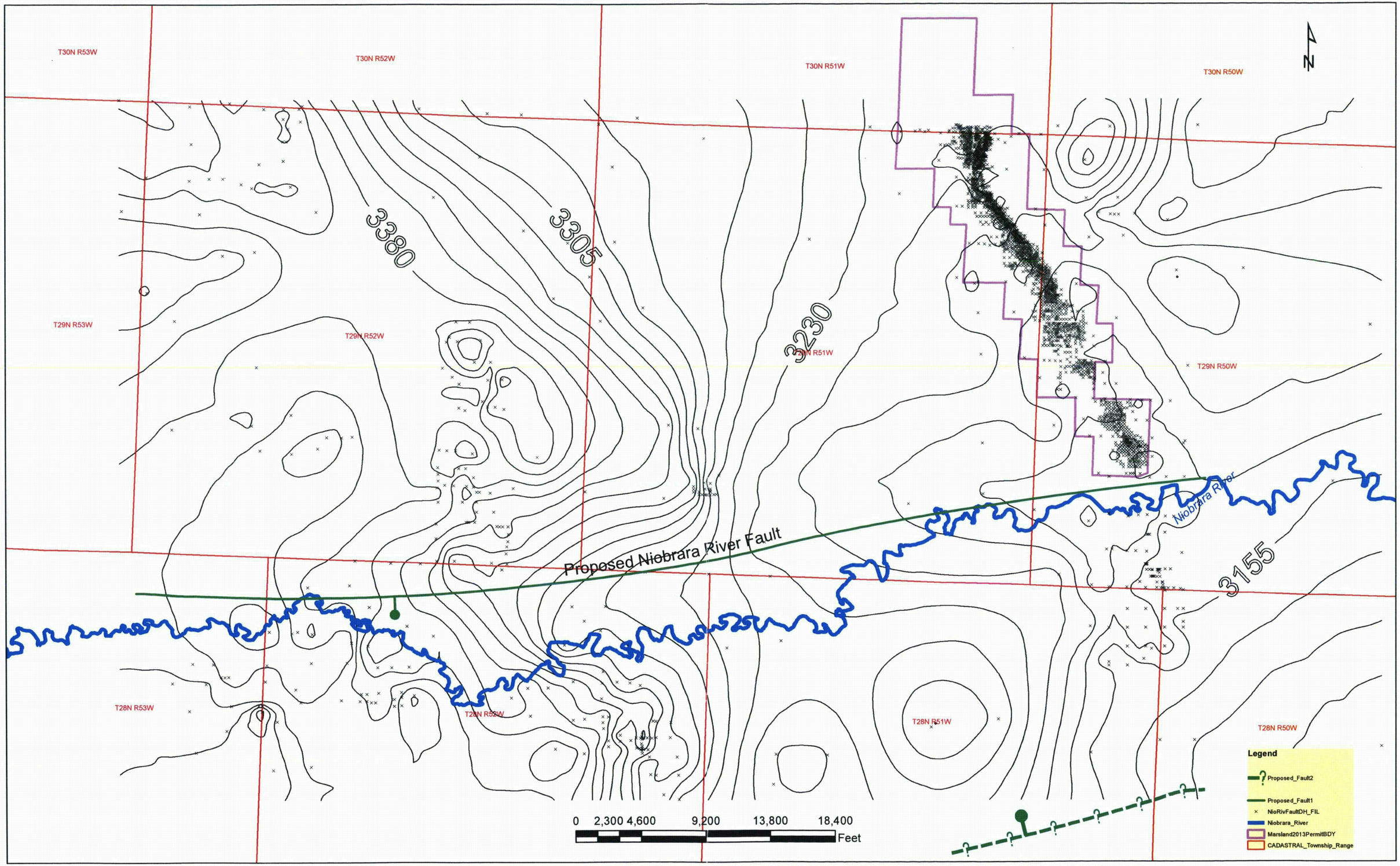
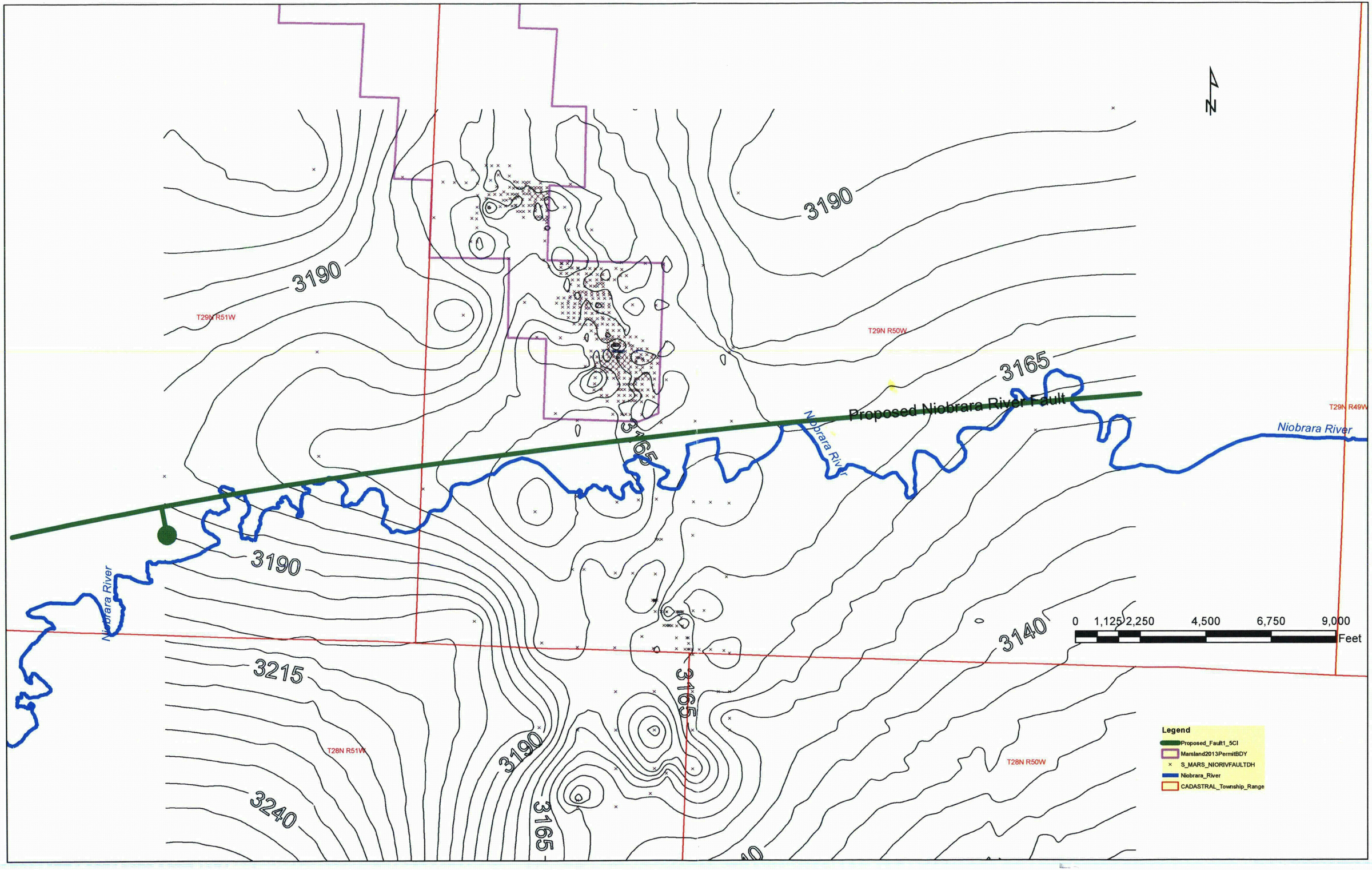


Figure 2

South Marsland Pierre Surface Elevation Contour 5' CI-2014



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