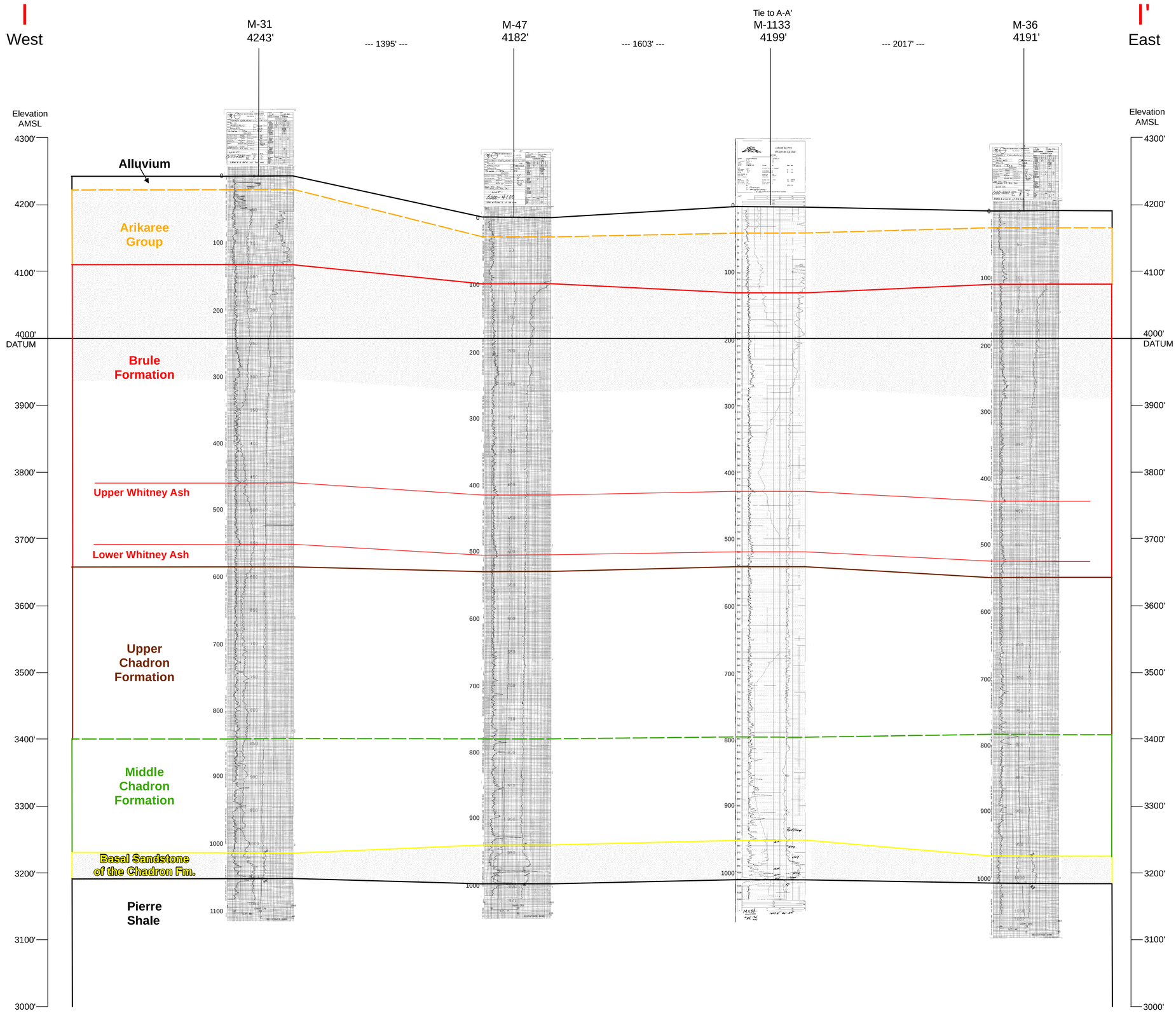


Legend

Vertical Scale

0 feet

50 feet

100 feet

200 feet

Horizontal Scale
as Designated

Geophysical Log Explanation

Gamma Ray Curve

Resistivity Curve

Spontaneous Potential (SP) Curve

Saturated Zone

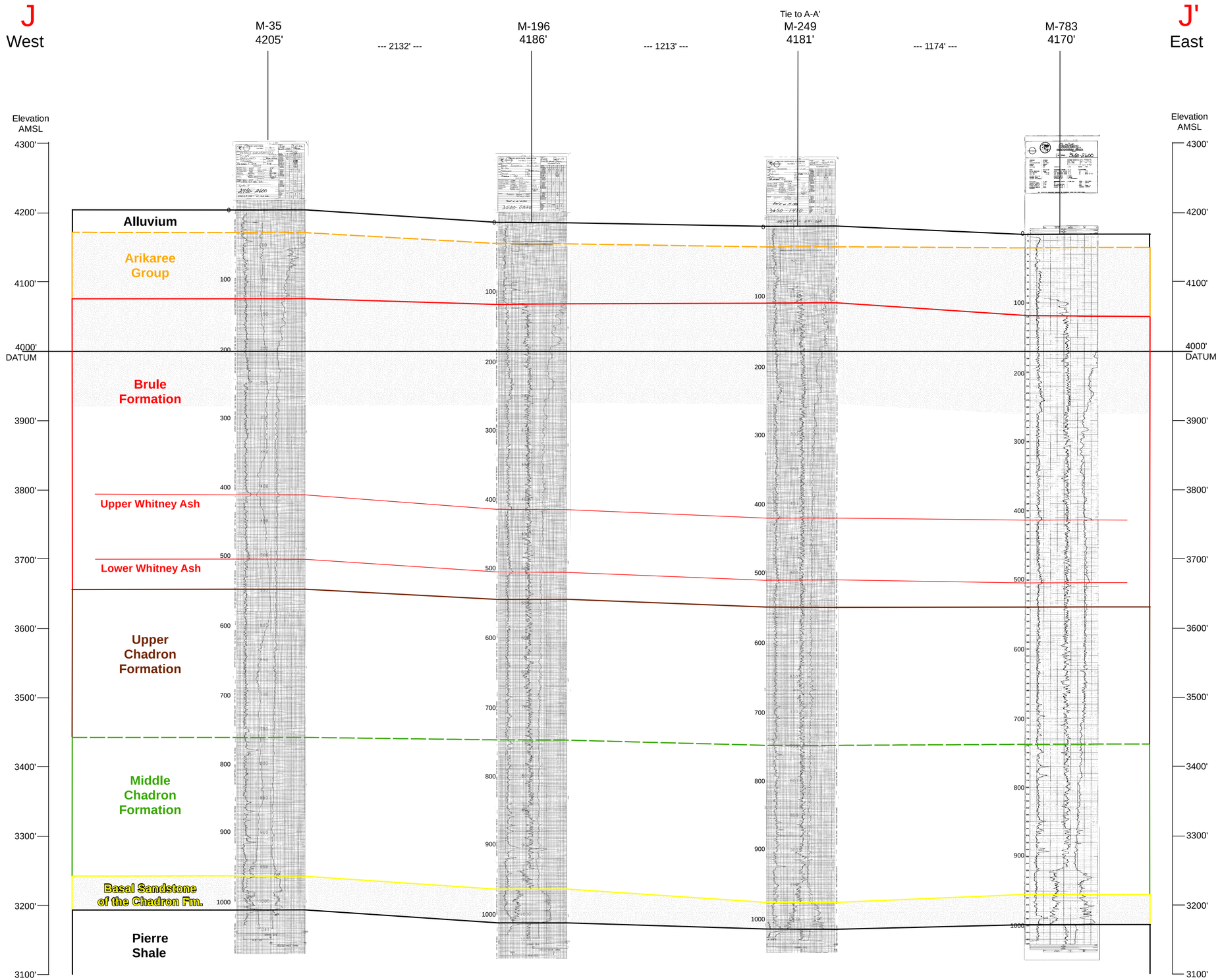
AMSL: Above Mean Sea Level

Crow Butte Resources, Inc

Figure 2.6-3i
Marsland Structural
Cross Section I-I'

Scale: See Scale Bar	Date: 12/8/2016
C:\Users\ca0142\Desktop\DBOW TEMP\TR-NRC\TR_I-I'.mxd	Checked by: JS

Looking North



Legend

Vertical Scale

0 feet

50 feet

100 feet

200 feet

Horizontal Scale
as Designated

Geophysical Log Explanation

Gamma Ray Curve

Resistivity Curve

Spontaneous Potential (SP) Curve

Saturated Zone

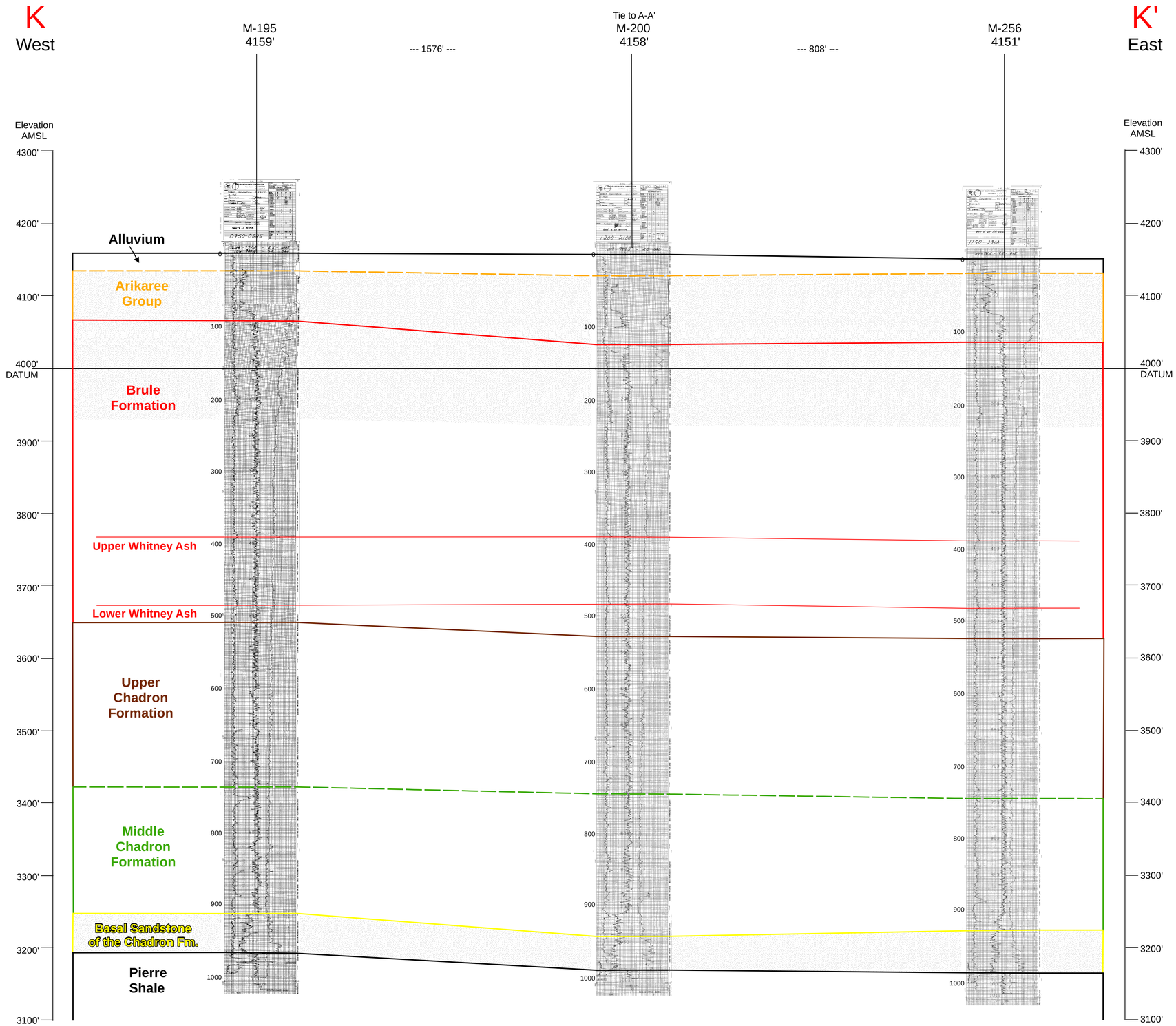
AMSL: Above Mean Sea Level

Crow Butte Resources, Inc

Figure 2.6-3j
Marsland Structural
Cross Section J-J'

Scale: See Scale Bar	Date: 12/8/2016
C:\Users\ca041426\Desktop\DBOW TEMP\TR-NRC\TR_J-J'.mxd	Checked by: JS

Looking North



Legend

Vertical Scale

0 feet

50 feet

100 feet

200 feet

Geophysical Log Explanation

Gamma Ray Curve

Resistivity Curve

Spontaneous Potential (SP) Curve

Saturated Zone

Horizontal Scale
as Designated

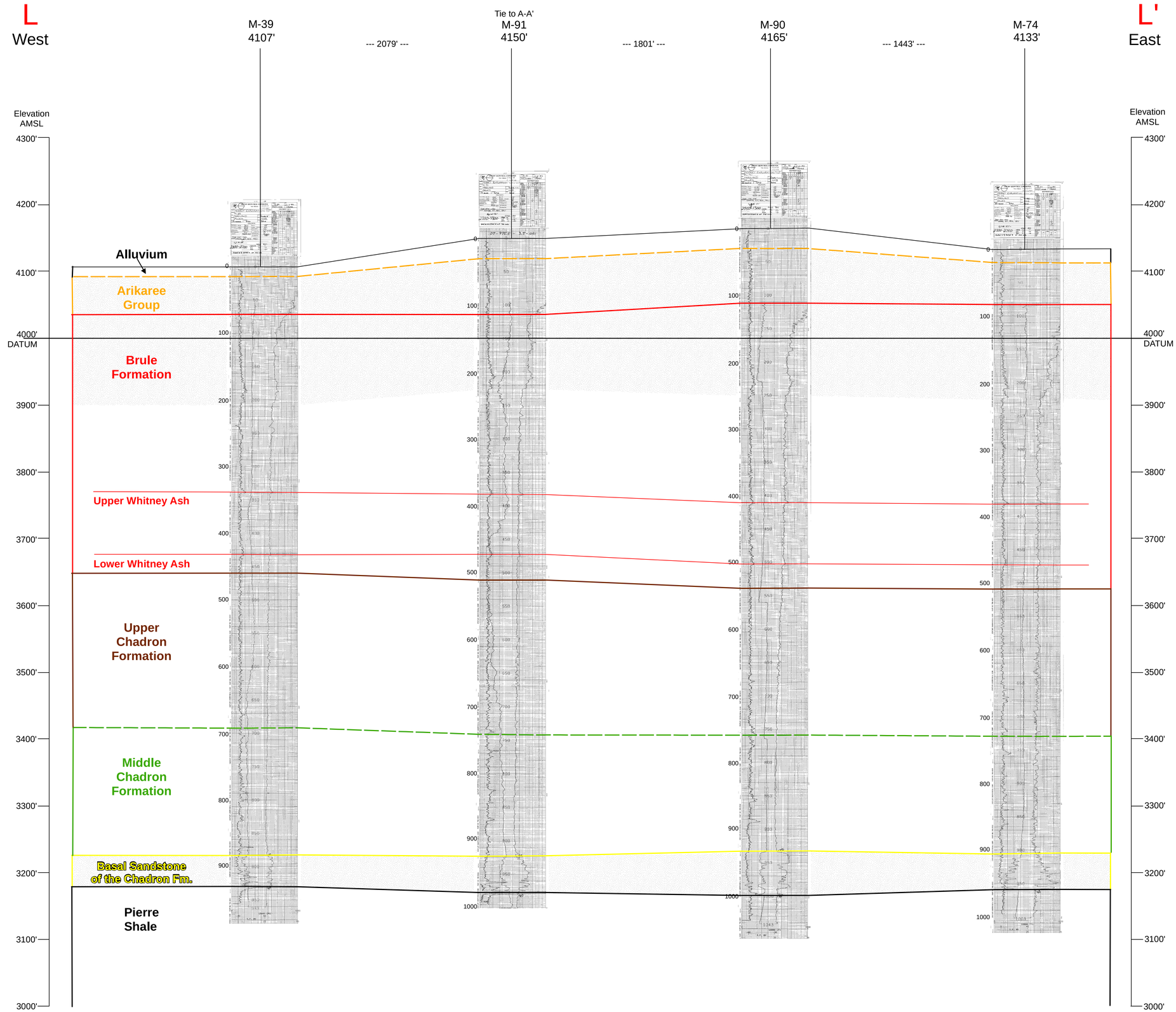
AMSL: Above Mean Sea Level

Crow Butte Resources, Inc

Figure 2.6-3k
Marsland Structural
Cross Section K-K'

Scale: See Scale Bar	Date: 12/8/2016
C:\Users\ca041420\Desktop\DBOW TEMP\TR-NRC\TR_K-K'.mxd	Checked by: JS

Looking North



Legend

Vertical Scale

0 feet

50 feet

100 feet

200 feet

Horizontal Scale
as Designated

Geophysical Log Explanation

Gamma Ray Curve

Resistivity Curve

Spontaneous Potential (SP) Curve

Saturated Zone

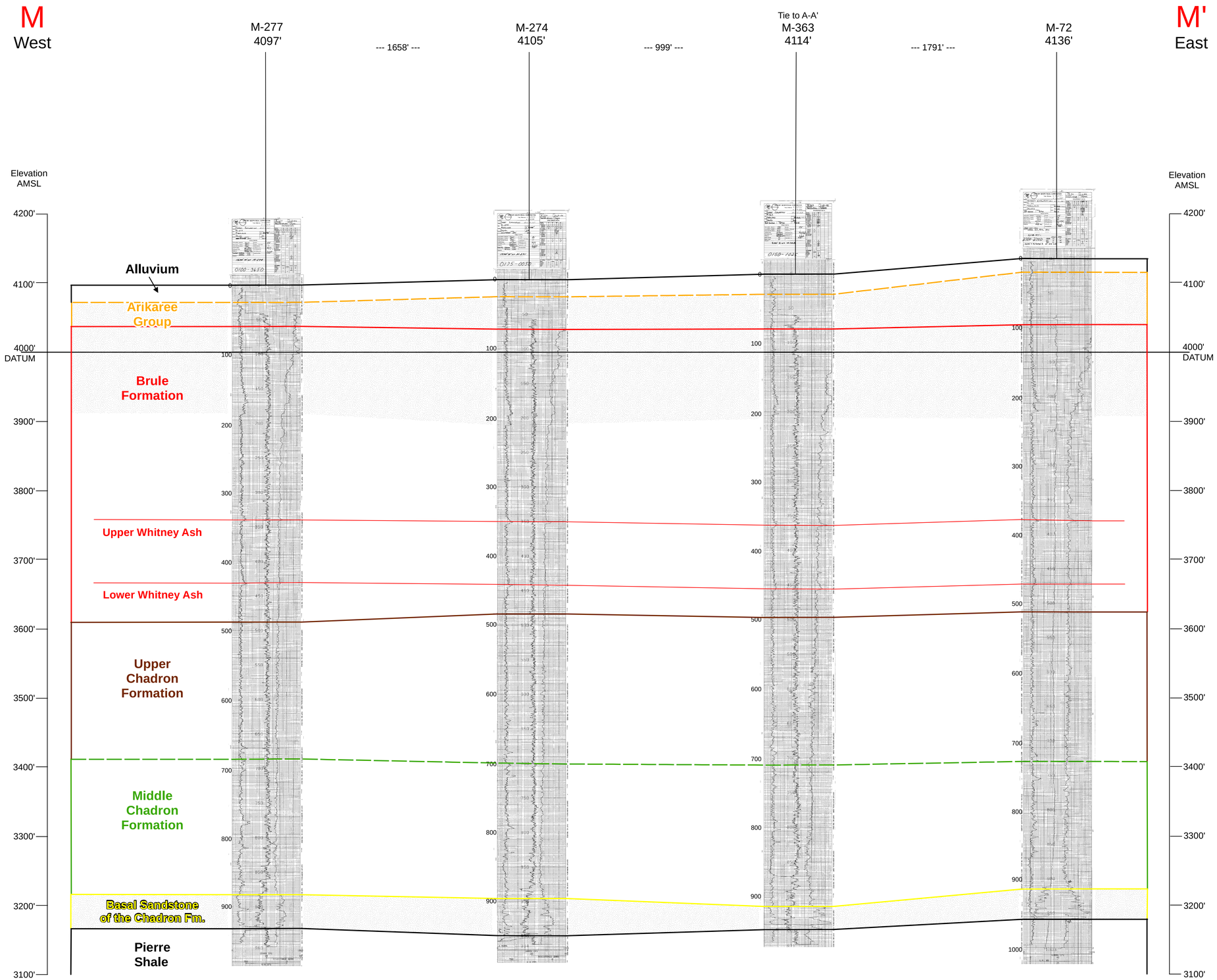
AMSL: Above Mean Sea Level

Crow Butte Resources, Inc

Figure 2.6-3l
Marsland Structural
Cross Section L-L'

Scale: See Scale Bar	Date: 12/8/2016
C:\Users\ca041428\Desktop\DBDW TEMP\TR NRC\TR_L-L'.mxd	Checked by: JS

Looking North



Legend

Vertical Scale

0 feet

50 feet

100 feet

200 feet

Horizontal Scale
as Designated

Geophysical Log Explanation

Gamma Ray Curve

Resistivity Curve

Spontaneous Potential (SP) Curve

Saturated Zone

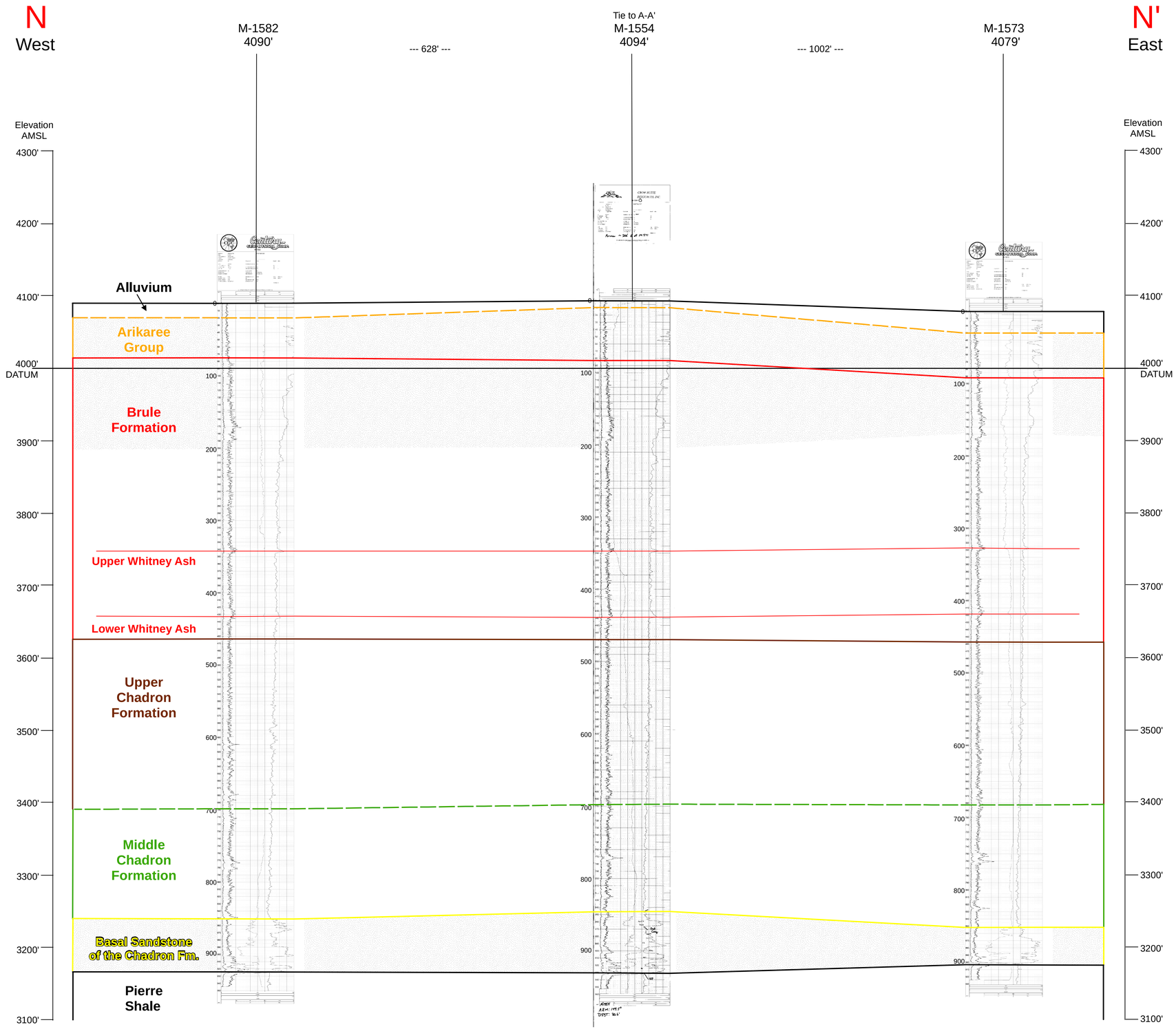
AMSL: Above Mean Sea Level

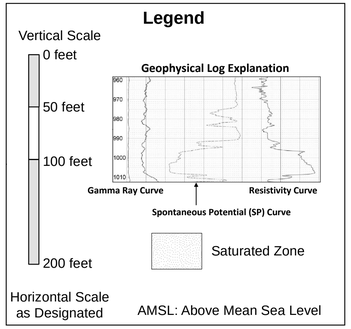
Crow Butte Resources, Inc

Figure 2.6-3m
Marsland Structural
Cross Section M-M'

Scale: See Scale Bar	Date: 12/8/2016
C:\Users\ica041426\Desktop\DBOW TEMP\TR-NRC\TR_M-M'.mxd	Checked by: JS

Looking North





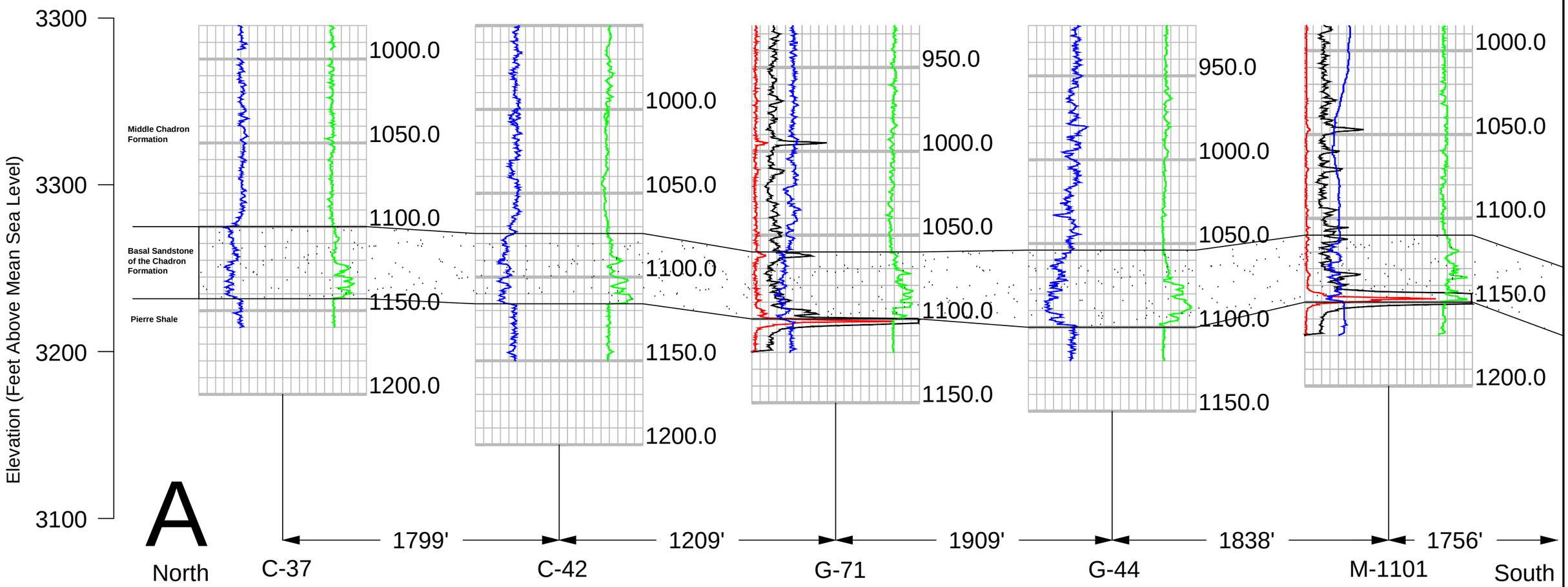
Crow Butte Resources, Inc

Figure 2.6-3n
Marsland Structural
Cross Section N-N'

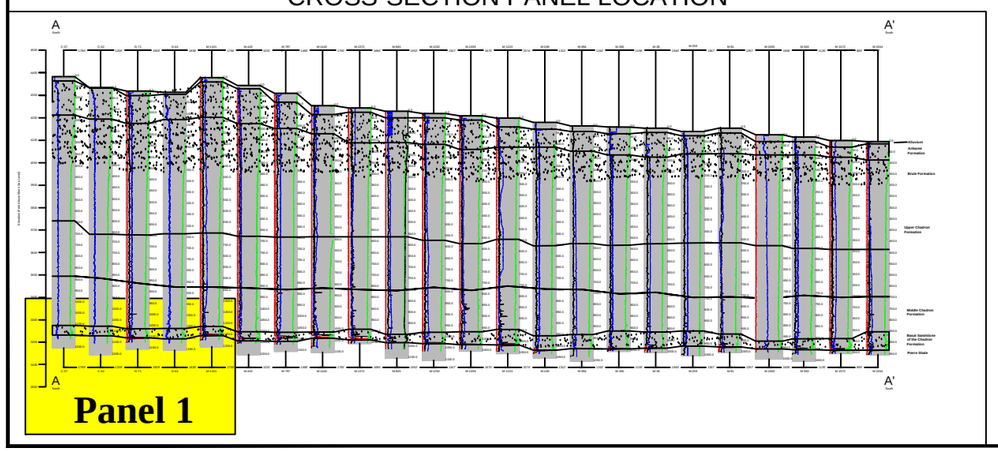
Scale: See Scale Bar	Date: 12/8/2016
C:\Users\ca041420\Desktop\DBOW TEMP\TR-NRC\TR_N-N'.mxd	Checked by: JS

Looking North

Marsland Cross-Section A-A' - Panel 1



CROSS-SECTION PANEL LOCATION



Vertical Scale	Legend
0 25 Meters 0 50 100 Feet	Main Lithology Sandstone Gamma Curve Neutron or SP Curve Resistivity Curve

Crow Butte Resources, Inc.

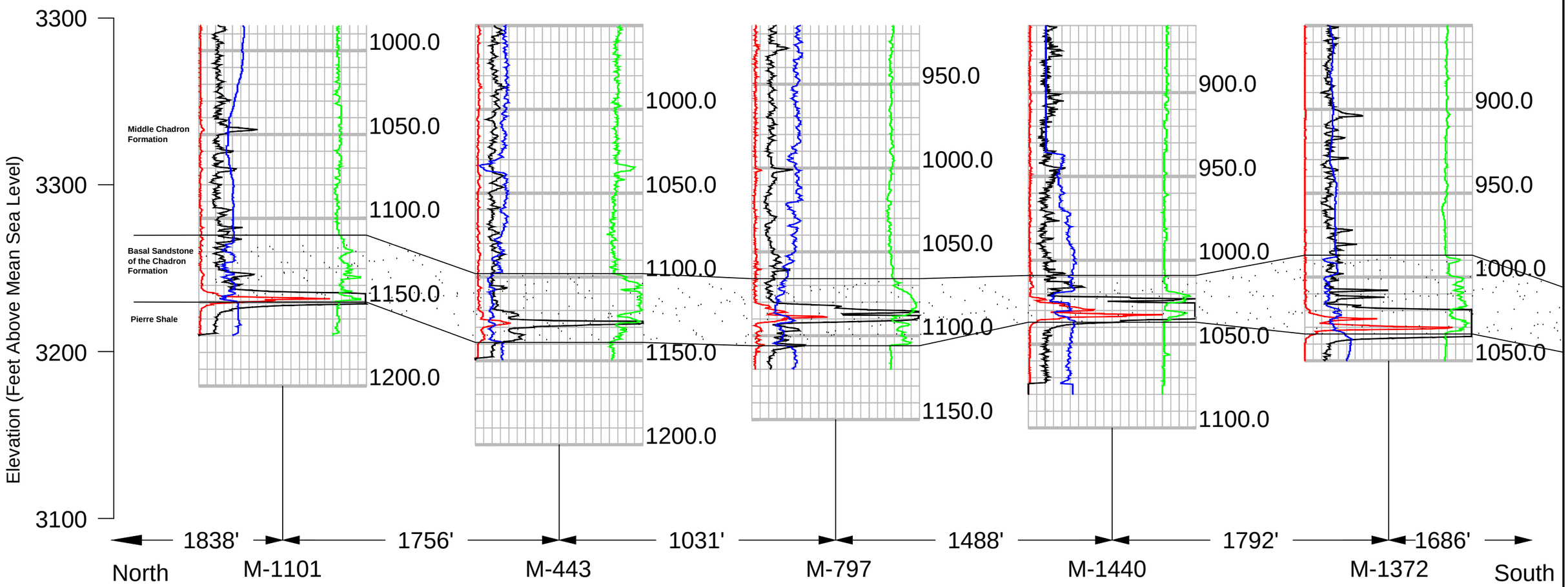
FIGURE 2.6-3o

EXPANDED MARSLAND CROSS SECTION A-A'

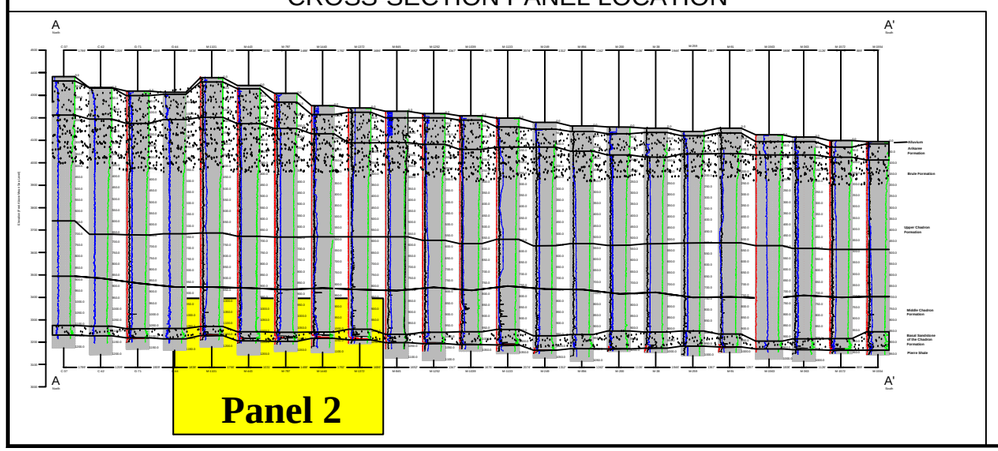
PANEL 1

Scale: See Bar Scale	Date: September 2015	
MEA_NRCTR_Figure 2.6-3o.pdf		By: WB

Marsland Cross-Section A-A' - Panel 2



CROSS-SECTION PANEL LOCATION



Vertical Scale	Legend
0 — 25 Meters 0 — 50 — 100 Feet	Main Lithology Sandstone Gamma Curve Neutron or SP Curve Resistivity Curve

Crow Butte Resources, Inc.

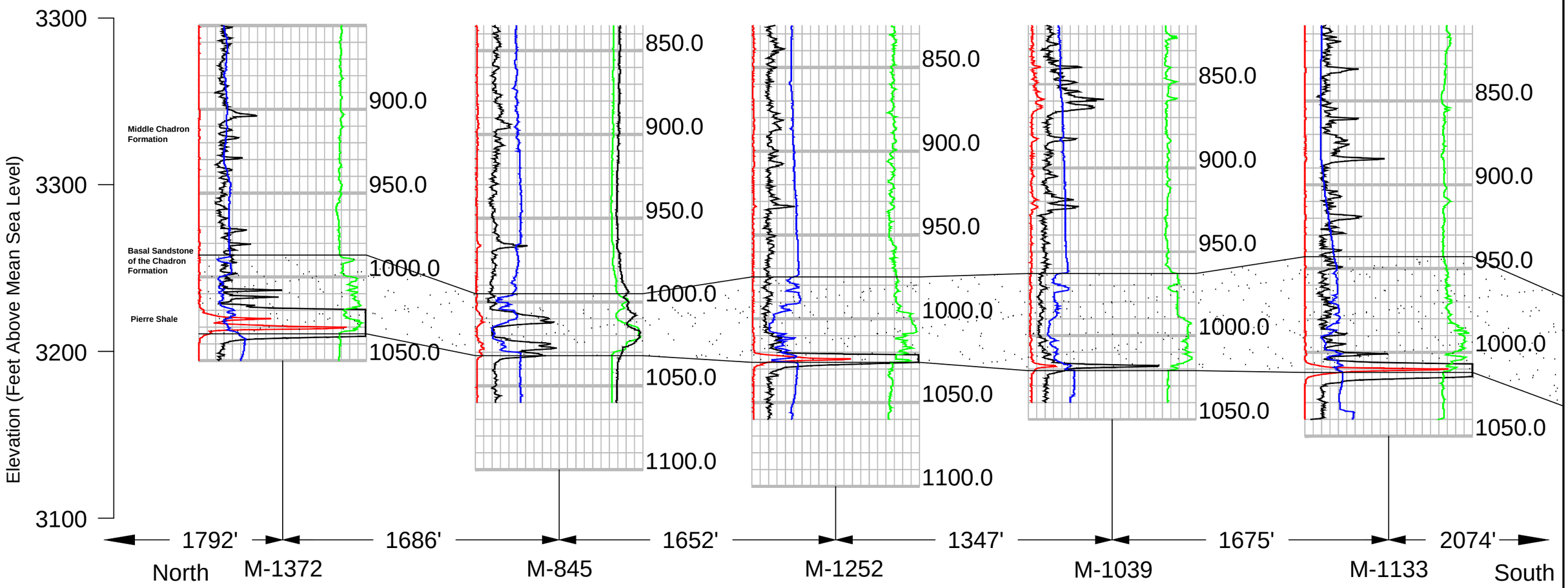
FIGURE 2.6-3p

EXPANDED MARSLAND CROSS SECTION A-A'

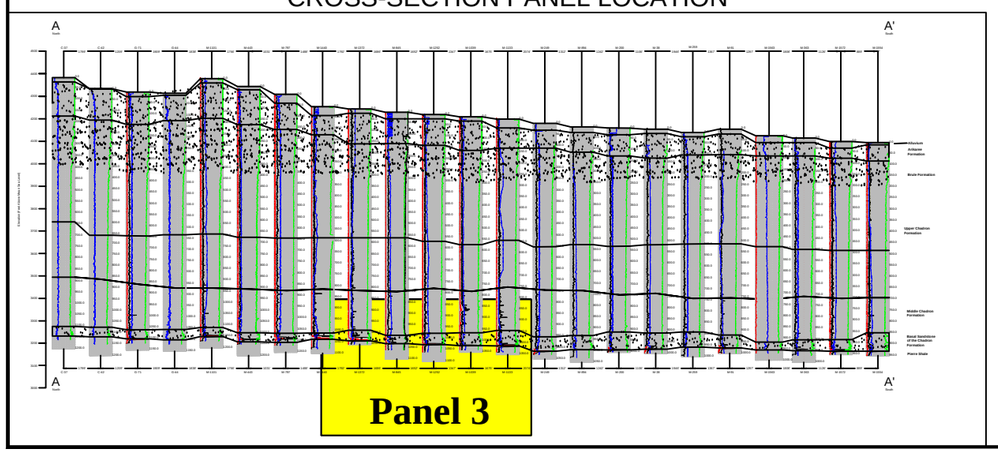
PANEL 2

Scale: See Bar Scale	Date: September 2015	
MEA_NRCTR_Figure 2.6-3p.pdf		By: WB

Marsland Cross-Section A-A' - Panel 3



CROSS-SECTION PANEL LOCATION



Vertical Scale	Legend
0 — 25 Meters 0 — 50 — 100 Feet	Main Lithology Sandstone Gamma Curve Neutron or SP Curve Resistivity Curve

Crow Butte Resources, Inc.

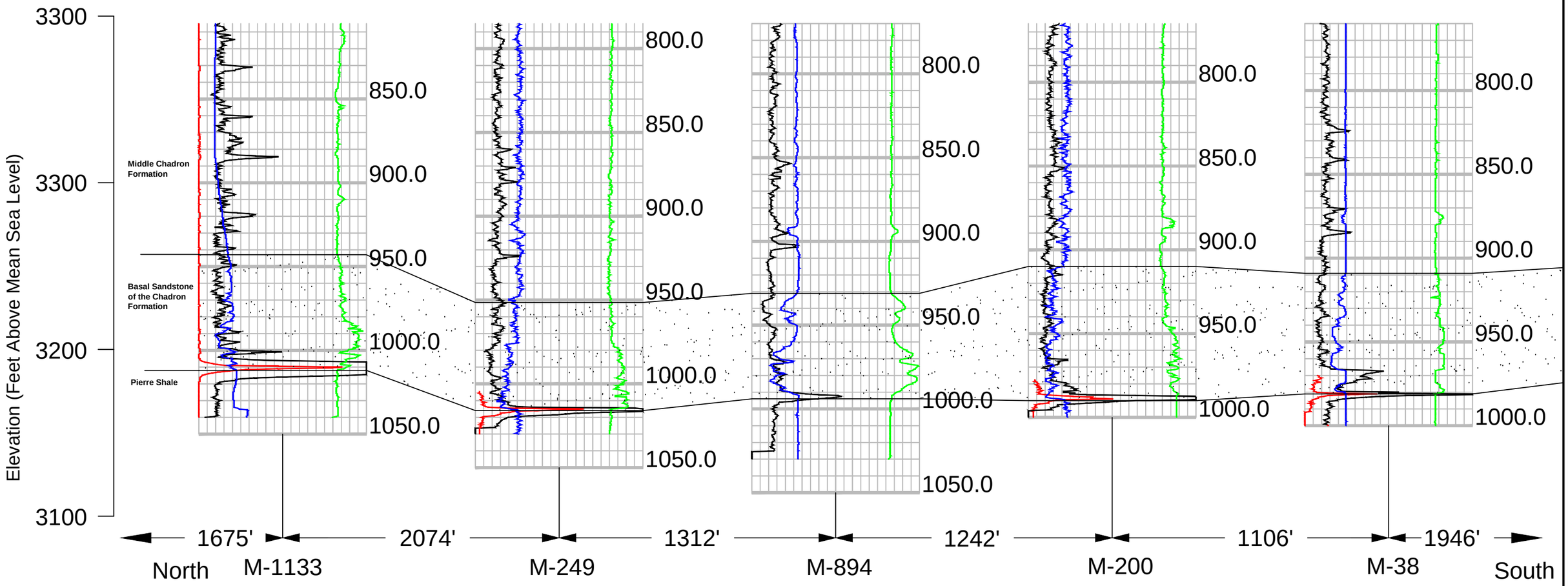
FIGURE 2.6-3q

EXPANDED MARSLAND CROSS SECTION A-A'

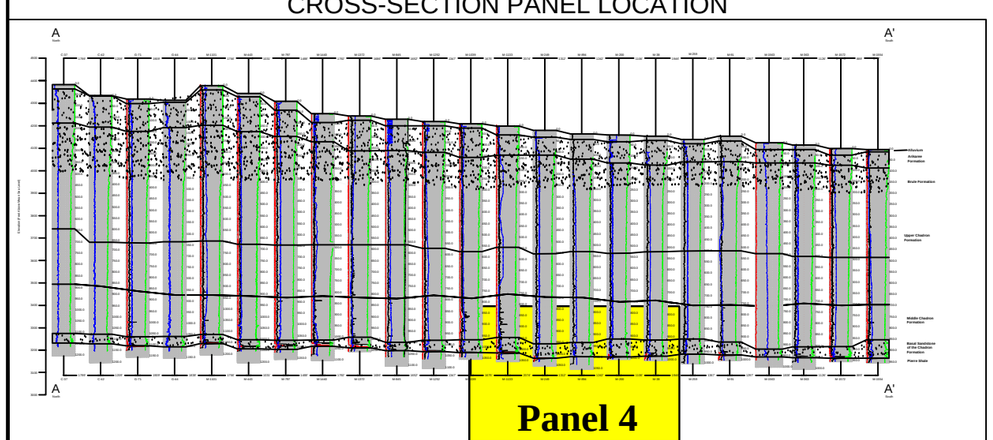
PANEL 3

Scale: See Bar Scale	Date: September 2015	
MEA_NRCTR_Figure 2.6-3q.pdf		By: WB

Marsland Cross-Section A-A' - Panel 4



CROSS-SECTION PANEL LOCATION



Vertical Scale	Legend
0 — 25 Meters 0 — 50 — 100 Feet	Main Lithology Sandstone Gamma Curve Neutron or SP Curve Resistivity Curve

Crow Butte Resources, Inc.

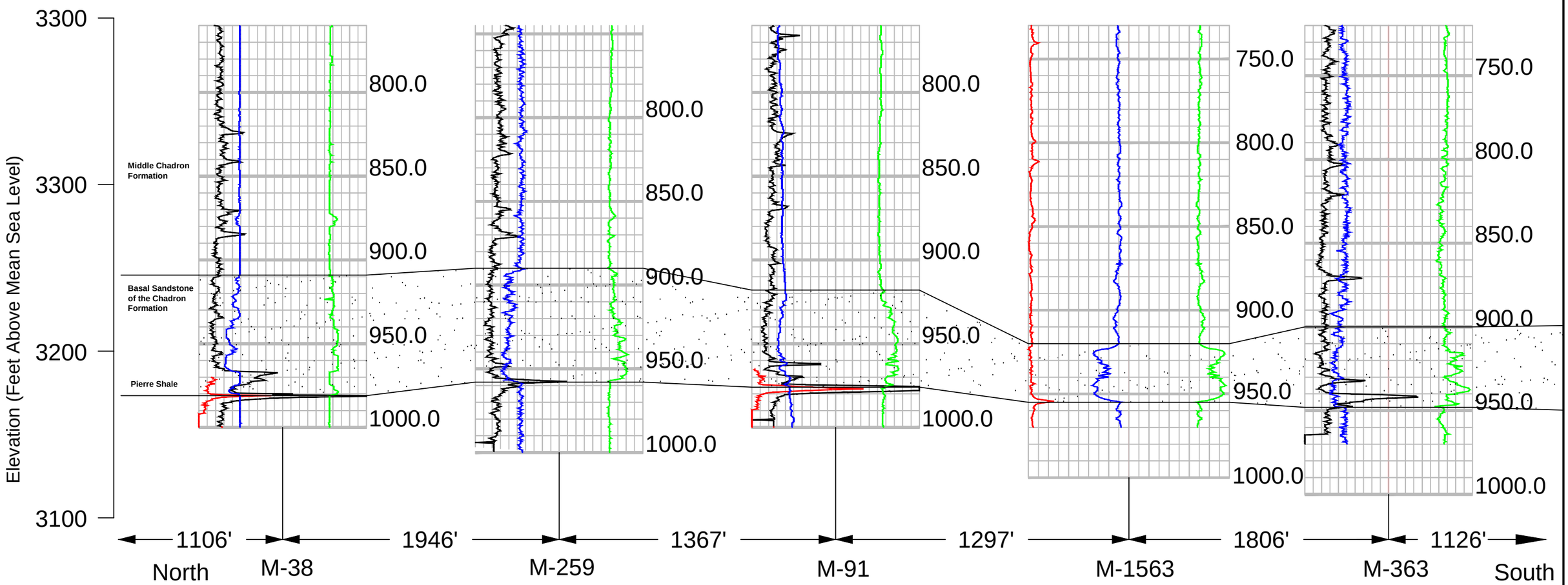
FIGURE 2.6-3r

EXPANDED MARSLAND CROSS SECTION A-A'

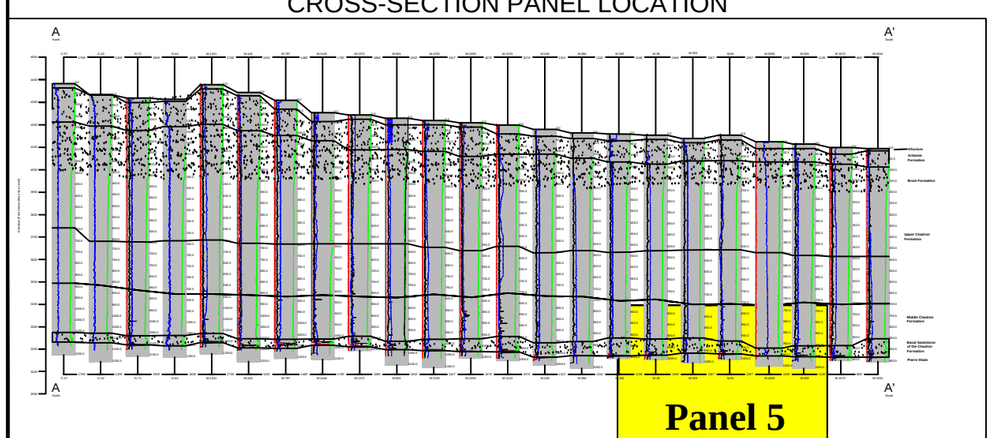
PANEL 4

Scale: See Bar Scale	Date: September 2015	
MEA_NRCTR_Figure 2.6-3r.pdf		By: WB

Marsland Cross-Section A-A' - Panel 5



CROSS-SECTION PANEL LOCATION



Vertical Scale	Legend
0 — 25 Meters 0 — 50 — 100 Feet	Main Lithology Sandstone Gamma Curve Neutron or SP Curve Resistivity Curve

Crow Butte Resources, Inc.

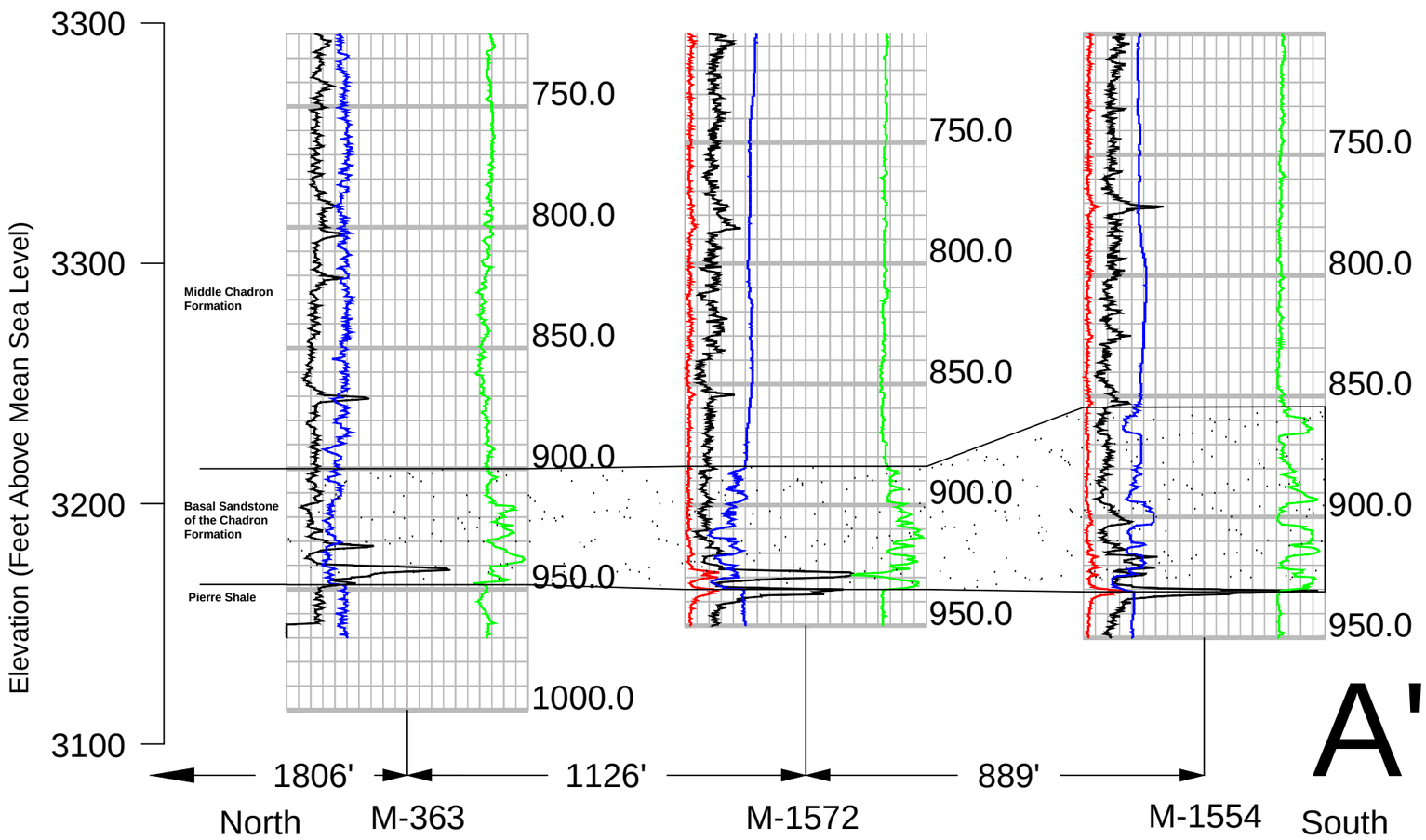
FIGURE 2.6-3s

EXPANDED MARSLAND CROSS SECTION A-A'

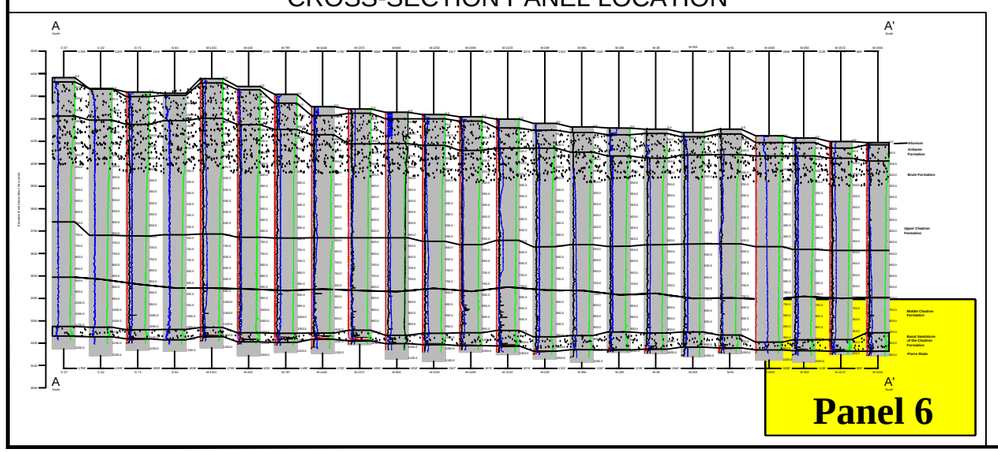
PANEL 5

Scale: See Bar Scale	Date: September 2015	
MEA_NRCTR_Figure 2.6-3s.pdf		By: WB

Marsland Cross-Section A-A' - Panel 6



CROSS-SECTION PANEL LOCATION



Vertical Scale	Legend
0 — 25 Meters 0 — 50 — 100 Feet	Main Lithology Sandstone Gamma Curve Neutron or SP Curve Resistivity Curve

Crow Butte Resources, Inc.

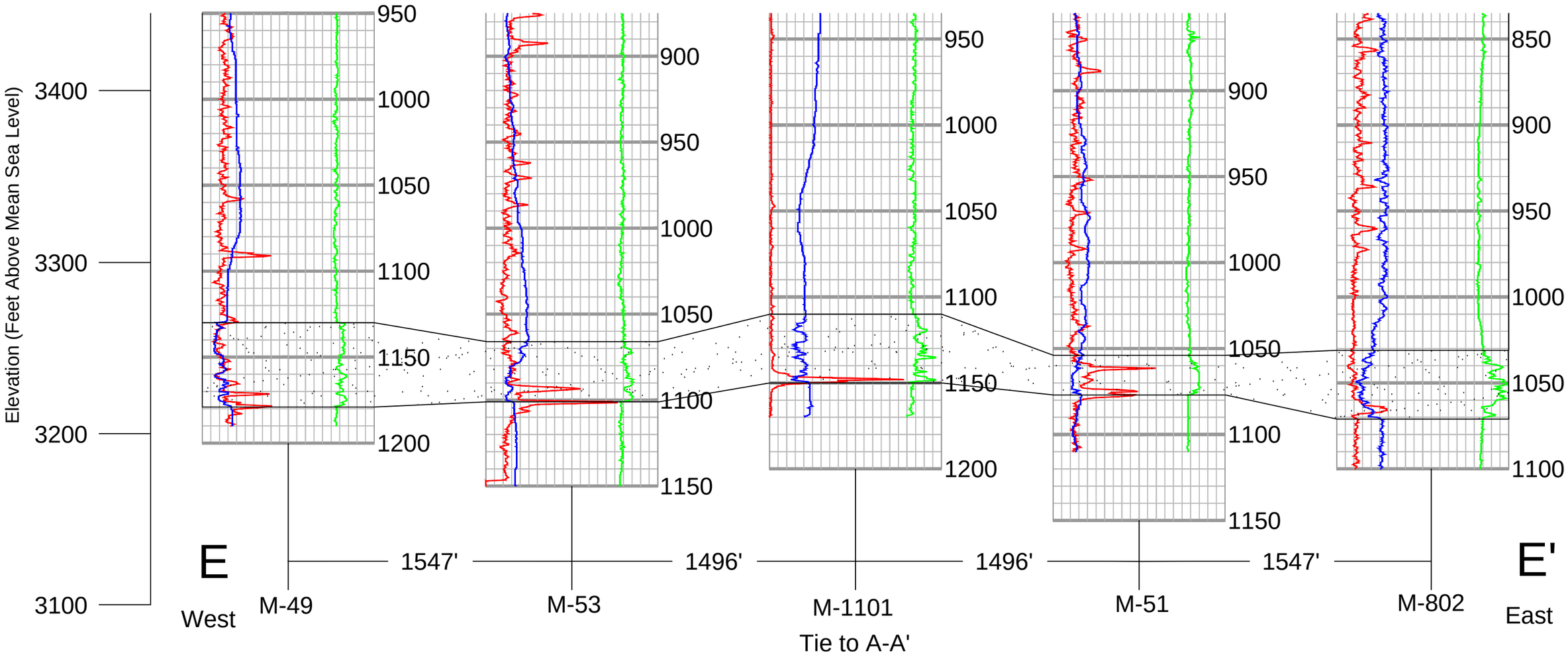
FIGURE 2.6-3t

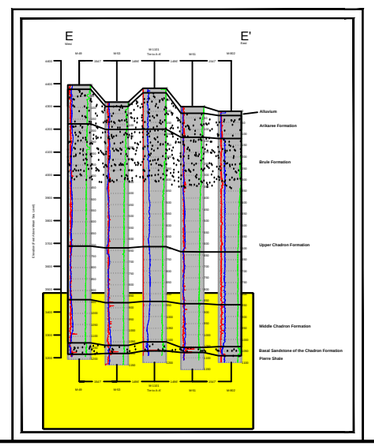
EXPANDED MARSLAND CROSS SECTION A-A'

PANEL 6

Scale: See Bar Scale	Date: September 2015	
MEA_NRCTR_Figure 2.6-3t.pdf		By: WB

Expanded Marsland Cross-Section E-E'





Vertical Scale	Legend
0 — 25 Meters 0 — 50 — 100 Feet	Main Lithology Sandstone Gamma Curve Neutron or SP Curve Resistivity Curve

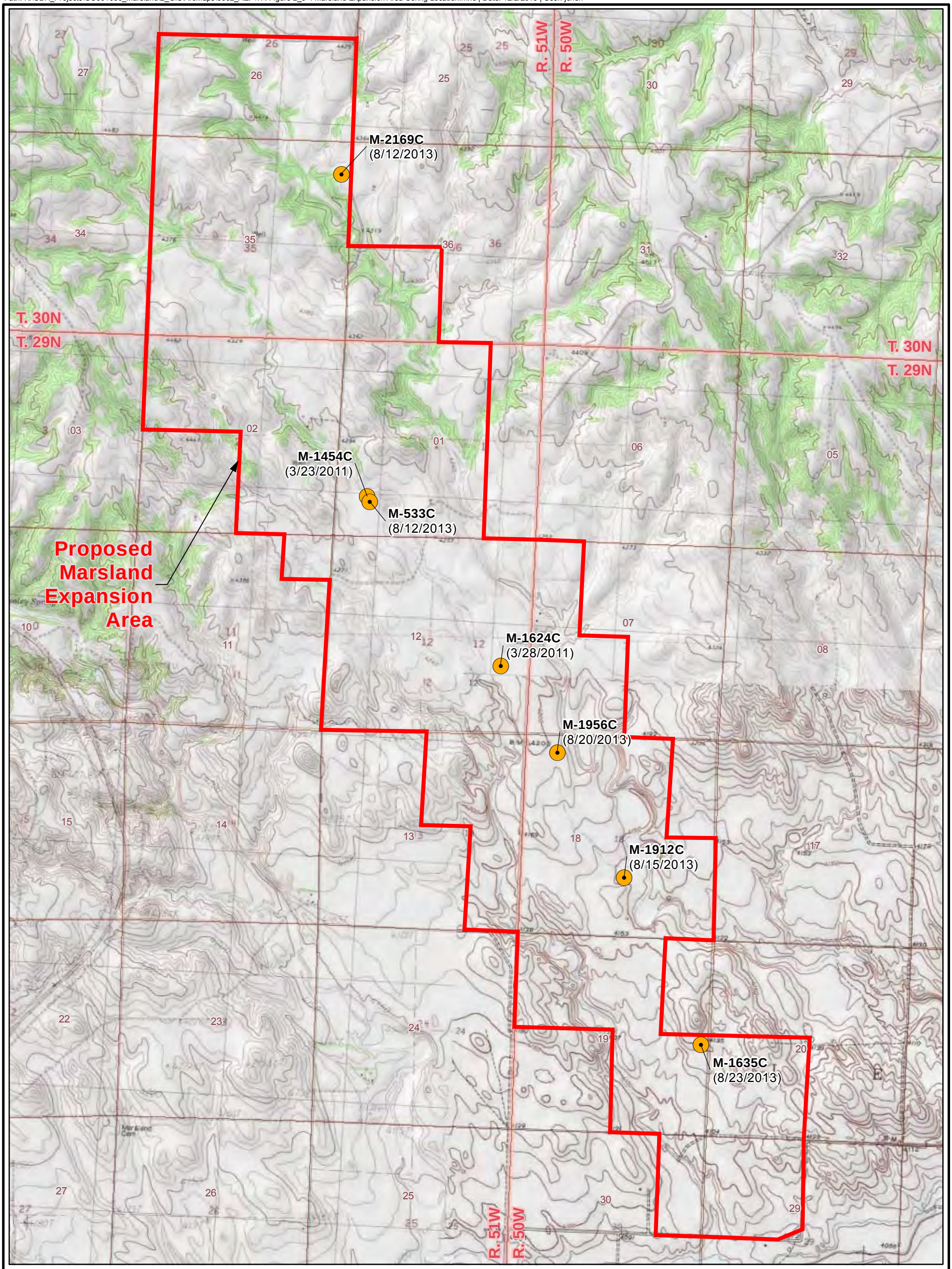
Crow Butte Resources, Inc.

FIGURE 2.6-3u

EXPANDED MARSLAND CROSS SECTION E-E'

Scale: See Bar Scale	Date: September 2015	
MEA_NRCTR_Figure 2.6-3u.pdf		By: WB

Path: K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0002_AEP\TR Figure 2_6-4 Marsland Expansion Area Coring Location.mxd | Date: 12/2/2013 | User: jchen



LEGEND

- Coring Location
- Proposed Marsland Expansion Area
- **M-1635C** Location ID
- (8/23/2013) Date of Collection

N

0 1,250 2,500

Feet

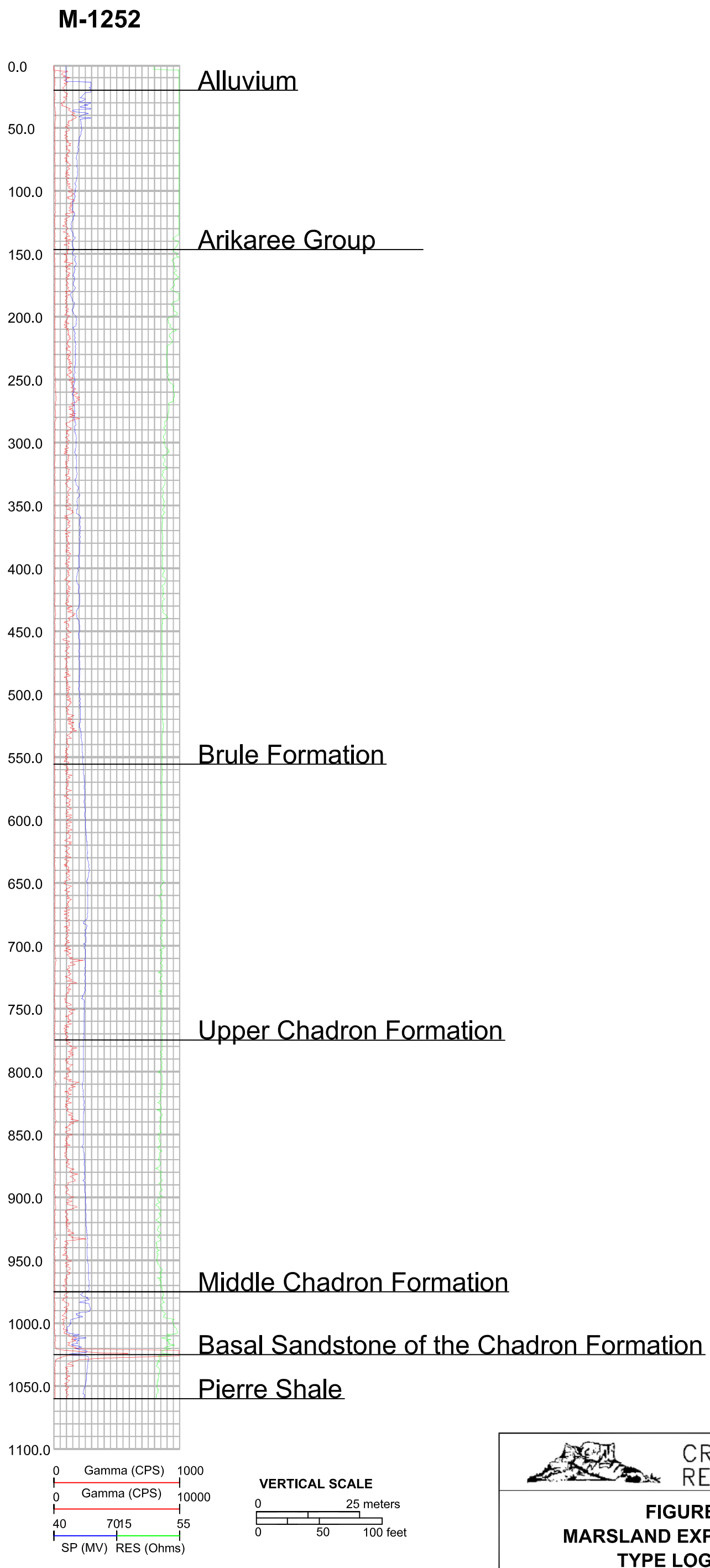
PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

FIGURE 2.6-4
MARSLAND EXPANSION AREA
CORING LOCATIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

ARCADIS
630 Plaza Drive, Ste. 100
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com



CROW BUTTE RESOURCES, INC.

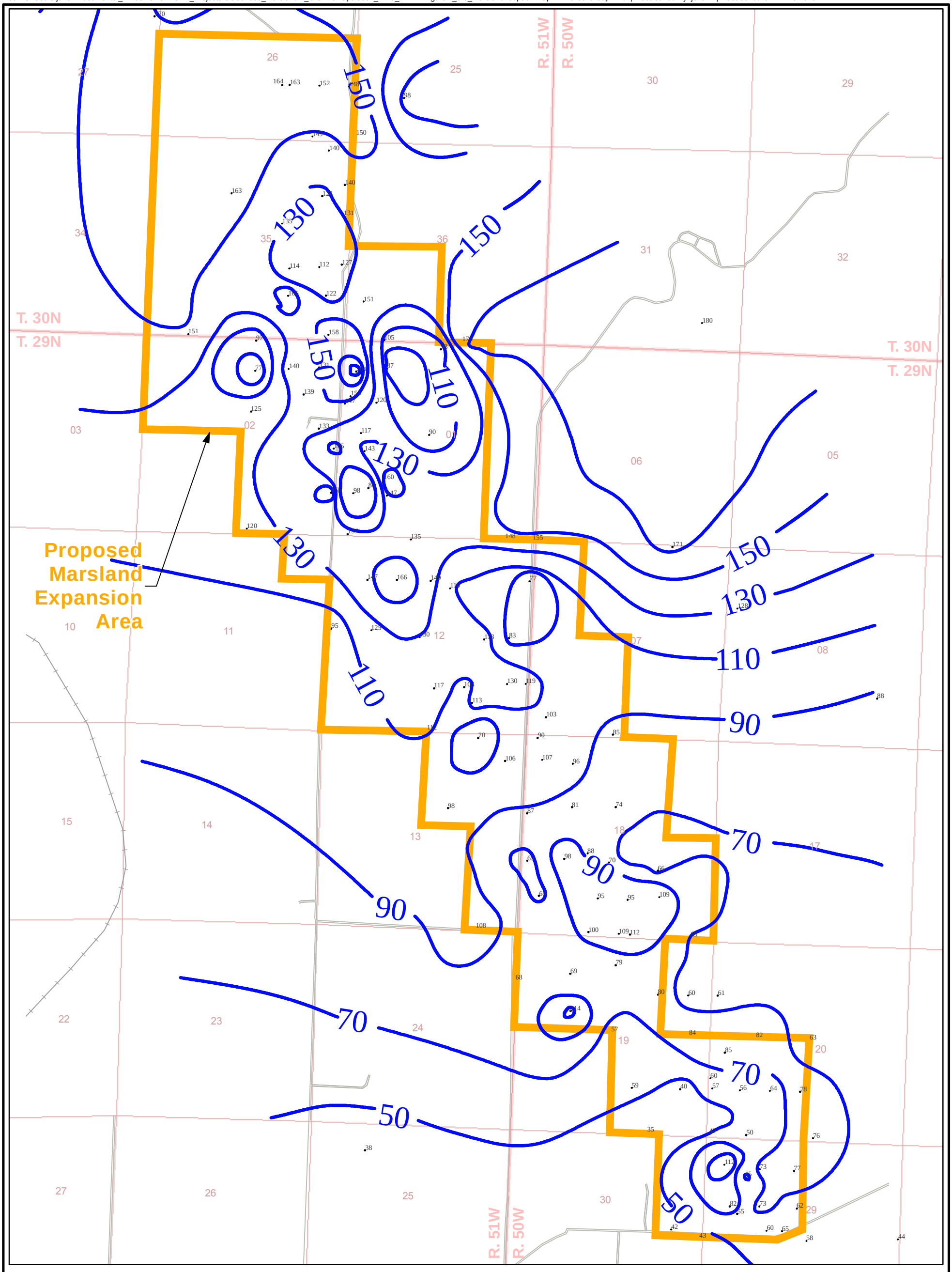
FIGURE 2.6-5
MARSLAND EXPANSION AREA
TYPE LOG (M-1252)

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JA

ARCADIS
630 Plaza Drive, Ste. 100
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com

Source: Cameco Resources, 2011

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_6-6_Marsland Isopach Map - Arikaree Group.mxd | Last Saved By: jchen | Last Saved On: 11/15/2013



LEGEND

- Proposed Marsland Expansion Area
- 38 Borehole Location and Unit Thickness Reading (Feet)
- Isopach Contour (Feet)
- Railroad
- Road

N

0 1,250 2,500

Feet

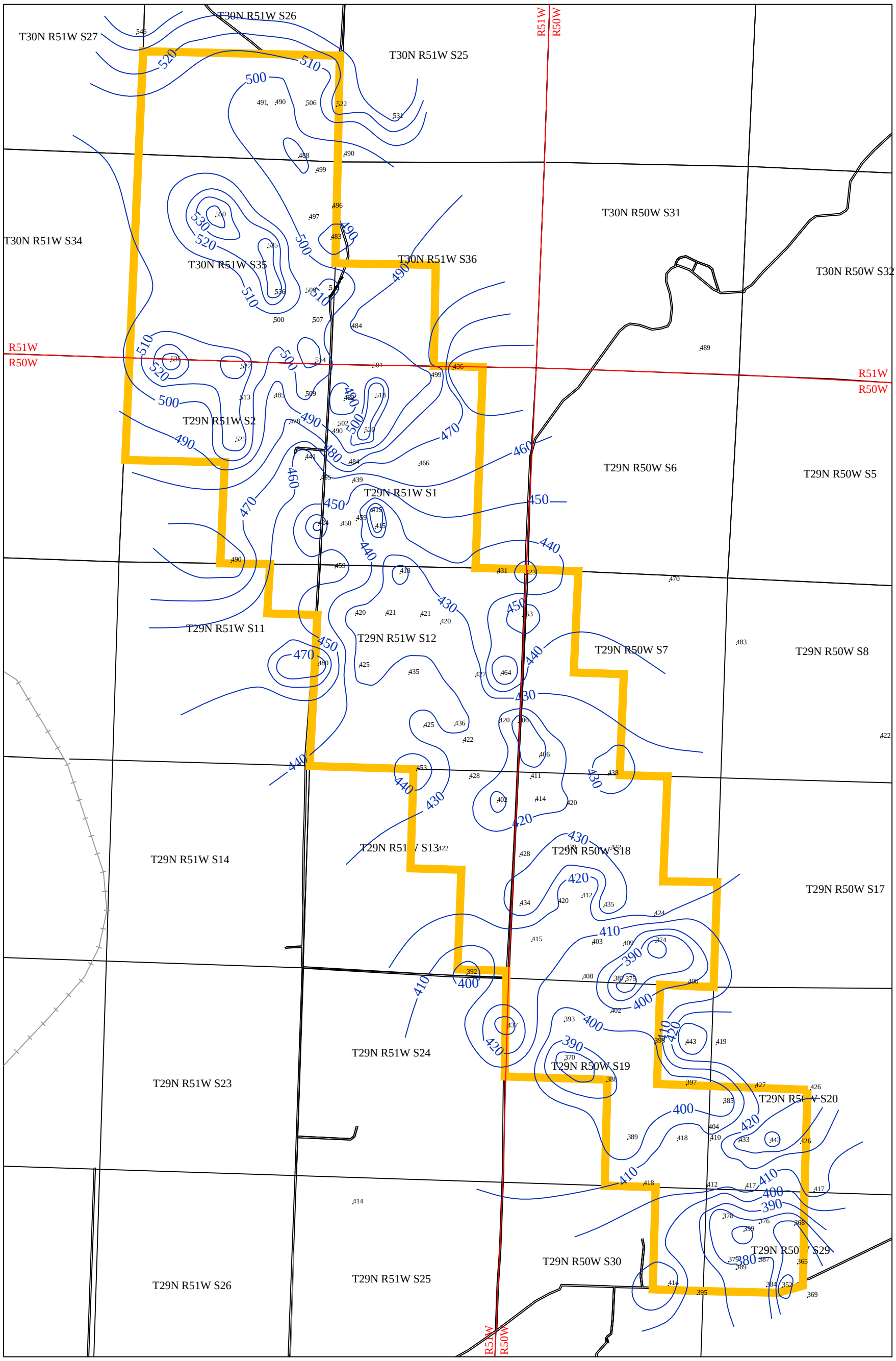
PROJECTION: NAD 1927, STATE PLANE NEBRASKA NORTH, FIPS 2601

CROW BUTTE RESOURCES, INC.

FIGURE 2.6-6
MARSLAND ISOPACH MAP
ARIKAREE GROUP

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

ARCADIS
630 Plaza Drive, Ste. 100
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com



LEGEND

- Proposed Marsland Expansion Area
- 362 Borehole Location and Unit Thickness (FT)
- Isopach Contour - Unit Thickness (FT)
- Railroad
- Road

N

0 2000 4000 FEET

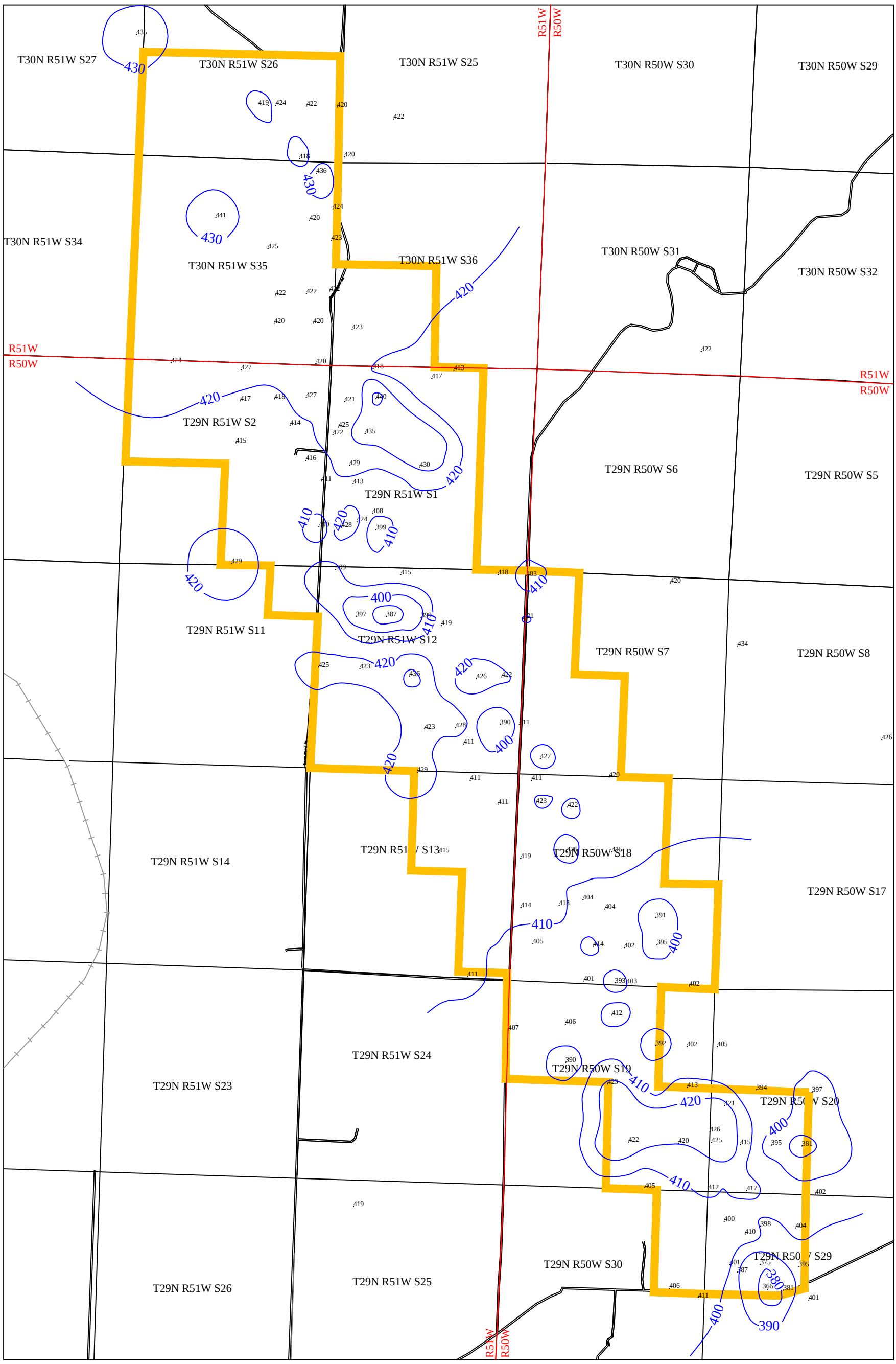
PROJECTION: NAD 1983, STATE PLANE
NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS – USGS

Crow Butte Resources, Inc.

Figure 2.6-7

Marsland Isopach Map
Brule Formation

Scale: See Bar Scale	Date: September 2015
MEA_NRCTR_Figure 2.6-7.pdf	By: WB



LEGEND

- Proposed Marsland Expansion Area
- 419 Borehole Location and Unit Thickness (FT)
- Isopach Contour - Unit Thickness (FT)
- Railroad
- Road

N

0 2000 4000 FEET

PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS – USGS

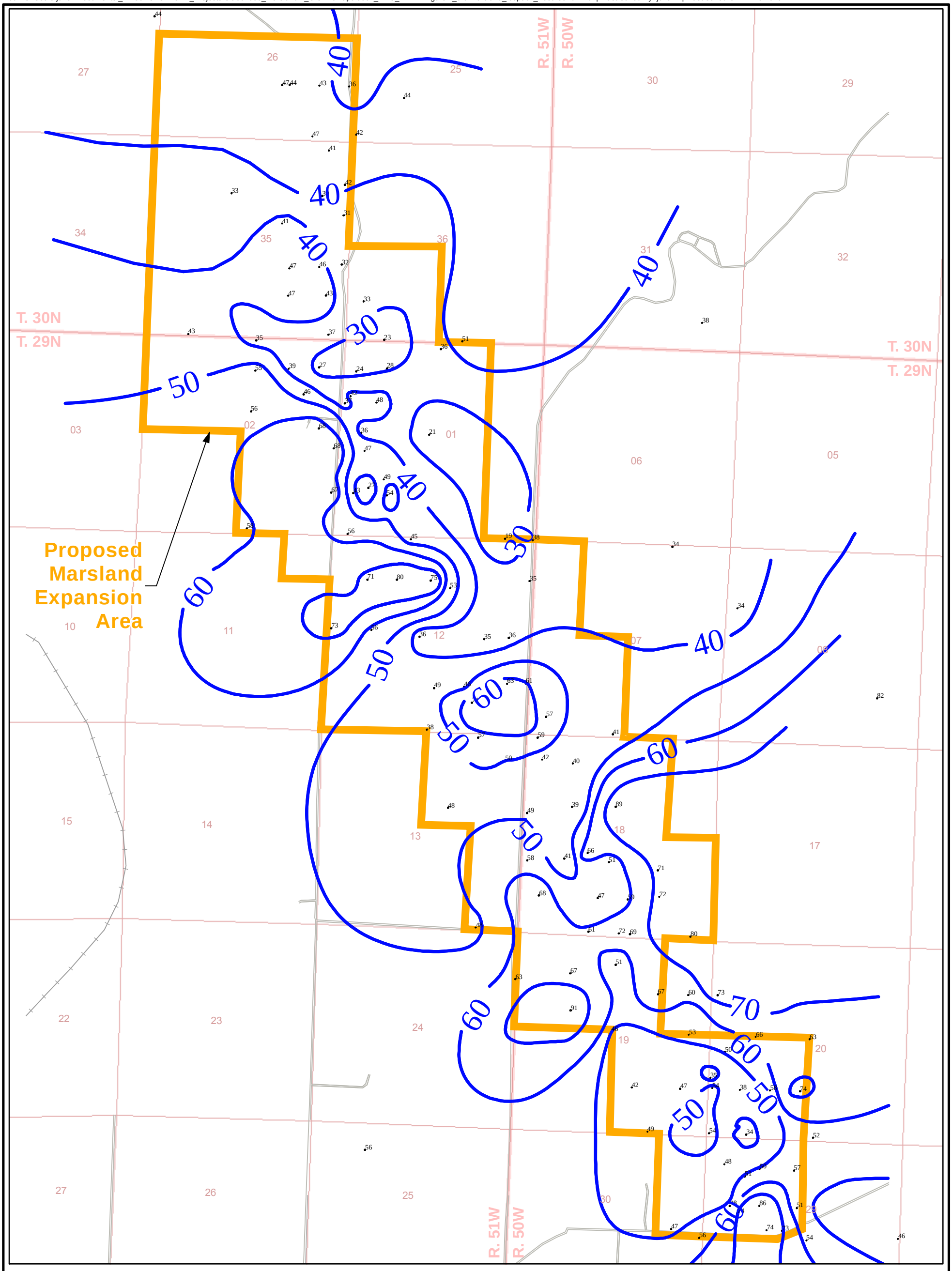
Crow Butte Resources, Inc.

Figure 2.6-8

Marsland Isopach Map
Upper and Middle
Chadron Formation

Scale: See Bar Scale	Date: September 2015
MEA_NRCTR_Figure 2.6-8.pdf	By: WB

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_6-9 Marsland_Isopach_BasalSand.mxd | Last Saved By: jchen | Last Saved On: 11/15/2013



LEGEND

- Proposed Marsland Expansion Area
- 46 Borehole Location and Unit Thickness Reading (Feet)
- Isopach Contour (Feet)
- Railroad
- Road

N

0 1,250 2,500

Feet

PROJECTION: NAD 1927, STATE PLANE NEBRASKA NORTH, FIPS 2601

CROW BUTTE RESOURCES, INC.

FIGURE 2.6-9
MARSLAND ISOPACH MAP
BASAL SANDSTONE OF
THE CHADRON FORMATION

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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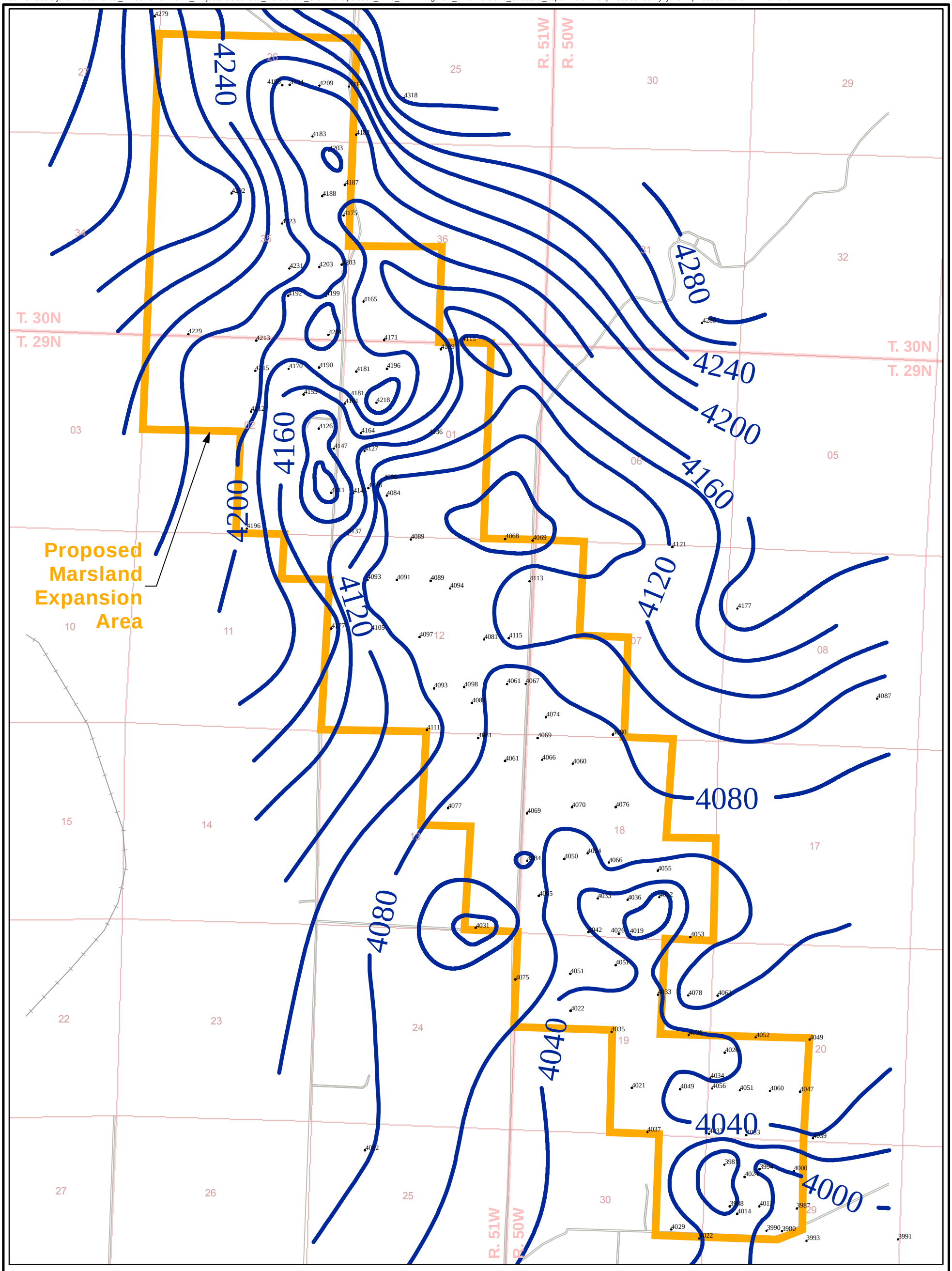
630 Plaza Drive, Ste. 100
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_6-10 Marsland_Structure_TopOfBrule.mxd | Last Saved By: jchen | Last Saved On: 11/15/2013



LEGEND

- Proposed Marsland Expansion Area
- 4021 Borehole Location and Elevation - Top of Brule Formation (FT-AMSL)
- Elevation Contour - Top of Brule Formation (FT-AMSL)
- Railroad
- Road

FT-AMSL = Feet Above Mean Sea Level

N

0 1,250 2,500

Feet

PROJECTION: NAD 1927, STATE PLANE NEBRASKA NORTH, FIPS 2601

CROW BUTTE RESOURCES, INC.

FIGURE 2.6-10
MARSLAND STRUCTURE MAP
TOP OF BRULE FORMATION

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

ARCADIS
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Highlands Ranch, CO 80129
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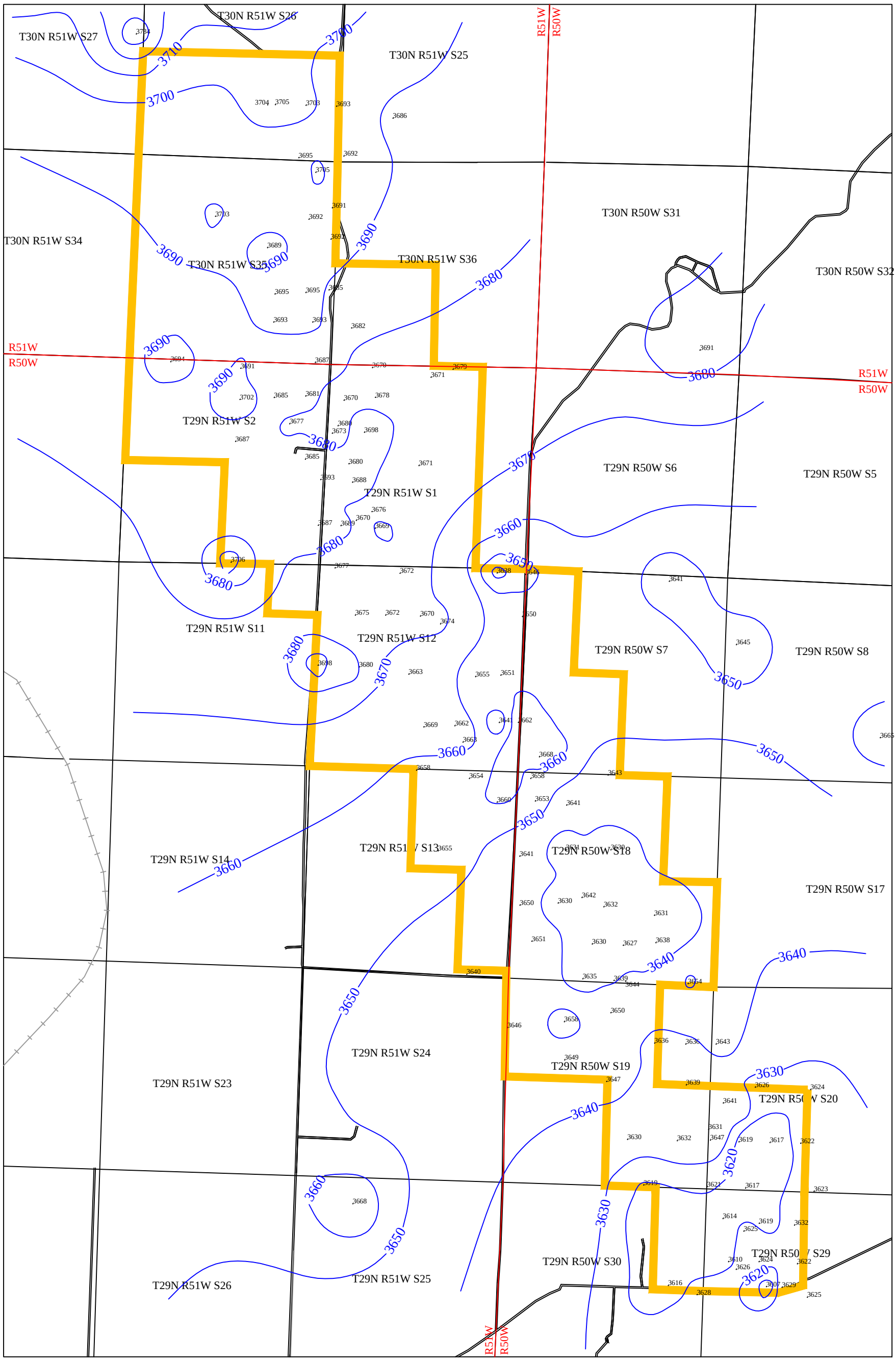
www.arcadis-us.com



LEGEND

- Proposed Marsland Expansion Area
- 3668 Borehole Location and Elevation (FT-AMSL) - Top of Chadron Formation
- Elevation Contour - Top of Chadron Formation (FT-AMSL)
- Railroad
- Road

N

0 2000 4000 FEET

PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS – USGS

FT-AMSL = Feet Above Mean Sea Level

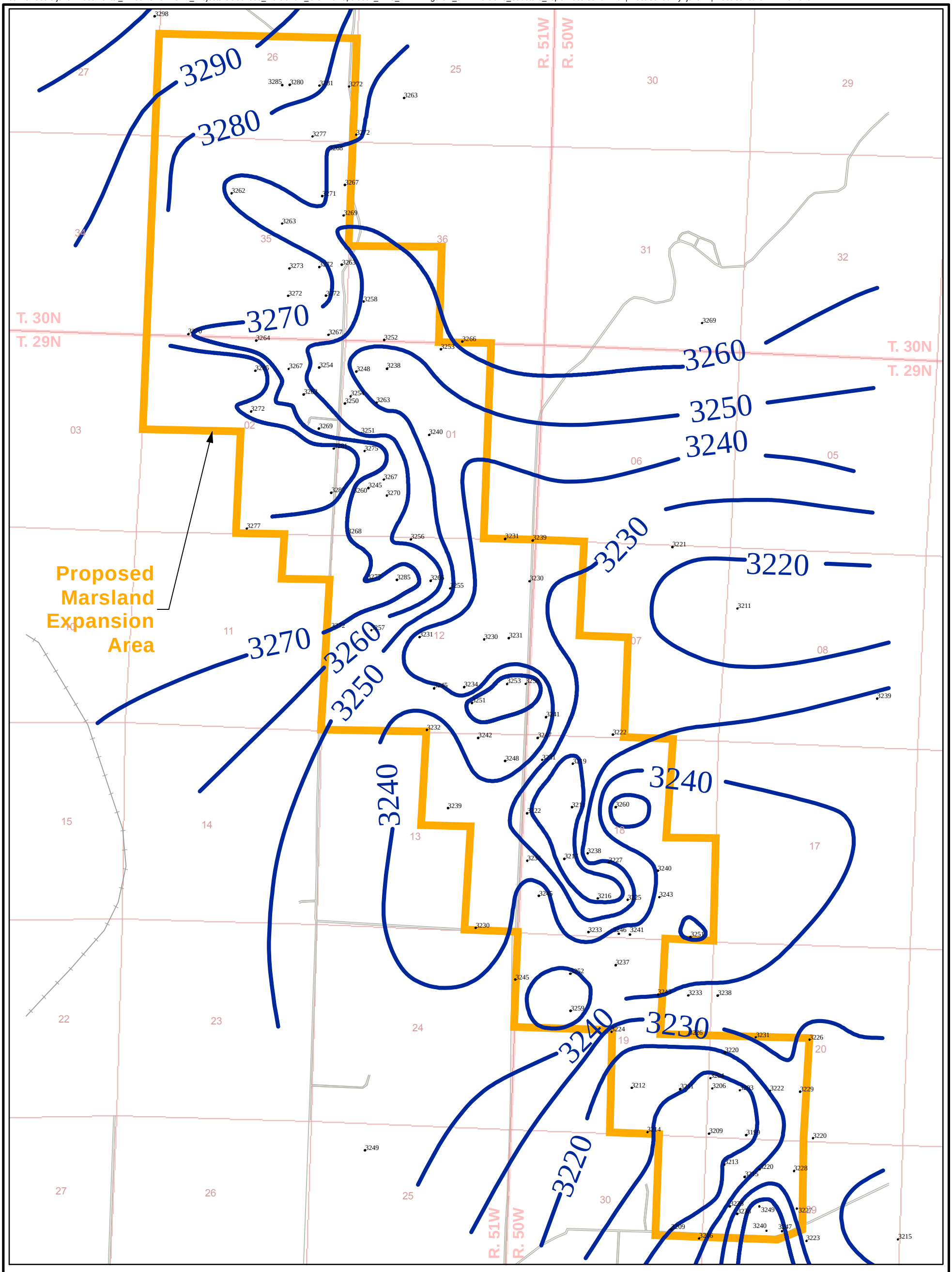
Crow Butte Resources, Inc.

Figure 2.6-11

Marsland Structure Map
Top of Chadron Formation

Scale: See Bar Scale	Date: September 2015	
MEA_NRCTR_Figure 2.6-11.pdf		By: WB

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_6-12 Marsland_Structure_TopOfBasalSand.mxd | Last Saved By: jchen | Last Saved On: 11/15/2013



LEGEND

- Proposed Marsland Expansion Area
- 3249 Borehole Location and Elevation - Top of Basal Sandstone (FT-AMSL)
- Elevation Contour - Top of Basal Sandstone (FT-AMSL)
- Railroad
- Road

FT-AMSL = Feet Above Mean Sea Level

N

0 1,250 2,500

Feet

PROJECTION: NAD 1927, STATE PLANE NEBRASKA NORTH, FIPS 2601

CROW BUTTE RESOURCES, INC.

FIGURE 2.6-12
MARSLAND STRUCTURE MAP
TOP OF BASAL SANDSTONE OF THE CHADRON FORMATION

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

ARCADIS
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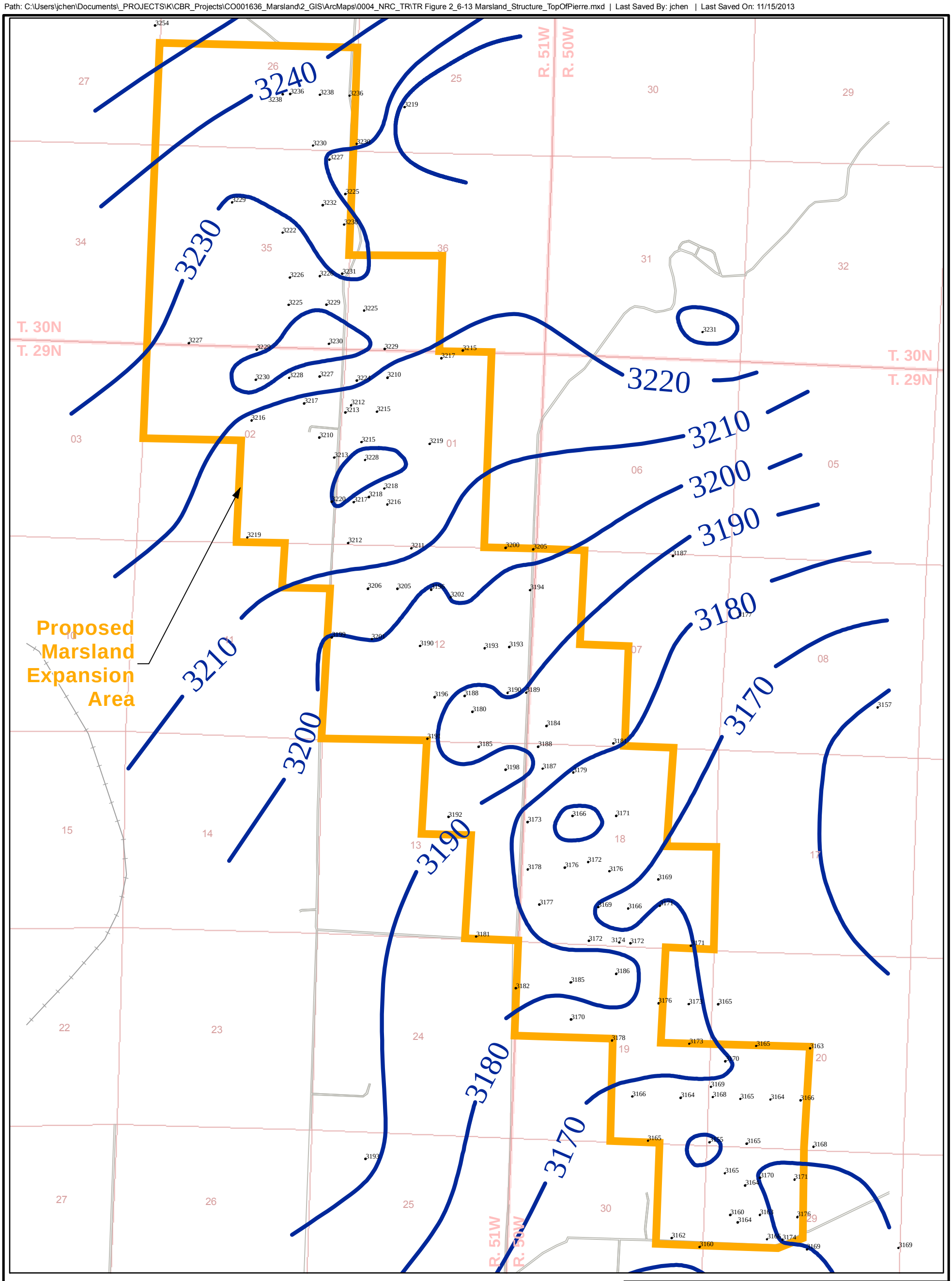
Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_6-13 Marsland_Structure_TopOfPierre.mxd | Last Saved By: jchen | Last Saved On: 11/15/2013



LEGEND

- Proposed Marsland Expansion Area
- 3193 Borehole Location and Elevation - Top of Pierre Shale (FT-AMSL)
- Elevation Contour - Top of Pierre Shale (FT-AMSL)
- Railroad
- Road

FT-AMSL = Feet Above Mean Sea Level

N

0 1,250 2,500

Feet

PROJECTION: NAD 1927, STATE PLANE NEBRASKA NORTH, FIPS 2601

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FIGURE 2.6-13
MARSLAND STRUCTURE MAP
TOP OF PIERRE SHALE

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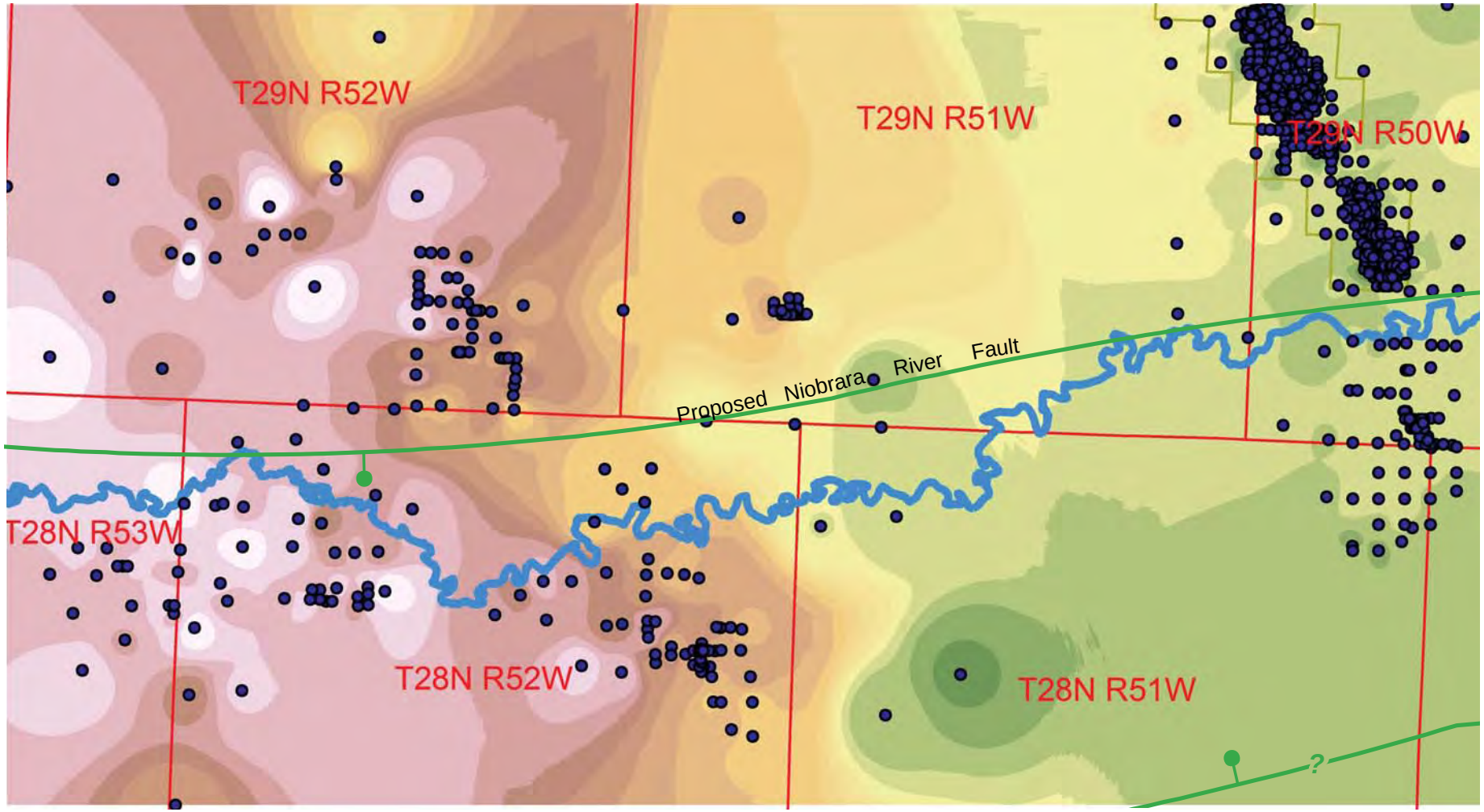

0 1 2
Miles

LEGEND

- Boring Locations Used for Structural Interpretation
- Proposed Marsland Expansion Area (MEA)
- Niobrara River

Elevation – Top of Pierre Shale (FT-AMSL)
(Structural contour interval is 20 feet)

- 3,100 - 3,120
- 3,120 - 3,140
- 3,140 - 3,160
- 3,160 - 3,180
- 3,180 - 3,200
- 3,200 - 3,220
- 3,220 - 3,240
- 3,240 - 3,260
- 3,260 - 3,280
- 3,280 - 3,300
- 3,300 - 3,320
- 3,320 - 3,340
- 3,340 - 3,360
- 3,360 - 3,380
- 3,380 - 3,400
- 3,400 - 3,420
- 3,420 - 3,440

Fault Interpretations by DeGraw (1971)
(Ball on downthrown side; ? denotes inferred)

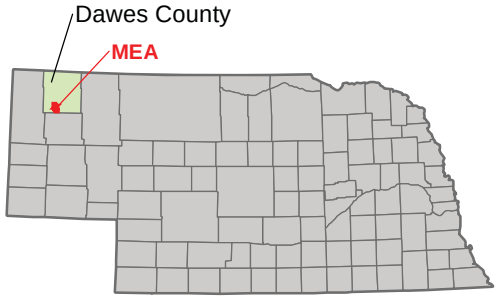

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FIGURE 2.6-14
REGIONAL STRUCTURE CONTOUR MAP – TOP OF PIERRE SHALE

PROJECT: CO001636.00001 MAPPED BY: JC CHECKED BY: JEC

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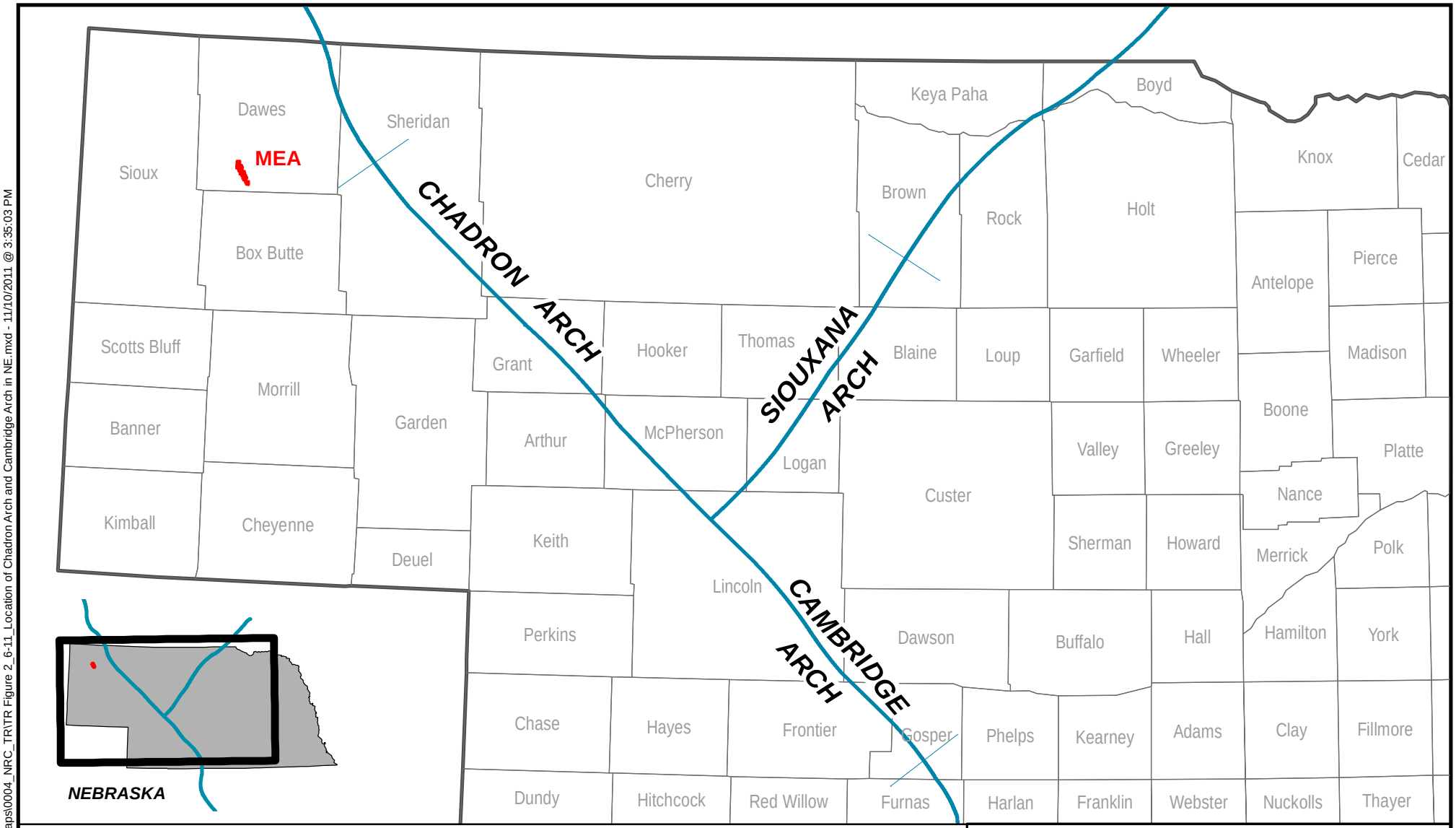
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2_6-14 Regional Structure Contour Map – Top of Pierre Shale.ai @12/15/2013



LEGEND

- Proposed Marsland Expansion Area (MEA)
- Nebraska County Boundary
- Nebraska State Boundary

N

0 15 30

Miles

PROJECTION:
NAD 1927, STATE PLANE
NEBRASKA NORTH FIPS 2601

SOURCE: STIX, J. 1982

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FIGURE 2.6-15
LOCATION OF CHADRON ARCH AND CAMBRIDGE ARCH IN NEBRASKA

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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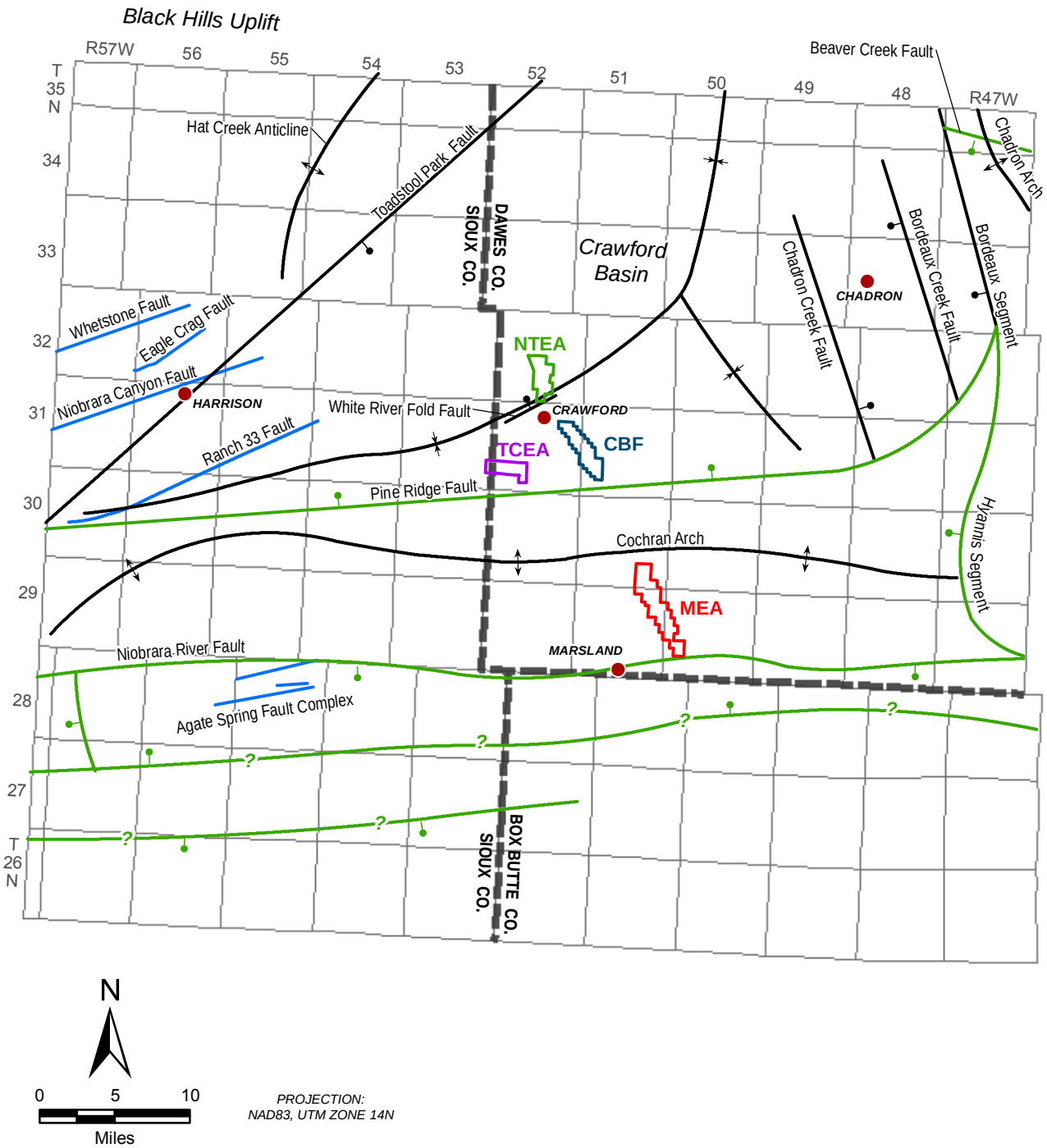
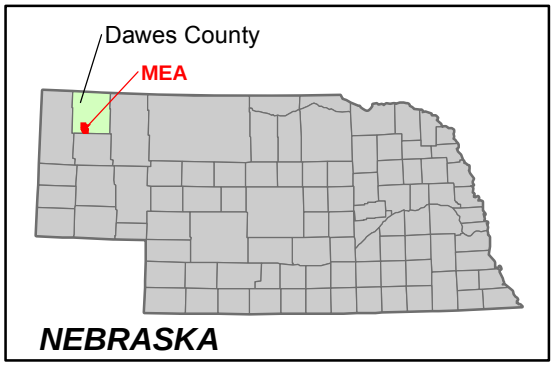
K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_6-11_Location of Chadron Arch and Cambridge Arch in NE.mxd - 11/10/2011 @ 3:35:03 PM





LEGEND

- City/Town
- Fault (Ball on downthrown side)
- Fault Interpretations by DeGraw (1971) (Ball on downthrown side; ? denotes inferred)
- Fault Interpretations by Hunt (1990)
- Anticline
- Syncline
- County Boundary
- Proposed Marsland Expansion Area (MEA)
- Crow Butte Facility (CPF) Permit Area
- Proposed North Trend Expansion Area (NTEA)
- Proposed Three Crow Expansion Area (TCEA)

Source:
Modified from DeGraw, 1969;
WFC-White River Fault only (Collings & Knode, 1984)

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FIGURE 2.6-16
STRUCTURAL FEATURES MAP OF THE CRAWFORD BASIN

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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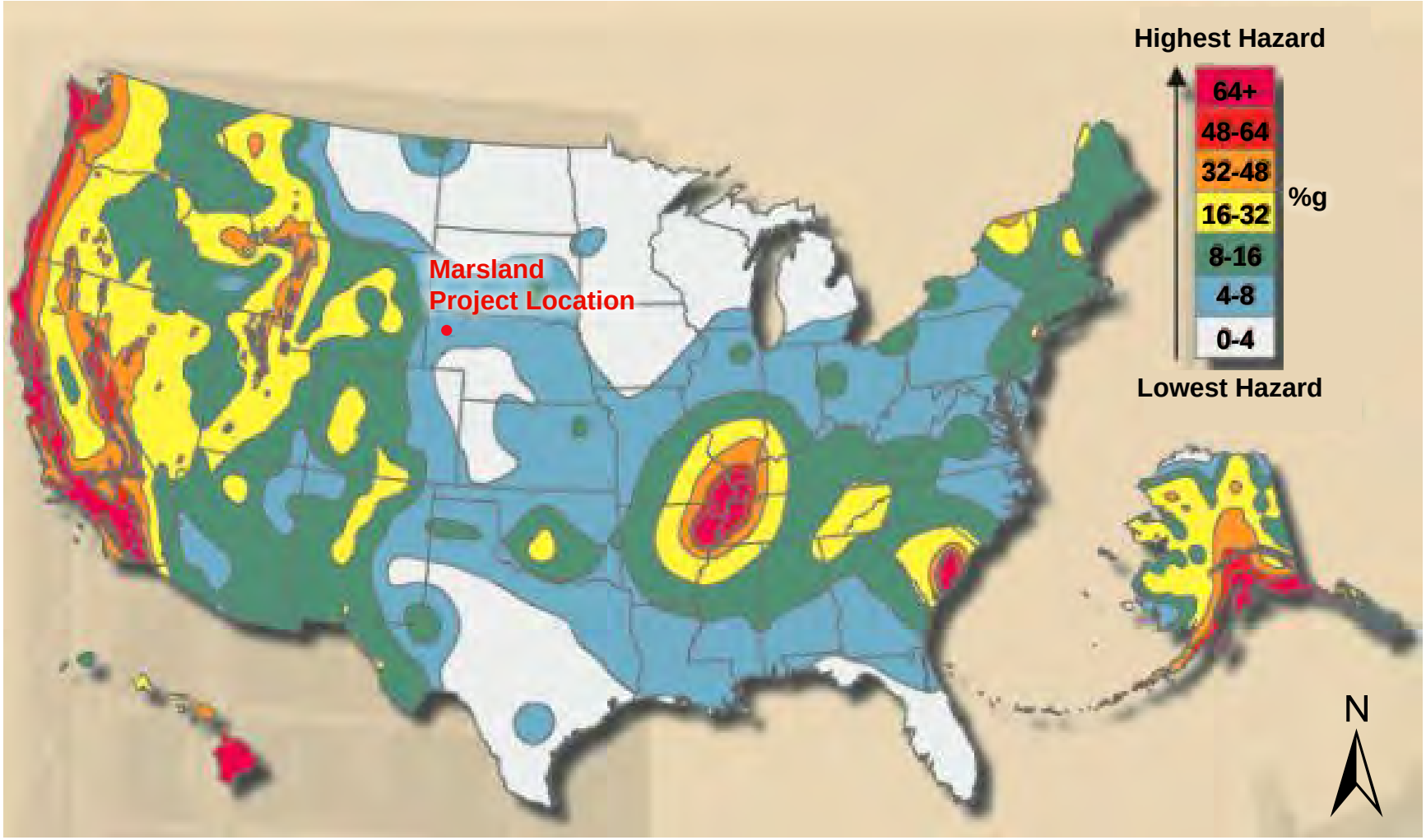

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FIGURE 2.6-17
EARTHQUAKE HAZARD RANKING IN THE U.S.

PROJECT: CO001636.00001 MAPPED BY: JC CHECKED BY: JEC

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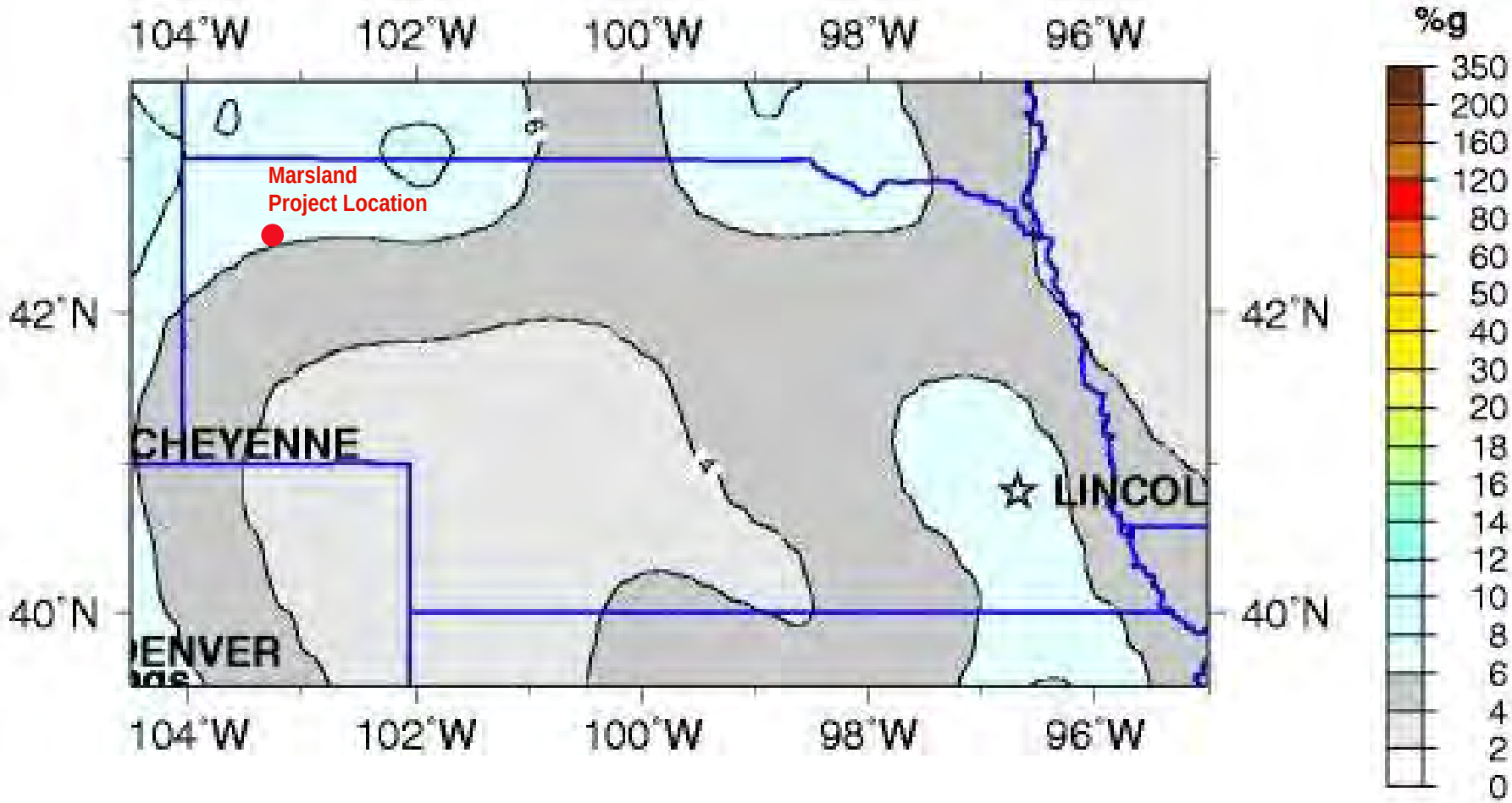
83

SOURCE: SD 2008

K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2_6-14 Earthquake Hazard Ranking in the US.ai @05/14/2013



Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years
Site: NEHRP B-C boundary
National Seismic Hazard Mapping Project (Peterson, M.D. 2008)

N

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FIGURE 2.6-18
SEISMIC HAZARD MAP
FOR NEBRASKA (2008)

PROJECT: CO0016 6.00001 MAPPED BY: JC CHECKED BY: LW

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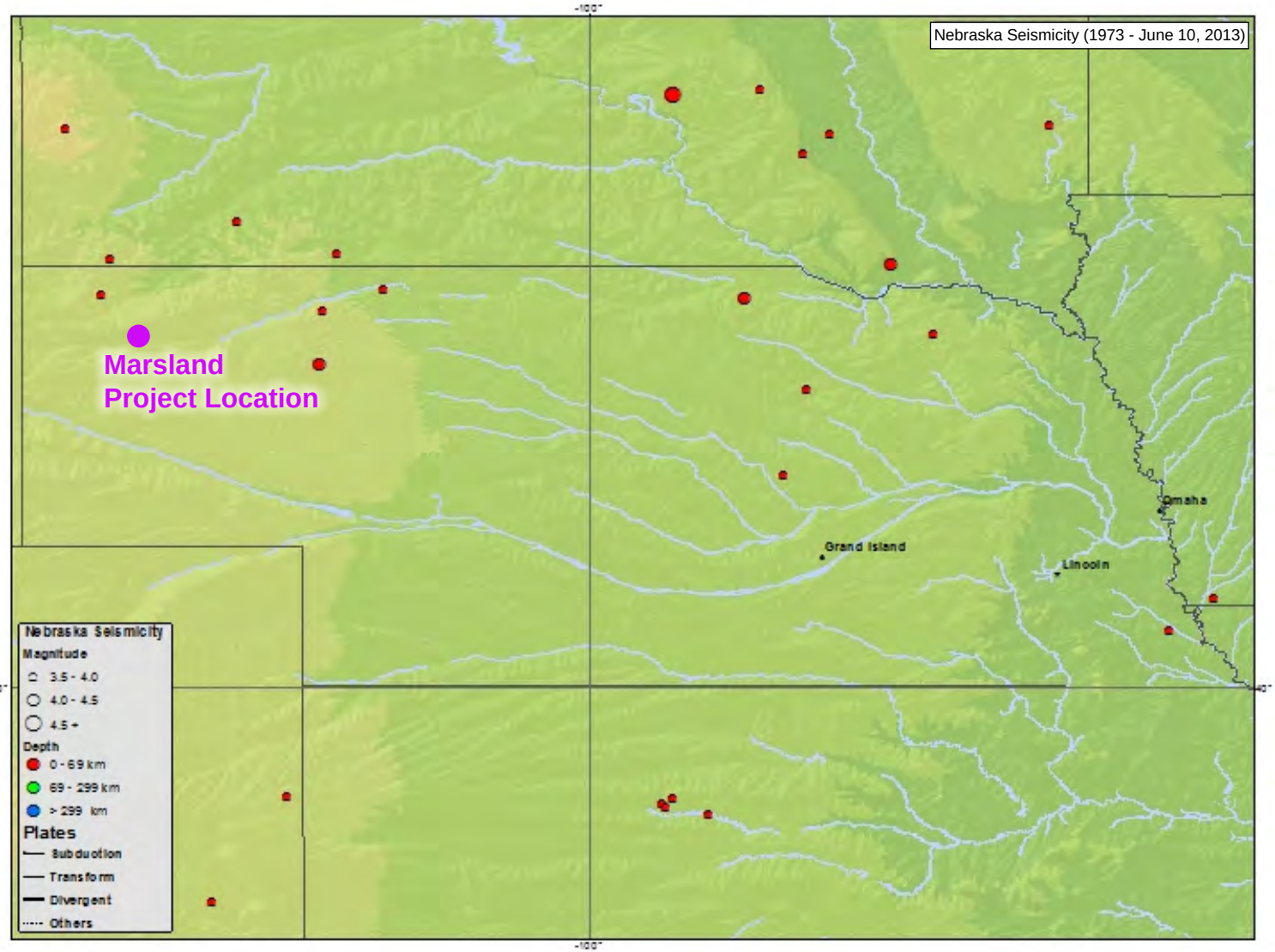
SOURCE: USGS 20009a

KK:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2_6-15 Seismic Hazard Map for Nebraska.ai @ 05/14/2013



N

Source: http://earthquake.usgs.gov/earthquakes/states/nebraska/seismicity.php

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FIGURE 2.6-19
SEISMICITY OF NEBRASKA
1973 - 2013

PROJECT: CO001636.00001 MAPPED BY: JC CHECKED BY: JEC

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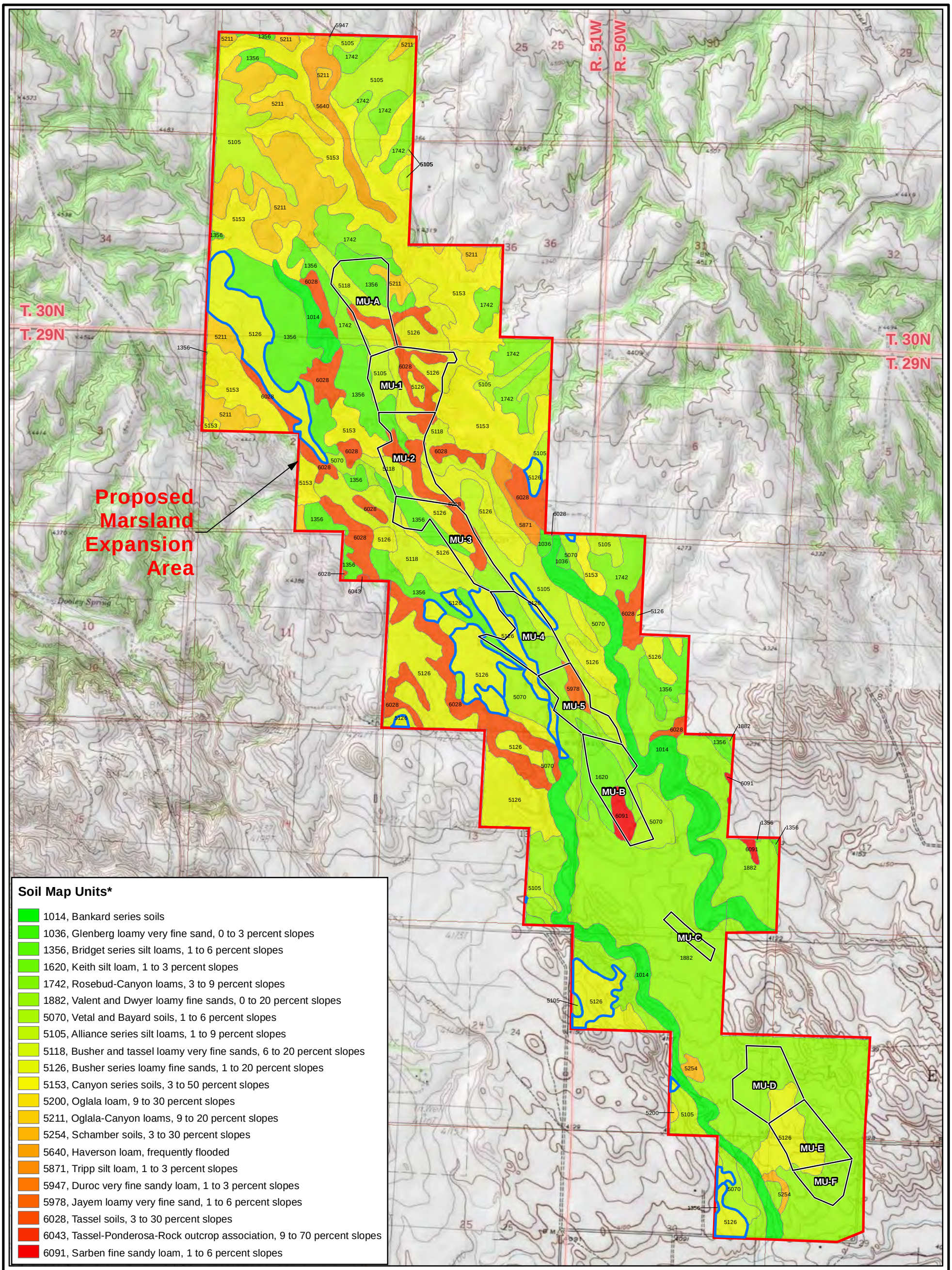
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2_6-16 Seismicity of Nebraska 1973-2013.ai @ 06/04/2013



LEGEND

- Mine Unit
- Soil units mapped by NRCS as exhibiting prevelant erosion
- Proposed Marsland Expansion Area

* Soil map units 1014, 1356, 1882, 5105, 5126, and 5153 represent combined NRCS map units. The map unit number represents the NRCS map unit with the greatest extent within the Proposed Marsland Expansion Area. See text for complete description of soil map units.

N

0 1,500 3,000
Feet

PROJECTION: NAD 1927, STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: US TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

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FIGURE 2.6-20
SOILS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: CM

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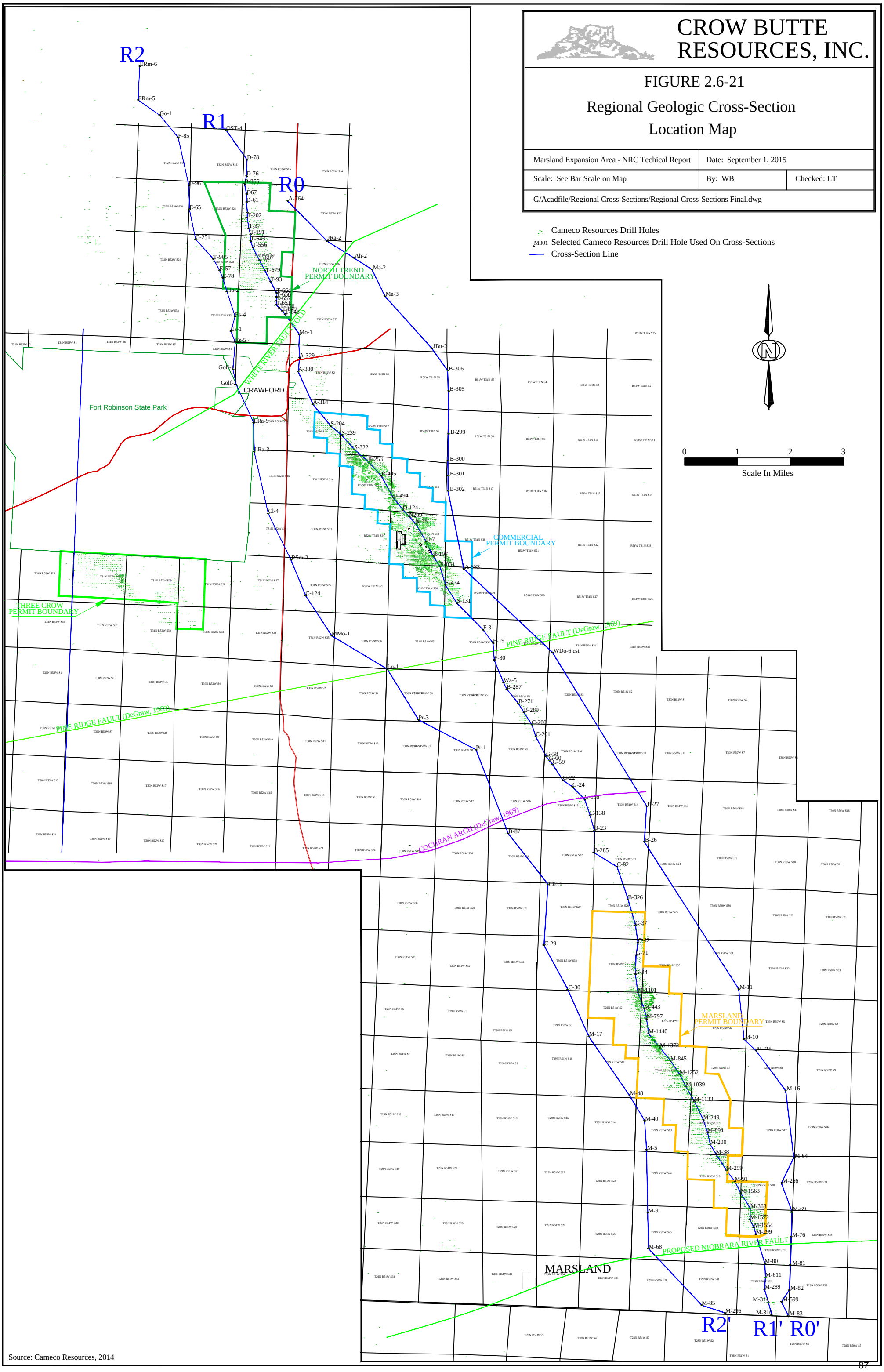
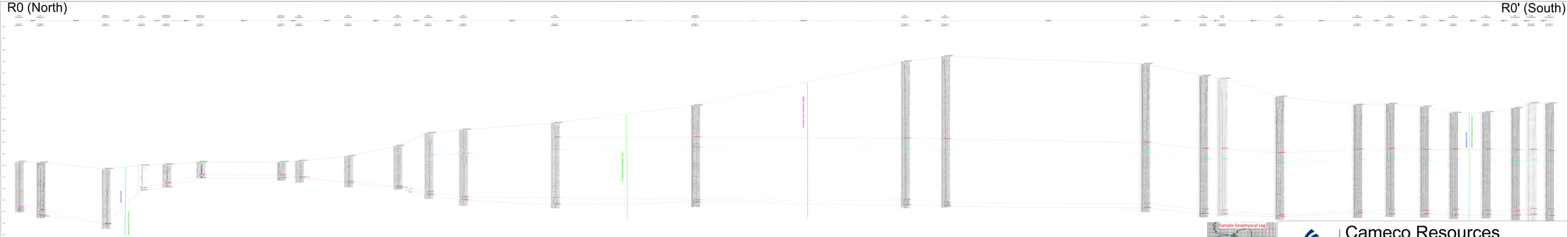
FIGURE 2.6-21

Regional Geologic Cross-Section Location Map

Marsland Expansion Area - NRC Techical Report	Date: September 1, 2015	
Scale: See Bar Scale on Map	By: WB	Checked: LT
G/Acadfile/Regional Cross-Sections/Regional Cross-Sections Final.dwg		



Source: Cameco Resources, 2014



Crawford Basin Geologic Structure

Cameco

Cameco Resources

Crow Butte Operation

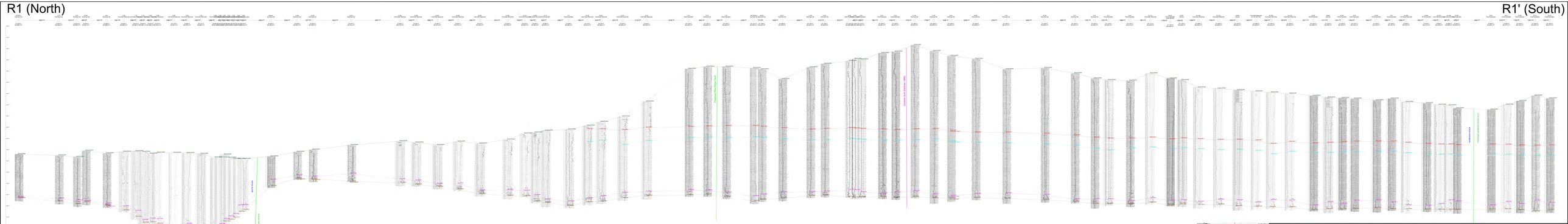
Cross Section R0 - R0'

Figure 2.6-22

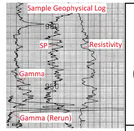
Date: September 2015	Department: Land & Evaluation	Vertical Exaggeration = 10X

R1 (North)

R1' (South)



Crawford Basin Geologic Structure



Cameco

Cameco Resources

Crow Butte Operation

Cross Section R1 - R1'

Figure **2.6-23**

Date: SEPTEMBER 2015	Department: Land & Evaluation	Vertical Exaggeration = 10X