United States Nuclear Regulatory Commission Official Hearing Exhibit			
In the Matter of:	CROW BUTTE RESOURCES, INC. (Marsland Expansion Area)		
ASLBP #:	13-926-01-MLA-BD01		
Docket #:	04008943		
Exhibit #:	CBR008-R-00-BD01	**Identified:**	10/30/2018
Admitted:	10/30/2018	**Withdrawn:**	
Rejected:		**Stricken:**	
Other:			

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

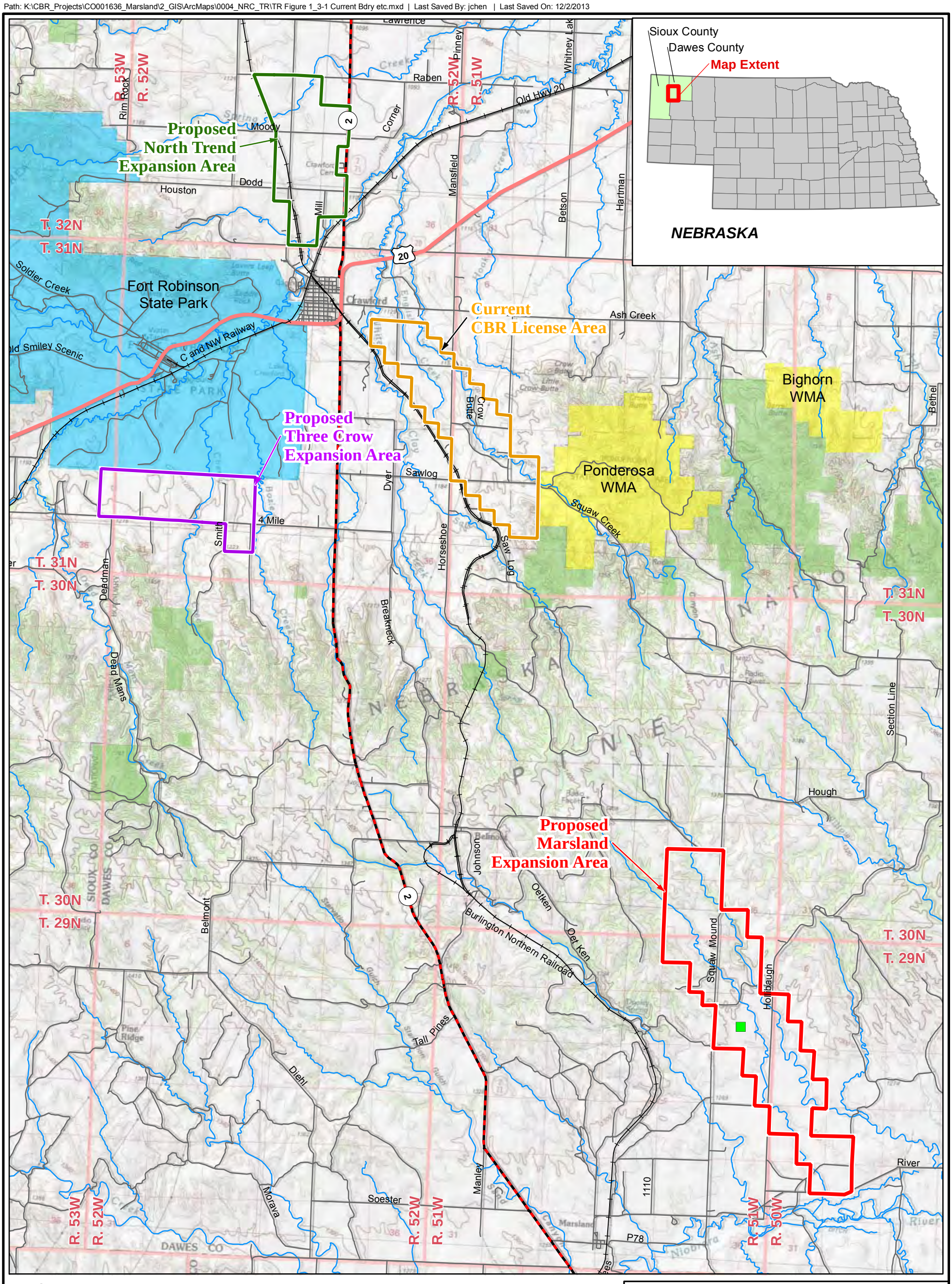
In the Matter of CROW BUTTE RESOURCES, INC. (Marsland Expansion Area)	Docket No. 40-8943-MLA-2 ASLBP No. 13-926-01-MLA-BD01

Hearing Exhibit

Exhibit Number: CBR008-R

Exhibit Title: Technical Report Figures

Path: K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 1_3-1 Current Bdry etc.mxd | Last Saved By: jchen | Last Saved On: 12/2/2013



LEGEND

- Proposed Marsland Satellite Facility Site
- Proposed Marsland Expansion Area
- Proposed Three Crow Expansion Area
- Proposed North Trend Expansion Area
- Current CBR License Area
- Township/Range
- WMA-Wildlife Management Area
- Fort Robinson State Park
- Nebraska National Forest
- Railroad
- U.S. Highway
- State Highway
- Roads, Other
- Stream

N

0 1 2

Miles

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

CROW BUTTE RESOURCES, INC.

FIGURE 1.3-1
CROW BUTTE RESOURCES INC.
CURRENT LICENSE AREA
AND PROPOSED EXPANSION AREAS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: J. CEARLEY

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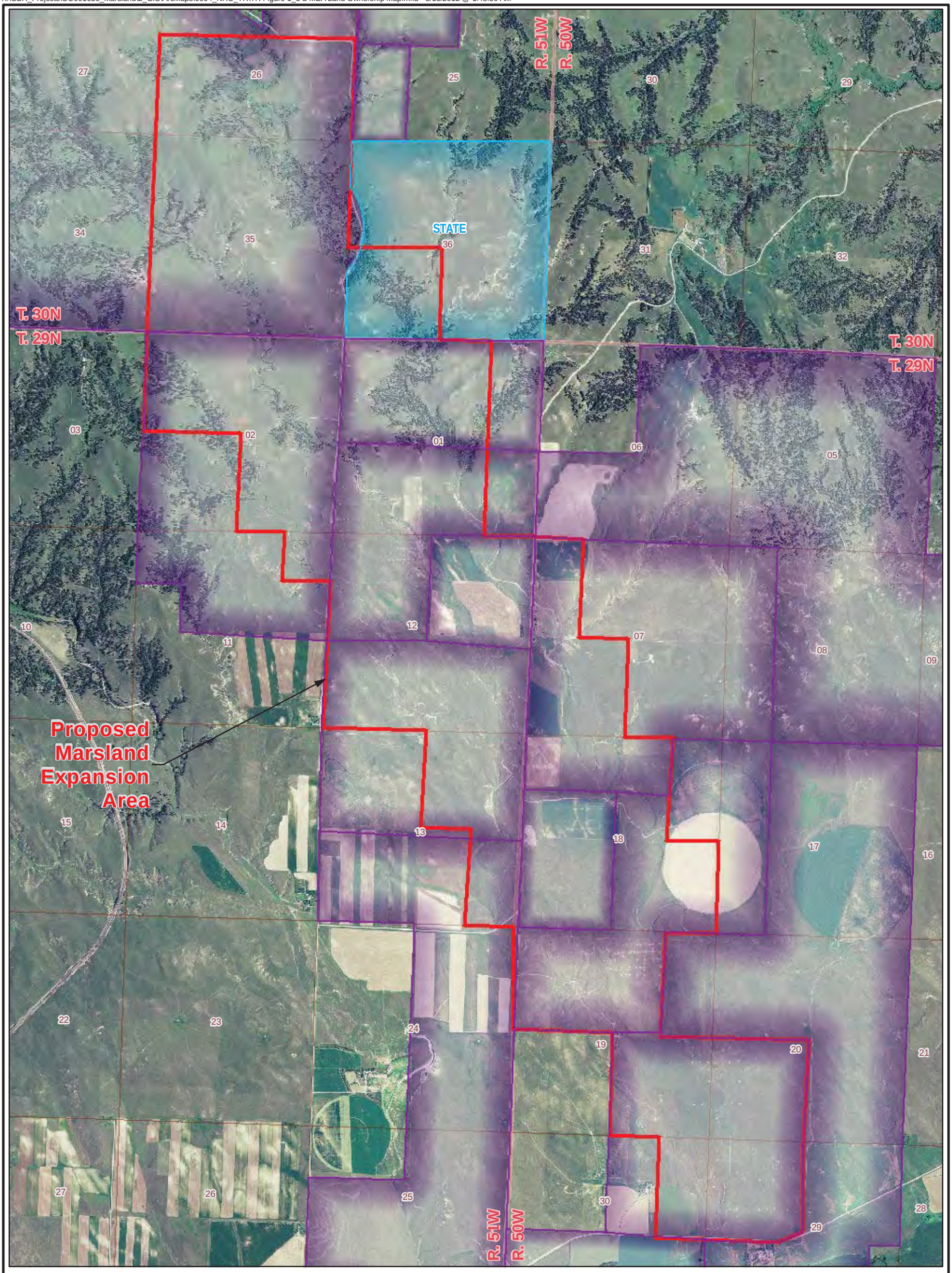
K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 1_3-2 MEA Land Ownership Map.mxd - 5/13/2012 @ 1:48:50 AM



LEGEND

- Proposed Marsland Expansion Area
- Private Land
- State Land

N

0 1,250 2,500

Feet

PROJECTION: NAD1927, STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: USDA NAIP IMAGERY 2010

CROW BUTTE RESOURCES, INC.

FIGURE 1.3-2
MARSLAND EXPANSION AREA
LAND OWNERSHIP

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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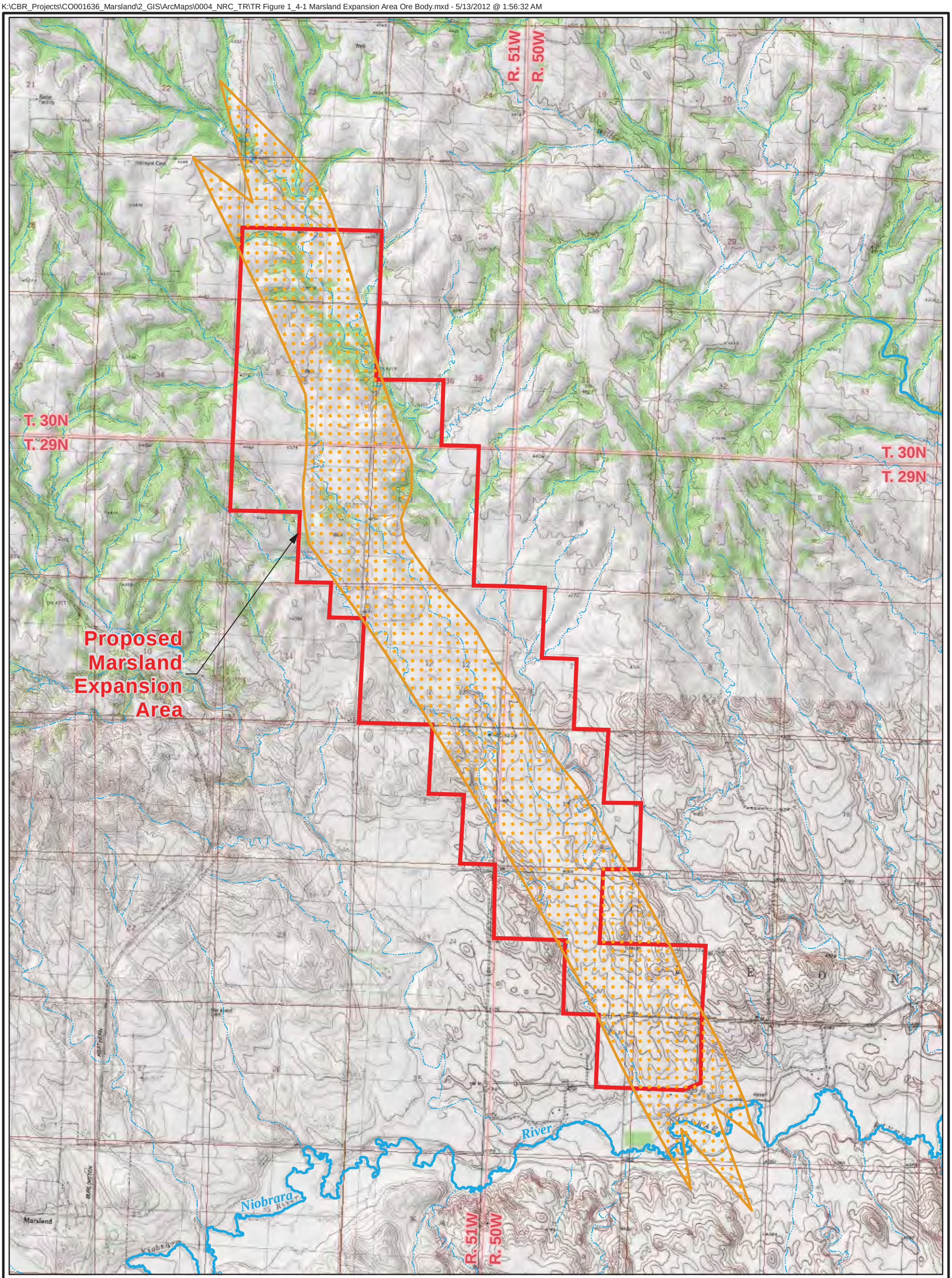
K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 1_4-1 Marsland Expansion Area Ore Body.mxd - 5/13/2012 @ 1:56:32 AM



LEGEND

- Estimated Ore Body
- Proposed Marsland Expansion Area
- Perennial Stream/River
- Intermittent Stream/River

N

0 1,750 3,500

Feet

PROJECTION: NAD1927, STATE PLANE NEBRASKA NORTH, FIPS 2601 SOURCES: USA TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

FIGURE 1.4-1
MARSLAND EXPANSION AREA
ESTIMATED ORE BODY

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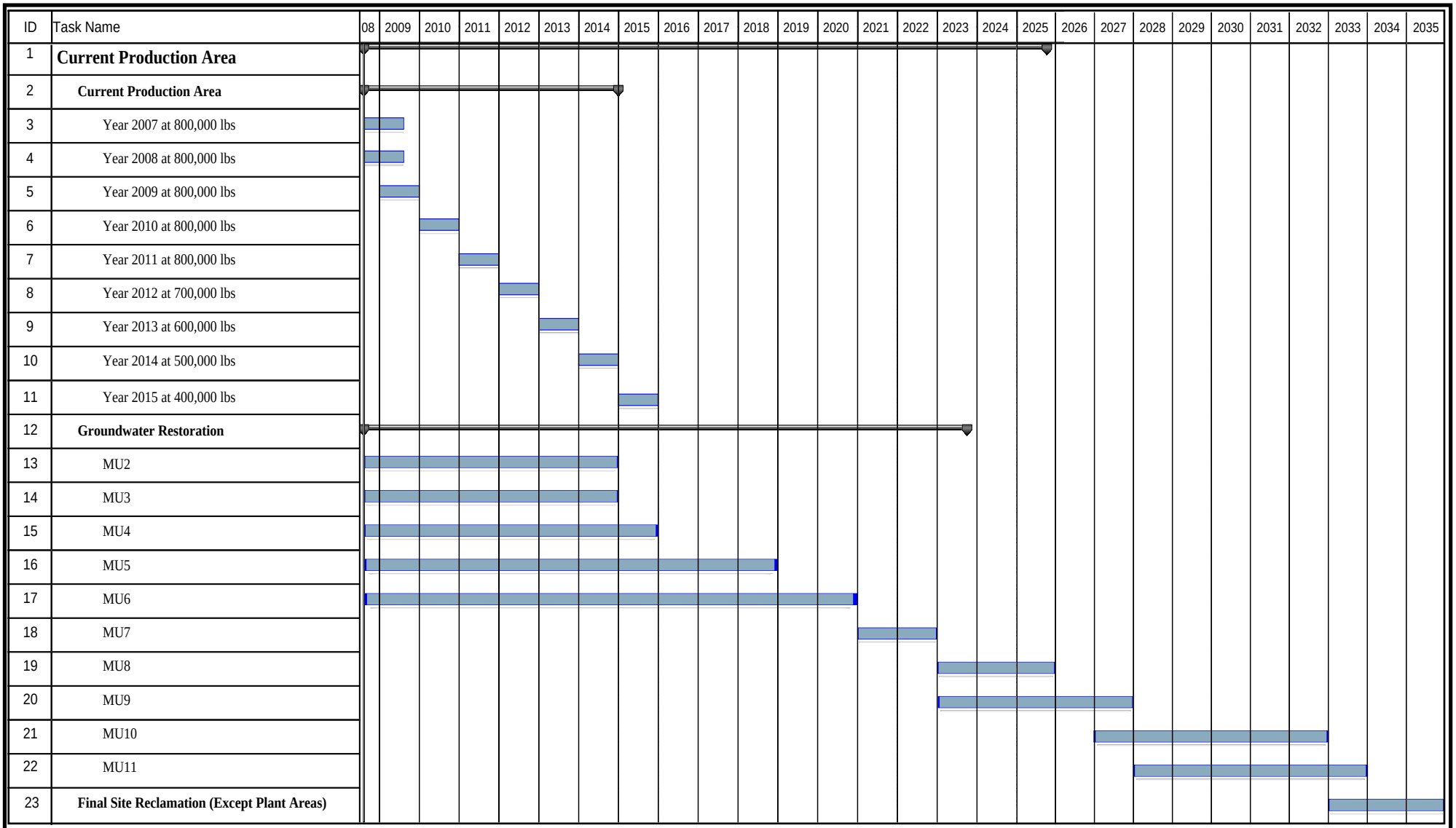

Task

Group By Summary

CROW BUTTE RESOURCES, INC.

FIGURE 1.7-1
CURRENT PRODUCTION AREA
MINE UNIT TIMELINE
EFFECTIVE AS OF JULY 1, 2013

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

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K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 1_7-1 Current Production Area Schedule_v10012013.ai @ 10/01/2013

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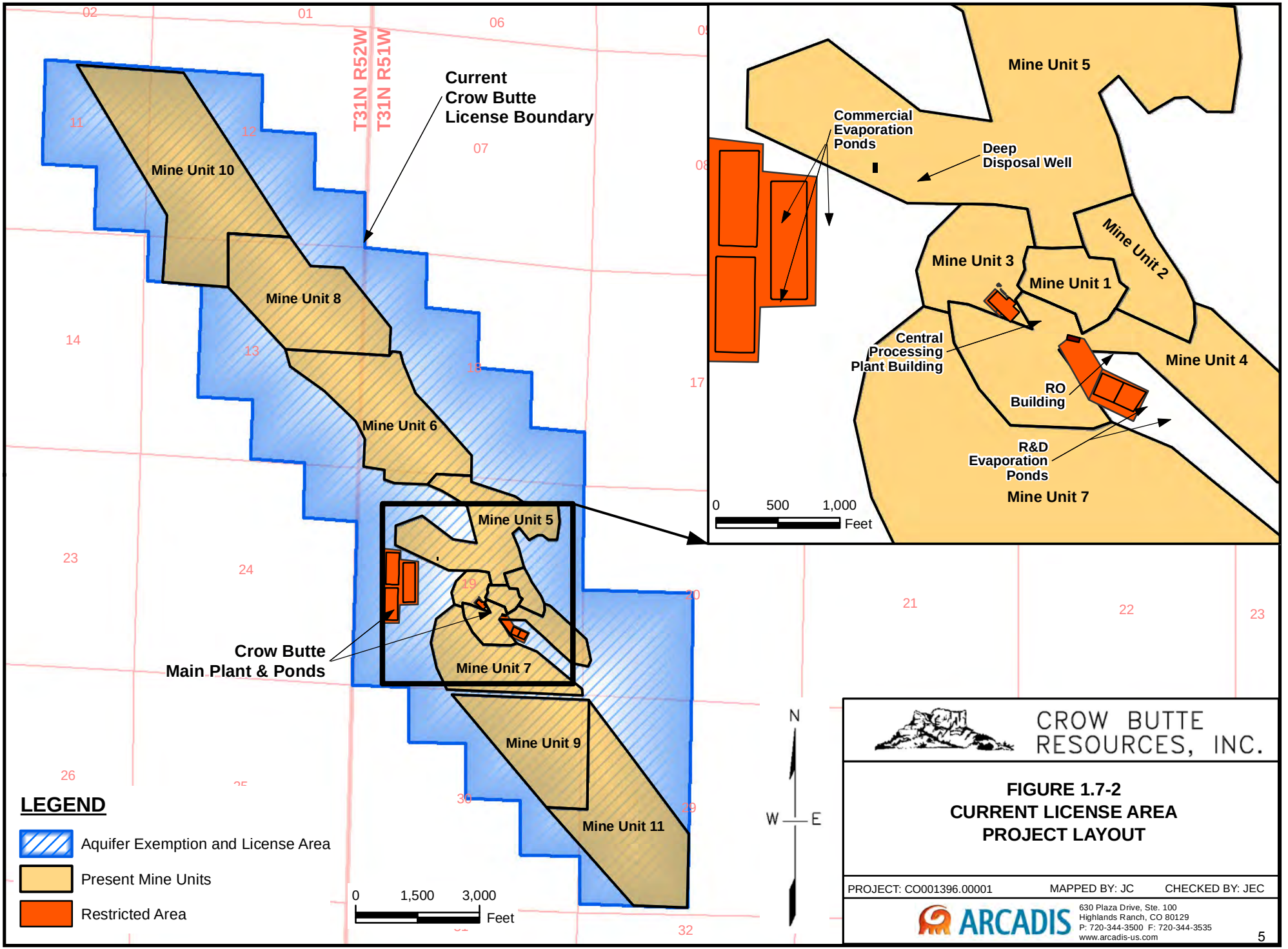

CROW BUTTE RESOURCES, INC.

FIGURE 1.7-2
CURRENT LICENSE AREA
PROJECT LAYOUT

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: JEC

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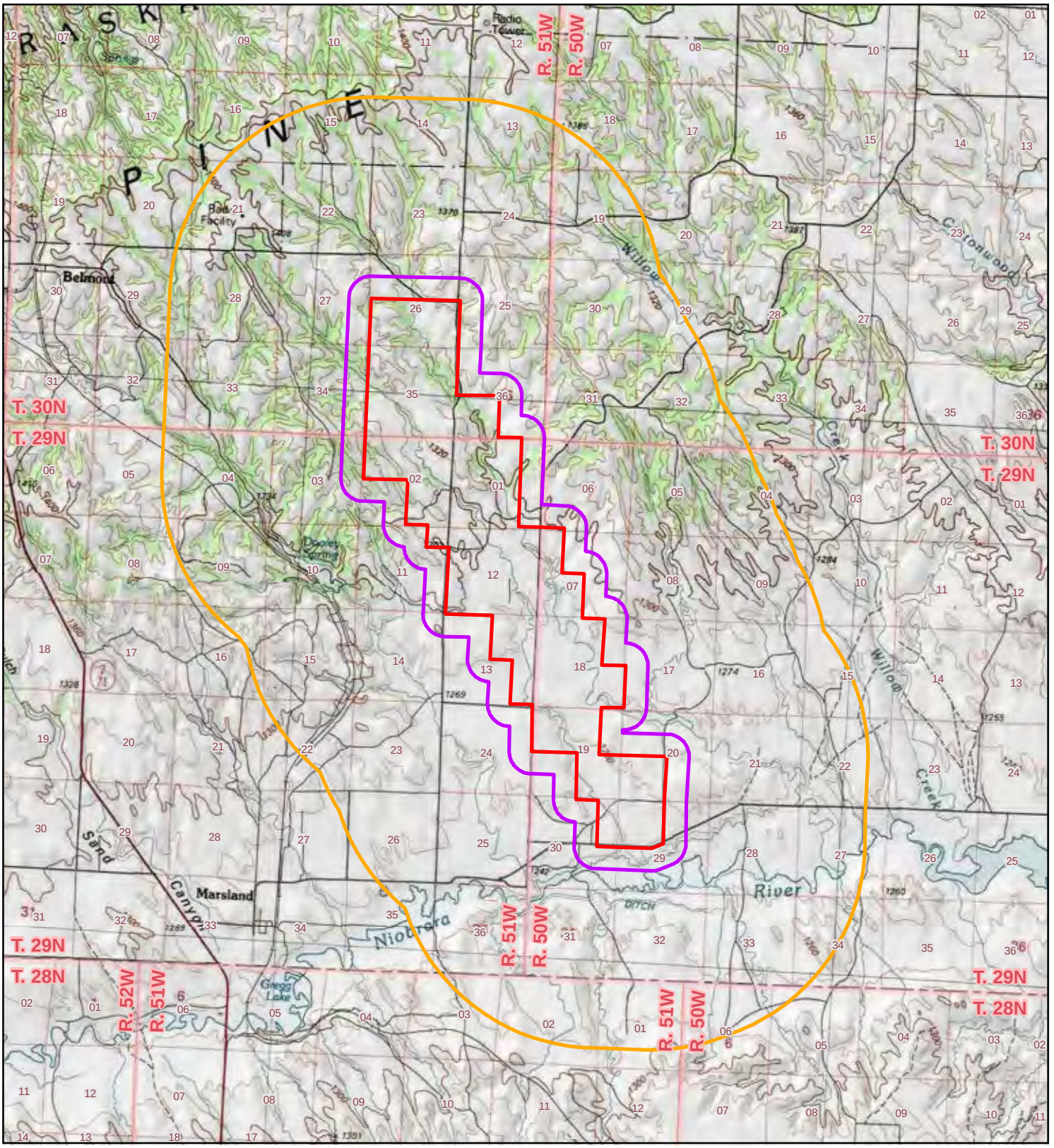

LEGEND

- Proposed Marsland Expansion Area
- ZOEI Boundary (1/4-mile fixed radius)
- AOR Boundary (2-mile fixed radius)

ZOEI = Zone of Endangering Influence

AOR = Area of Review

N

0 4,000 8,000

Feet

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

CROW BUTTE RESOURCES, INC.

FIGURE 1.7-3
PROJECT LOCATION MAP
ZOEI AND AOR

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: J. CEARLEY

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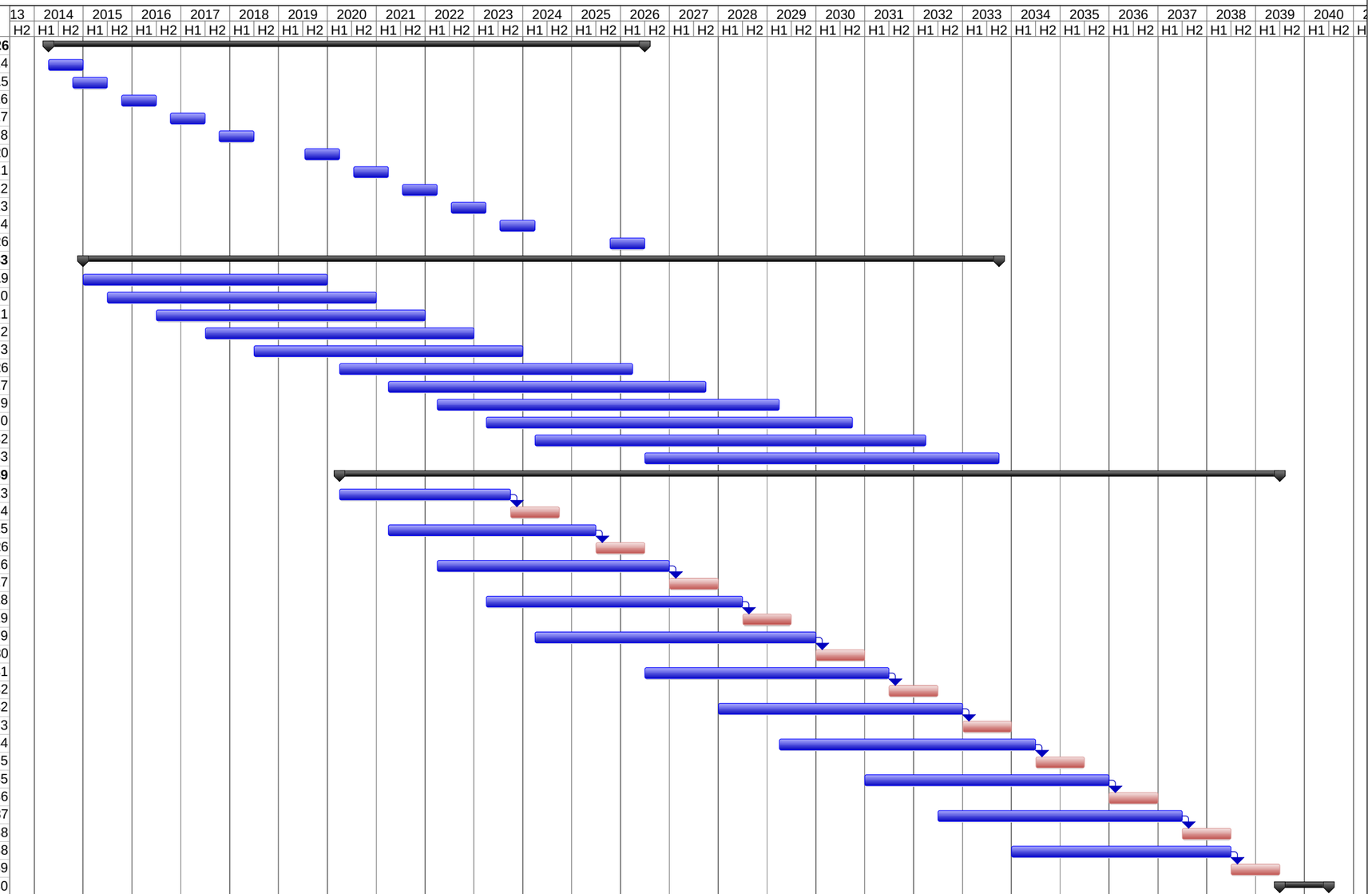
K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TRTR Figure 1_7-3 Project Loc_ZOEI and AOR.mxd - 3/15/2012 @ 2:18:01 PM

Figure 1.7-4 Marsland Expansion Area Mining and Restoration Timeline

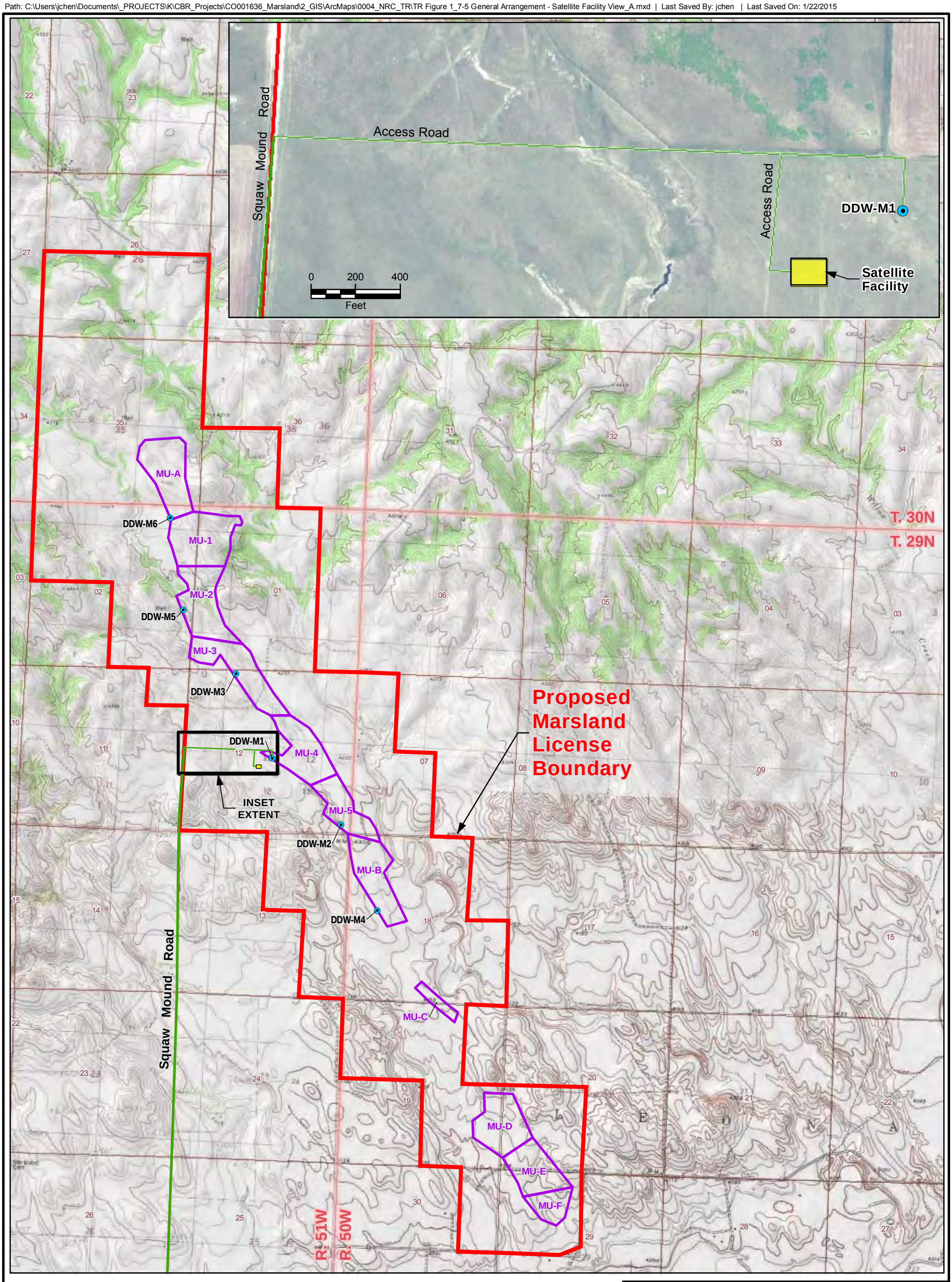
ID	ℹ	Task Name	Duration	Start	Finish
1		**Facility Construction**	**3184 days**	**Thu 4/17/14**	**Tue 6/30/26**
2	▦	MU-1	185 days	Thu 4/17/14	Wed 12/31/14
3	▦	MU-2	185 days	Wed 10/15/14	Tue 6/30/15
4	▦	MU-3	186 days	Thu 10/15/15	Thu 6/30/16
5	▦	MU-4	186 days	Fri 10/14/16	Fri 6/30/17
6	▦	MU-5	186 days	Fri 10/13/17	Sat 6/30/18
7	▦	MU-A	186 days	Tue 7/16/19	Tue 3/31/20
8	▦	MU-B	185 days	Thu 7/16/20	Wed 3/31/21
9	▦	MU-C	186 days	Thu 7/15/21	Thu 3/31/22
10	▦	MU-D	186 days	Fri 7/15/22	Fri 3/31/23
11	▦	MU-E	186 days	Fri 7/14/23	Sun 3/31/24
12	▦	MU-F	186 days	Tue 10/14/25	Tue 6/30/26
13		**Production**	**4892 days**	**Thu 1/1/15**	**Fri 9/30/33**
14	▦	MU-1	1304 days	Thu 1/1/15	Tue 12/31/19
15	▦	MU-2	1437 days	Wed 7/1/15	Thu 12/31/20
16	▦	MU-3	1436 days	Fri 7/1/16	Fri 12/31/21
17	▦	MU-4	1435 days	Mon 7/3/17	Sat 12/31/22
18	▦	MU-5	1435 days	Mon 7/2/18	Sun 12/31/23
19	▦	MU-A	1565 days	Wed 4/1/20	Tue 3/31/26
20	▦	MU-B	1696 days	Thu 4/1/21	Thu 9/30/27
21	▦	MU-C	1826 days	Fri 4/1/22	Sat 3/31/29
22	▦	MU-D	1956 days	Mon 4/3/23	Mon 9/30/30
23	▦	MU-E	2088 days	Mon 4/1/24	Wed 3/31/32
24	▦	MU-F	1893 days	Wed 7/1/26	Fri 9/30/33
25		**Groundwater Restoration**	**5022 days**	**Wed 4/1/20**	**Thu 6/30/39**
26	▦	MU-1	913 days	Wed 4/1/20	Sat 9/30/23
27	▦	Stabilization Sampling	261 days	Mon 10/2/23	Mon 9/30/24
28	▦	MU-2	1108 days	Thu 4/1/21	Mon 6/30/25
29		Stabilization Sampling	261 days	Tue 7/1/25	Tue 6/30/26
30	▦	MU-3	1240 days	Fri 4/1/22	Thu 12/31/26
31	▦	Stabilization Sampling	261 days	Fri 1/1/27	Fri 12/31/27
32	▦	MU-4	1370 days	Mon 4/3/23	Fri 6/30/28
33	▦	Stabilization Sampling	260 days	Mon 7/3/28	Fri 6/29/29
34	▦	MU-5	1500 days	Mon 4/1/24	Sun 12/30/29
35	▦	Stabilization Sampling	261 days	Tue 1/1/30	Tue 12/31/30
36	▦	MU-A	1304 days	Wed 7/1/26	Mon 6/30/31
37	▦	Stabilization Sampling	262 days	Tue 7/1/31	Wed 6/30/32
38	▦	MU-B	1305 days	Mon 1/3/28	Fri 12/31/32
39	▦	Stabilization Sampling	260 days	Mon 1/3/33	Sat 12/31/33
40	▦	MU-C	1370 days	Mon 4/2/29	Fri 6/30/34
41	▦	Stabilization Sampling	260 days	Mon 7/3/34	Sat 6/30/35
42	▦	MU-D	1304 days	Wed 1/1/31	Mon 12/31/35
43	▦	Stabilization Sampling	262 days	Tue 1/1/36	Wed 12/31/36
44	▦	MU-E	1304 days	Thu 7/1/32	Tue 6/30/37
45	▦	Stabilization Sampling	261 days	Wed 7/1/37	Wed 6/30/38
46	▦	MU-F	1173 days	Mon 1/2/34	Wed 6/30/38
47	▦	Stabilization Sampling	261 days	Thu 7/1/38	Thu 6/30/39
48	▦	**Site Reclamation**	261 days	Fri 7/1/39	Sat 6/30/40



Project: Marsland Expansion Area
Date: Wed 5/22/13

Task	▬	Project Summary	▬	Inactive Milestone	◇	Manual Summary Rollup	▬	Progress	▬
Split	⋯	External Tasks	▬	Inactive Summary	▭	Manual Summary	▬	Deadline	⇩
Milestone	◆	External Milestone	◆	Manual Task	▬	Start-only	[		
Summary	▬	Inactive Task	▭	Duration-only	▬	Finish-only	]		

Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 1_7-5 General Arrangement - Satellite Facility View_A.mxd | Last Saved By: jchen | Last Saved On: 1/22/2015



LEGEND

- Proposed Deep Disposal Well
- Squaw Mound Road
- Access Road
- Satellite Facility (Restricted Area)
- Mine Unit
- Proposed Marsland License Boundary

N

0 1,500 3,000

Feet

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

CROW BUTTE RESOURCES, INC.

FIGURE 1.7-5
GENERAL ARRANGEMENT
SATELLITE FACILITY VIEW

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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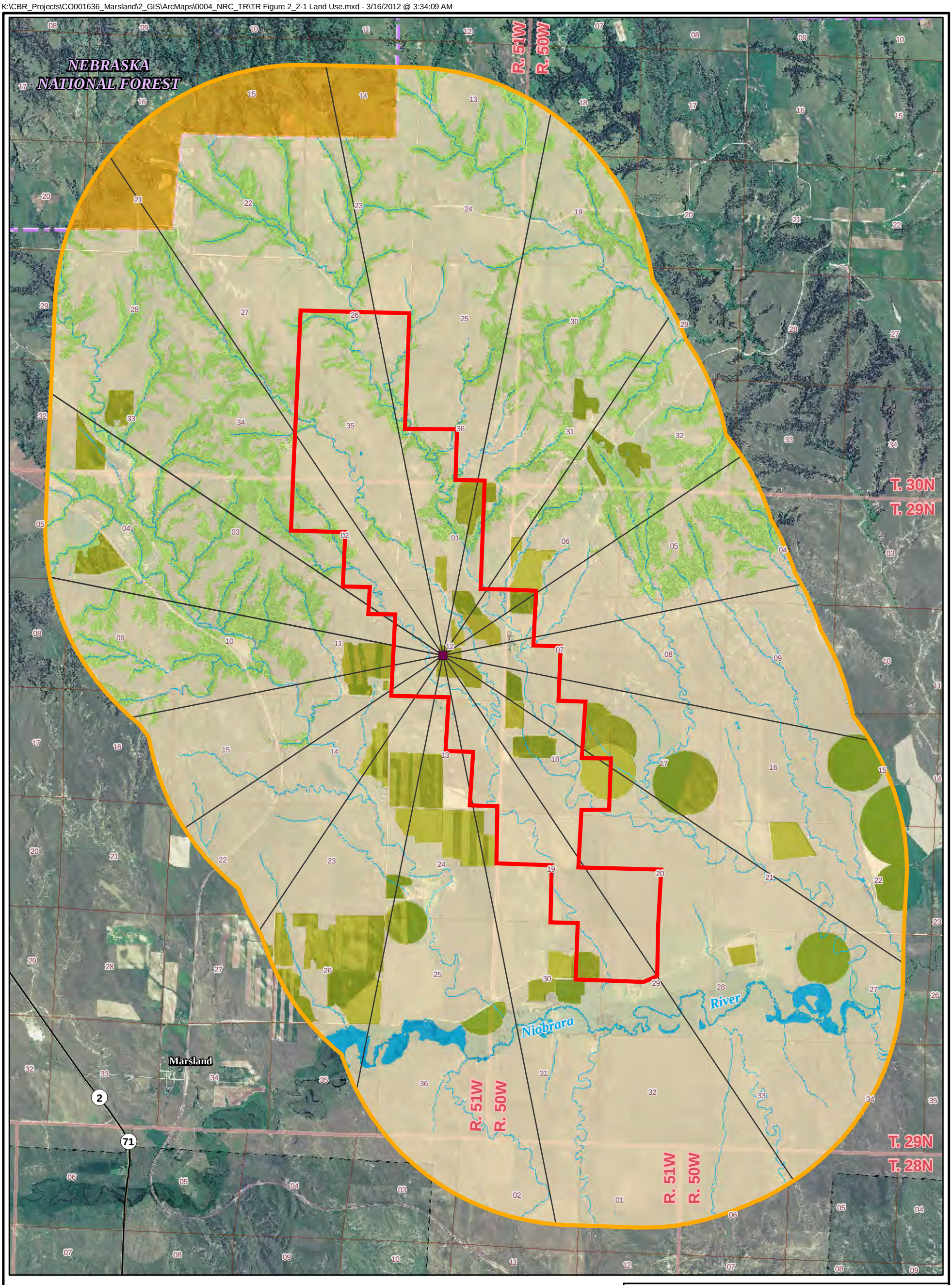
K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_2-1 Land Use.mxd - 3/16/2012 @ 3:34:09 AM



LEGEND

- Proposed Marsland Satellite Plant Centroid
- Compass Sector Boundary
- Proposed Marsland Expansion Area
- Area of Review
- Nebraska National Forest Boundary

Land Use*

- Cropland
- Drainage/Potential Wetland
- Forest Land
- Rangeland
- Recreational Land

N

0 2,250 4,500

Feet

PROJECTION: NAD1927, STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: USDA NAIP IMAGERY 2010

***** Land use data were interpreted from aerial image. The delineation of "Drainage/Potential Wetland" type also referenced NHD Flowlines and NWI Wetland Dataset.

CROW BUTTE RESOURCES, INC.

FIGURE 2.2-1
MARSLAND EXPANSION AREA
LAND USE

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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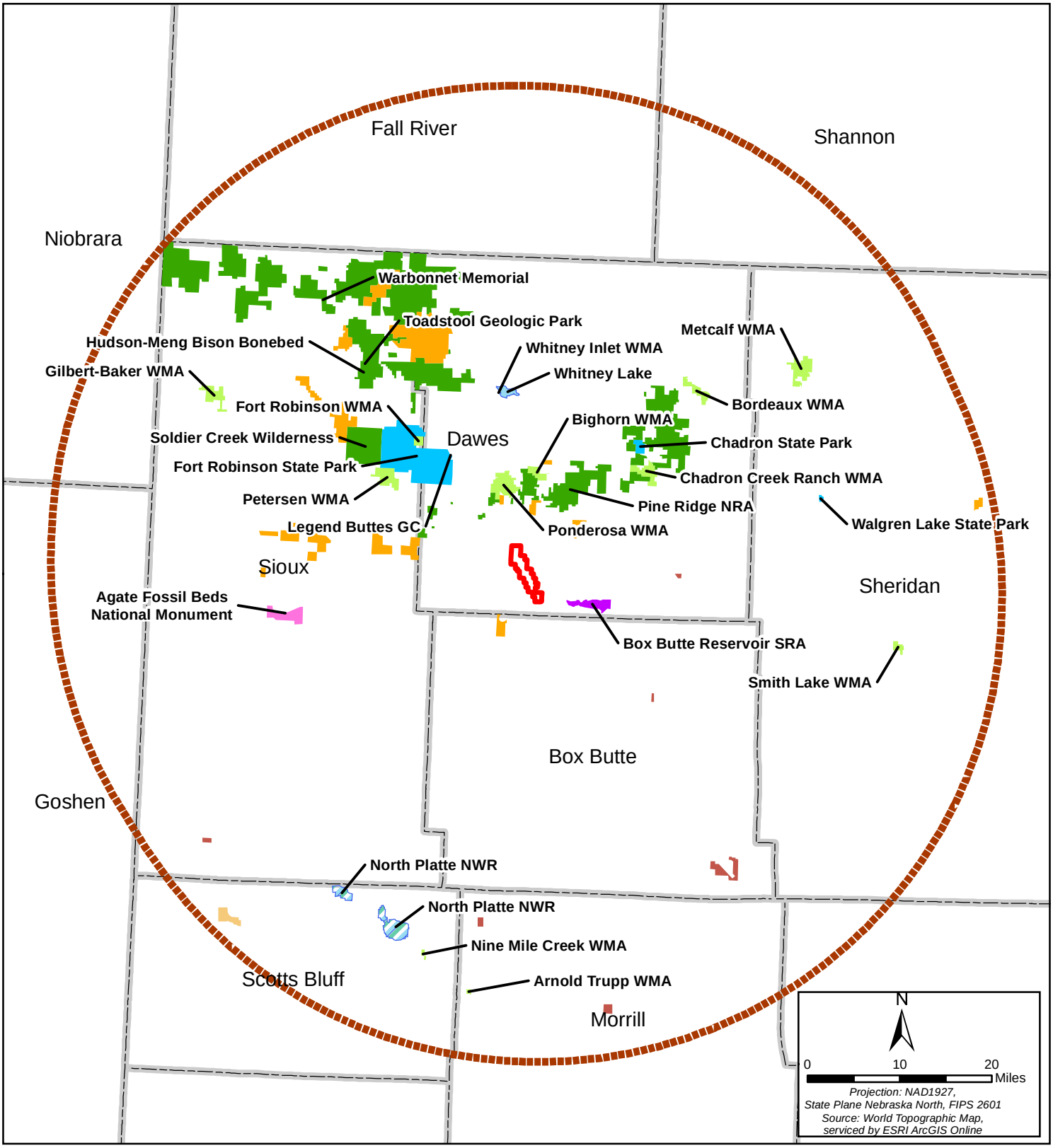

LEGEND

- Agate Fossil Beds National Monument
- Proposed Marsland Expansion Area
- 50 Mile Radius
- Wildlife Management Area
- State Recreation Area
- State Park; Walgren Lake State Park
- Conservation Partner Lands
- Natural Resource District Area
- Nebraska National Forest
- National Wildlife Refuge
- Open Fields and Waters
- Whitney Lake

CROW BUTTE RESOURCES, INC.

FIGURE 2.2-2
MARSLAND EXPANSION AREA
PROXIMITY TO RECREATION AREAS
AND WILDLIFE MANAGEMENT AREAS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: CM

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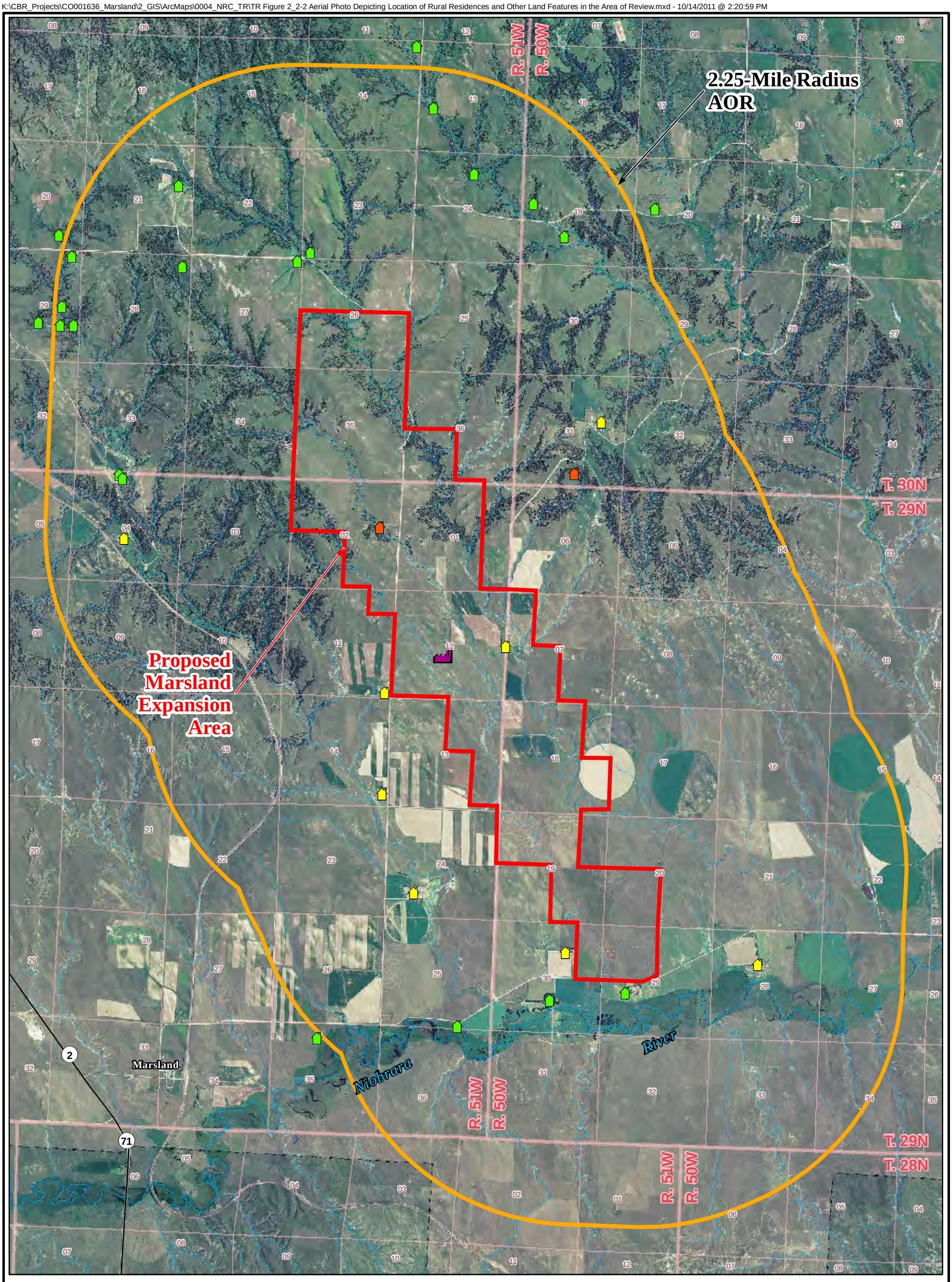
Document Path: I:\Marsland\GIS\ArcMap_MXD\TR Figure 2_x Recreation Facilities.mxd

K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_2-2 Aerial Photo Depicting Location of Rural Residences and Other Land Features in the Area of Review.mxd - 10/14/2011 @ 2:20:59 PM



LEGEND

- Structure
- Satellite Plant
- Occupied Residence
- Unoccupied Residence
- Proposed Marsland Expansion Area
- Area of Review (AOR)
- Intermittent Stream/River
- Perennial Stream/River

N

0 3,000 6,000

Feet

PROJECTION: NAD1927, STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: USDA NAIP IMAGERY 2010

CROW BUTTE RESOURCES, INC.

FIGURE 2.2-3
AERIAL PHOTO DEPICTING LOCATION OF RURAL RESIDENCES AND OTHER LAND FEATURES IN THE AREA OF REVIEW

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: J. CEARLEY

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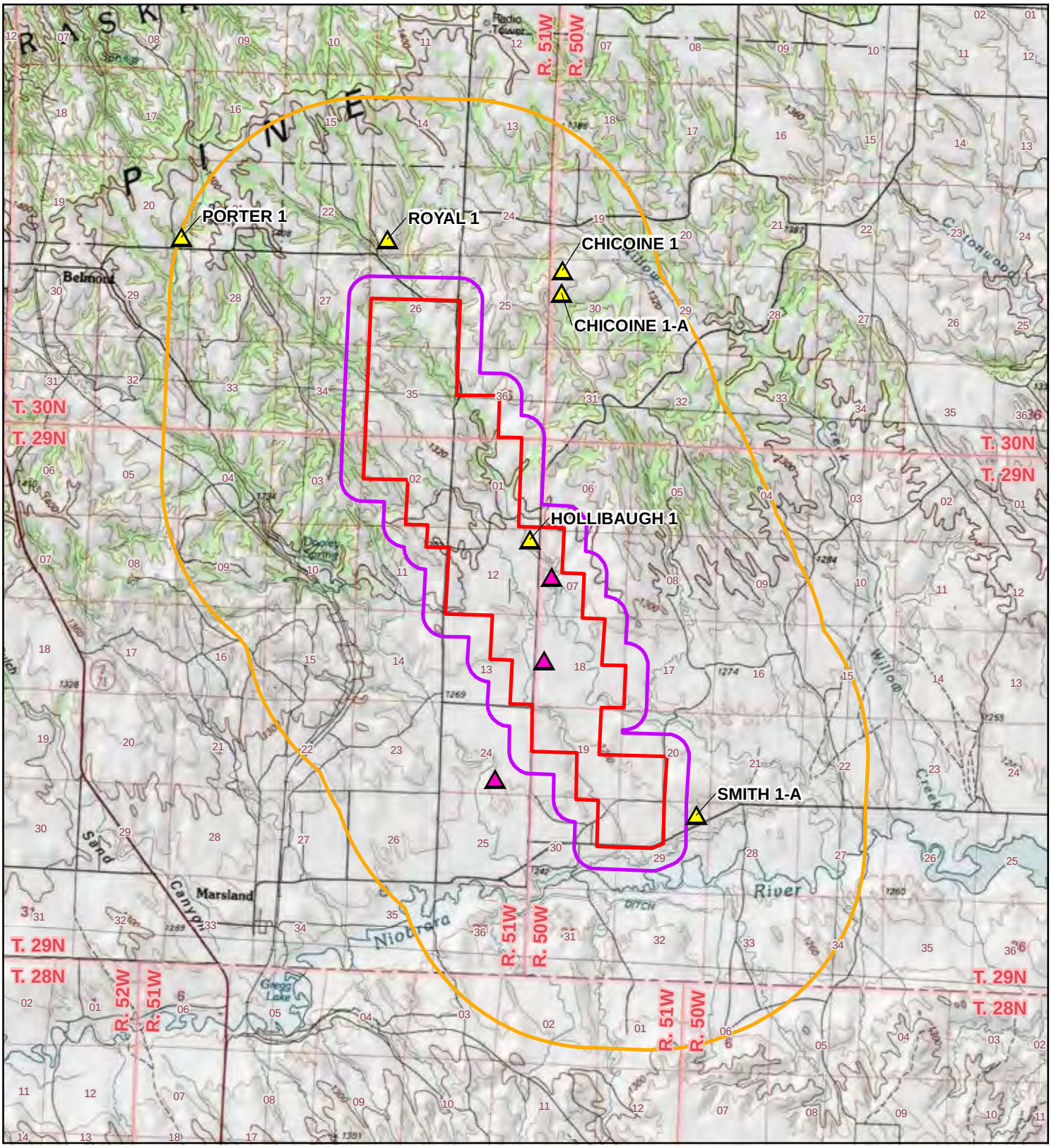

LEGEND

- Sand/Gravel Pit, Inactive
- Dry Hole, Dry and Abandoned
- Proposed Marsland Expansion Area
- ZOEI Boundary (1/4-mile fixed radius)
- AOR Boundary (2-mile fixed radius)

Sources for Sand/Gravel Pits

1. Dawes County, (http://dawes.assessor.gisworkshop.com/Assessor/index.jsp), Accessed on 08/03/2011, and
2. Burchett, R.R. 1971. Directory of Nebraska Quarries, Pits and Mines. Resource Report Number 5. University of Nebraska Conservation and Survey Division, Lincoln. March.

Sources for Oil/Gas Test Holes

Nebraska Oil and Gas Conservation Commission, (http://www.nogcc.ne.gov/NOGCCPublications.aspx), Accessed on 08/01/2011

N

0 4,000 8,000

Feet

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

CROW BUTTE RESOURCES, INC.

FIGURE 2.2-4
MARSLAND EXPANSION AREA
LOCATIONS OF GRAVEL PITS AND OIL/GAS TEST HOLES

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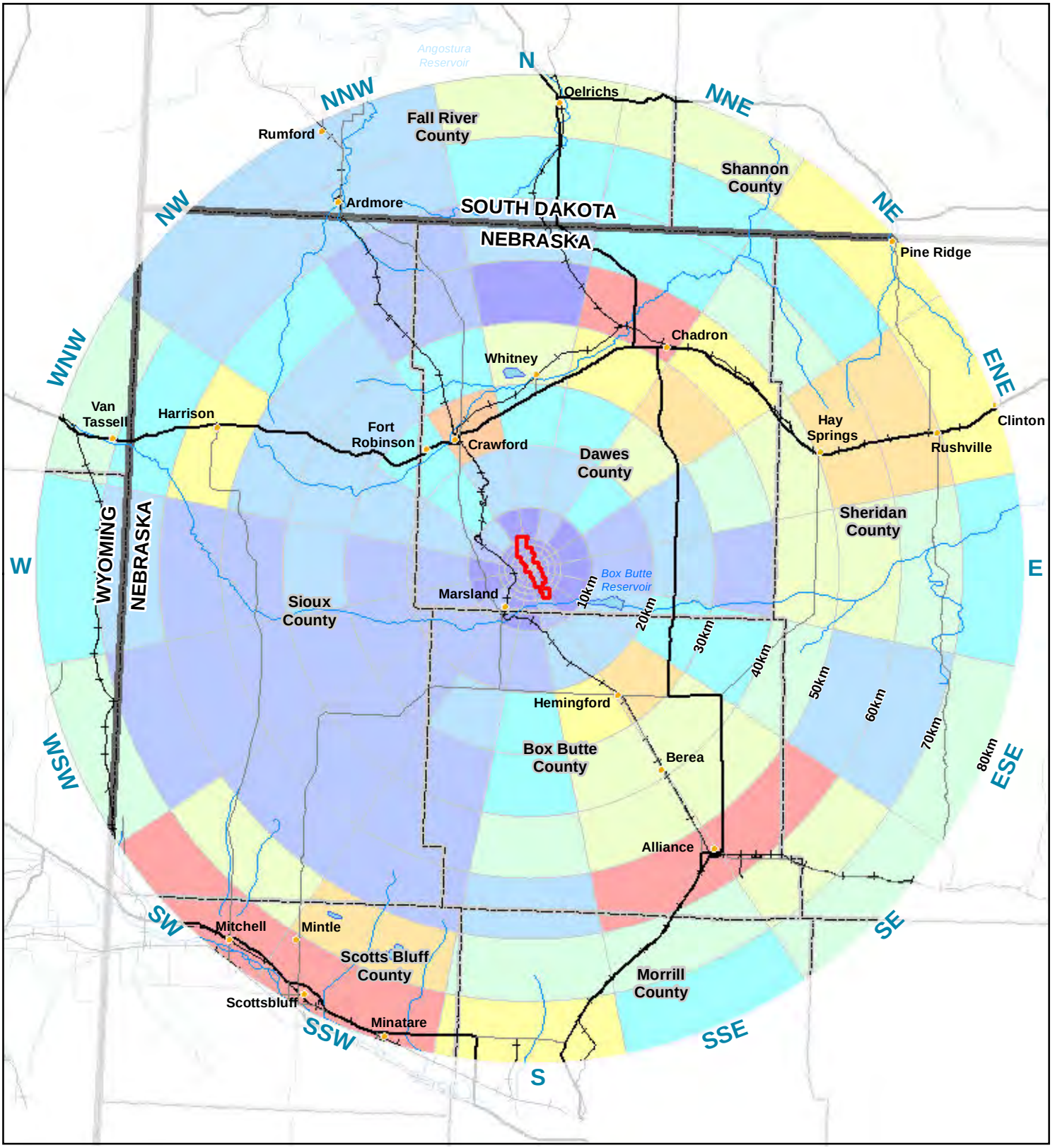
K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TRTR Figure 2_2-3 Gravel Pits and OG Test Holes.mxd.mxd - 11/8/2011 @ 11:16:59 PM



LEGEND

Proposed Cameco/Marsland Expansion Area

Population (Census 2010)

0 - 6	86 - 208
7 - 18	209 - 523
19 - 31	524 - 1,101
32 - 51	1,102 - 2,997
52 - 85	2,998 - 19,150

N

0 5 10 15 Miles

0 10 20 30 Kilometers

CROW BUTTE RESOURCES, INC.

FIGURE 2.3-1
SIGNIFICANT POPULATION CENTERS WITHIN AN 80-Km (50 mi) RADIUS OF THE MARSLAND SITE

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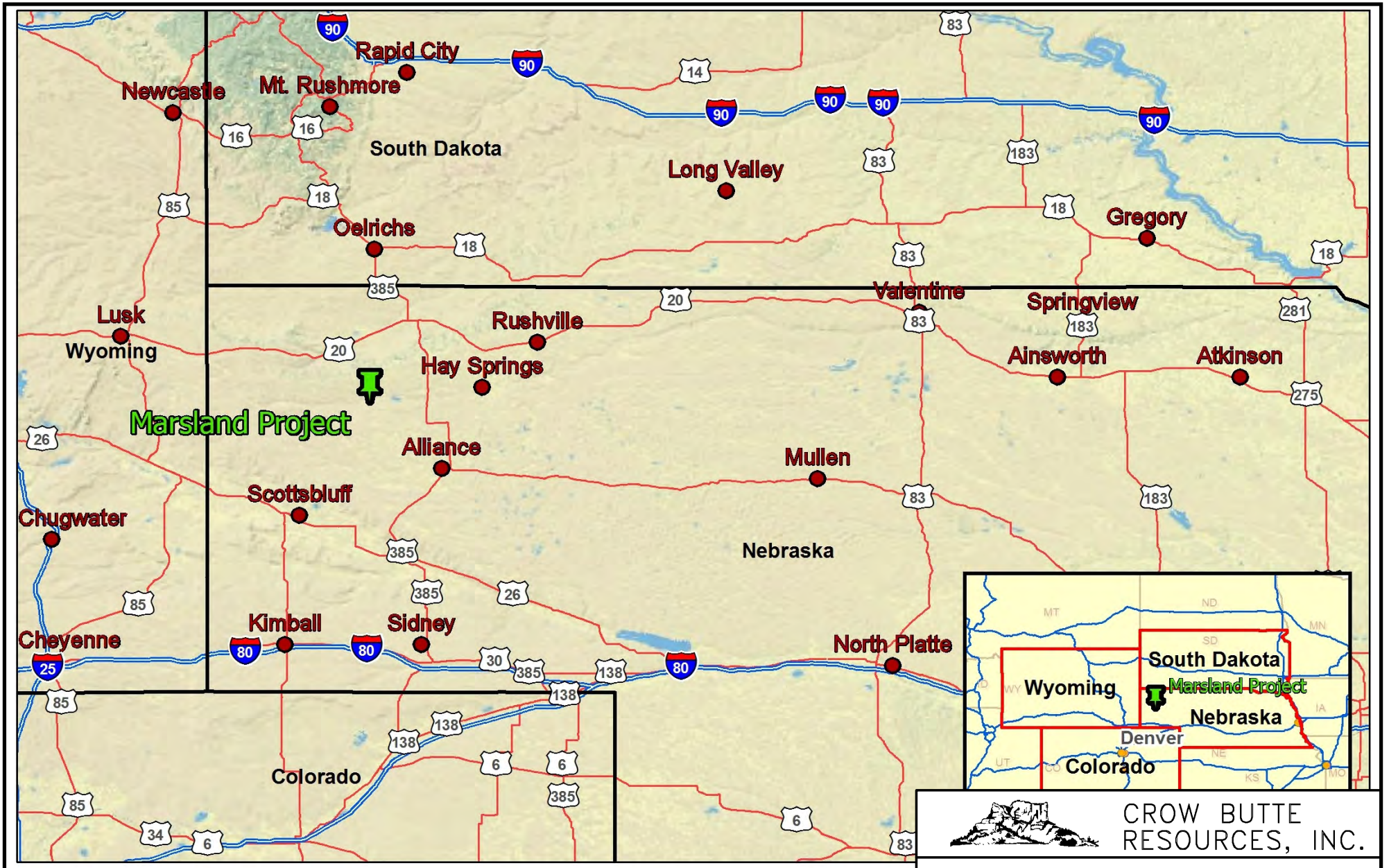
K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_3-1 Pop_Rose_byBlock_2010data.mxd - 10/14/2011 @ 12:00:42 PM



Source: Inter-Mountain Lab (IML) Air Science, 2011

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-1
MARSLAND PROJECT
MET STATIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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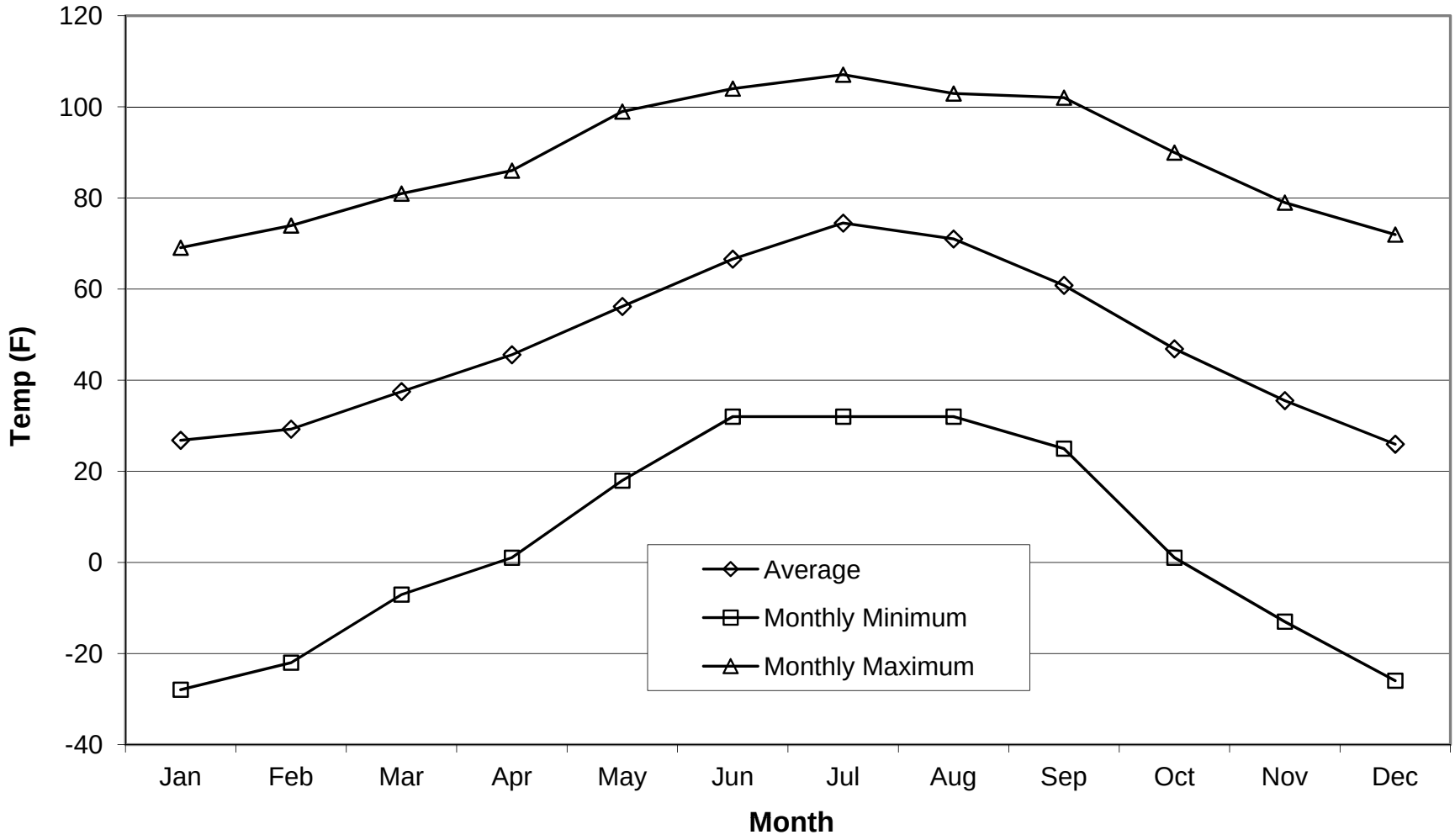
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\IllustratorNTR Figure 2_5-1 Marsland Project Met Stations.ai @ 10/17/2011



CROW BUTTE RESOURCES, INC.

FIGURE 2.5-2
SCOTTSBLUFF AP
MONTHLY TEMPERATURES

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

Source: National Climate Data Center, 2011, hourly data from 1996 through 2011.

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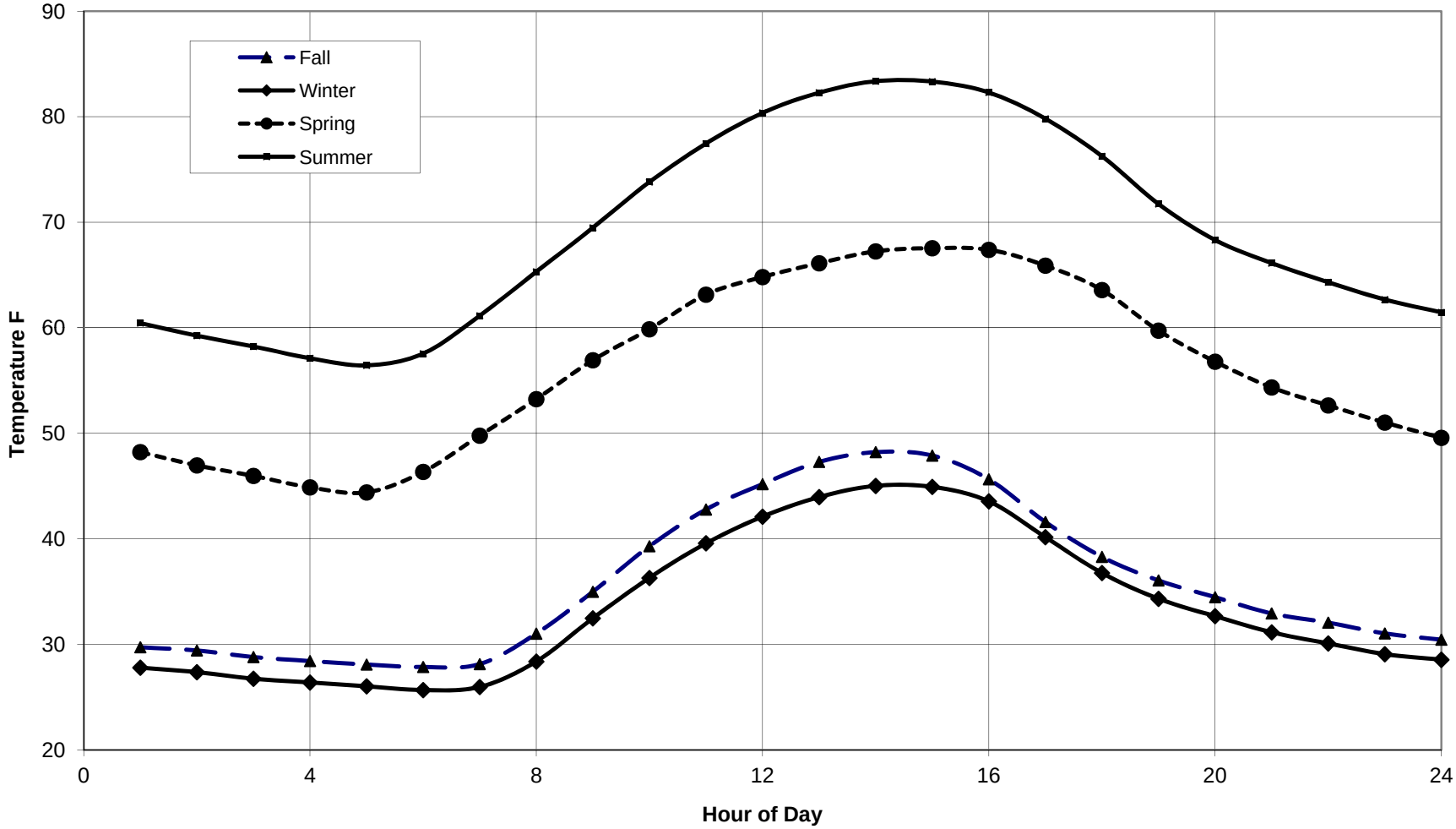
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2_5-2 Scottsbluff AP Monthly Temp.ai @ 11/08/2011



Source: National Climate Data Center, 2011, hourly data from 1996 through 2011.

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-3
SCOTTSBLUFF AP SEASONAL DIURNAL TEMPERATURE VARIATIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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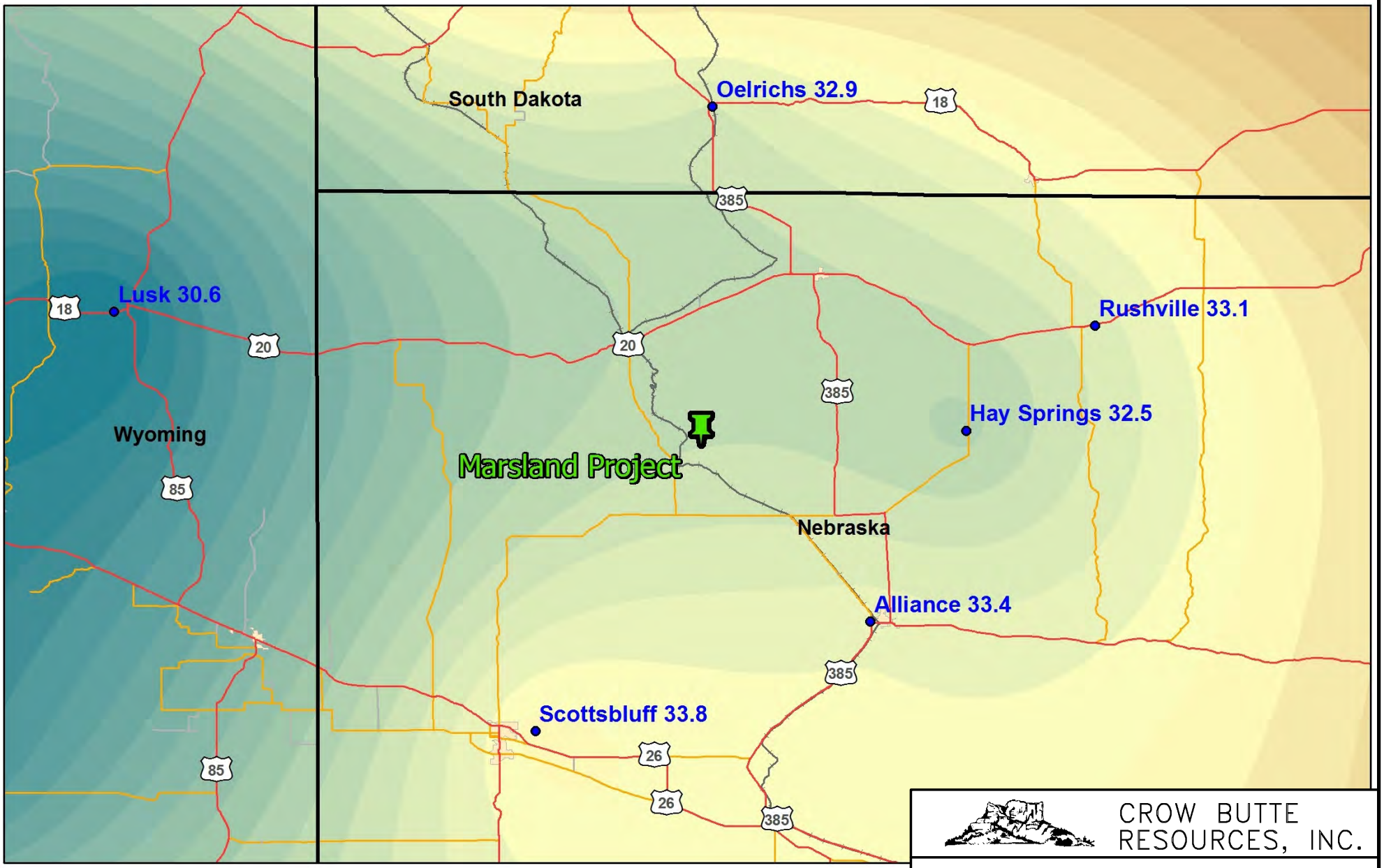
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2_5-3 Scottsbluff AP Seasonal Diurnal Temp Variation.ai @ 11/08/2011



Source: Inter-Mountain Lab (IML) Air Science, 2011

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-4
REGIONAL ANNUAL AVERAGE MINIMUM TEMPERATURES

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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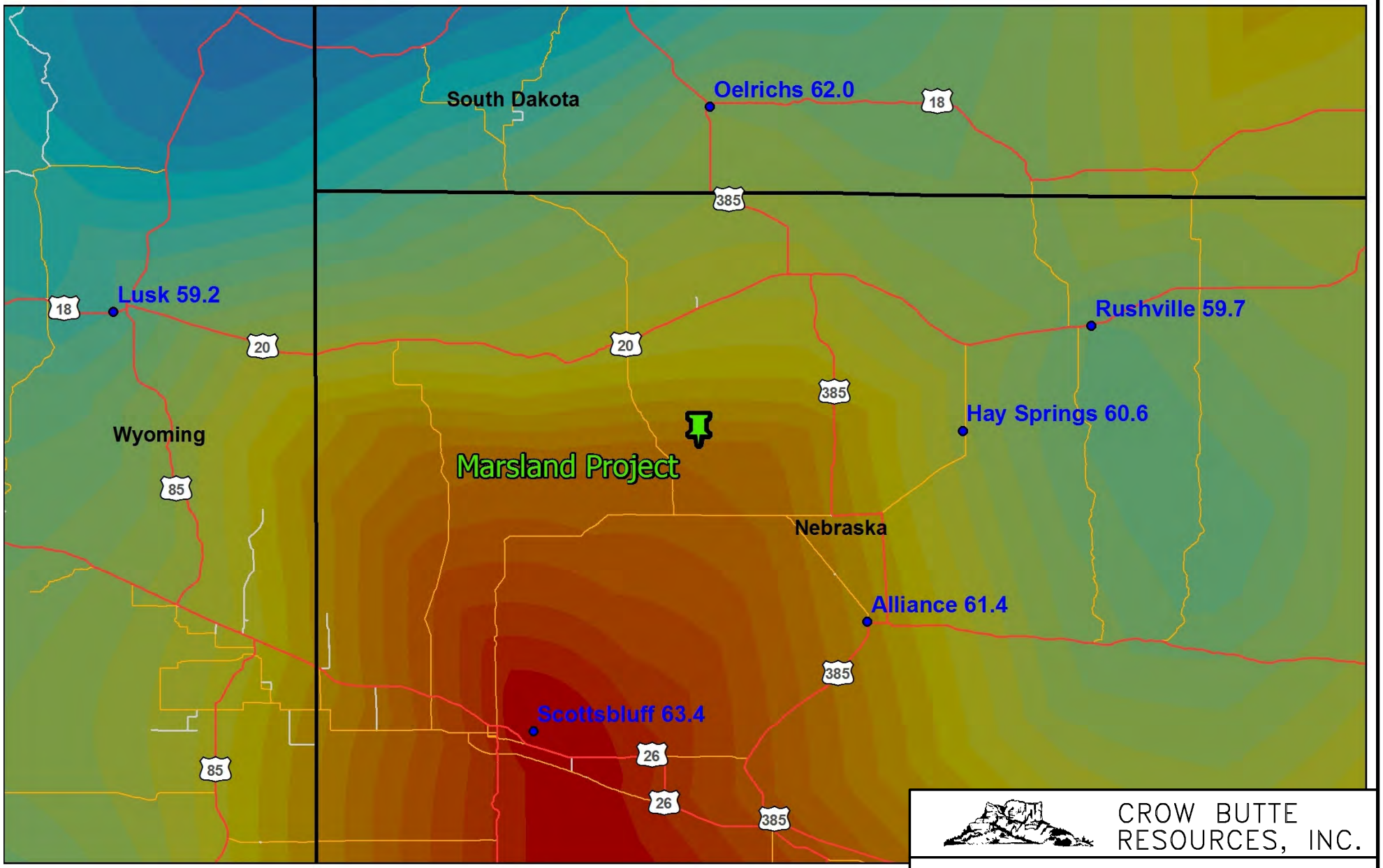
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\IllustratorTR Figure 2_5-4 Regional Annual Average Minimum Temp.ai @ 10/17/2011



Source: Inter-Mountain Lab (IML) Air Science, 2011

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FIGURE 2.5-5
REGIONAL ANNUAL AVERAGE MAXIMUM TEMPERATURES

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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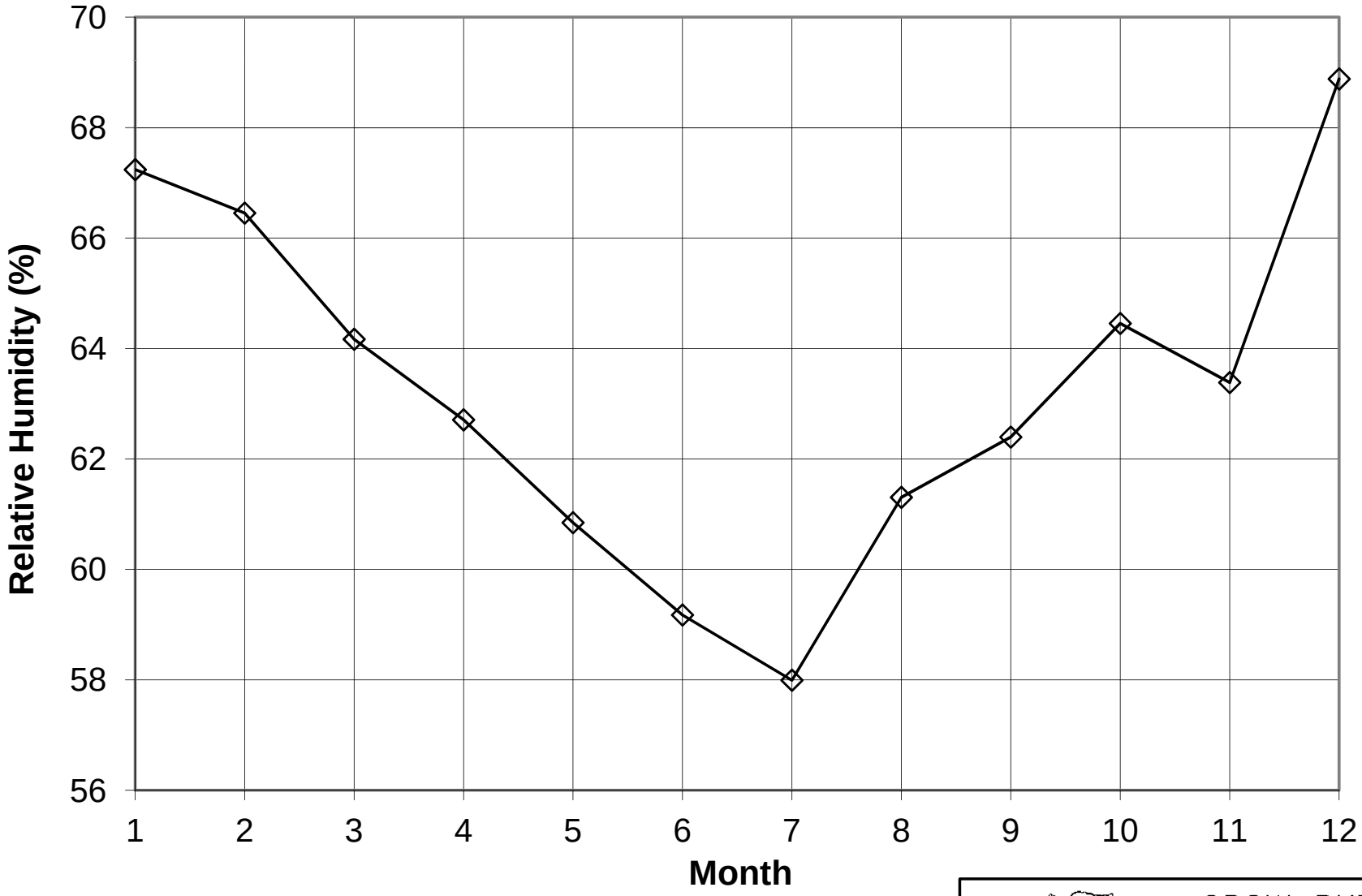

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FIGURE 2.5-6
MONTHLY RELATIVE HUMIDITY
STATISTICS FOR SCOTTSBLUFF AP

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

Source: National Climate Data Center, 2011, hourly data from 1996 through 2011.

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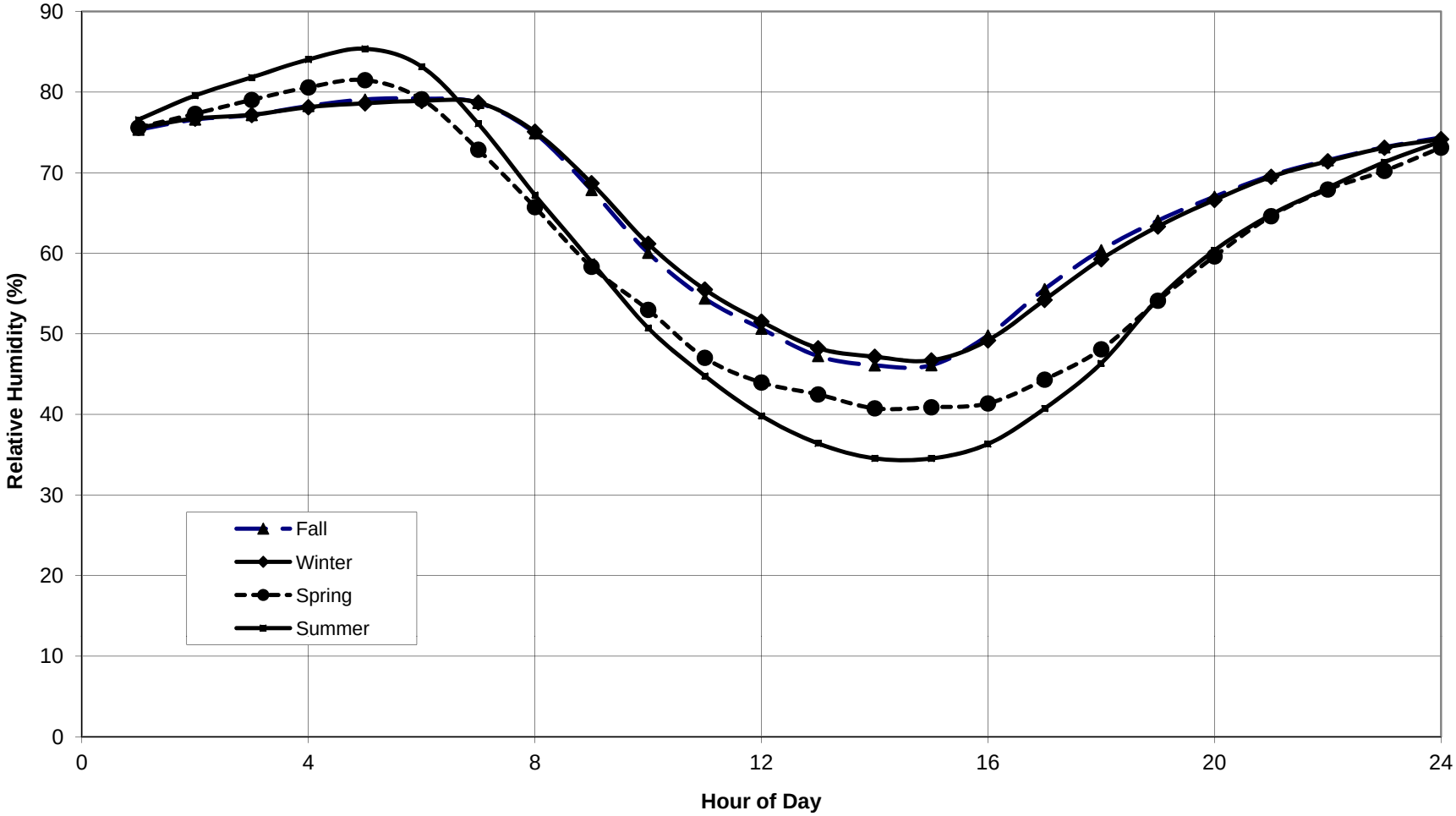

Source: National Climate Data Center, 2011, hourly data from 1996 through 2011.

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FIGURE 2.5-7
DIURNAL VARIATION IN RELATIVE HUMIDITY FOR SCOTTSBLUFF BY SEASON

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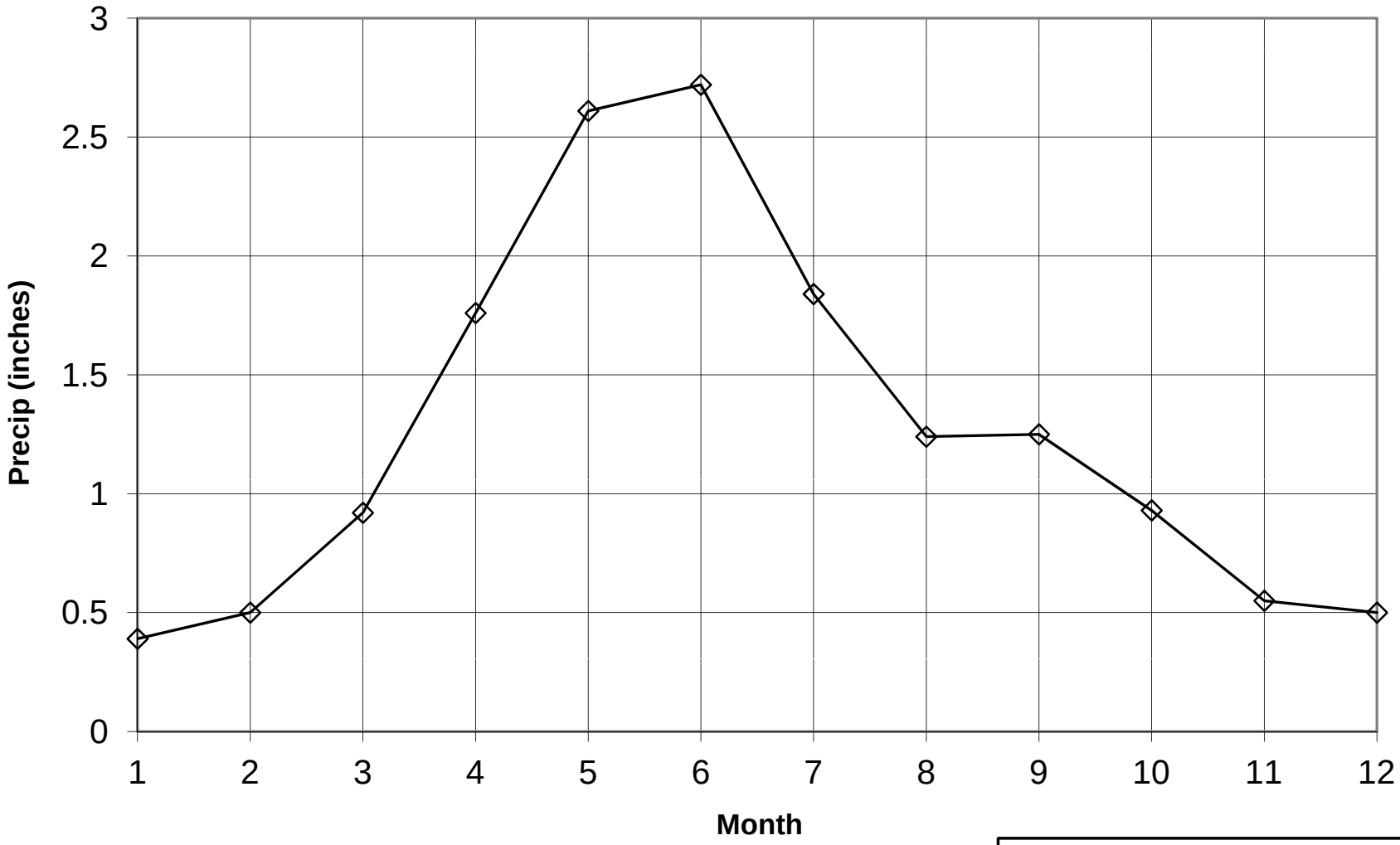

Source: High Plains Regional Climate Data Center, 2011, hourly data from 1893 through 2010.

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FIGURE 2.5-8
SCOTTSBLUFF AP
MONTHLY AVERAGE PRECIPITATION

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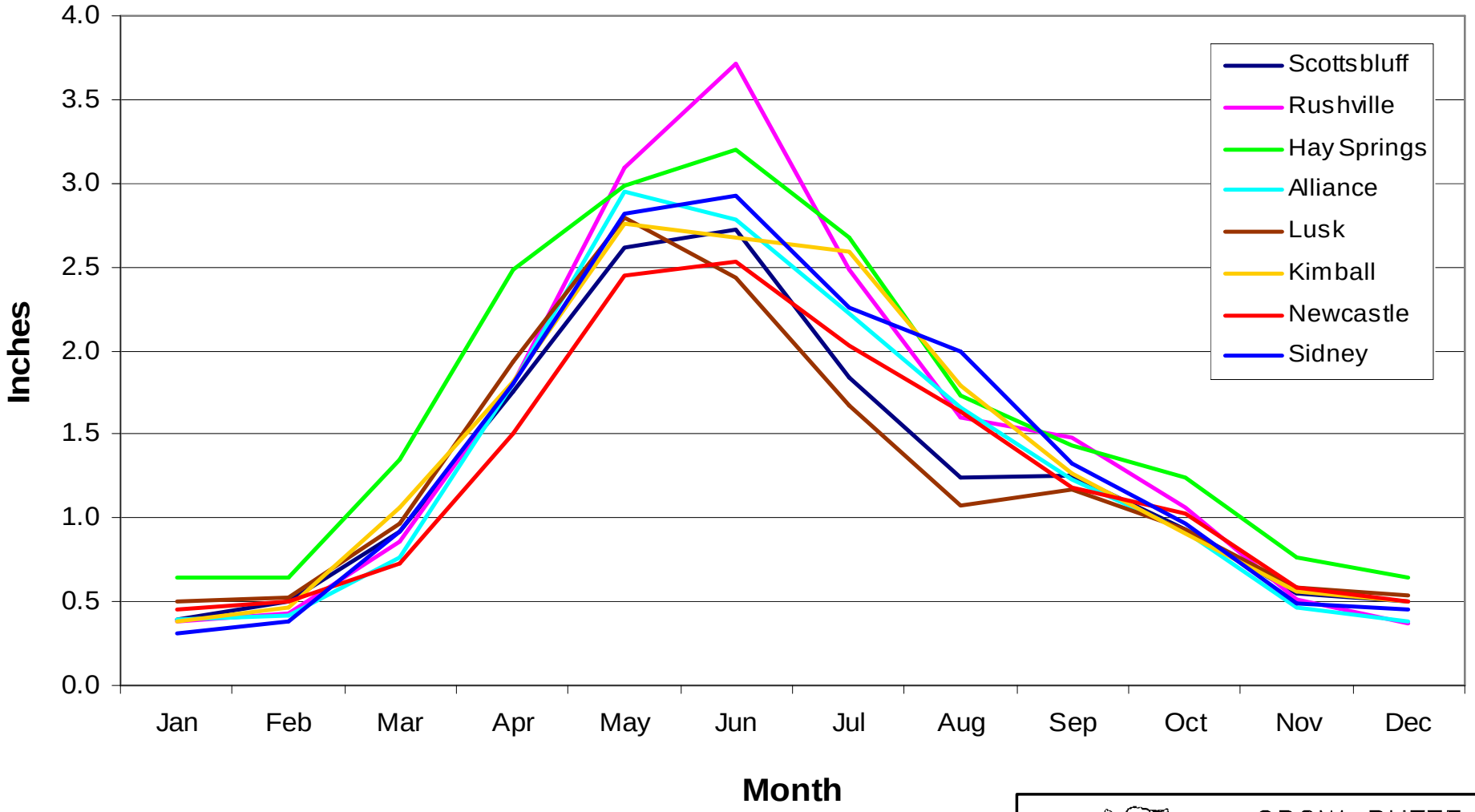

Source: National Climate Data Center, 2011.

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FIGURE 2.5-9
REGIONAL
MONTHLY AVERAGE PRECIPITATION

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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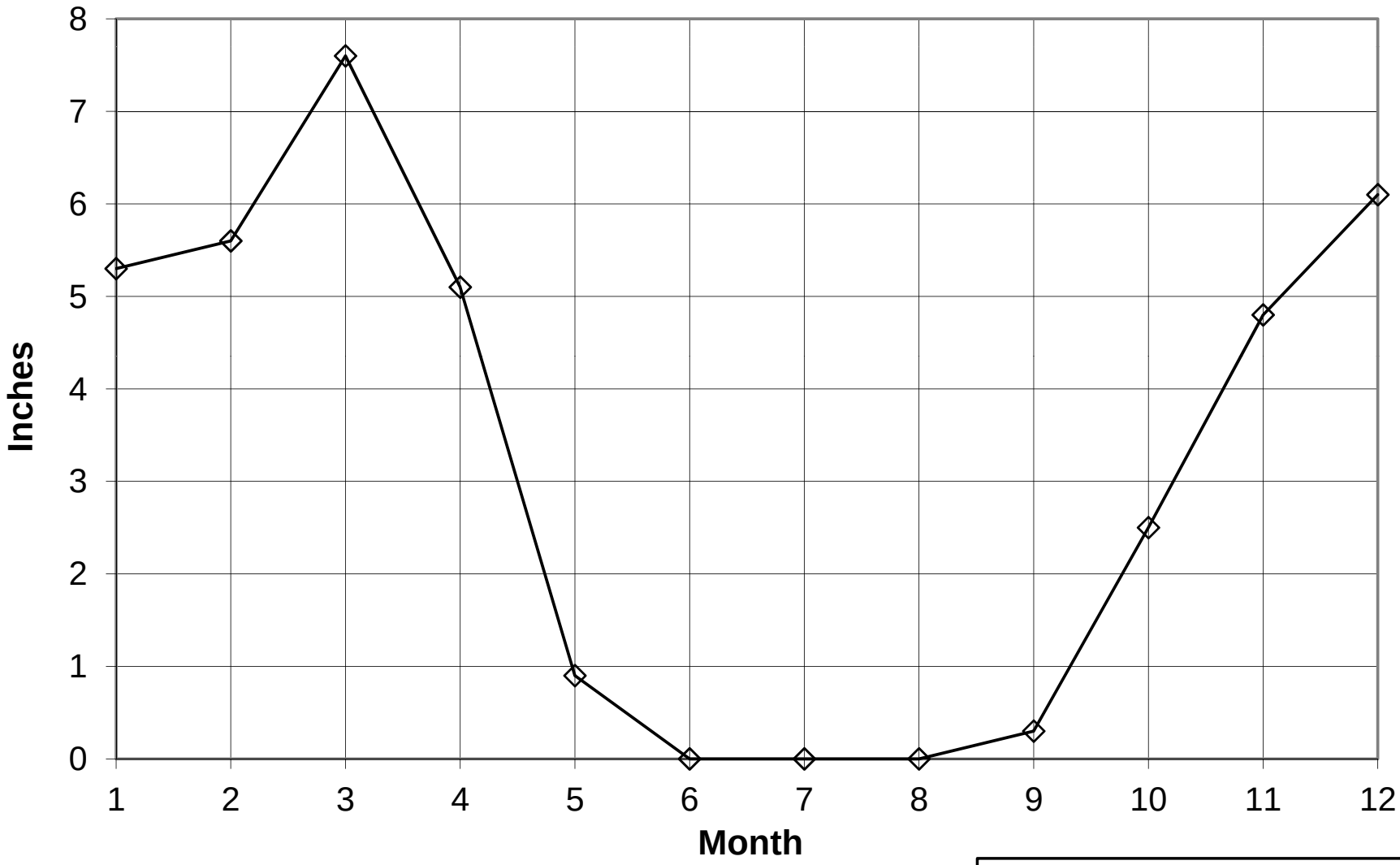

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FIGURE 2.5-10
SCOTTSBLUFF AP
MONTHLY SNOWFALL

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

Source: High Plains Regional Climate Data Center, 2011, hourly data from 1893 through 2010.

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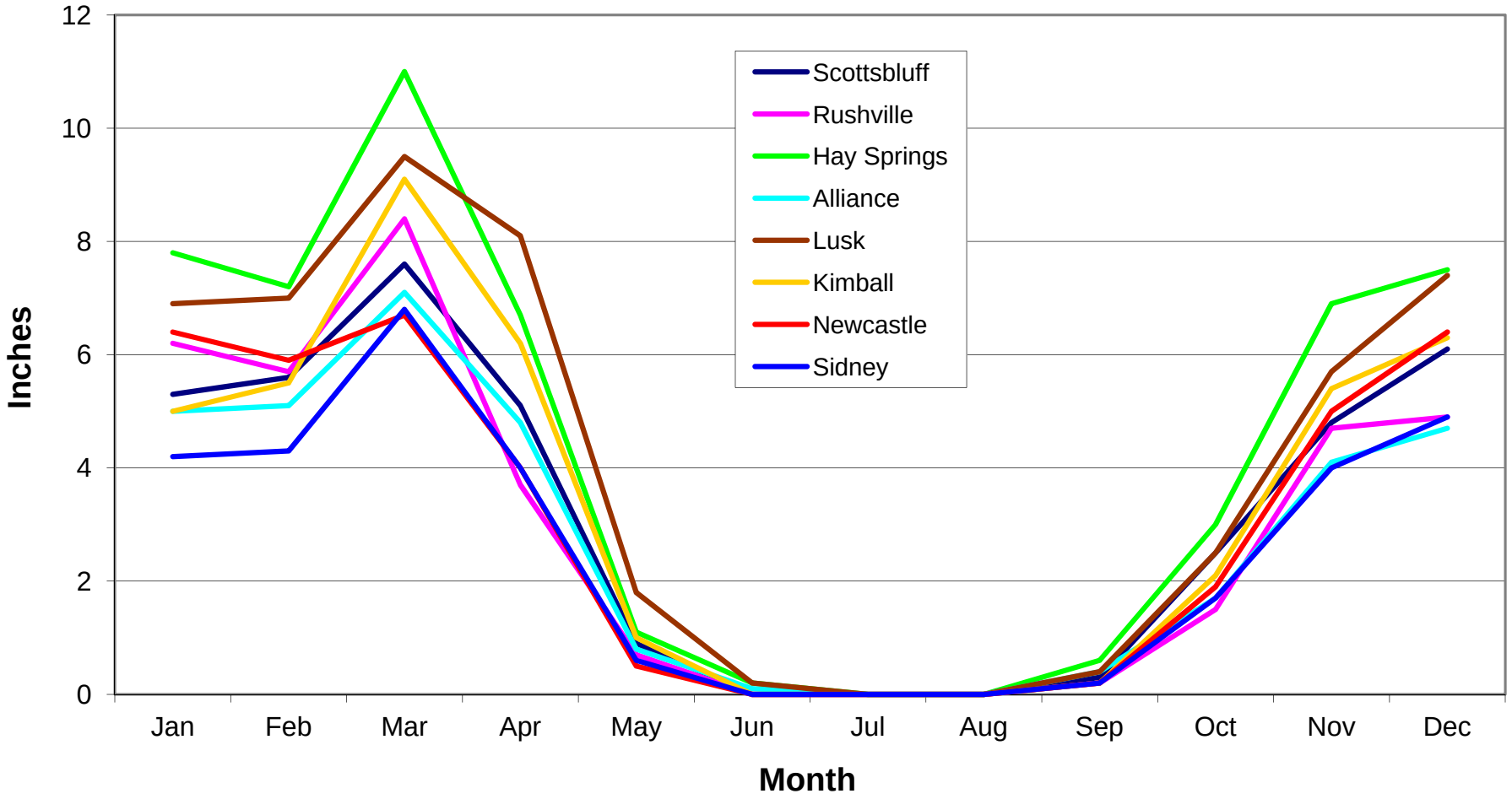

Source: National Climate Data Center, 2011.

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FIGURE 2.5-11
REGIONAL
MONTHLY AVERAGE SNOWFALL

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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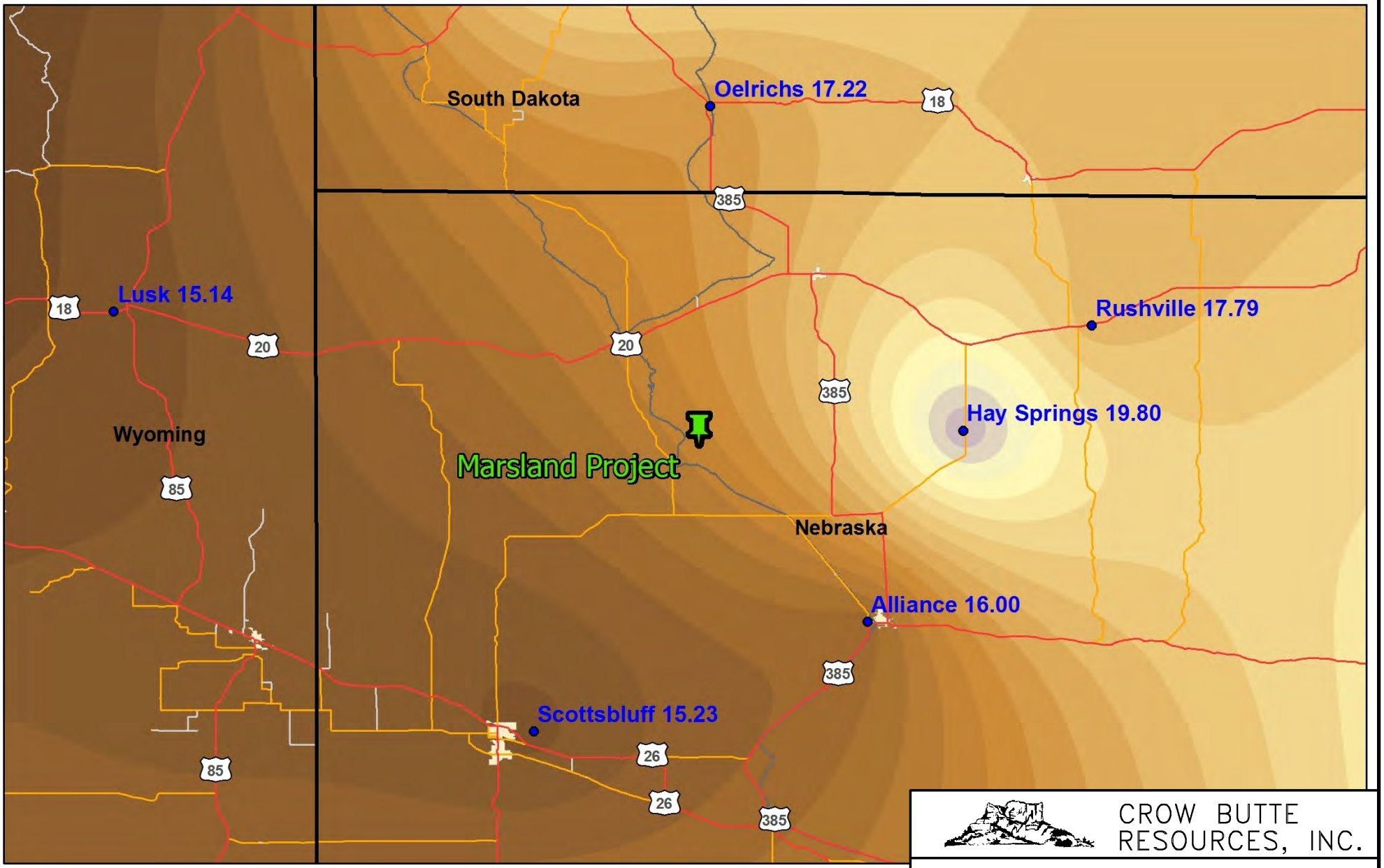
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\IllustratorNTR Figure 2_5-11 Regional Monthly Average Snowfall.ai @ 11/08/2011



Source: Inter-Mountain Lab (IML) Air Science, 2011

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FIGURE 2.5-12
REGIONAL ANNUAL AVERAGE PRECIPITATION

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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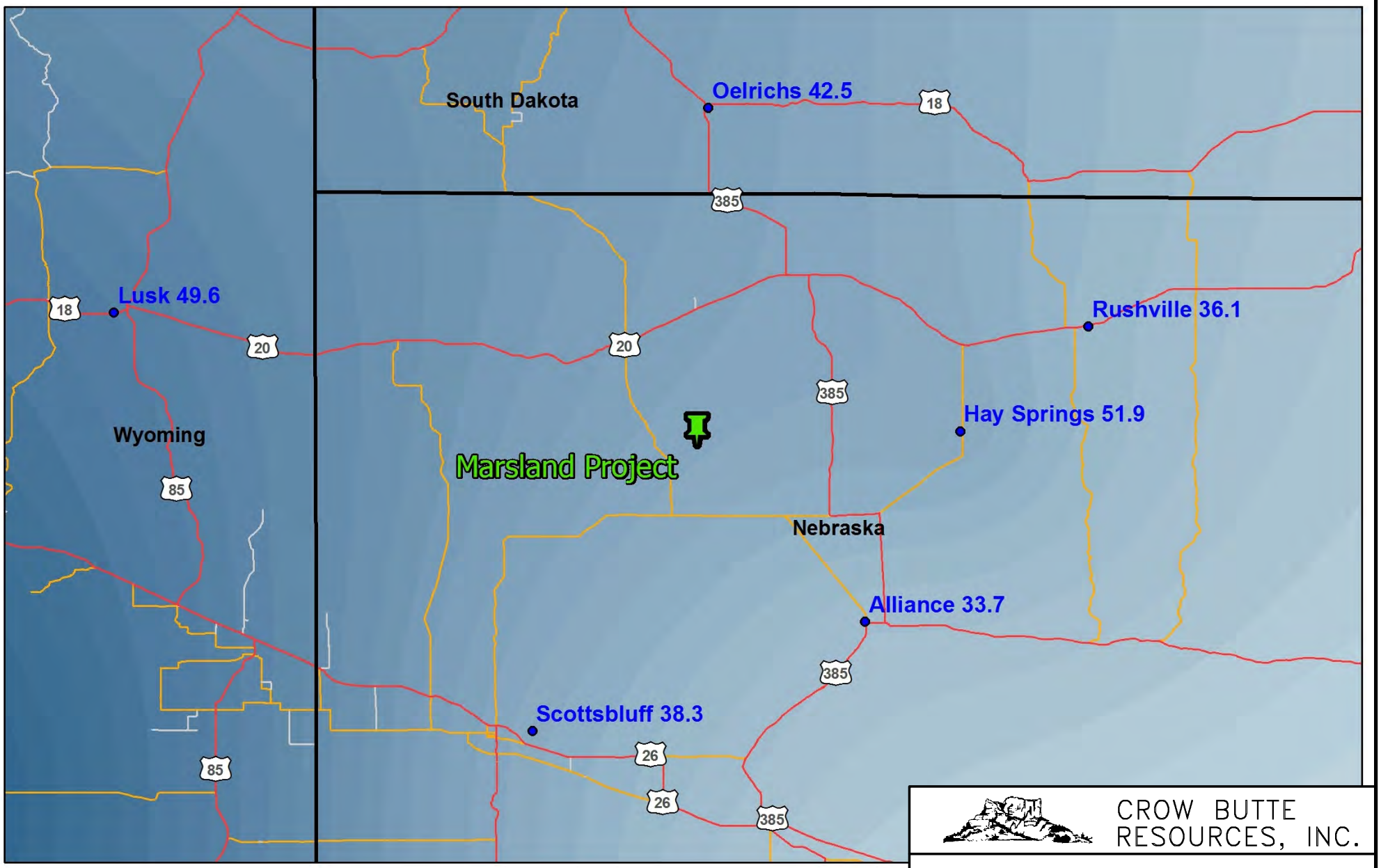

Source: Inter-Mountain Lab (IML) Air Science, 2011

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FIGURE 2.5-13
REGIONAL ANNUAL AVERAGE SNOWFALL

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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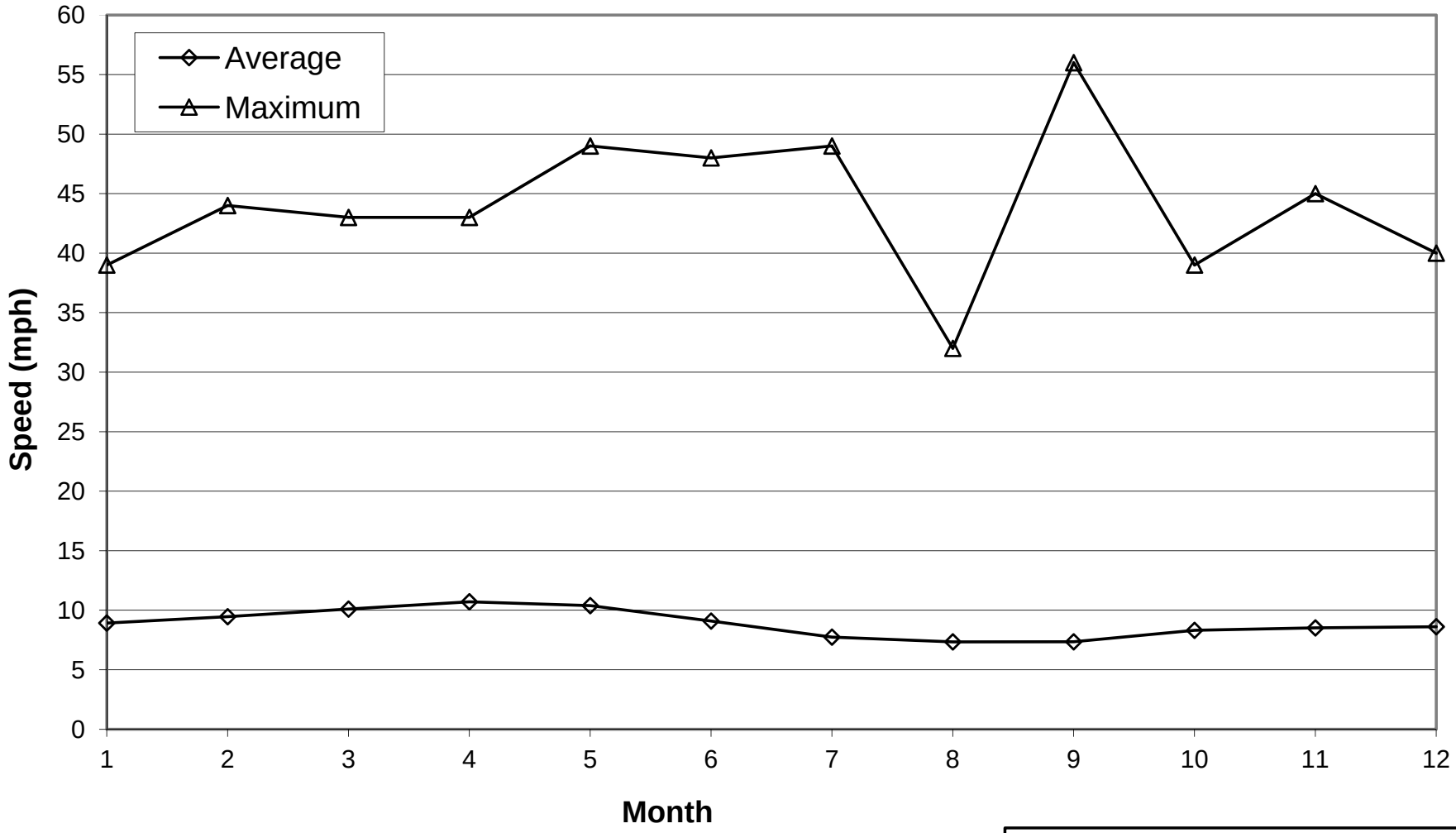
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\IllustratorTR Figure 2_5-13 Regional Annual Average Snowfall.ai @ 10/17/2011



CROW BUTTE RESOURCES, INC.

FIGURE 2.5-14
SCOTTSBLUFF AP
15-YEAR WIND SPEEDS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

Source: National Climate Data Center, 2011, hourly data from 1996 through 2011.

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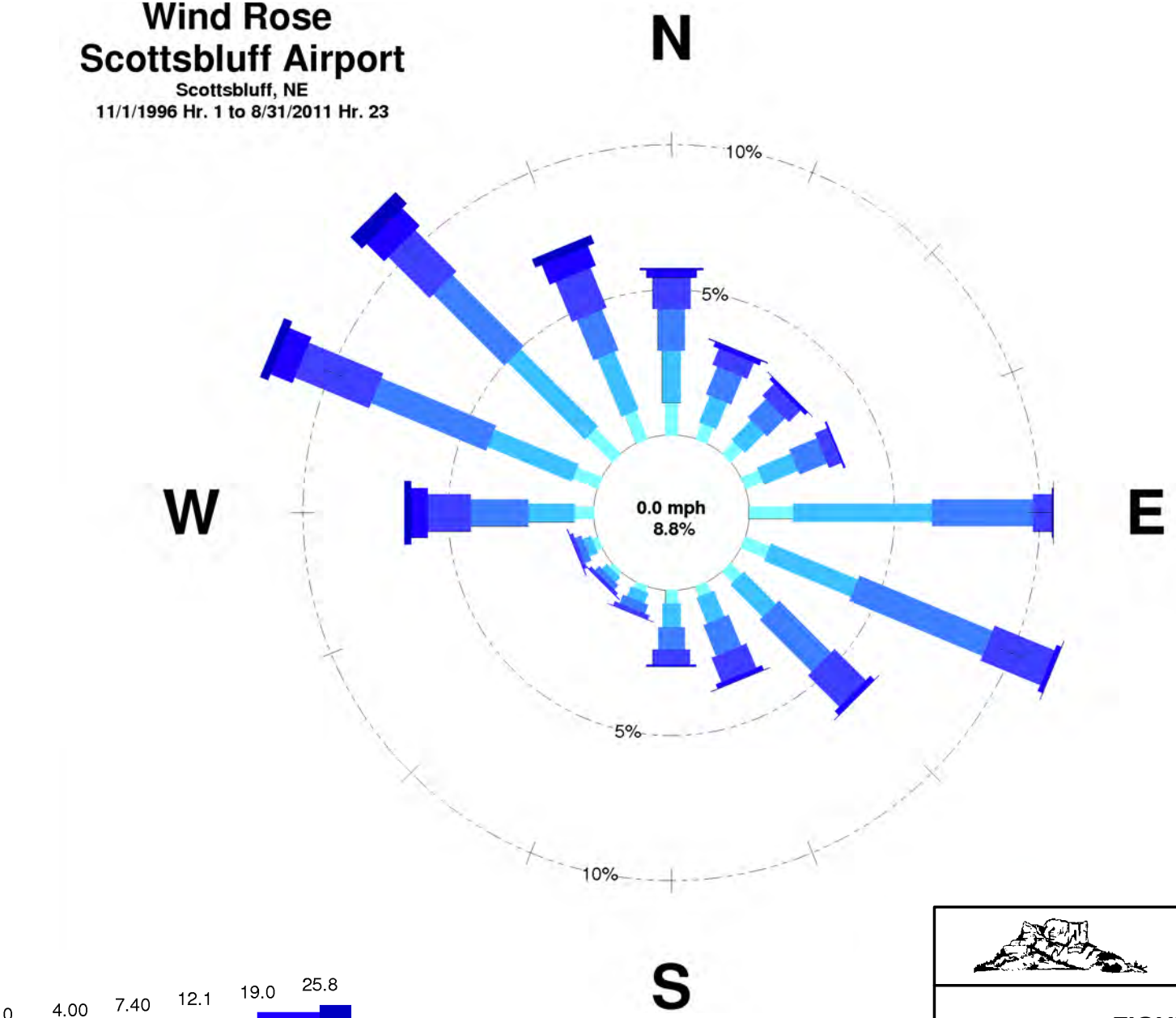
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\IllustratorTR Figure 2_5-14 Scottsbluff 15-Year Wind Speeds.ai @ 11/08/2011

Wind Rose
Scottsbluff Airport

Scottsbluff, NE
11/1/1996 Hr. 1 to 8/31/2011 Hr. 23



Source: National Climate Data Center, 2011, hourly data from 1996 through 2011.

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-15
SCOTTSBLUFF AP
15-YEAR WIND ROSE

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2_5-15 Scottsbluff AP 15-Year Wind Rose.ai @ 10/17/2011

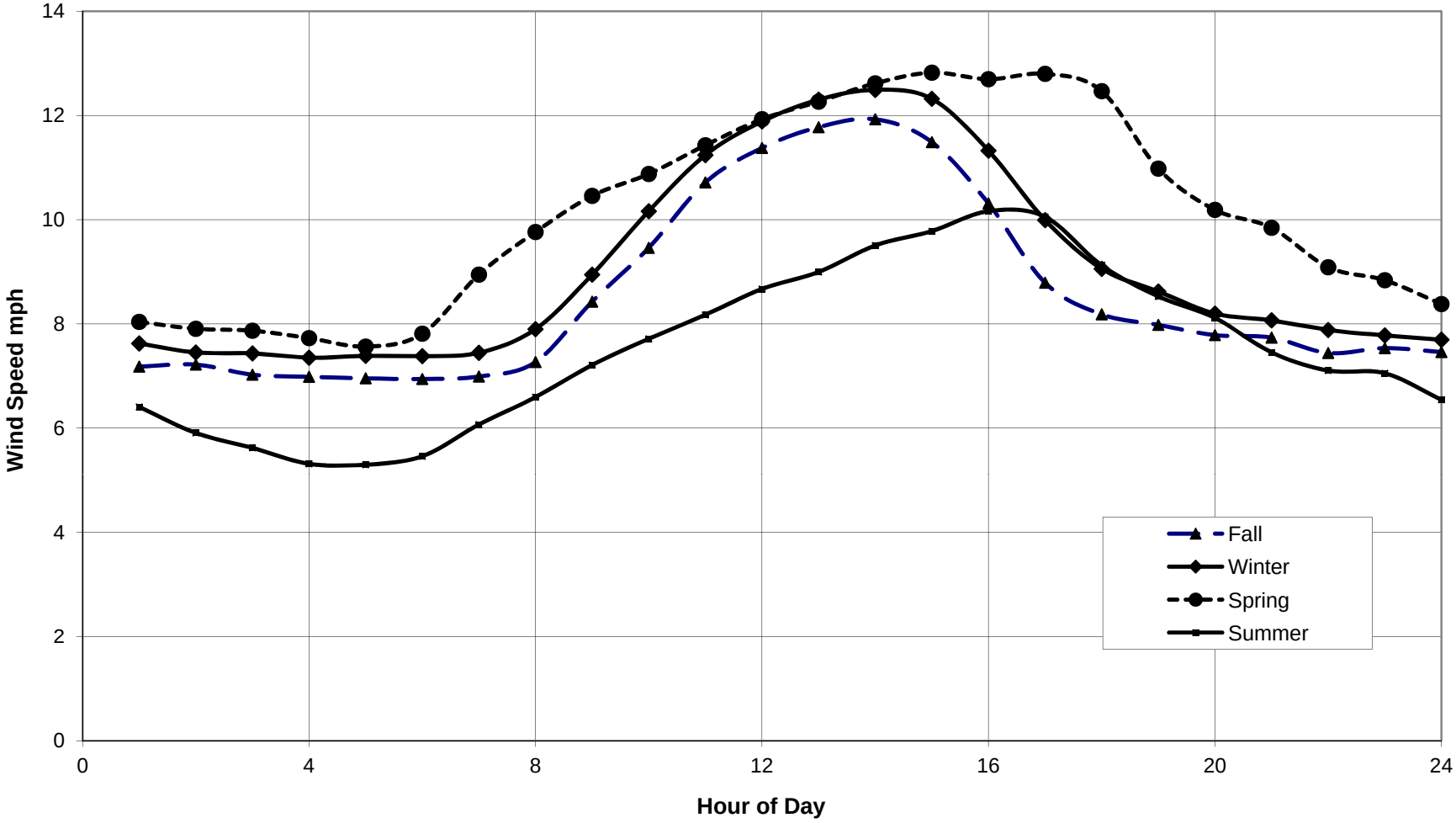

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FIGURE 2.5-16
SCOTTSBLUFF AP
DIURNAL WIND SPEEDS BY SEASON

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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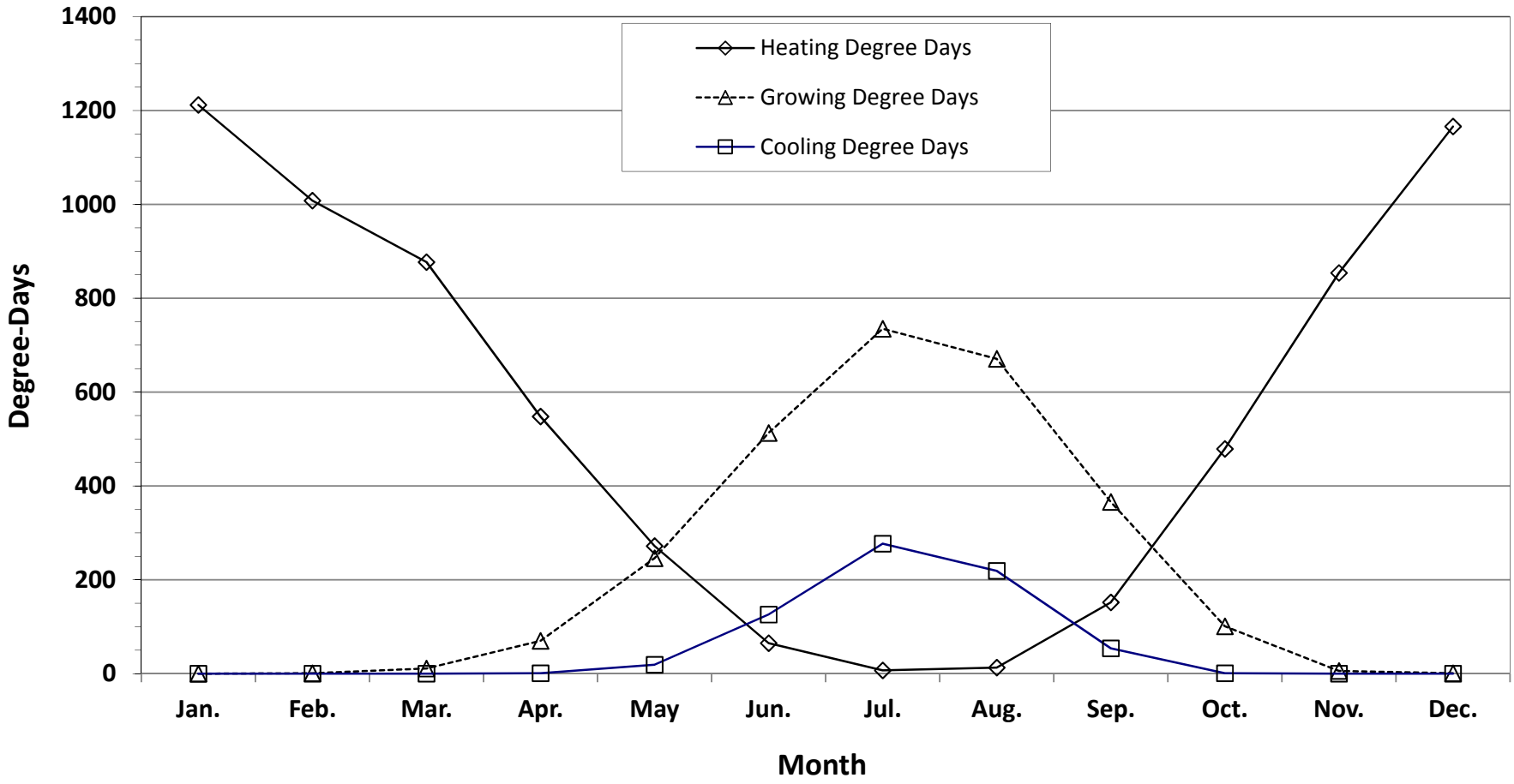
Source: National Climate Data Center, 2011, hourly data from 1996 through 2011.



Source: High Plains Regional Climate Data Center, 2011, data from 1893 through 2010.

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FIGURE 2.5-17
SCOTTSBLUFF AP
COOLING, HEATING, AND GROWING DEGREE DAYS

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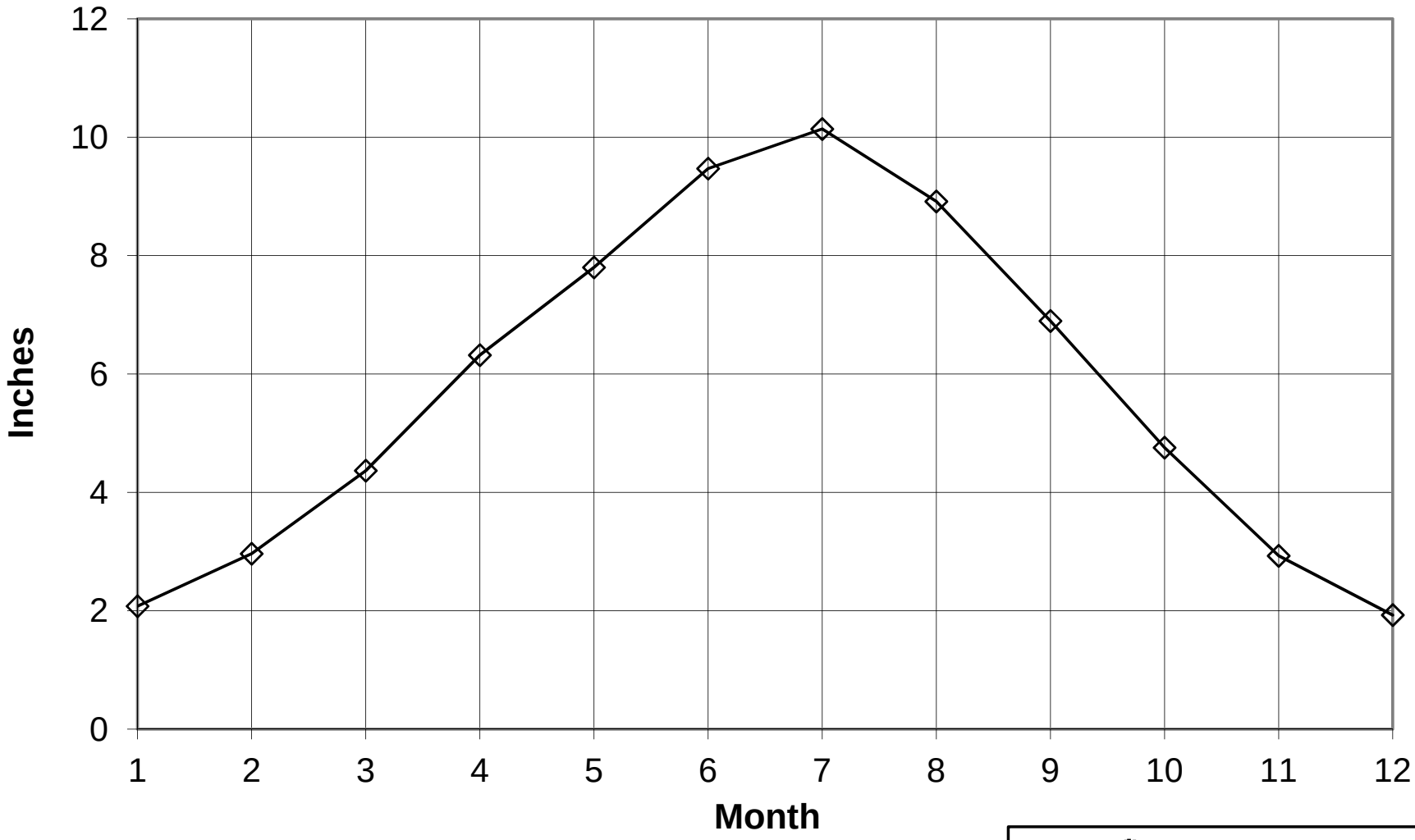

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FIGURE 2.5-18
SCOTTSBLUFF AP
POTENTIAL EVAPOTRANSPIRATION

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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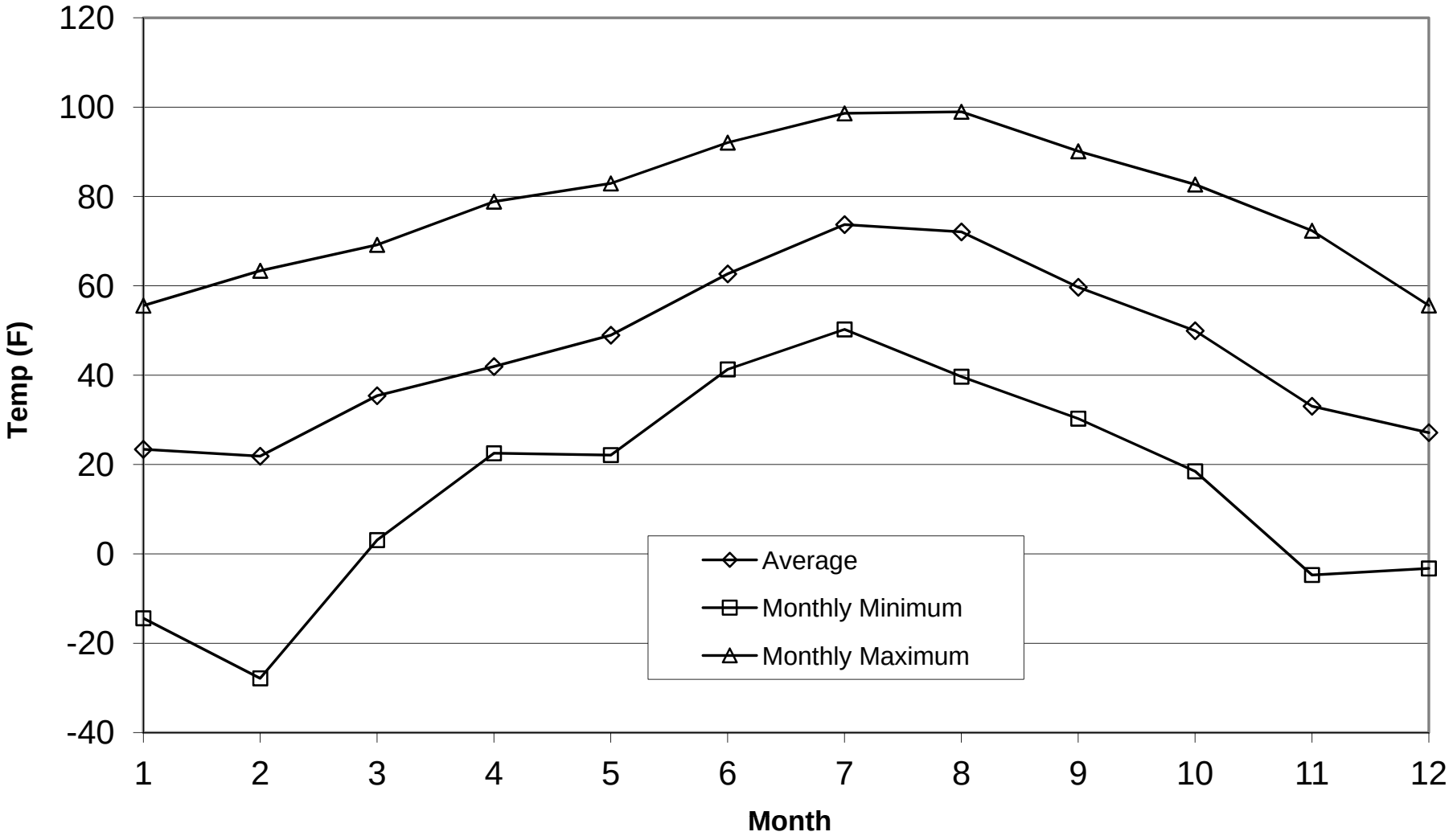
Source: Calculation based on Penman Equation.



Source: Cameco Resources, 2011, data from 8/24/2010 to 8/29/2011.

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-19
MARSLAND EXPANSION AREA
MONTHLY TEMPERATURES

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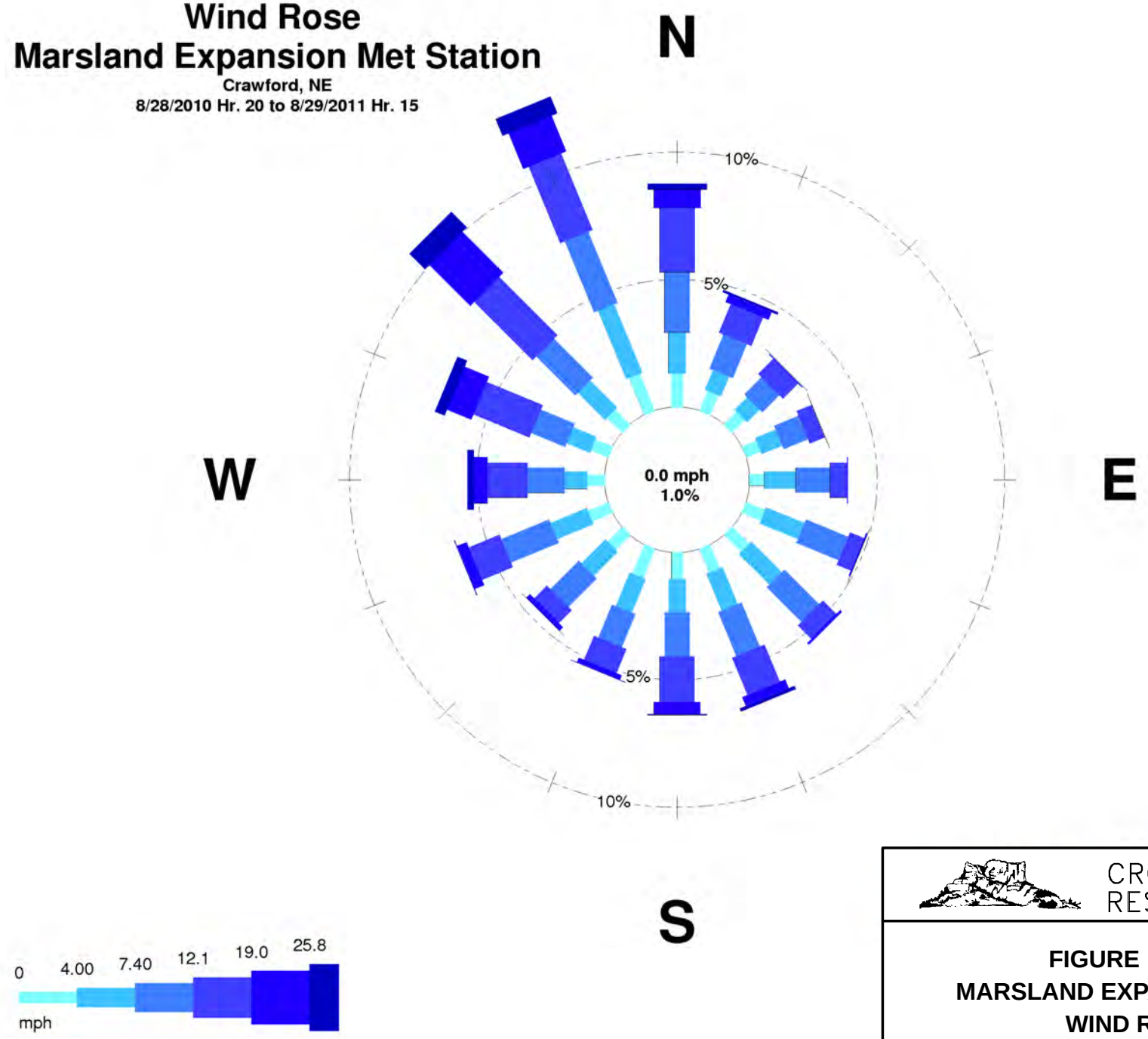

Source: Inter-Mountain Lab (IML) Air Science, 2011.

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-20
MARSLAND EXPANSION AREA
WIND ROSE

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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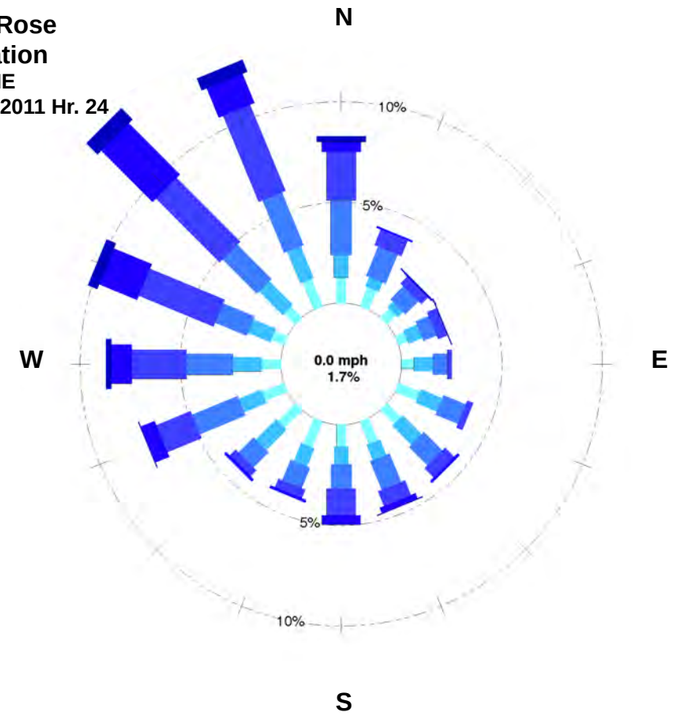
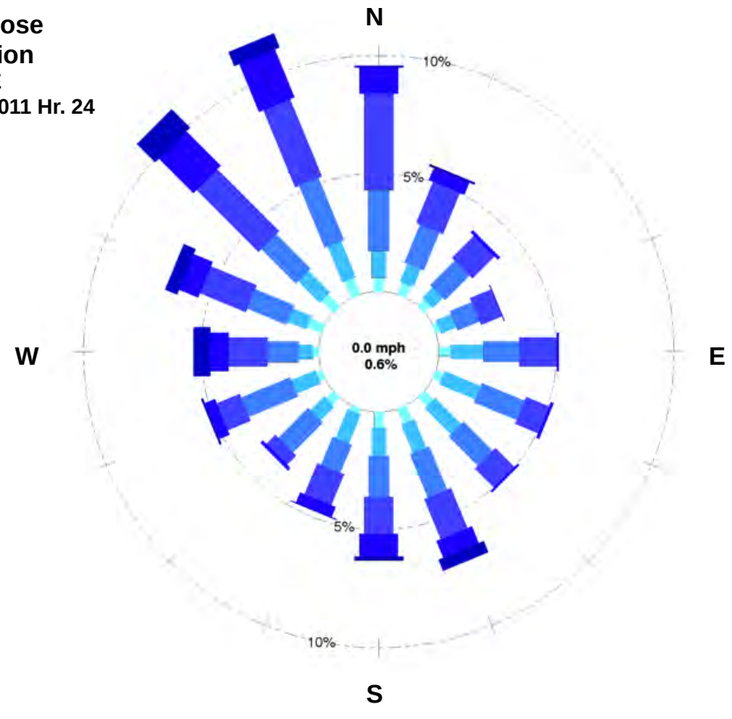
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2_5-20 Marsland Expansion Area Wind Rose.ai @ 10/17/2011

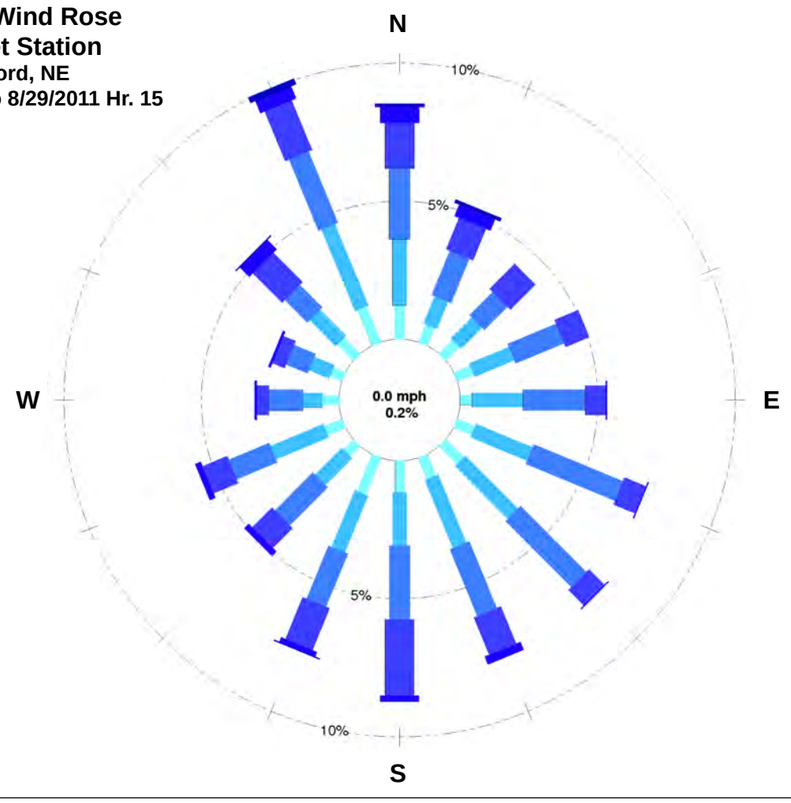
Winter Wind Rose
MEA Met Station
Crawford, NE
1/1/2011 Hr. 1 to 3/31/2011 Hr. 24



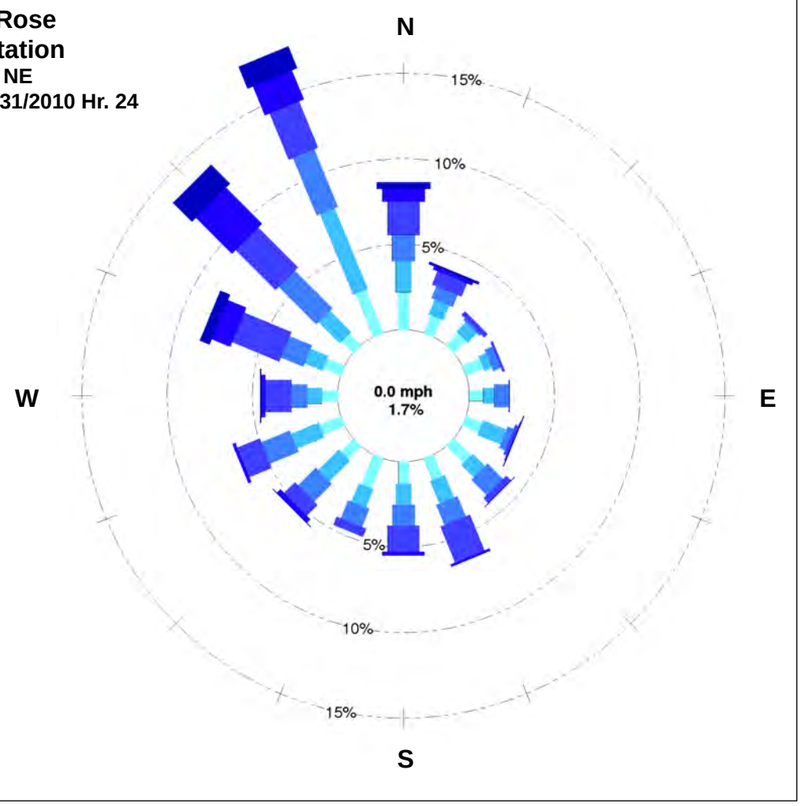
Spring Wind Rose
MEA Met Station
Crawford, NE
4/1/2011 Hr. 1 to 6/30/2011 Hr. 24



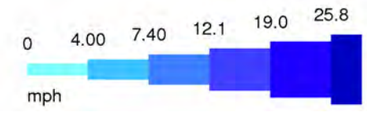
Summer Wind Rose
MEA Met Station
Crawford, NE
9/7/2010 Hr. 8 to 8/29/2011 Hr. 15



Fall Wind Rose
MEA Met Station
Crawford, NE
10/1/2010 Hr. 1 to 12/31/2010 Hr. 24



Note: The "summer" wind rose represents the 3rd calendar quarter, which includes July, August and September. Because the monitoring year spans parts of two calendar years, the summer wind rose software program utilized all of the available summer data from both years. This turned out to be September of 2010 (beginning with the 7th), July of 2011, and August of 2011 (up to the 29th). So the summer months are extracted from the stated date range.



Source:
Inter-Mountain Lab (IML) Air Science, 2011

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FIGURE 2.5-21
MARSLAND EXPANSION AREA
SEASONAL WIND ROSES

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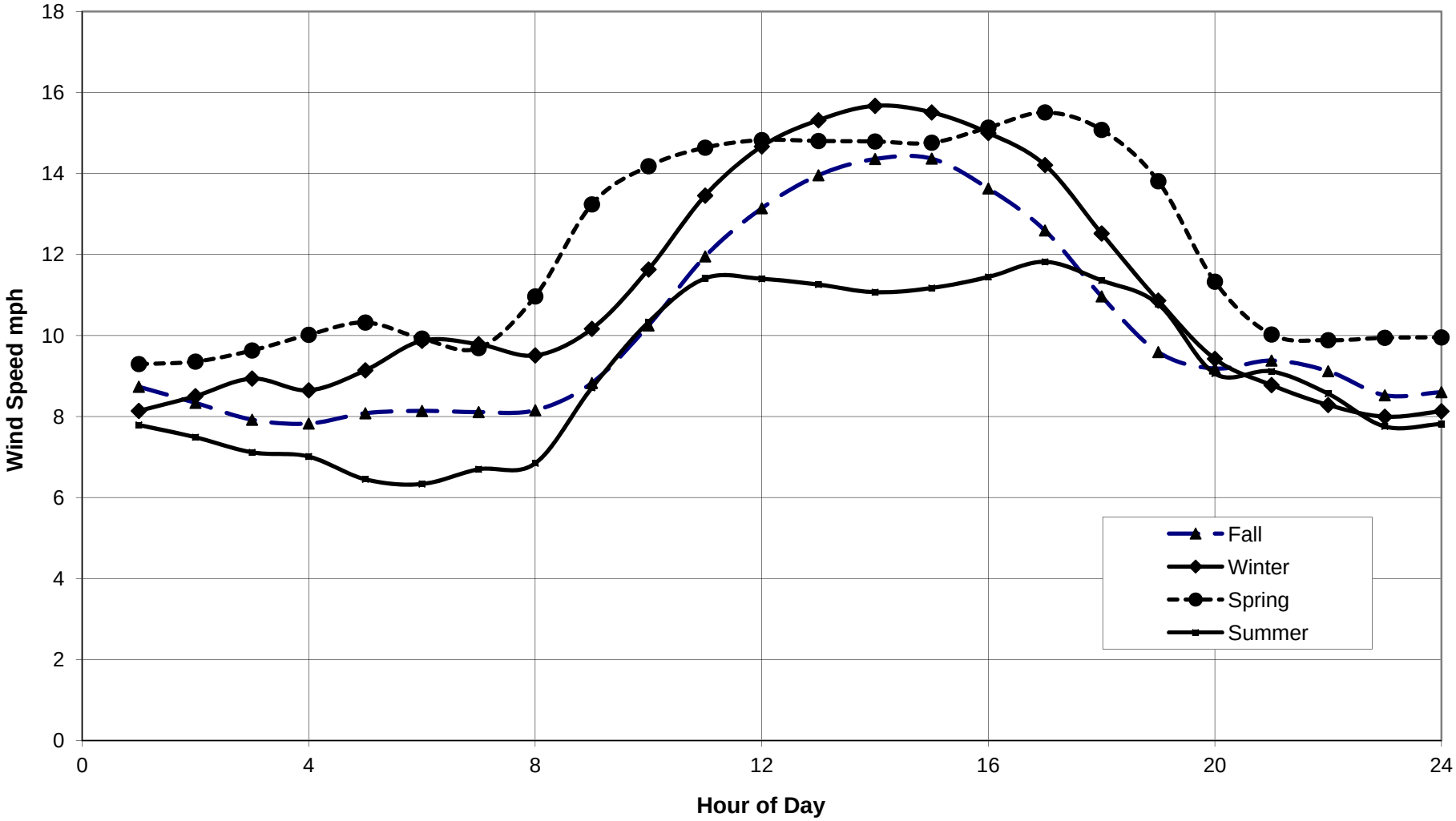

Source: Cameco Resources, 2011, data from 8/24/2010 to 8/29/2011.

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FIGURE 2.5-22
MARSLAND EXPANSION AREA
DIURNAL WIND SPEEDS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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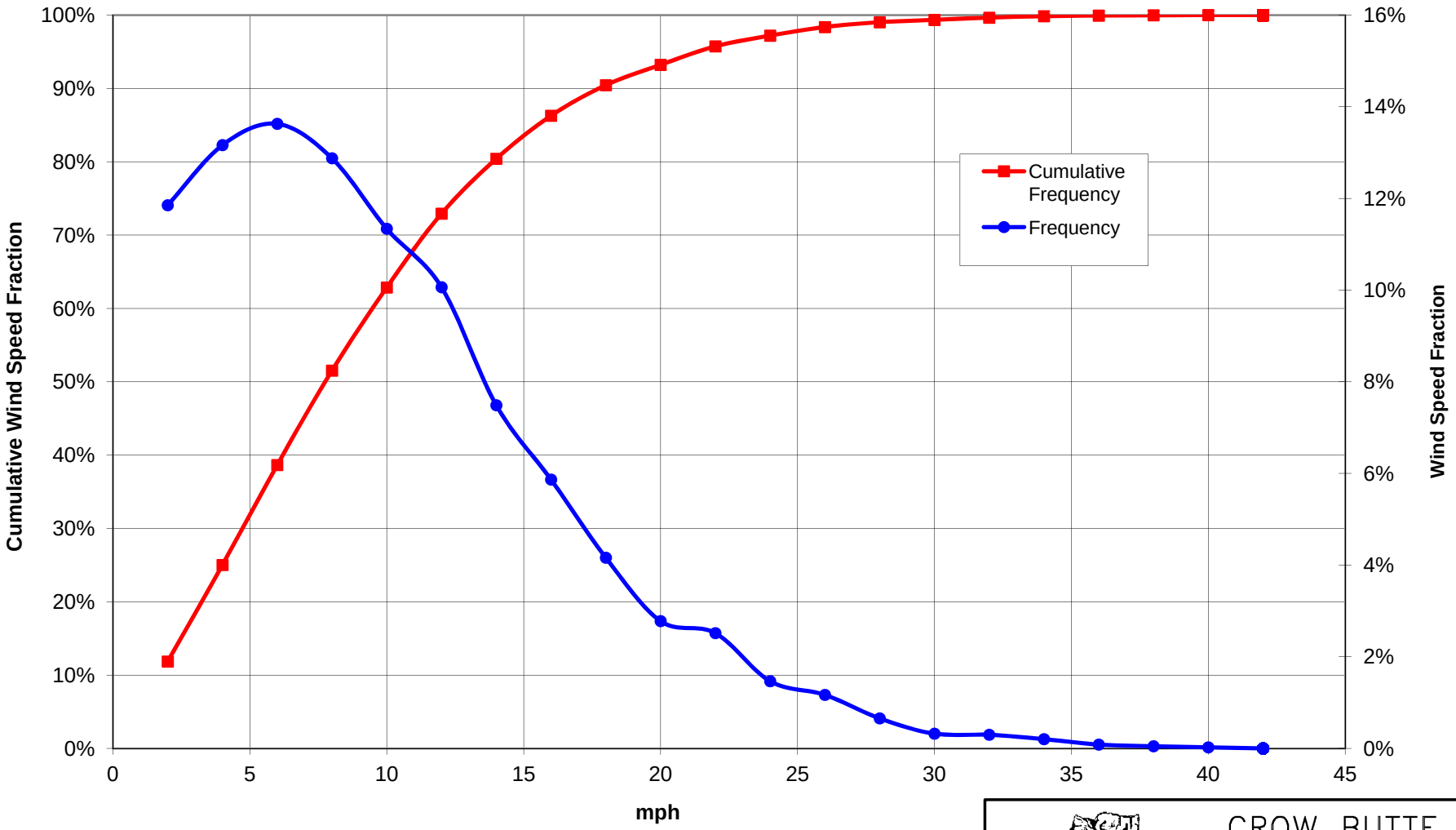

Source: Cameco Resources, 2011, data from 8/24/2010 to 8/29/2011.

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-23
MARSLAND EXPANSION AREA
WIND SPEED DISTRIBUTION

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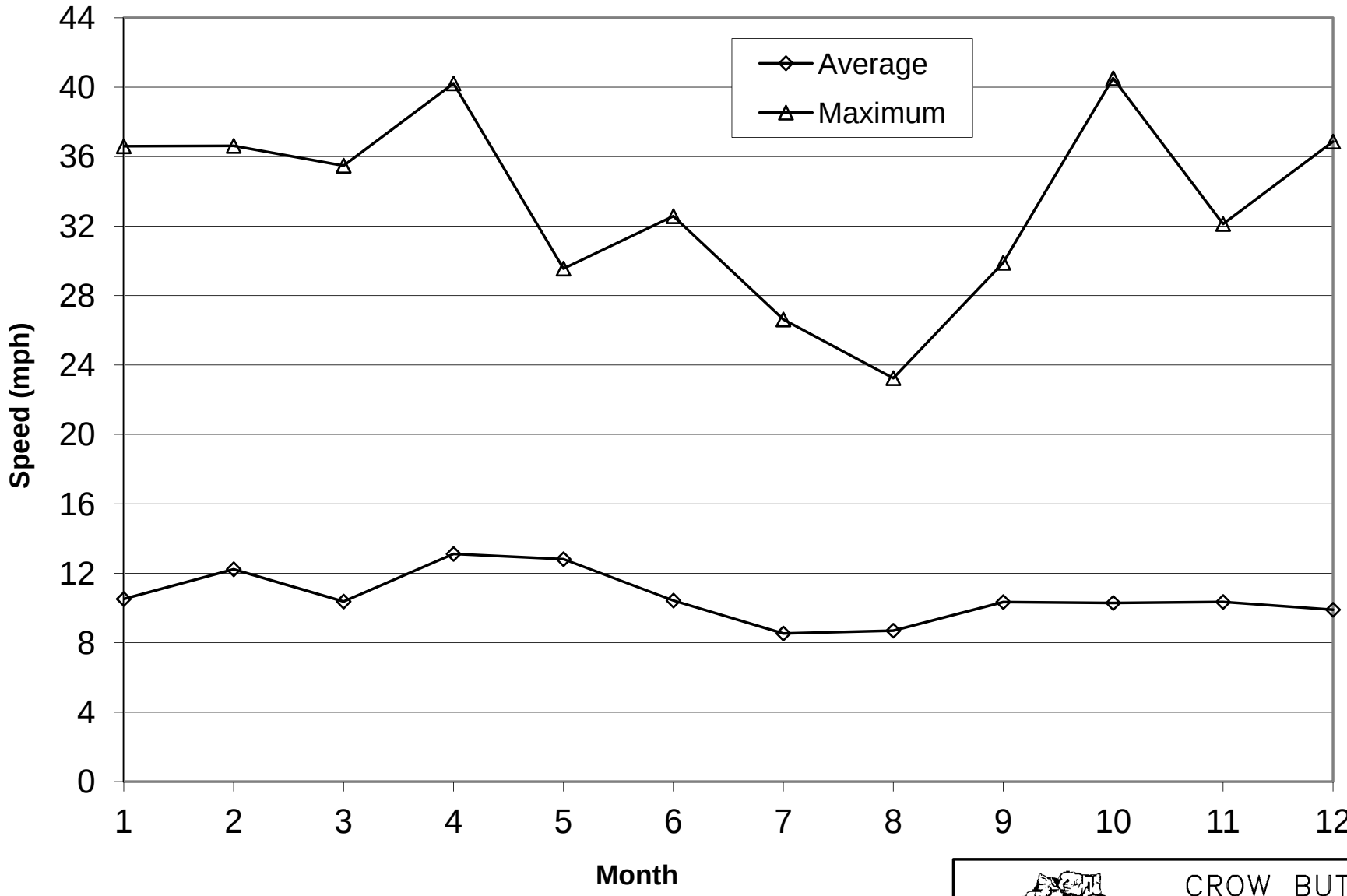

Source: Cameco Resources, 2011, data from 8/24/2010 to 8/29/2011.

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-24
PROJECT AREA
MONTHLY AVERAGE WIND SPEEDS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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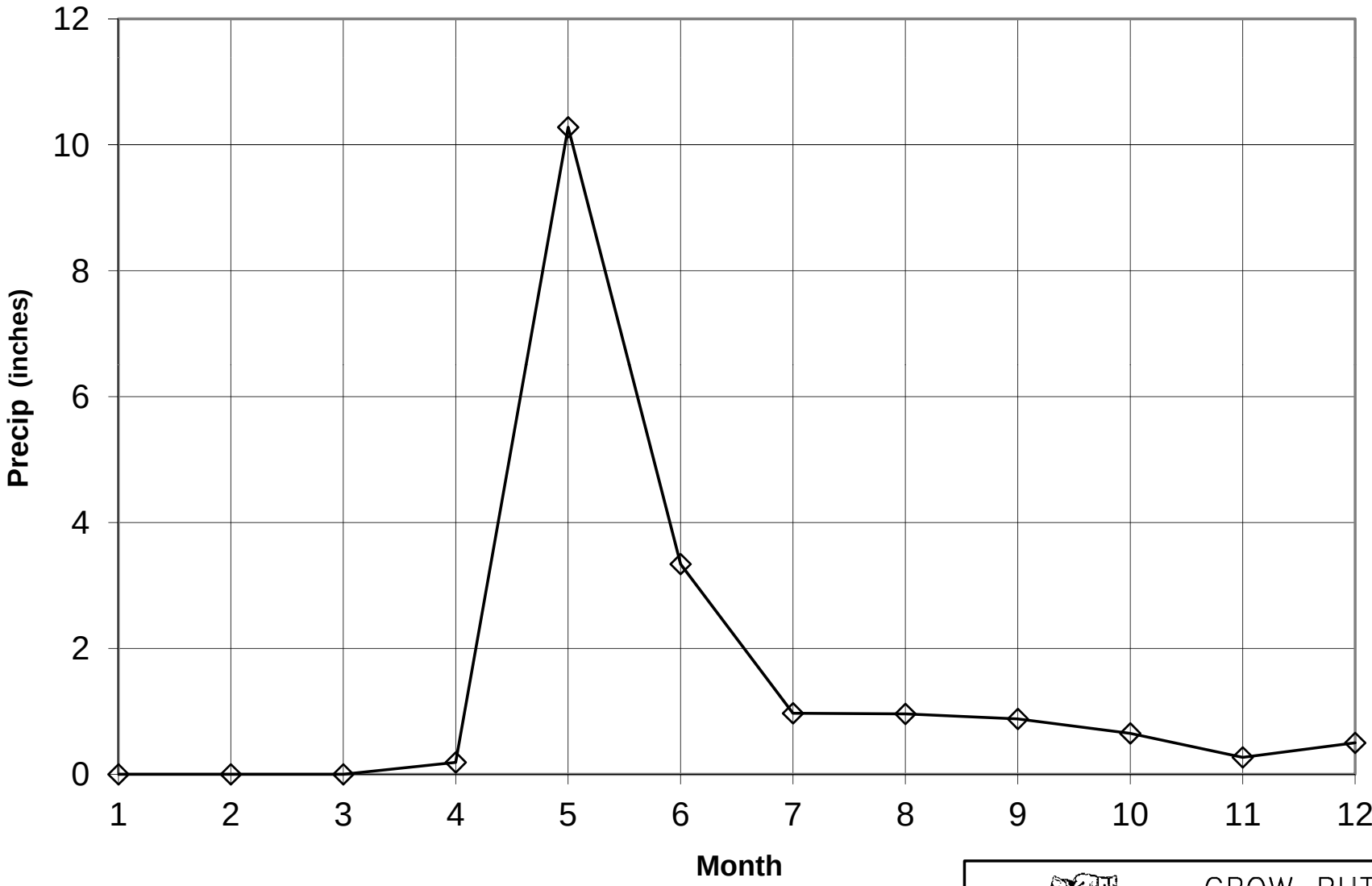

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FIGURE 2.5-25
MARSLAND EXPANSION AREA
TOTAL MONTHLY PRECIPITATION

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

Source: Cameco Resources, 2011, data from 8/24/2010 to 8/29/2011.

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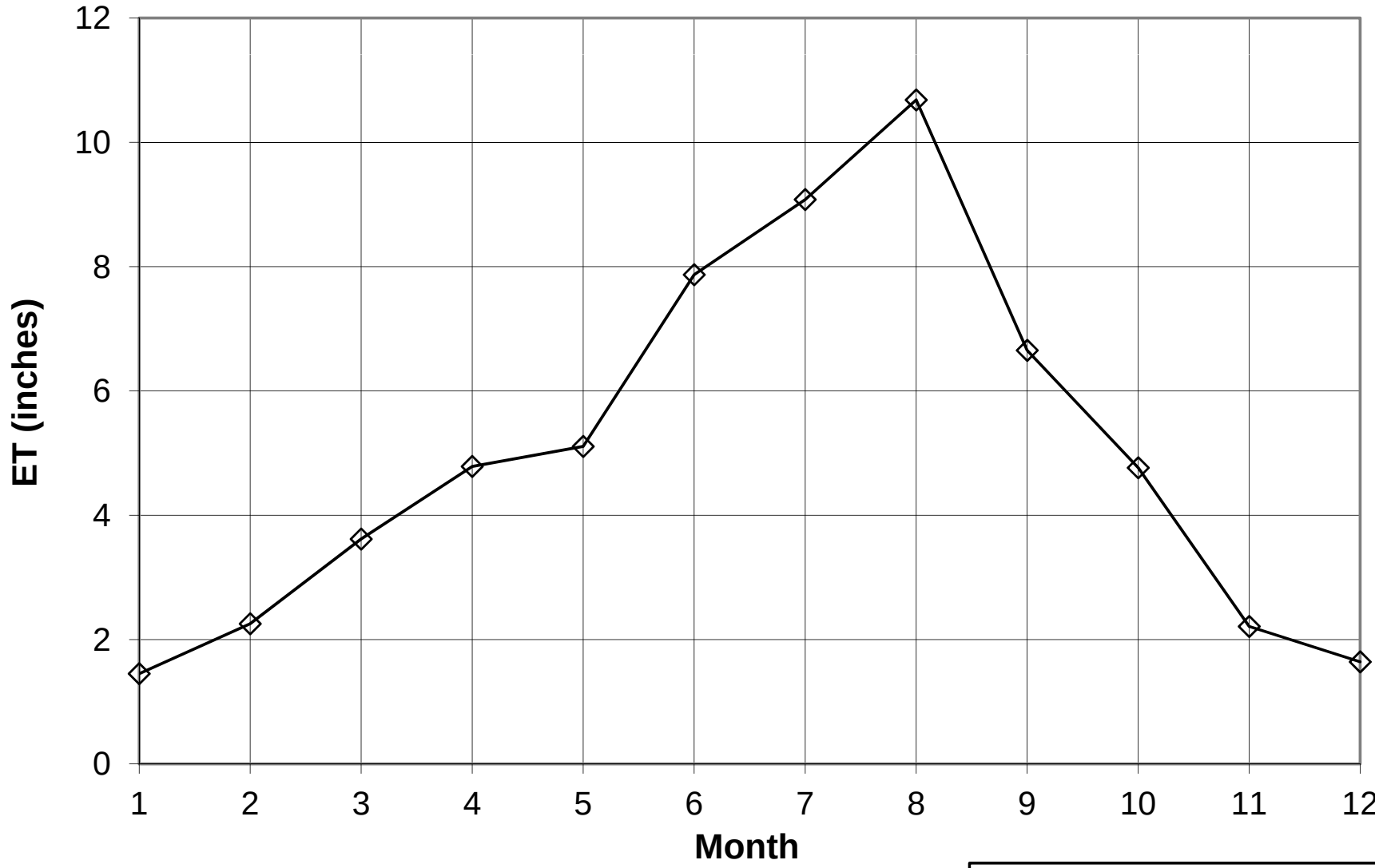

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FIGURE 2.5-26
MARSLAND EXPANSION AREA
POTENTIAL MONTHLY
EVAPOTRANSPIRATION

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

Source:
Calculation based on Penman Equation, from data supplied by Cameco Resources, from 8/24/2010 to 8/29/2011.

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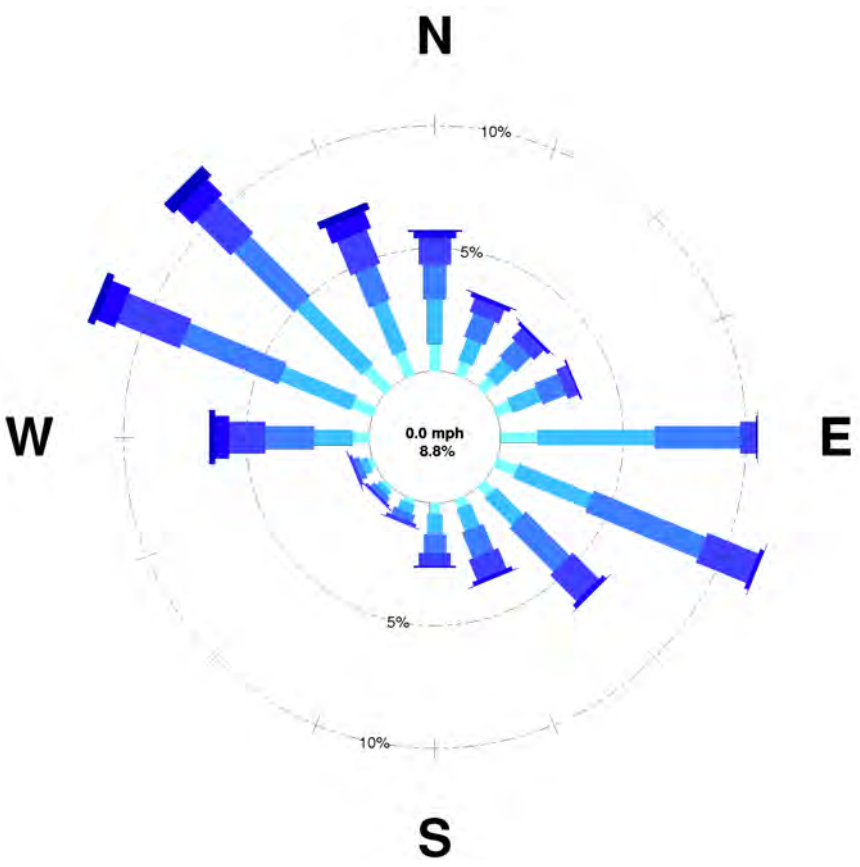
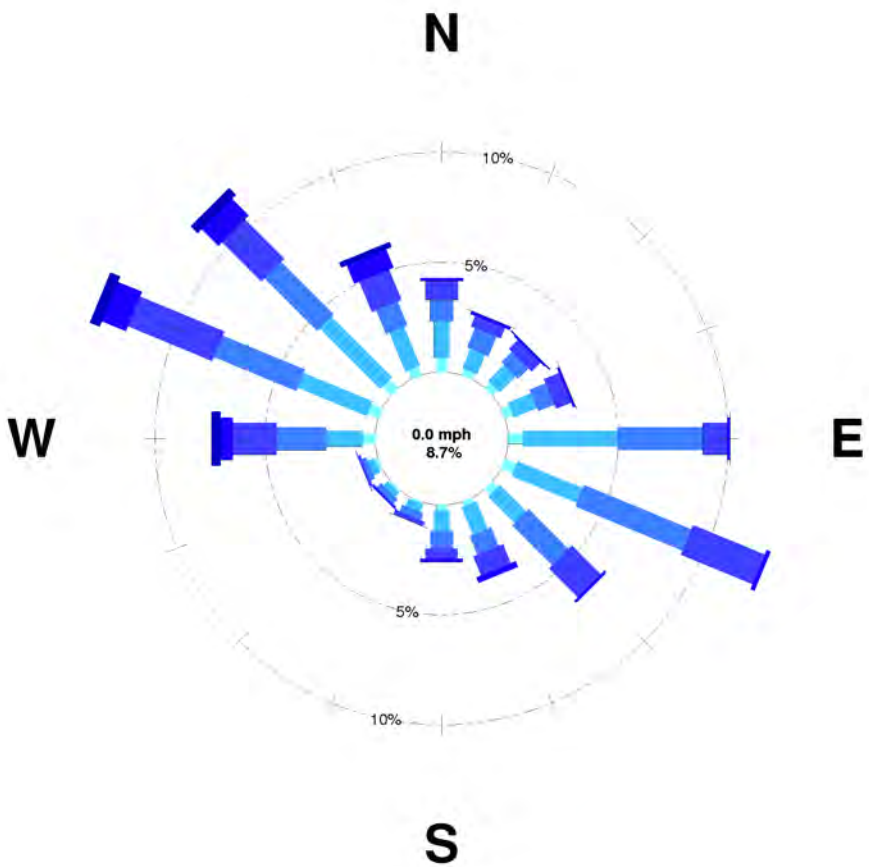
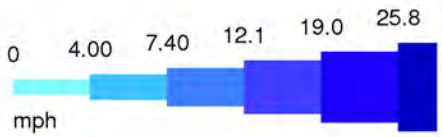
Wind Rose
Scottsbluff Airport
Scottsbluff, NE
11/1/1996 Hr. 1 to 8/31/2011 Hr. 23



Wind Rose
Scottsbluff Airport
Scottsbluff, NE
8/24/2010 Hr. 2 to 8/29/2011 Hr. 15





Source: Inter-Mountain Lab (IML) Air Science, 2011

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FIGURE 2.5-27
SCOTTSBLUFF 15-YEAR vs
BASELINE YEAR WIND ROSES

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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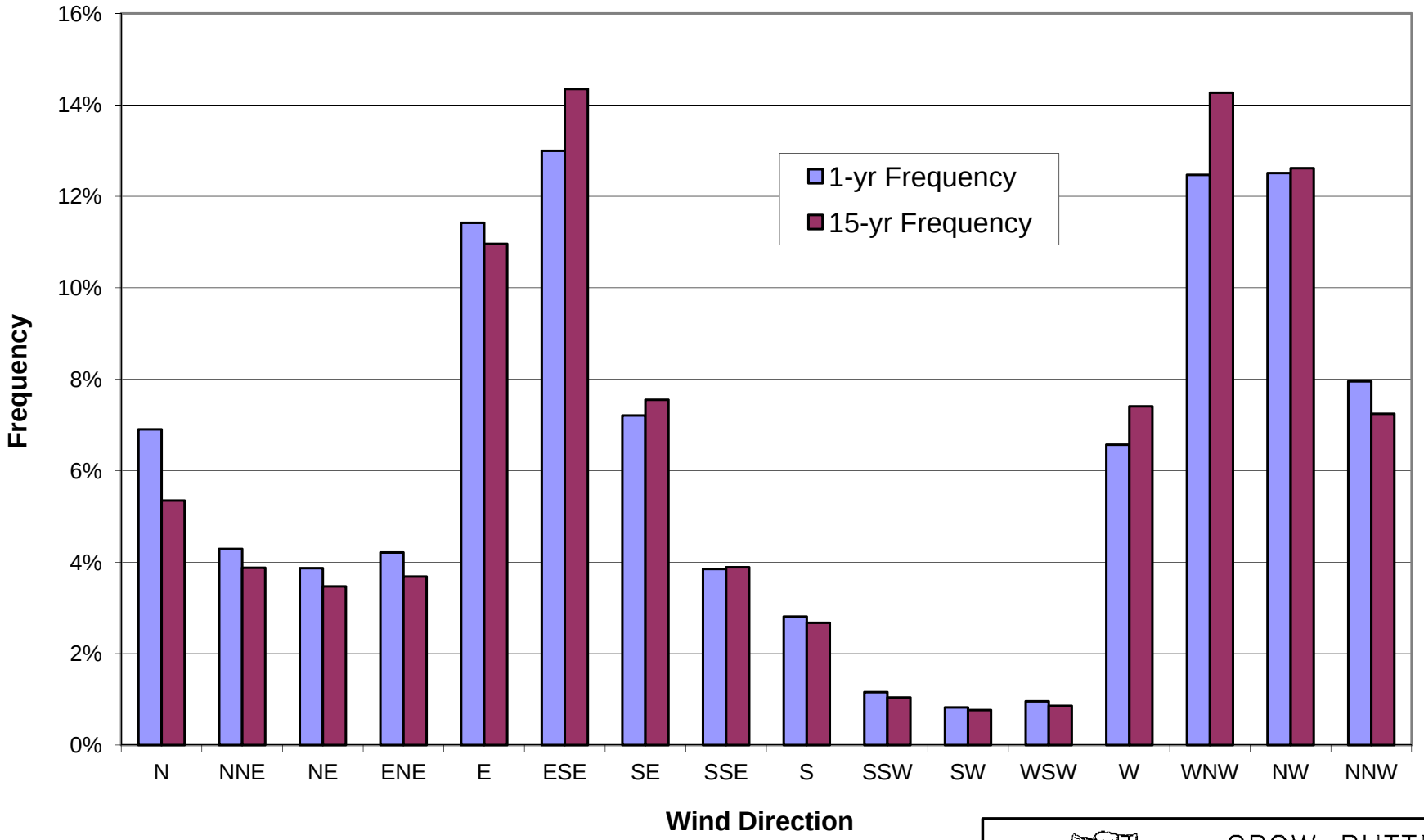
Scottsbluff Airport Wind Direction Distribution



Source: National Climate Data Center, 2011, hourly data from 1996 through 2011.

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-28
SCOTTSBLUFF 15-YEAR VS BASELINE YEAR WIND DIRECTIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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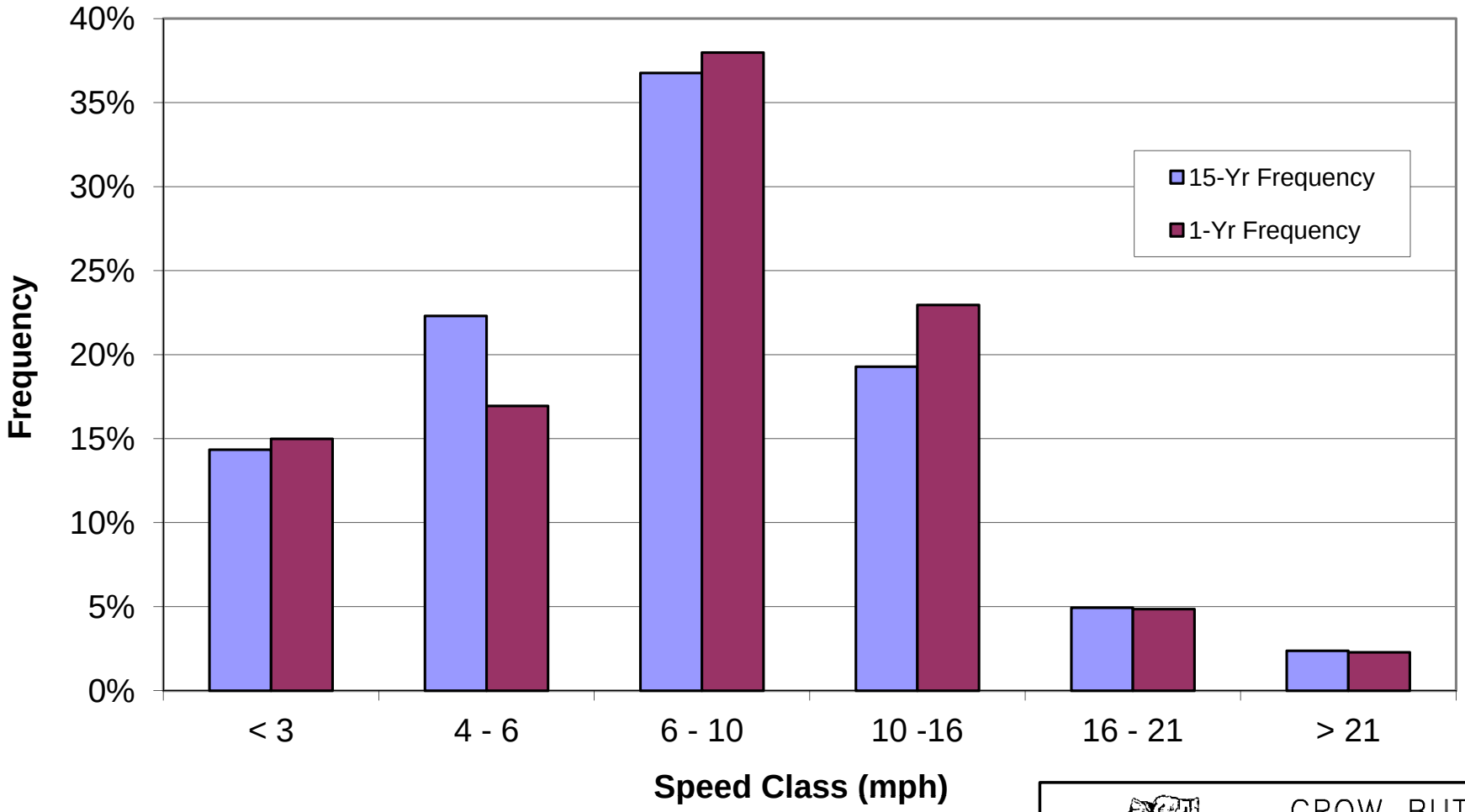
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\IllustratorTR Figure 2_5-28 Scottsbluff 15-Year vs Baseline Year Wind Directions.ai @ 11/08/2011

Scottsbluff Airport Wind Speed Distribution



Source: National Climate Data Center, 2011, hourly data from 1996 through 2011.

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-29
SCOTTSBLUFF 15-YEAR VS BASELINE YEAR WIND SPEEDS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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630 Plaza Drive, Ste. 100
Highlands Ranch, CO 80129
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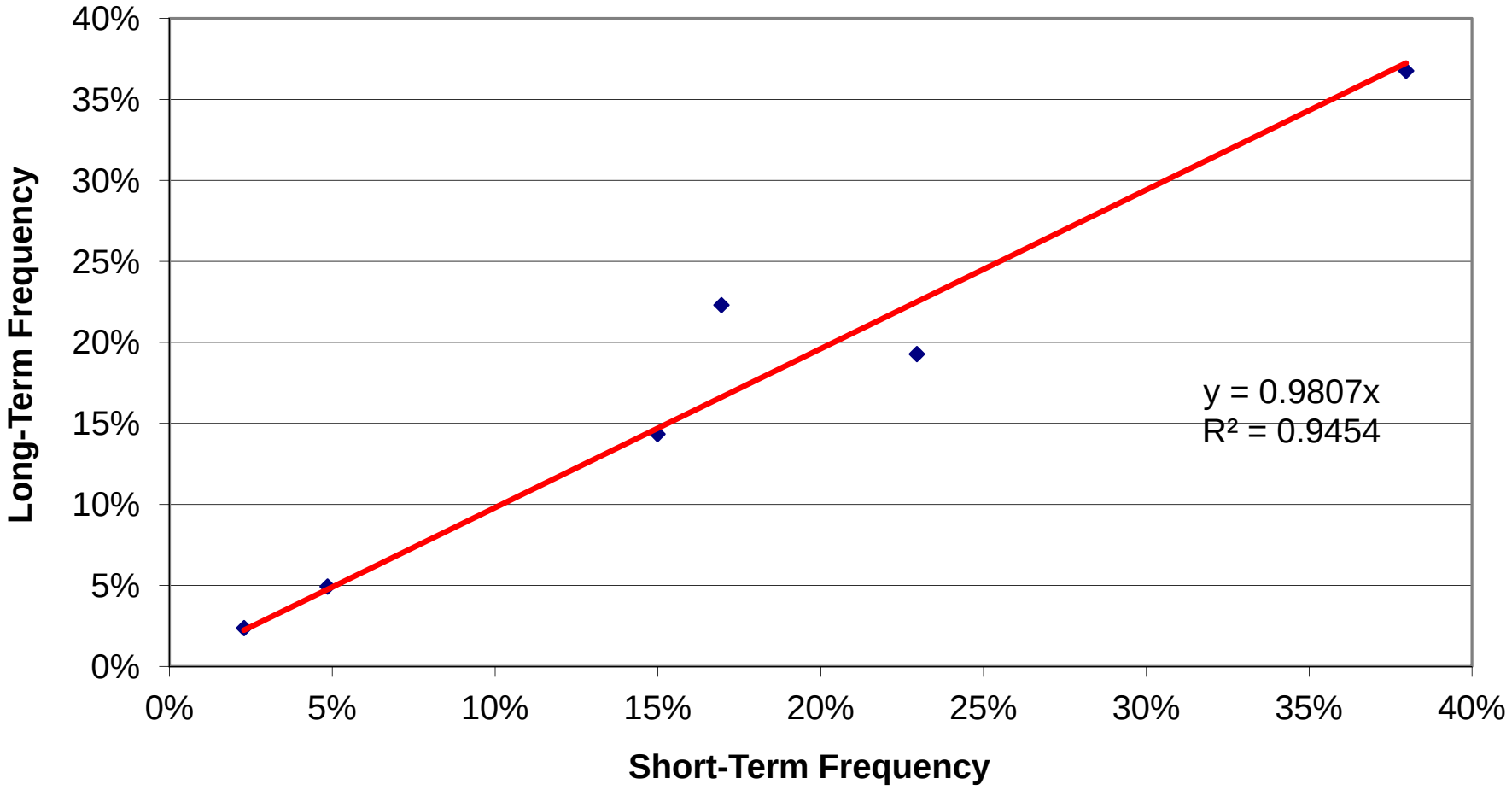
www.arcadis-us.com

K:\CBR_Projects\CO001636_Marsland\3_IMAGES\IllustratorTR Figure 2_5-29 Scottsbluff 15-Year vs Baseline Year Wind Speeds.ai @ 11/08/2011

Scottsbluff Wind Speeds:
Correlation Between Short and Long Term



Source:
Analysis by IML Air Science using hourly data supplied by National Climate Data Center, from 1996 through 2011.

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-30
SCOTTSBLUFF 15-YEAR
VS BASELINE YEAR
WIND SPEED DISTRIBUTIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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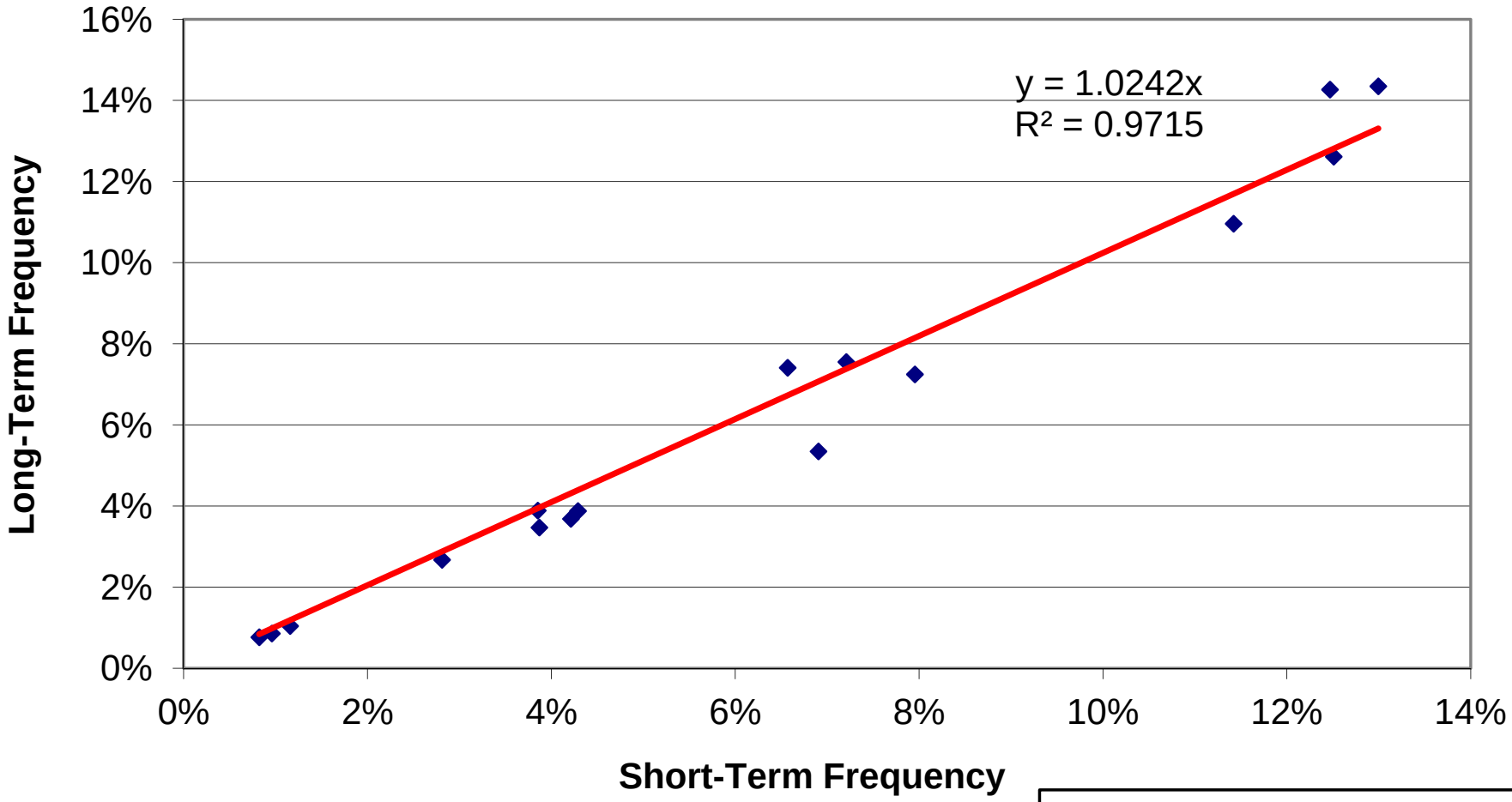
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\IllustratorTR Figure 2_5-30 Scottsbluff 15-Year vs Baseline Year Wind Speed Distributions.ai @ 11/08/2011

Scottsbluff Wind Direction:
Correlation Between Short and Long Term



Source:
Analysis by IML Air Science using hourly data supplied by National Climate Data Center, from 1996 through 2011.

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-31
SCOTTSBLUFF 15-YEAR
VS BASELINE YEAR
WIND DIRECTION DISTRIBUTIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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Highlands Ranch, CO 80129
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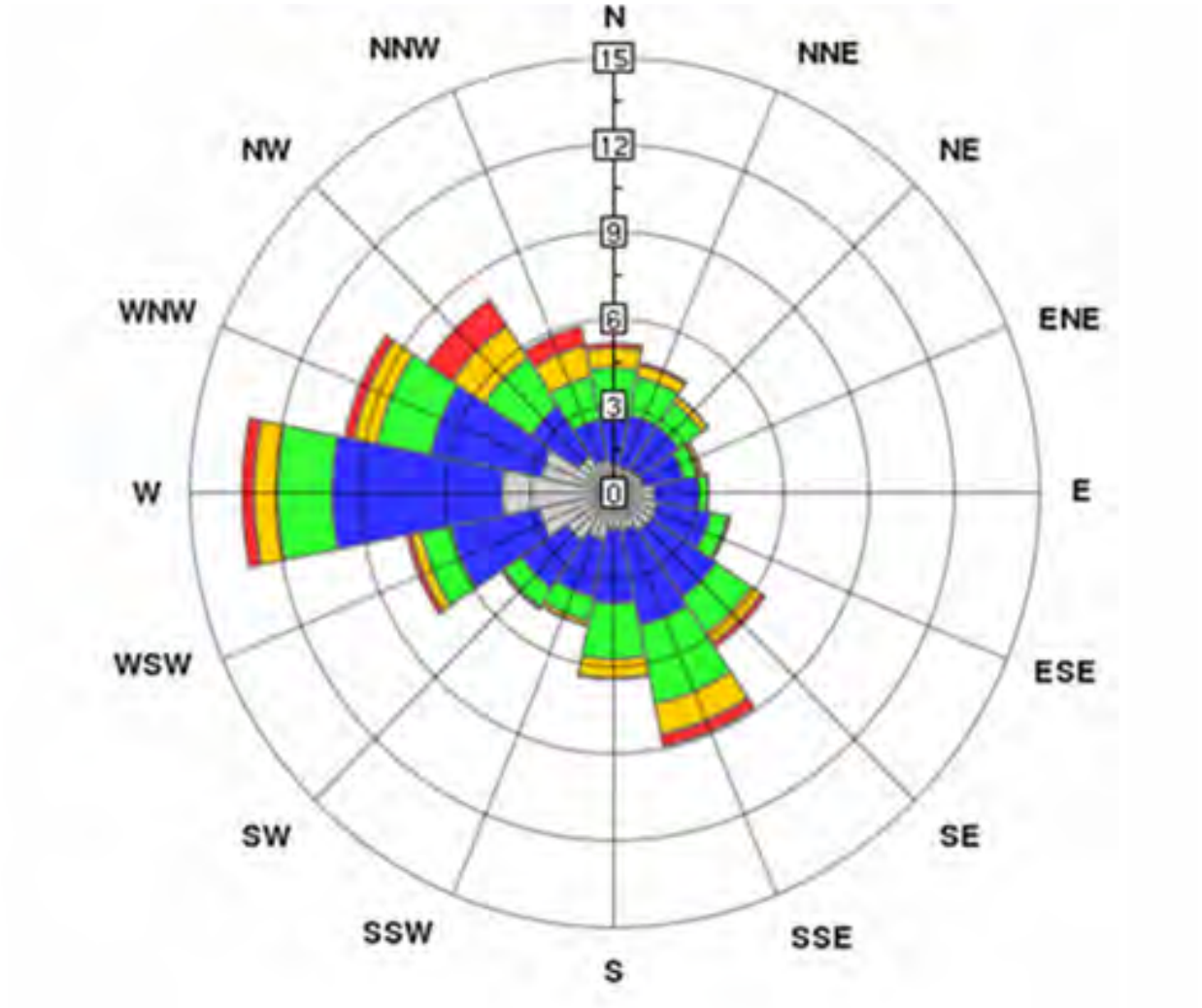

Alliance West
Station ID: a250138
Location: 42.02, -103.13
Elevation: 3978 Feet

Source: Smith 2013.

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-32
ALLIANCE WEST 10-YEAR WIND ROSE
1996-2005

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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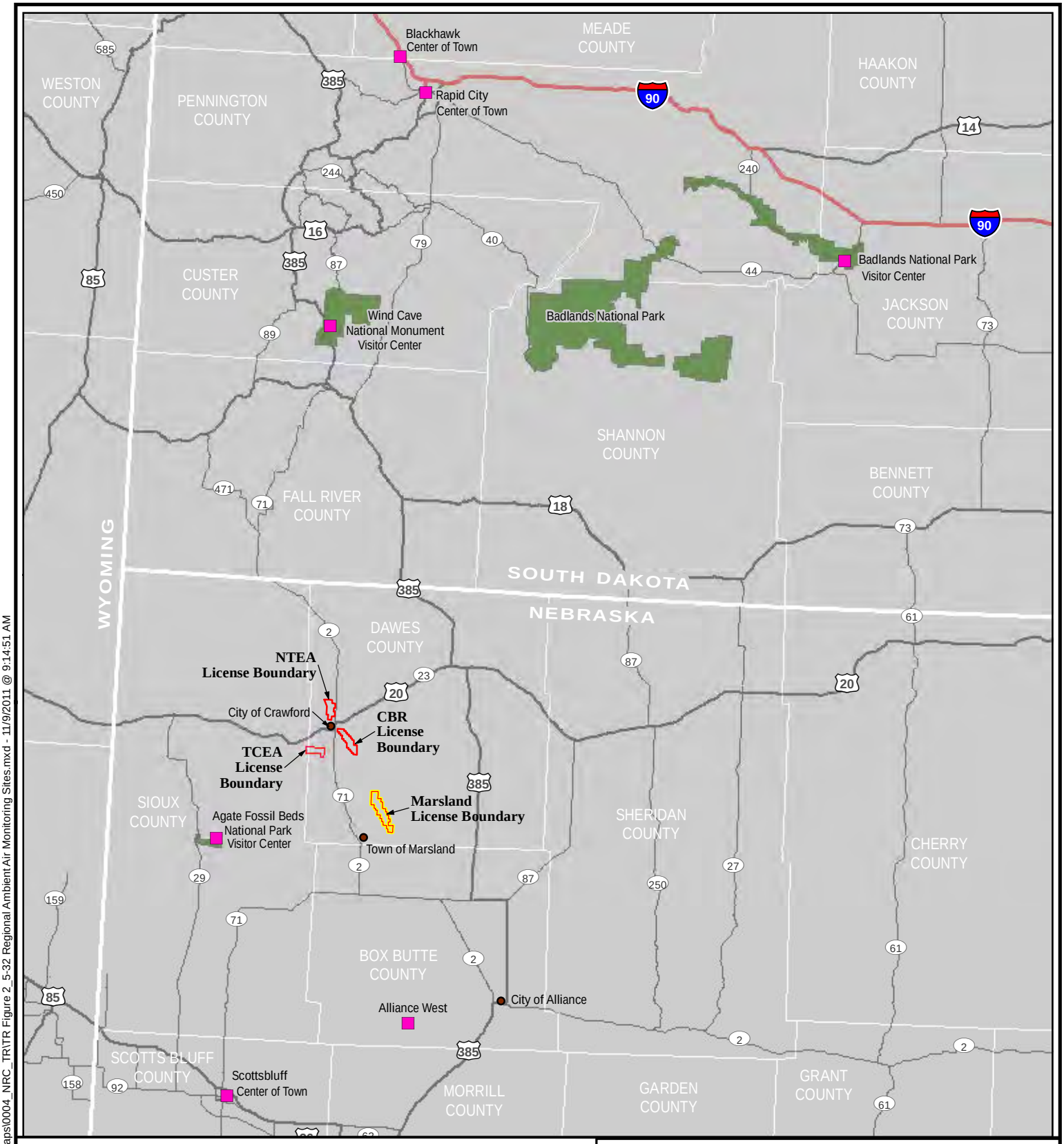
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com



LEGEND

- City/Town of Interest
- Regional Ambient Air Monitoring Site
- Marsland License Boundary
- Other License Boundary
- National Park/Monument
- Interstate Highway
- U.S. Route
- State Highway

N

0 10 20

Miles

PROJECTION:
NAD 1983 UTM ZONE 13N

CROW BUTTE RESOURCES, INC.

FIGURE 2.5-33
LOCATION OF REGIONAL AMBIENT AIR MONITORING SITES

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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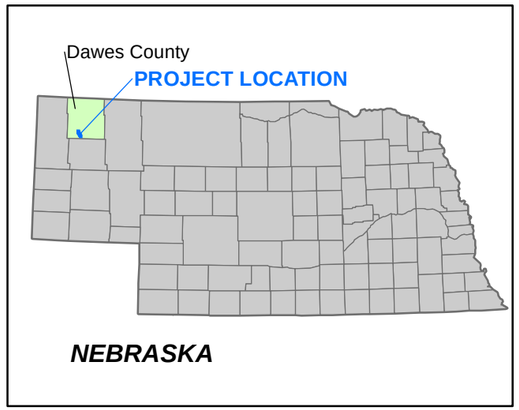
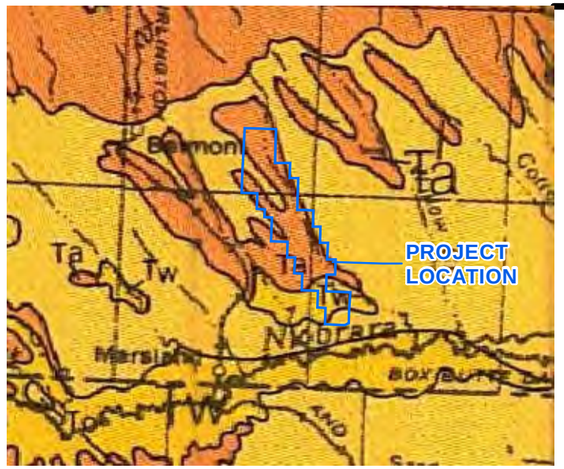
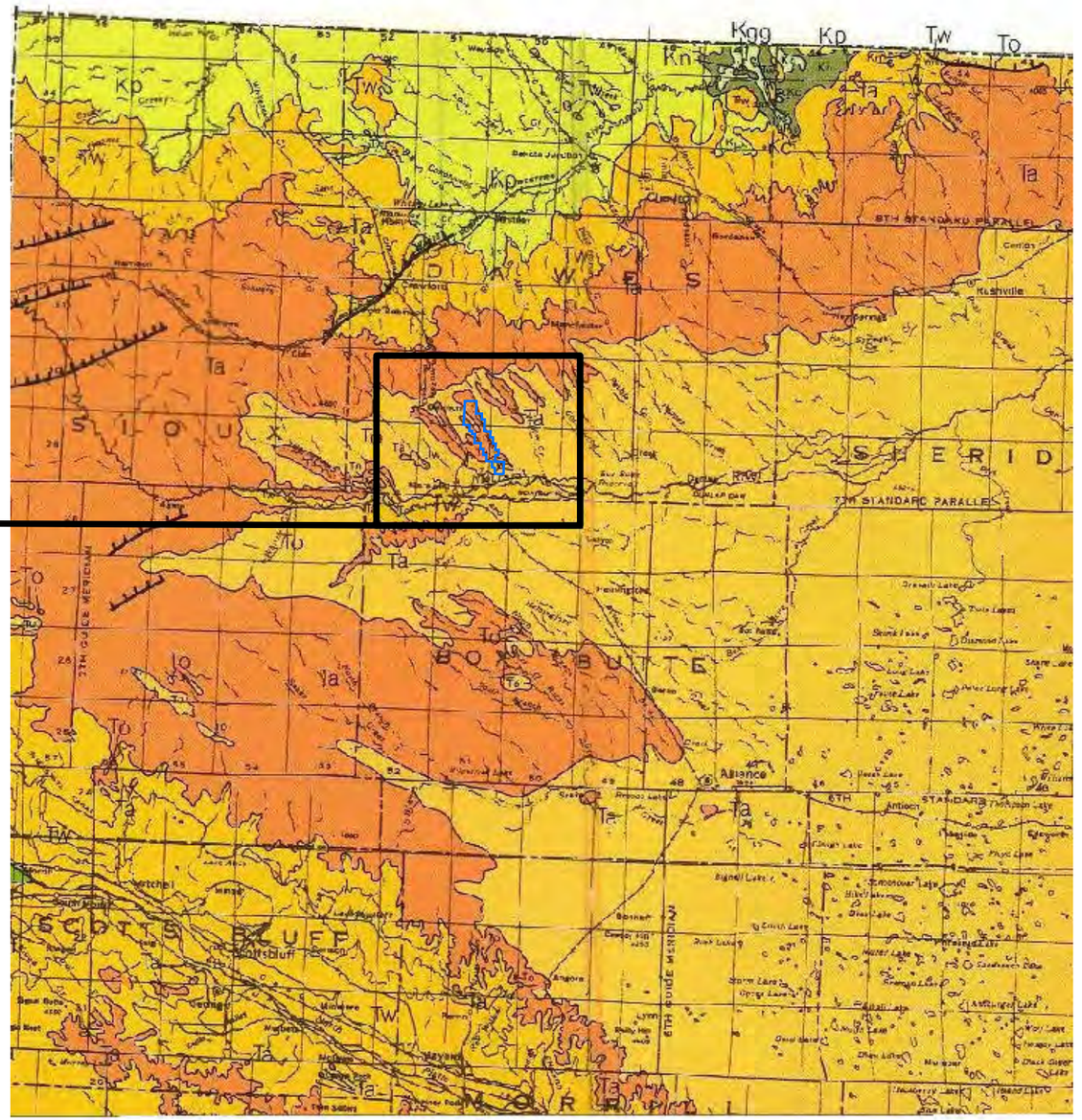
Highlands Ranch, CO 80129
P: 720-344-3500 F: 720-344-3535
www.arcadis-us.com

K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_5-32 Regional Ambient Air Monitoring Sites.mxd - 11/9/2011 @ 9:14:51 AM





0 5 10
Miles



0 20 40
Miles

LEGEND

GEOLOGIC PERIOD	SERIES	GROUP OR FORMATION		
TERTIARY	MIOCENE		OGALLALA	To
			ARIKAREE	Ta
	OLIGOCENE		WHITE RIVER	Tw
CRETACEOUS	UPPER CRETACEOUS	MONTANA	Fox Hills	Kf
			Pierre	Kp
			Niobrara	Kn
		COLORADO	Carlile	Kc
			Greenhorn-Graneros	Kgg
	LOWER CRETACEOUS		DAKOTA	Kd
JURASSIC				
PERMIAN	BIG BLUE		CHASE	Pc
			COUNCIL GROVE	Pcg
			ADMIRE	Pa
			WABAUNSEE	IPw
	VIRGIL		SHAWNEE	IPs
PENNSYLVANIAN			DOUGLAS	IPd
	MISSOURI		LANSING	IPl
			KANSAS CITY	IPkc
	DES MOINES		MARMATON	IPm
MISSISSIPPIAN				
DEVONIAN				
SILURIAN				
ORDOVICIAN (Middle & Upper)				
CAMBRIAN & ORDOVICIAN (Lower)				
PRECAMBRIAN				

Source:
Burchett, R.R., 1986, Geologic bedrock map of Nebraska: University of Nebraska Conservation and Survey Division, Geologic Maps and Charts 1, scale 1:1000000.

N

PROJECTION: NAD 1927, STATE PLANE NEBRASKA NORTH FIPS 2601

CROW BUTTE RESOURCES, INC.

FIGURE 2.6-1
BEDROCK GEOLOGY OF THE MARSLAND EXPANSION AREA

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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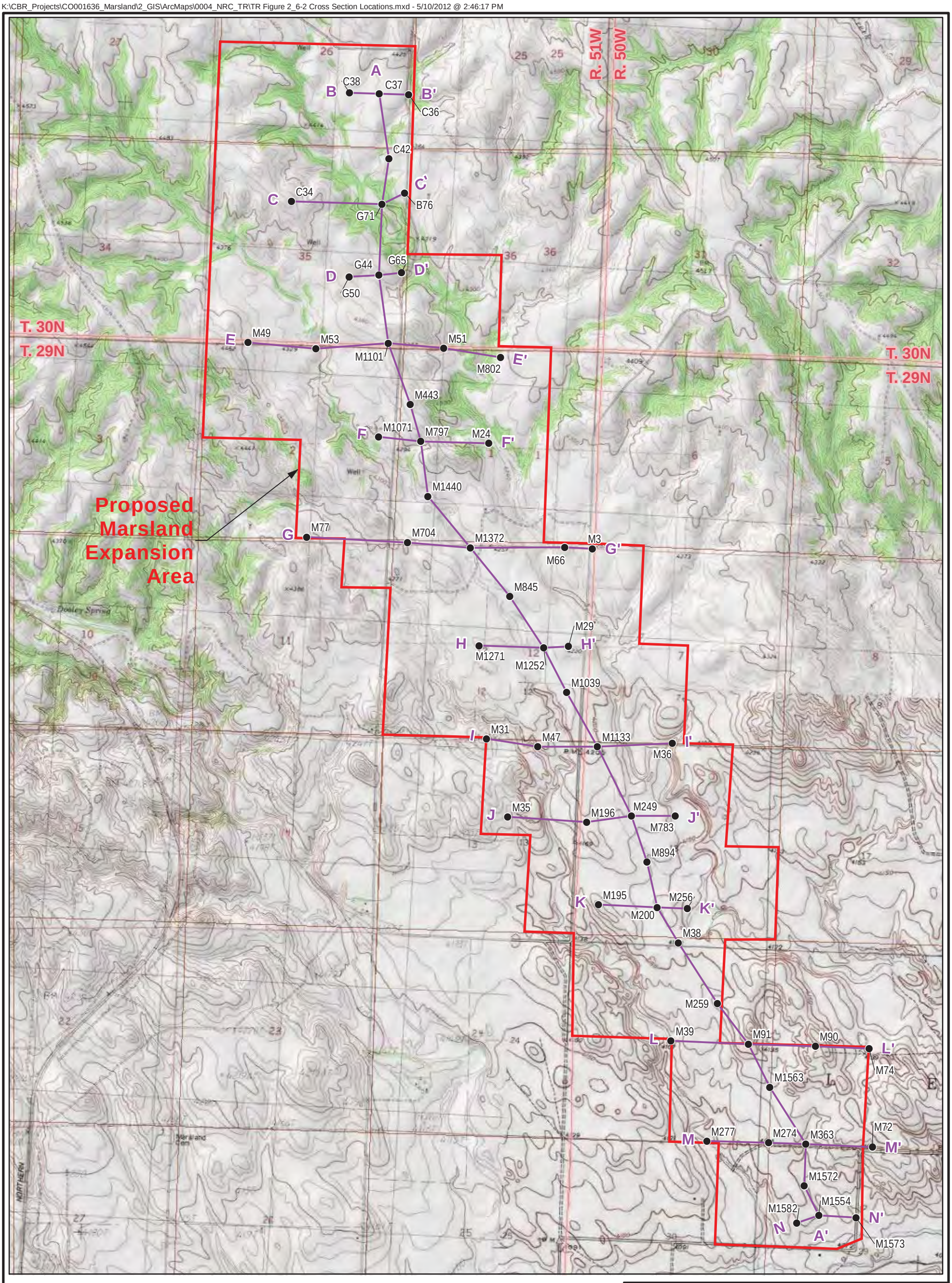
K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_6-2 Cross Section Locations.mxd - 5/10/2012 @ 2:46:17 PM



LEGEND

- Borehole
- Cross Section Line
- Proposed Marsland Expansion Area

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

CROW BUTTE RESOURCES, INC.

FIGURE 2.6-2
MARSLAND CROSS-SECTION MAP SHOWING ARTIFICIAL PENETRATIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JA

ARCADIS
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A
North
A'
South
Elevation AMSL
4400'
4300'
4200'
4100'
4000' DATUM
3900'
3800'
3700'
3600'
3500'
3400'
3300'
3200'
3100'
Tie to B-B' C-37 4381'
--- 1799' ---
C-42 4344'
--- 1209' ---
Tie to C-C' G-71 4333'
--- 1909' ---
Tie to D-D' G-44 4326'
--- 1836' ---
Tie to E-E' M-1101 4379'
--- 1756' ---
M-443 4352'
--- 1031' ---
Tie to F-F' M-797 4321'
--- 1488' ---
M-1440 4255'
--- 1792' ---
Tie to G-G' M-1372 4245'
--- 1686' ---
M-845 4234'
--- 1652' ---
Tie to H-H' M-1252 4220'
--- 1347' ---
M-1039 4211'
--- 1675' ---
Tie to I-I' M-1133 4199'
--- 2074' ---
Tie to J-J' M-249 4181'
--- 1312' ---
M-894 4167'
--- 1242' ---
Tie to K-K' M-200 4158'
--- 1106' ---
M-38 4155'
--- 1946' ---
M-259 4134'
--- 1367' ---
Tie to L-L' M-91 4150'
--- 1297' ---
M-1563 4125'
--- 1806' ---
Tie to M-M' M-363 4114'
--- 1126' ---
M-1572 4099'
--- 889' ---
Tie to N-N' M-1554 4094'
Alluvium
Arikaree Group
Brule Formation
Upper Whitney Ash
Lower Whitney Ash
Upper Chadron Formation
Middle Chadron Formation
Basal Sandstone of the Chadron Fm.
Pierre Shale
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
Scale: See Scale Bar
Date: 12/15/2016
Checked by: JS
Looking East

Figure 2.6-3a
Marsland Structural
Cross Section A-A'

B

West

C-38
4373'

--- 757' ---

Tie to A-A'
C-37
4381'

--- 742' ---

C-36
4393'

B'

East

Elevation AMSL

4400'
4300'
4200'
4100'
4000' DATUM
3900'
3800'
3700'
3600'
3500'
3400'
3300'
3200'
3100'

Alluvium

Arikaree Group

Brule Formation

Upper Whitney Ash

Lower Whitney Ash

Upper Chadron Formation

Middle Chadron Formation

Basal Sandstone of the Chadron Fm.

Pierre Shale

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 2.6-3b
Marsland Structural Cross Section B-B'

Scale: See Scale Bar	Date: 12/12/2016
C:\Users\ca04142l\Desktop\OBOW TEMP\TR-NRC\TR_B-B'.mxd	Checked by: JS

Looking North

C
West

C'
East

C-34
4465'

--- 2448' ---

Tie to A-A'
G-71
4333'

--- 675' ---

B-76
4347'

Elevation AMSL

4500'
4400'
4300'
4200'
4100'
4000' DATUM
3900'
3800'
3700'
3600'
3500'
3400'
3300'
3200'

Alluvium

Arikaree Group

Brule Formation

Upper Whitney Ash

Lower Whitney Ash

Upper Chadron Formation

Middle Chadron Formation

Basal Sandstone of the Chadron Fm.

Pierre Shale

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 2.6-3c
Marsland Structural
Cross Section C-C'

Scale: See Scale Bar	Date: 12/12/2016
C:\Users\ca041426\Desktop\DBOW TEMPTR-NRC\TR_C-C'.mxd	Checked by: JS

Looking North

D West — D' East

G-50 4355' | --- 804' --- | Tie to A-A' G-44 4326' | --- 610' --- | G-65 4340'

Elevation AMSL

4400' / 4300' / 4200' / 4100' / 4000' DATUM / 3900' / 3800' / 3700' / 3600' / 3500' / 3400' / 3300' / 3200' / 3100'

0 / 100 / 200 / 300 / 400 / 500 / 600 / 700 / 800 / 900 / 1000 / 1100

Alluvium

Arikaree Group

Brule Formation

Upper Whitney Ash

Lower Whitney Ash

Upper Chadron Formation

Middle Chadron Formation

Basal Sandstone of the Chadron Fm.

Pierre Shale

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 2.6-3d
Marsland Structural Cross Section D-D'

Scale: See Scale Bar	Date: 12/12/2016
C:\Users\ca841428\Desktop\DBOW TEMPTR-NRCTR_D-D'.mxd	Checked by: JS

Looking North

E West — E' East

M-49	M-53	Tie to A-A' M-1101	M-51	M-802
4400'	4330'	4379'	4306'	4288'

--- 1830' --- --- 1949' --- --- 1496' --- --- 1547' ---

Elevation AMSL

4500' 4400' 4300' 4200' 4100' 4000' DATUM 3900' 3800' 3700' 3600' 3500' 3400' 3300' 3200'

Alluvium

Arikaree Group

Brule Formation

Upper Whitney Ash

Lower Whitney Ash

Upper Chadron Formation

Middle Chadron Formation

Basal Sandstone of the Chadron Fm.

Pierre Shale

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 2.6-3e
Marsland Structural Cross Section E-E'

Scale: See Scale Bar	Date: 12/15/2016	
C:\Users\ca0414260\Desktop\DBOW TEMP\TR-ARCITR_E-E'.mxd		Checked by: JS

Looking North

F — West

F' — East

M-1071
4289'

--- 1142' ---

Tie to A-A'
M-797
4321'

--- 1826' ---

M-24
4267'

Elevation AMSL

4400'
4300'
4200'
4100'
4000' DATUM
3900'
3800'
3700'
3600'
3500'
3400'
3300'
3200'
3100'

Alluvium

Arikaree Group

Brule Formation

Upper Whitney Ash

Lower Whitney Ash

Upper Chadron Formation

Middle Chadron Formation

Basal Sandstone of the Chadron Fm.

Pierre Shale

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 2.6-3f
Marsland Structural Cross Section F-F'

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

Looking North

G West — G' East

M-77	M-704	Tie to A-A' M-1372	M-66	M-3
4336'	4304'	4245'	4237'	4249'

--- 2715' --- --- 1700' --- --- 2531' --- --- 744' ---

Elevation AMSL

4400' 4300' 4200' 4100' 4000' DATUM 3900' 3800' 3700' 3600' 3500' 3400' 3300' 3200' 3100'

Alluvium

Arikaree Group

Brule Formation

Upper Whitney Ash

Lower Whitney Ash

Upper Chadron Formation

Middle Chadron Formation

Basal Sandstone of the Chadron Fm.

Pierre Shale

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 2.6-3g
Marsland Structural Cross Section G-G'

Scale: See Scale Bar	Date: 12/8/2016
C:\Users\ca0414260\Desktop\DBOW TEMP\TR-ARC\TR_G-G'.mxd	Checked by: JS

Looking North

H

West

M-1271
4248'

--- 1740' ---

Tie to A-A'
M-1252
4220'

--- 670' ---

M-29
4228'

H'

East

Elevation
AMSL

4300'
4200'
4100'
4000'
DATUM
3900'
3800'
3700'
3600'
3500'
3400'
3300'
3200'
3100'
3000'

Alluvium

Arikaree
Group

Brule
Formation

Upper Whitney Ash

Lower Whitney Ash

Upper
Chadron
Formation

Middle
Chadron
Formation

Basal Sandstone
of the Chadron Fm.

Pierre
Shale

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 2.6-3h
Marsland Structural
Cross Section H-H'

Scale: See Scale Bar	Date: 12/15/2016
C:\Users\ca041426\Desktop\DBOW TEMPTR-NRC\TR_H-H'.mxd	Checked by: JS

Looking North

West

East

M-31
4243'

--- 1395' ---

M-47
4182'

--- 1603' ---

Tie to A-A'
M-1133
4199'

--- 2017' ---

M-36
4191'

Elevation
AMSL

4300'
4200'
4100'
4000'
DATUM
3900'
3800'
3700'
3600'
3500'
3400'
3300'
3200'
3100'
3000'

Alluvium

Arikaree Group

Brule Formation

Upper Whitney Ash

Lower Whitney Ash

Upper Chadron Formation

Middle Chadron Formation

Basal Sandstone of the Chadron Fm.

Pierre Shale

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 2.6-3i
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

J

West

J'

East

M-35
4205'

--- 2132' ---

M-196
4186'

--- 1213' ---

Tie to A-A'
M-249
4181'

--- 1174' ---

M-783
4170'

Elevation AMSL

4300'
4200'
4100'
4000' DATUM
3900'
3800'
3700'
3600'
3500'
3400'
3300'
3200'
3100'

Alluvium

Arikaree Group

Brule Formation

Upper Whitney Ash

Lower Whitney Ash

Upper Chadron Formation

Middle Chadron Formation

Basal Sandstone of the Chadron Fm.

Pierre Shale

0
100
200
300
400
500
600
700
800
900
1000

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

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

Looking North

K
West

K'
East

Tie to A-A'

M-195
4159'

--- 1576' ---

M-200
4158'

--- 808' ---

M-256
4151'

Elevation
AMSL

4300'
4200'
4100'
4000'
DATUM
3900'
3800'
3700'
3600'
3500'
3400'
3300'
3200'
3100'

Alluvium

Arikaree
Group

Brule
Formation

Upper Whitney Ash

Lower Whitney Ash

Upper
Chadron
Formation

Middle
Chadron
Formation

Basal Sandstone
of the Chadron Fm.

Pierre
Shale

0
100
200
300
400
500
600
700
800
900
1000

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\ca041426\Desktop\DBOW TEMP\TR-NRC\TR_K-K'.mxd	Checked by: JS

Looking North

L
West

L'
East

M-39
4107'

--- 2079' ---

Tie to A-A'
M-91
4150'

--- 1801' ---

M-90
4165'

--- 1443' ---

M-74
4133'

Elevation
AMSL

4300'
4200'
4100'
4000'
DATUM
3900'
3800'
3700'
3600'
3500'
3400'
3300'
3200'
3100'
3000'

Alluvium

Arikaree
Group

Brule
Formation

Upper Whitney Ash

Lower Whitney Ash

Upper
Chadron
Formation

Middle
Chadron
Formation

Basal Sandstone
of the Chadron Fm.

Pierre
Shale

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

Scale: See Scale Bar

Date: 12/8/2016

C:\Users\ca04142\Desktop\DBOW TEMP\TR-NRC\TR_L-L'.mxd

Checked by: JS

Looking North

M
West

M'
East

M-277
4097'

--- 1658' ---

M-274
4105'

--- 999' ---

Tie to A-A'
M-363
4114'

--- 1791' ---

M-72
4136'

Elevation AMSL

4200'
4100'
4000' DATUM
3900'
3800'
3700'
3600'
3500'
3400'
3300'
3200'
3100'

Alluvium

Arikaree Group

Brule Formation

Upper Whitney Ash

Lower Whitney Ash

Upper Chadron Formation

Middle Chadron Formation

Basal Sandstone of the Chadron Fm.

Pierre Shale

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

Scale: See Scale Bar	Date: 12/8/2016
C:\Users\ca0414261\Desktop\DBOW TEMP\TR-NRC\TR_M-M'.mxd	Checked by: JS

Looking North

N
West

N'
East

M-1582
4090'

--- 628' ---

Tie to A-A'
M-1554
4094'

--- 1002' ---

M-1573
4079'

Elevation
AMSL

4300'
4200'
4100'
4000'
DATUM
3900'
3800'
3700'
3600'
3500'
3400'
3300'
3200'
3100'

Alluvium

Arikaree
Group

Brule
Formation

Upper Whitney Ash

Lower Whitney Ash

Upper
Chadron
Formation

Middle
Chadron
Formation

Basal Sandstone
of the Chadron Fm.

Pierre
Shale

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

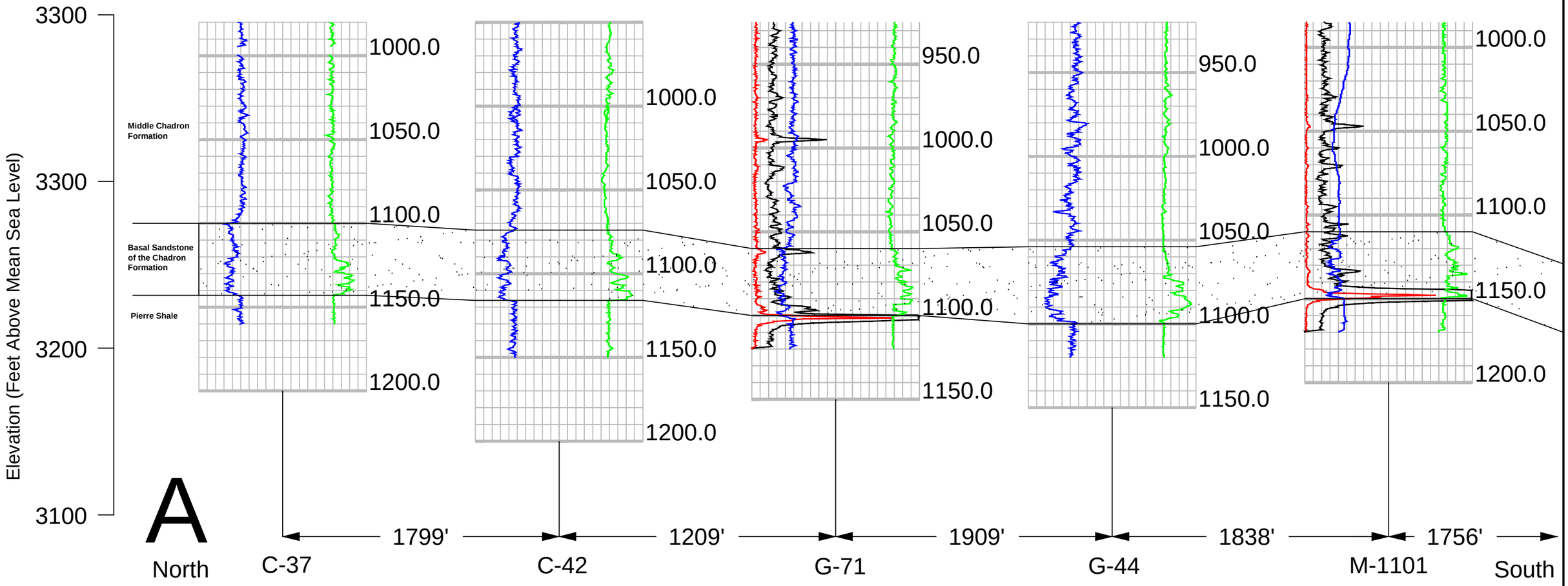
Crow Butte Resources, Inc

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

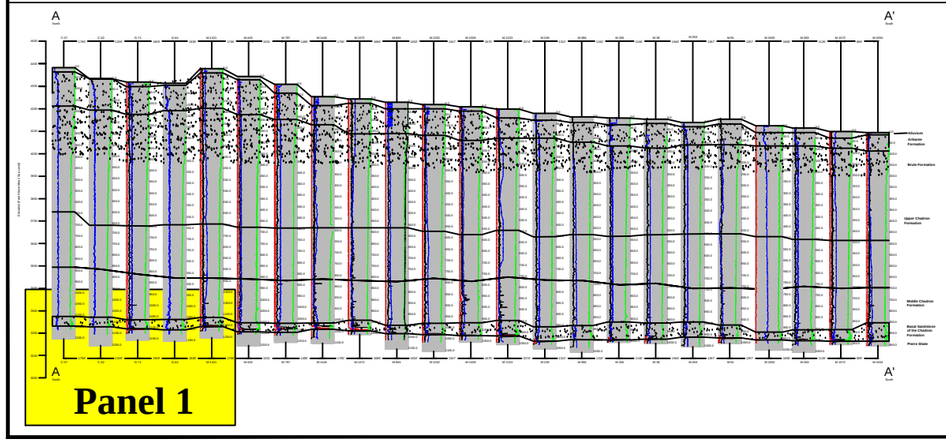
Scale: See Scale Bar	Date: 12/8/2016
C:\Users\cab04142\Desktop\DBOW TEMP\TR-NRC\TR_N-N'.mxd	Checked by: JS

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

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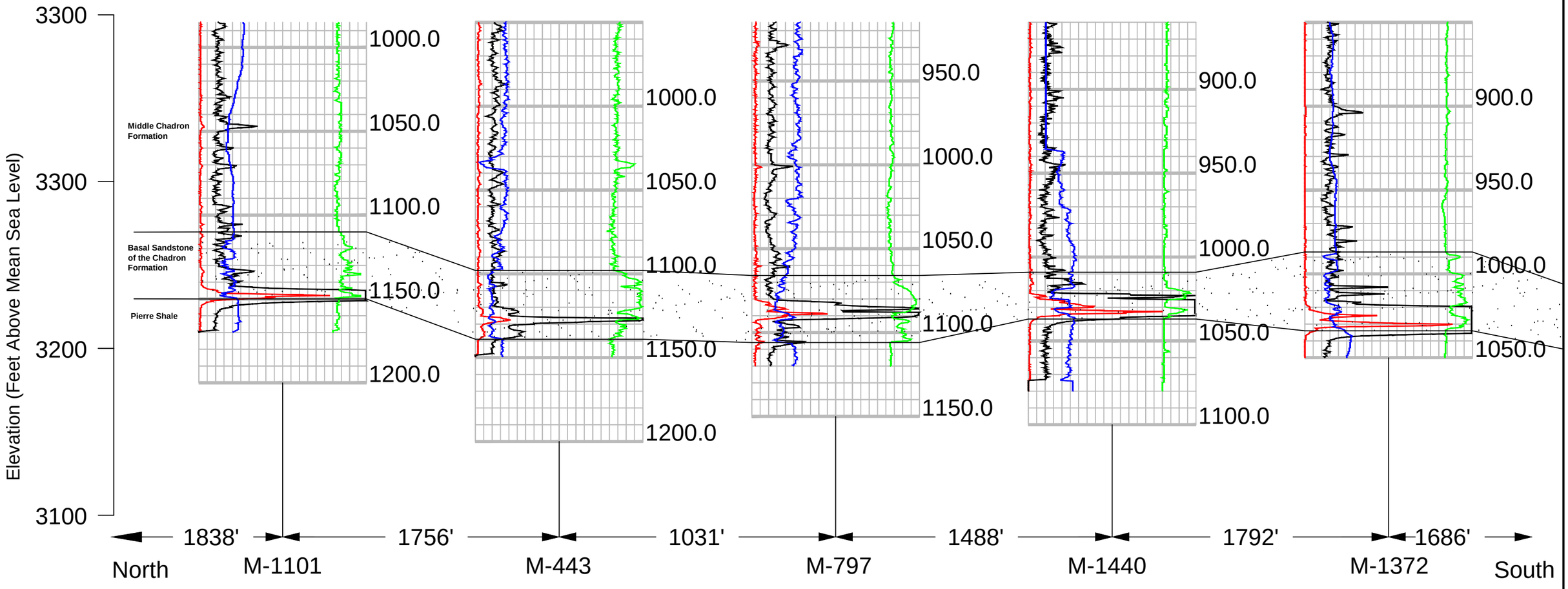
FIGURE 2.6-3o

EXPANDED MARSLAND CROSS SECTION A-A'

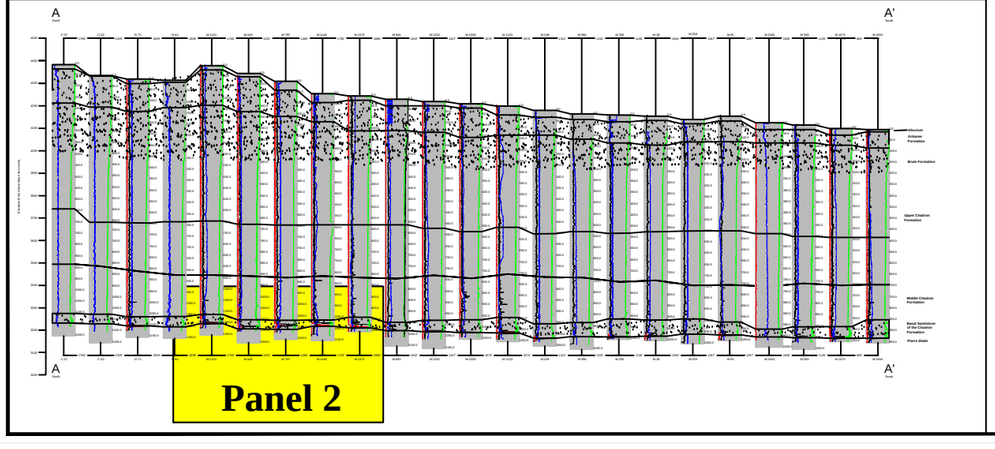
PANEL 1

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

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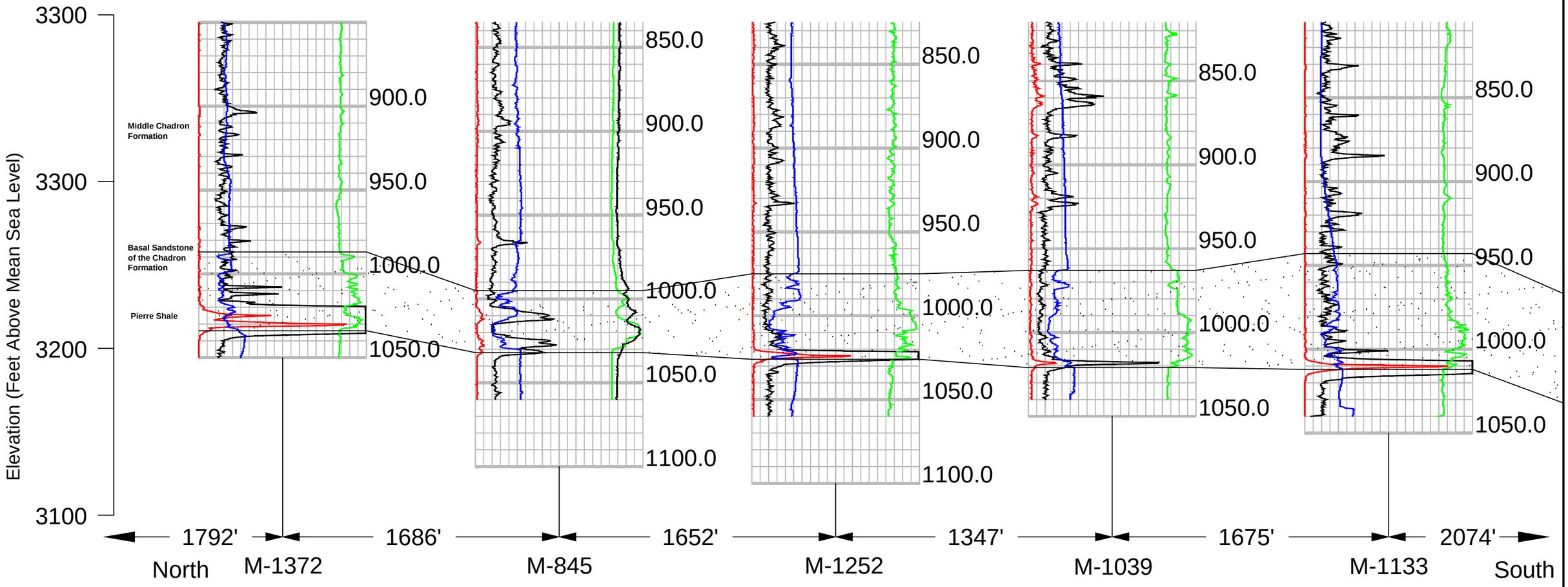
FIGURE 2.6-3p

EXPANDED MARSLAND CROSS SECTION A-A'

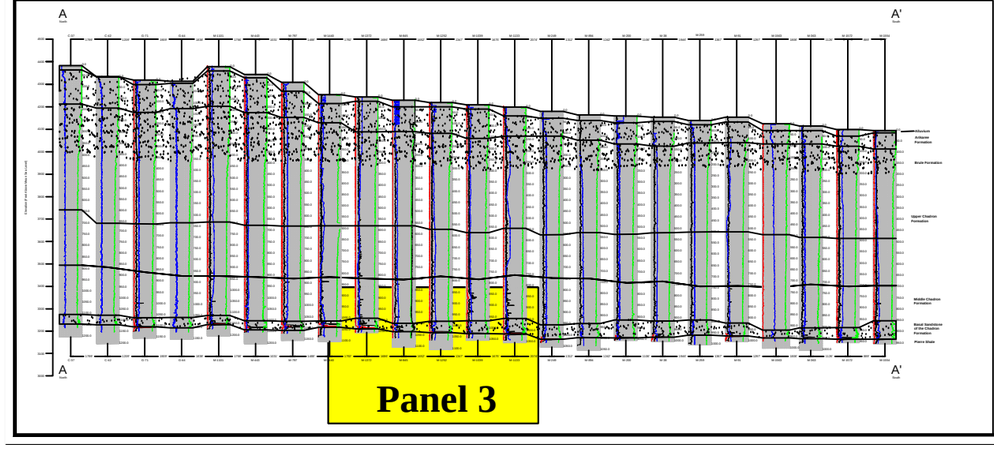
PANEL 2

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

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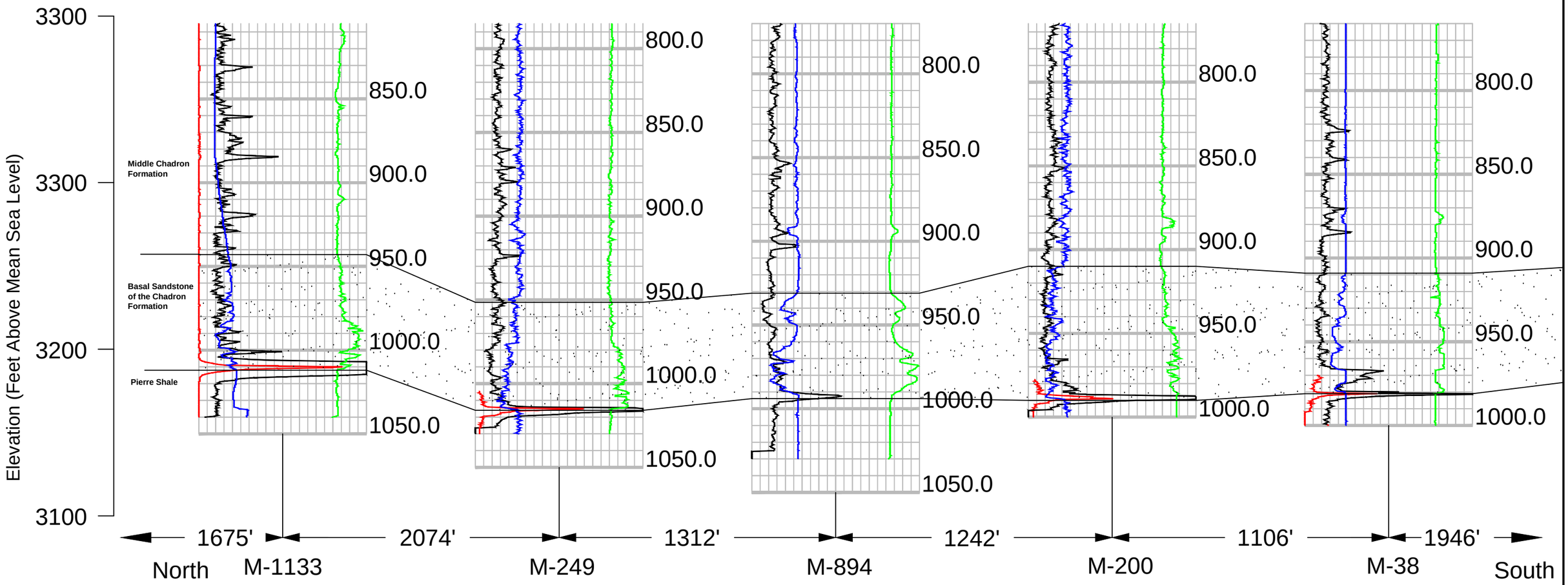
FIGURE 2.6-3q

EXPANDED MARSLAND CROSS SECTION A-A'

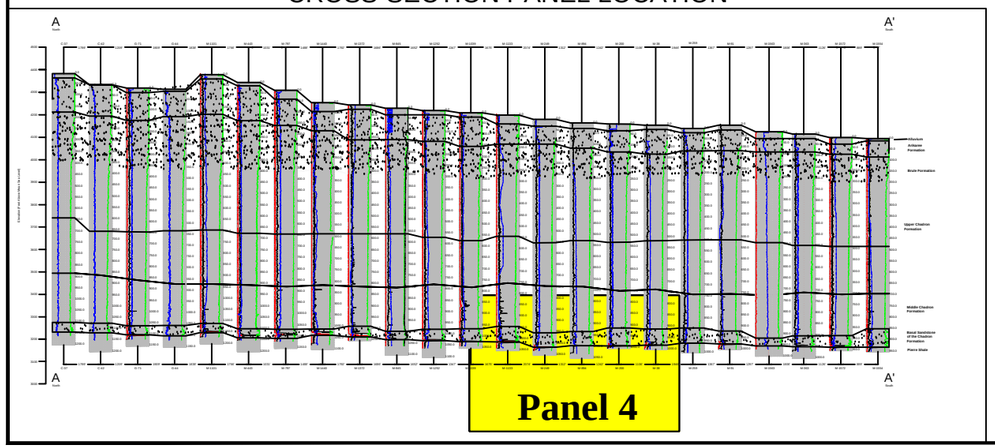
PANEL 3

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

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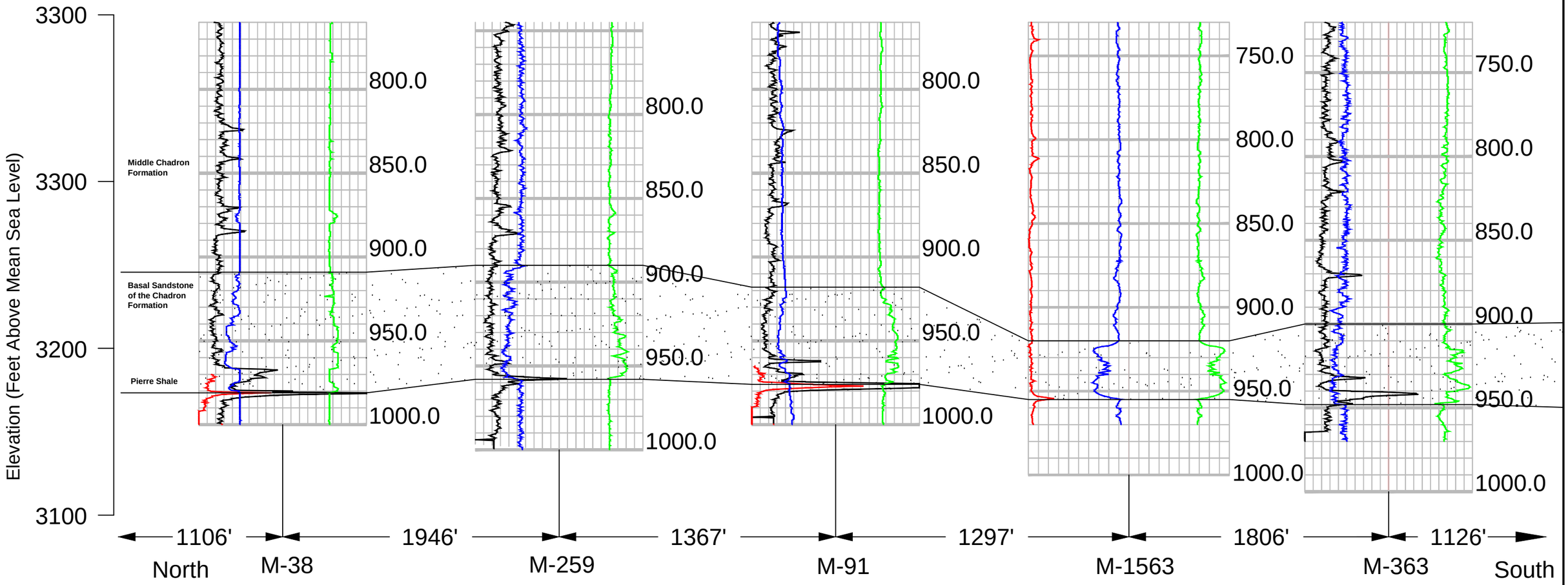
FIGURE 2.6-3r

EXPANDED MARSLAND CROSS SECTION A-A'

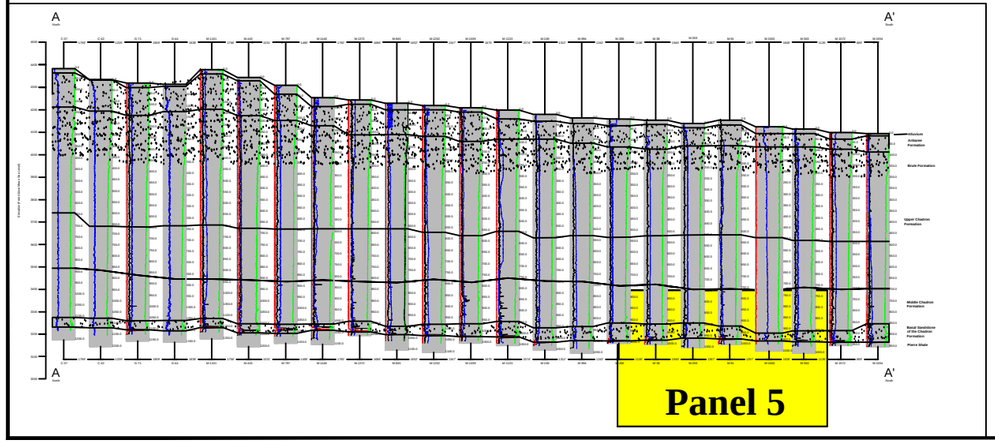
PANEL 4

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

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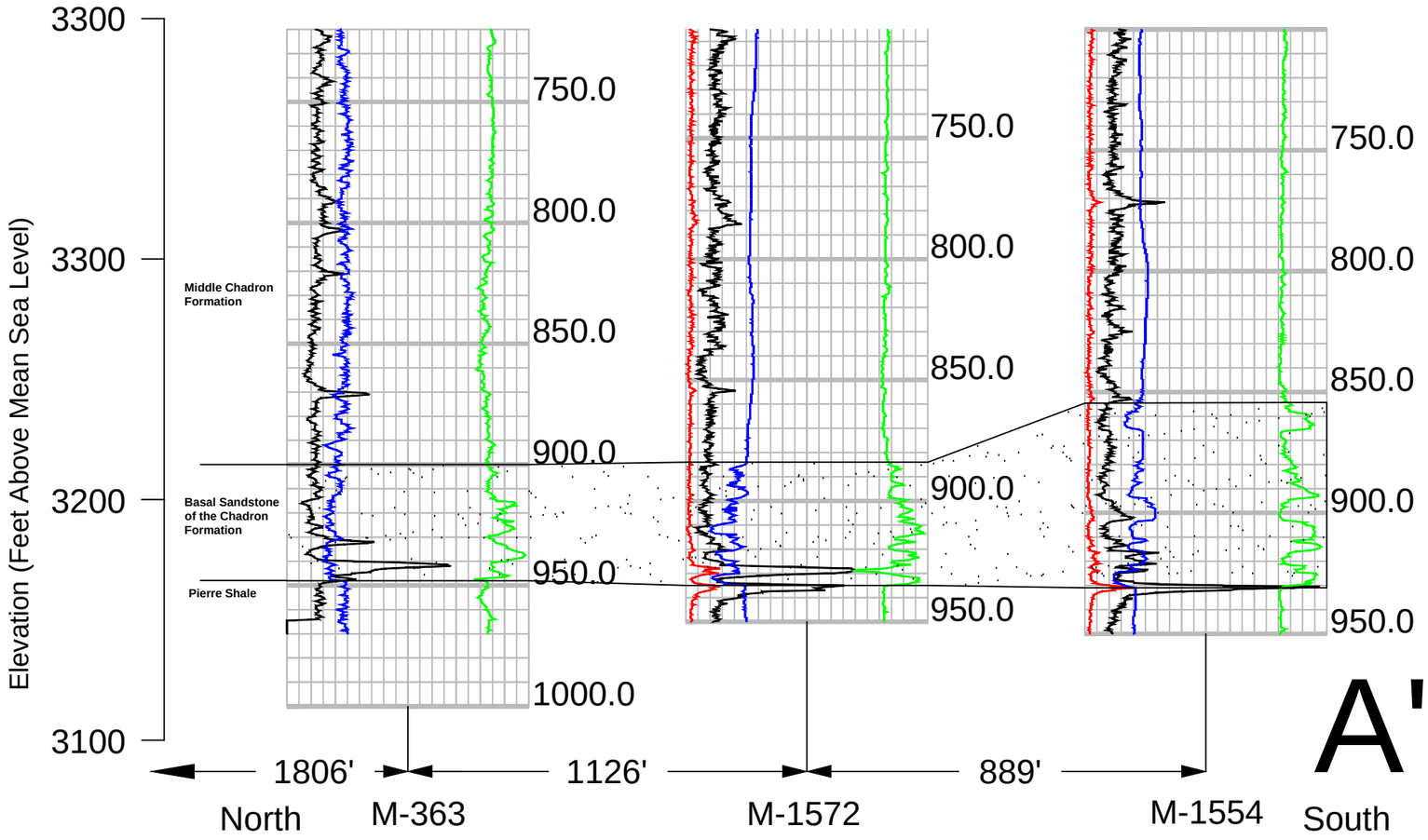
FIGURE 2.6-3s

EXPANDED MARSLAND CROSS SECTION A-A'

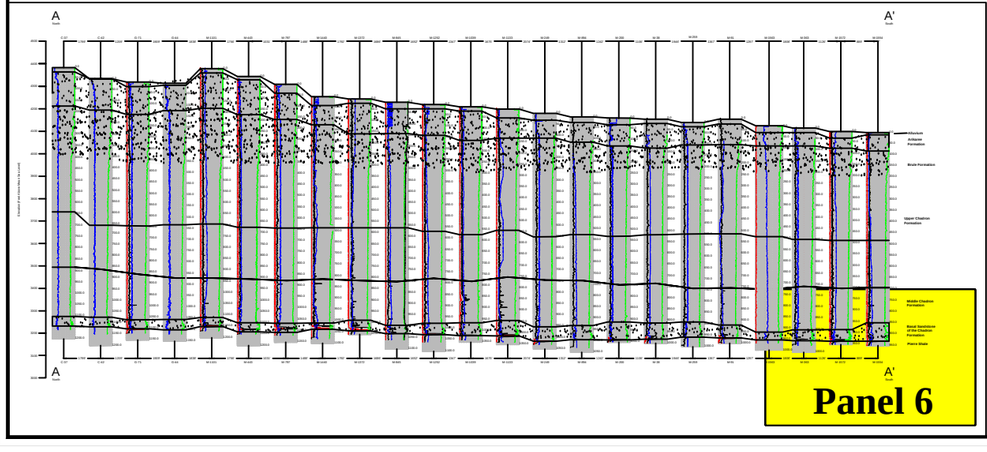
PANEL 5

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

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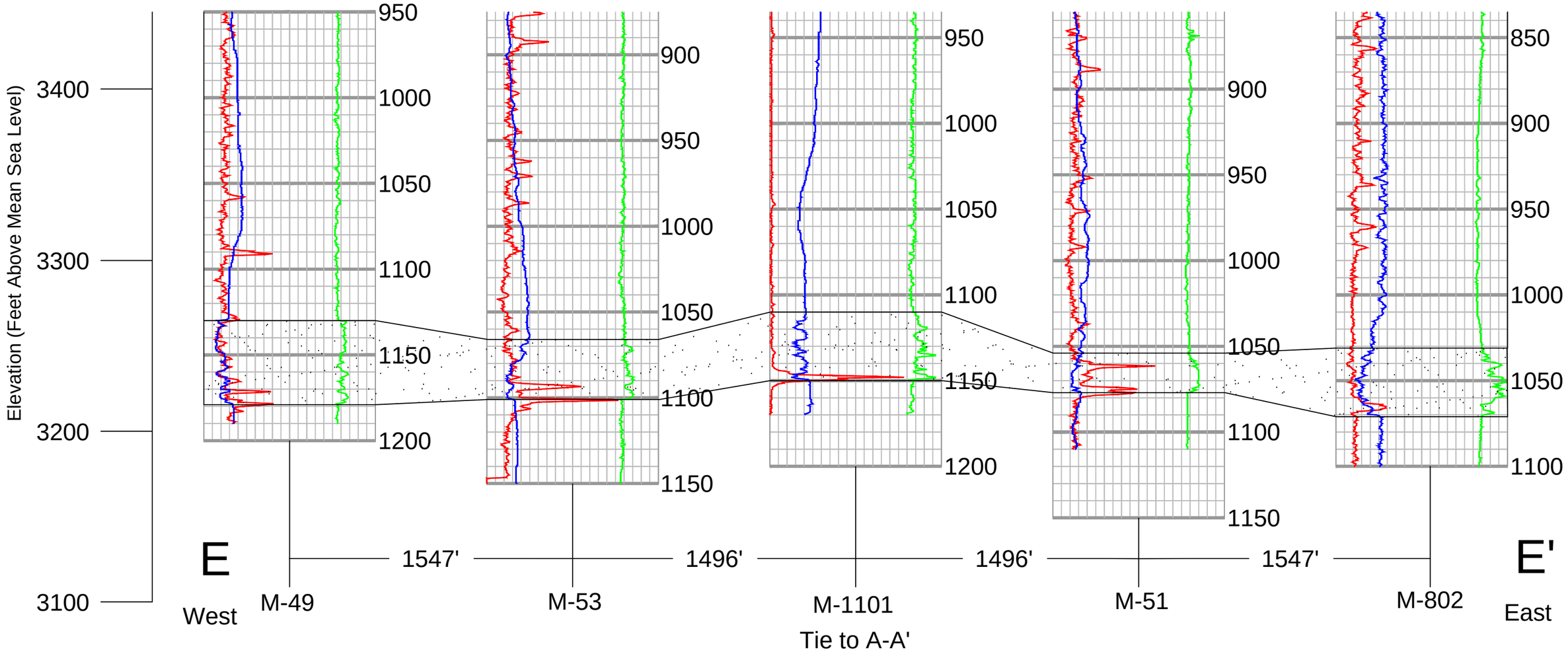
FIGURE 2.6-3t

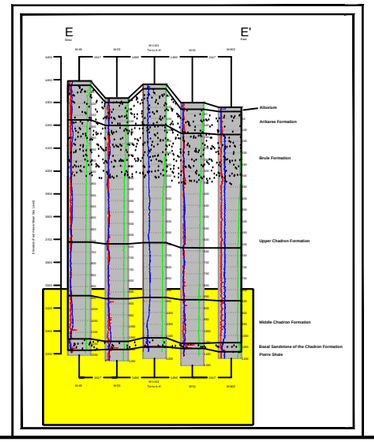
EXPANDED MARSLAND CROSS SECTION A-A'

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

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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

M-2169C
(8/12/2013)

M-1454C
(3/23/2011)

M-533C
(8/12/2013)

M-1624C
(3/28/2011)

M-1956C
(8/20/2013)

M-1912C
(8/15/2013)

M-1635C
(8/23/2013)

Proposed Marsland Expansion Area

R. 51W
R. 50W

T. 30N
T. 29N

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

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FIGURE 2.6-4
MARSLAND EXPANSION AREA
CORING LOCATIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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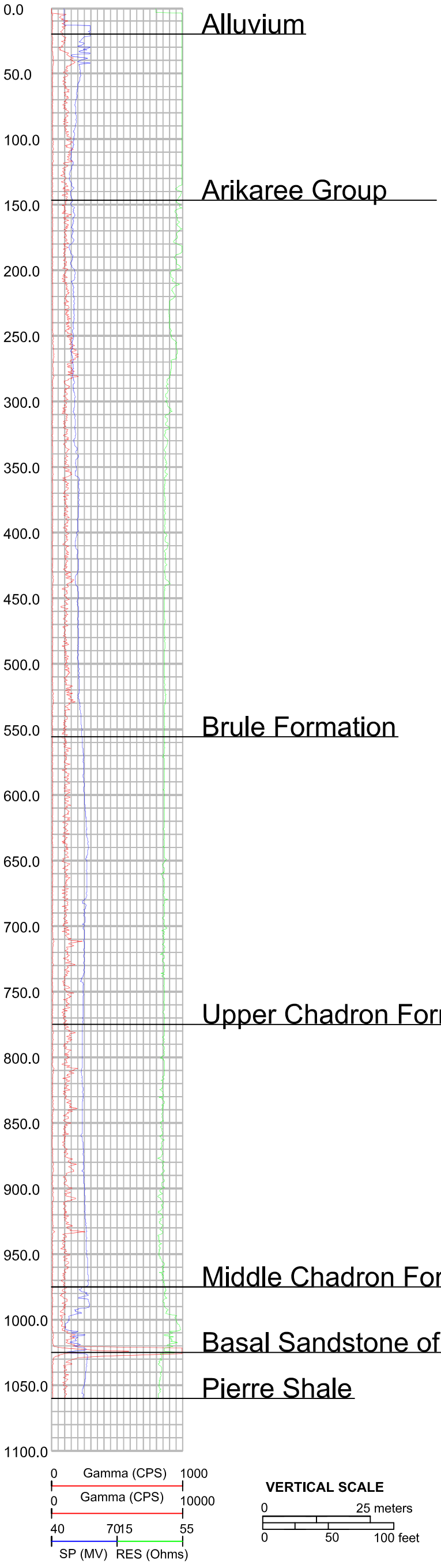
M-1252



VERTICAL SCALE

0 25 meters

0 50 100 feet

Source: Cameco Resources, 2011

CROW BUTTE RESOURCES, INC.

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

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JA

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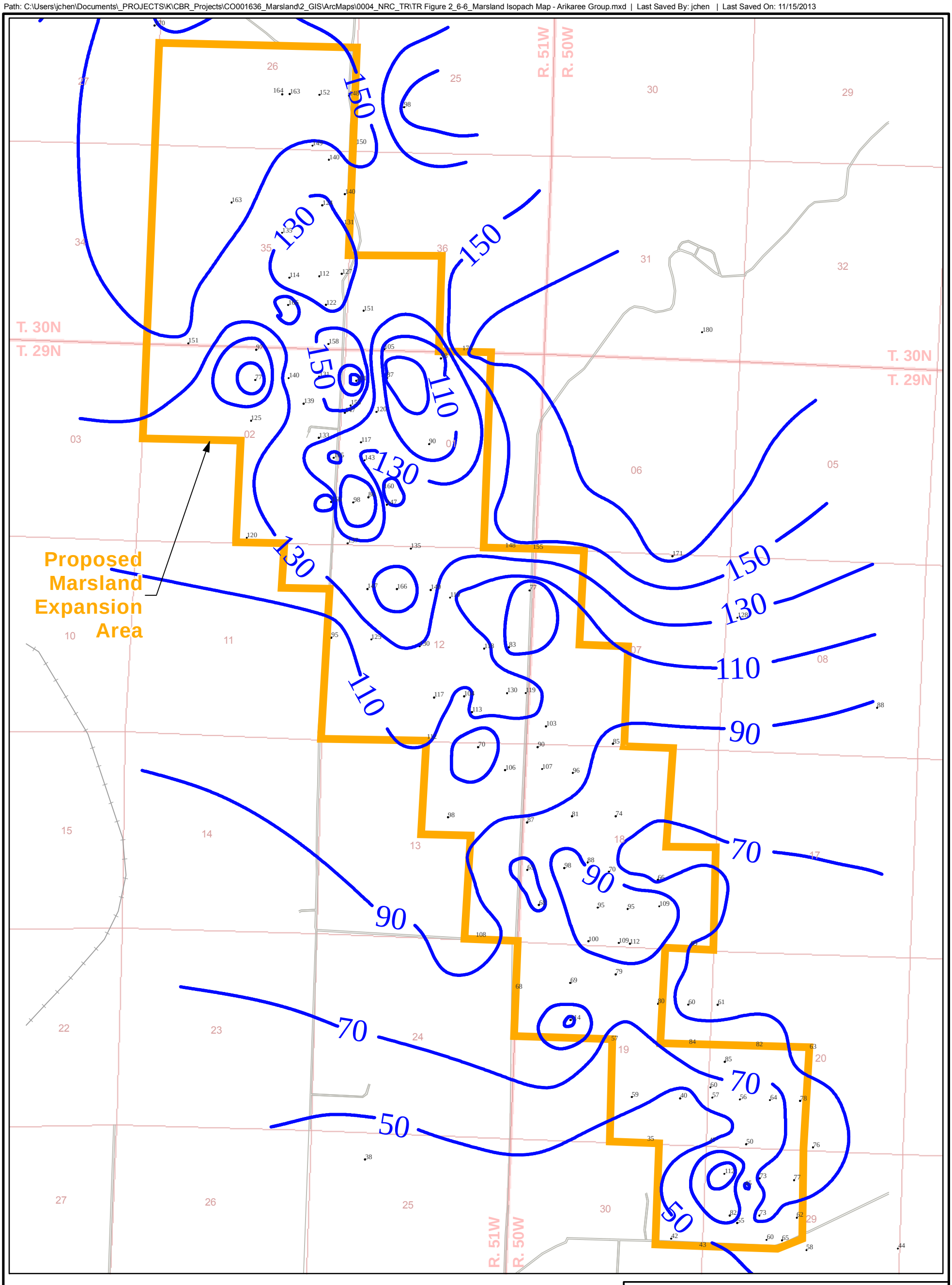
Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_6-6_Marsland Isopach Map - Arikaree Group.mxd | Last Saved By: jchen | Last Saved On: 11/15/2013



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

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FIGURE 2.6-6
MARSLAND ISOPACH MAP
ARIKAREE GROUP

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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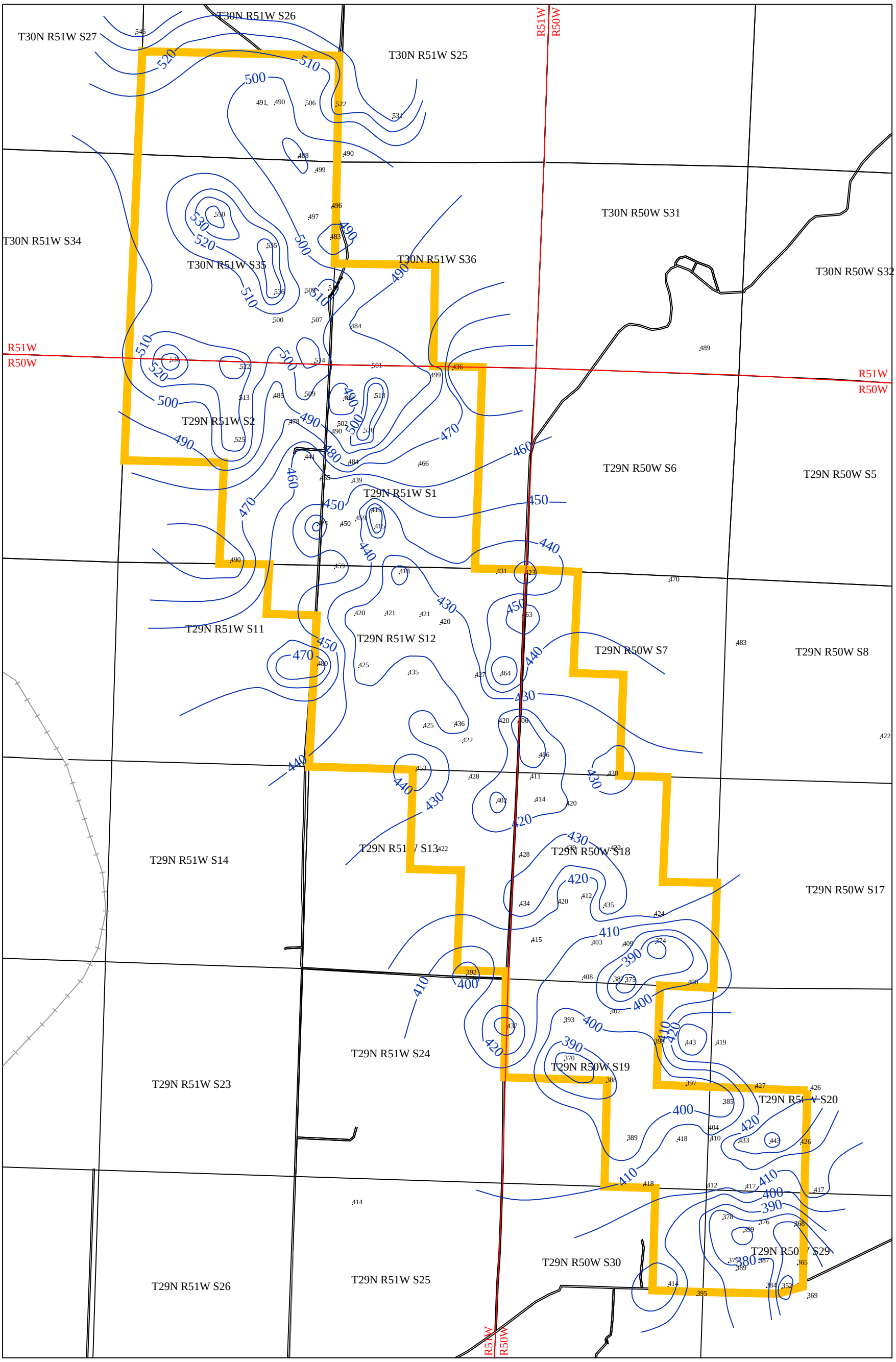


LEGEND

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

N

0 2000 4000 FEET

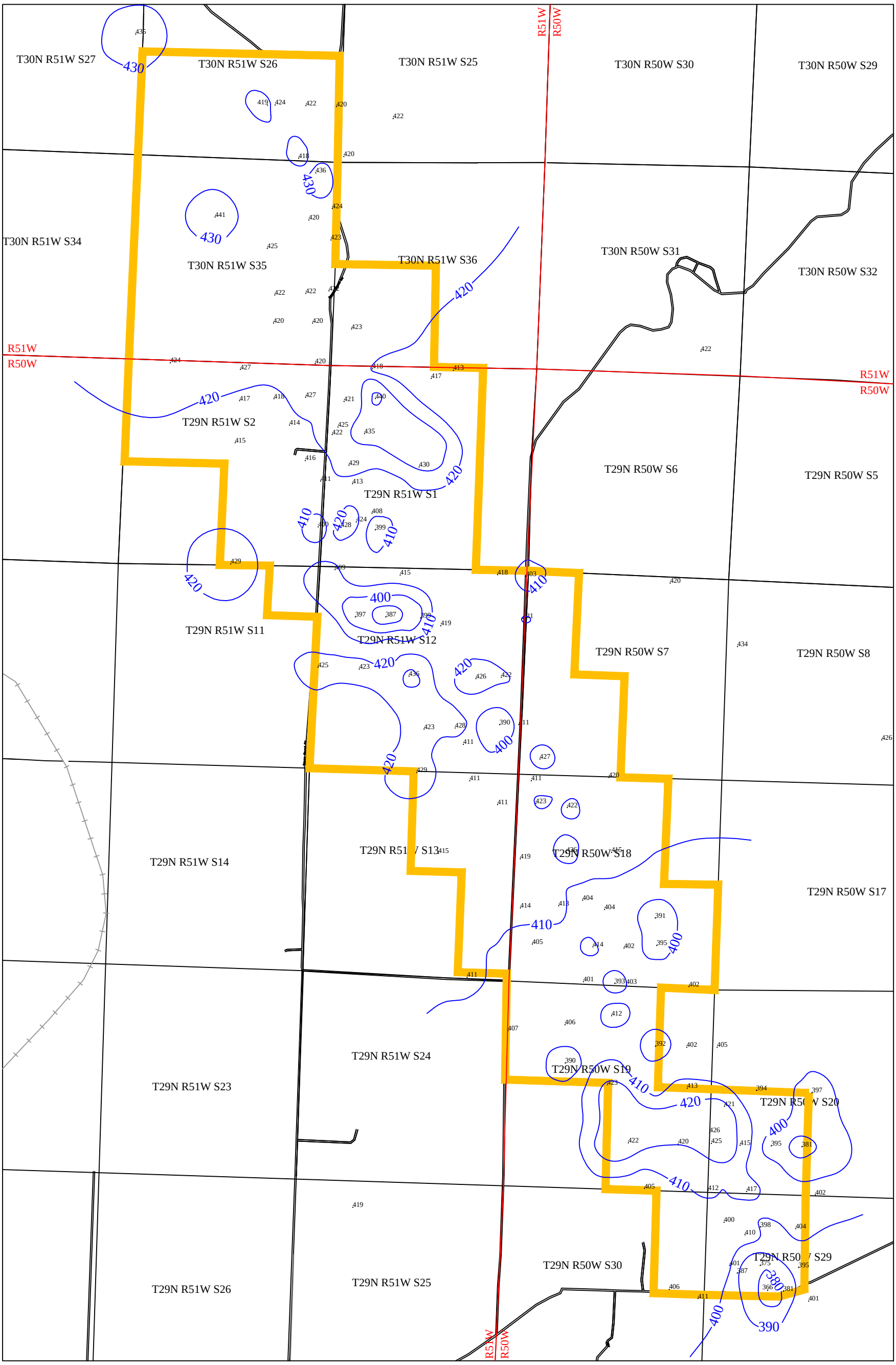
PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS – USGS

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

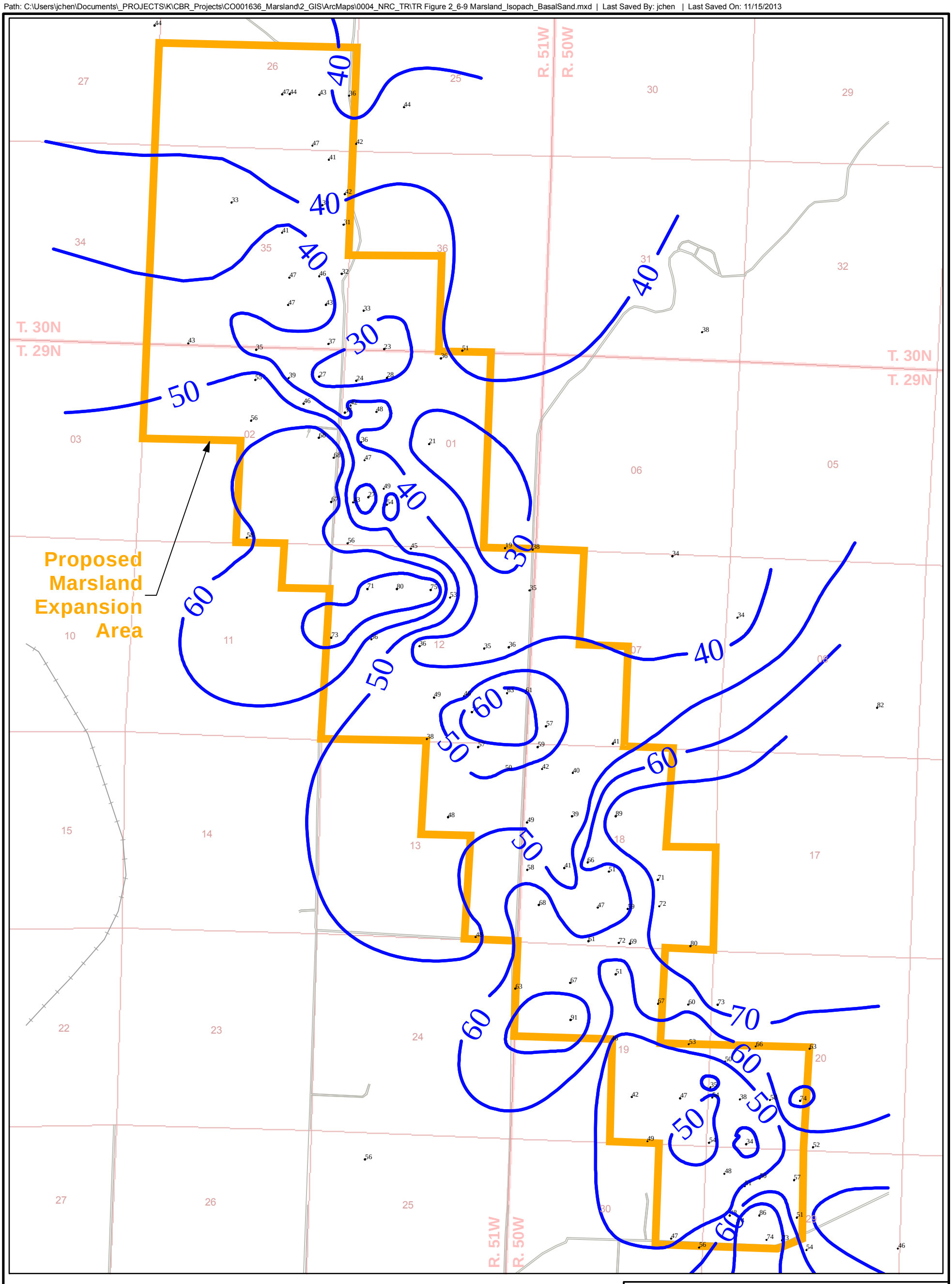
Crow Butte Resources, Inc.

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

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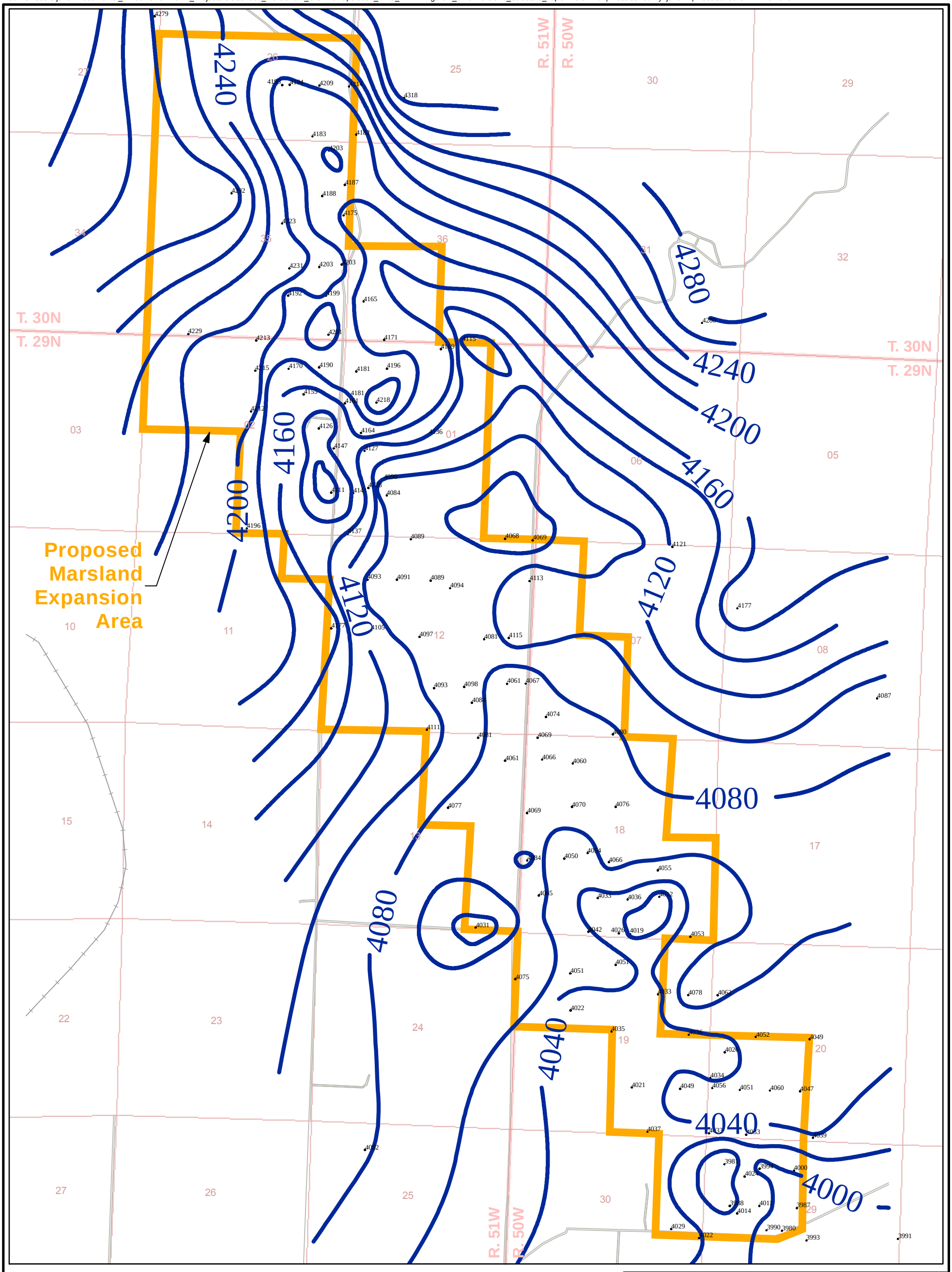
Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_6-10 Marsland_Structure_TopOfBrule.mxd | Last Saved By: jchen | Last Saved On: 11/15/2013



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

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FIGURE 2.6-10
MARSLAND STRUCTURE MAP
TOP OF BRULE FORMATION

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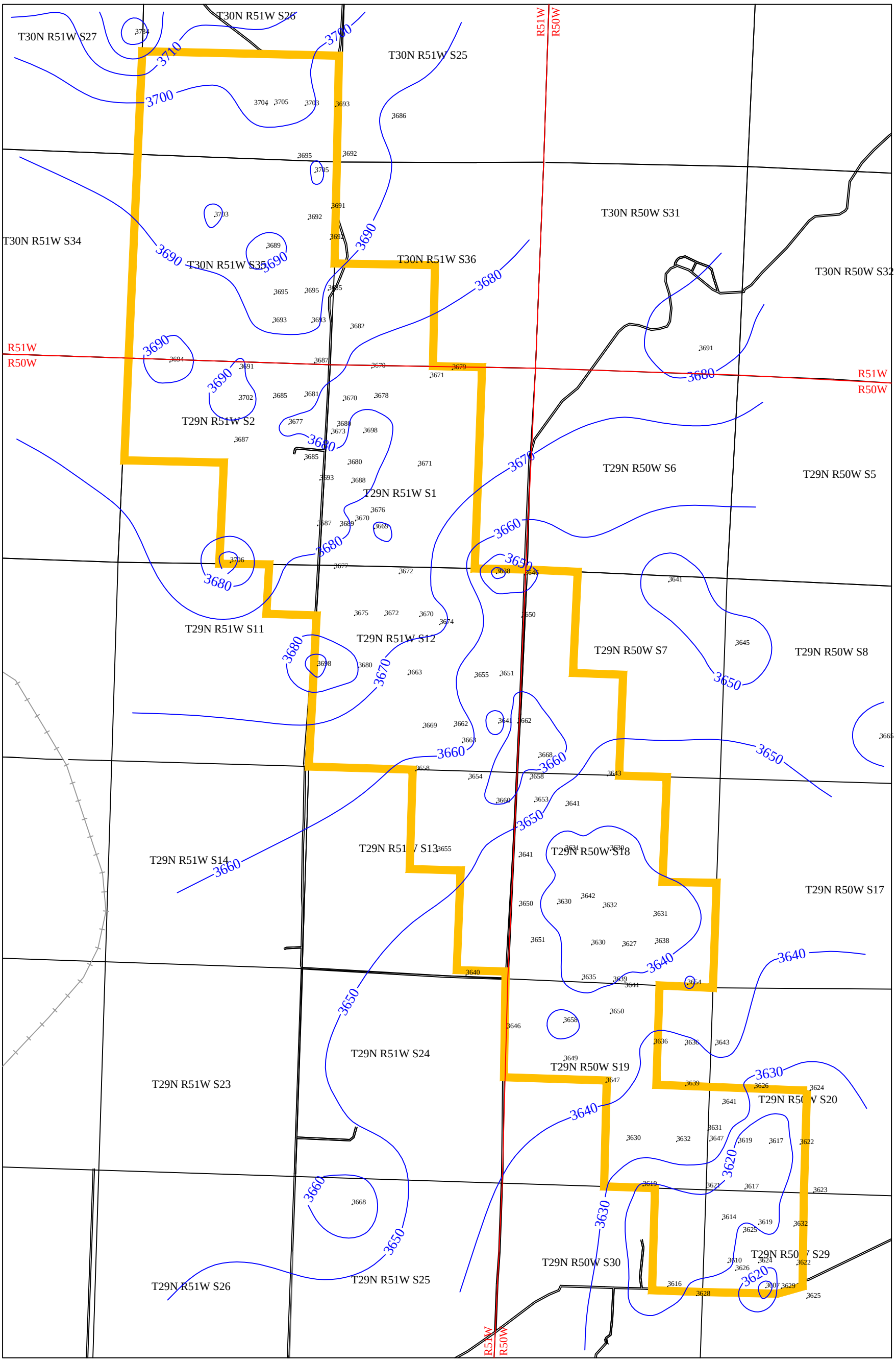


LEGEND

- 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

FT-AMSL = Feet Above Mean Sea Level

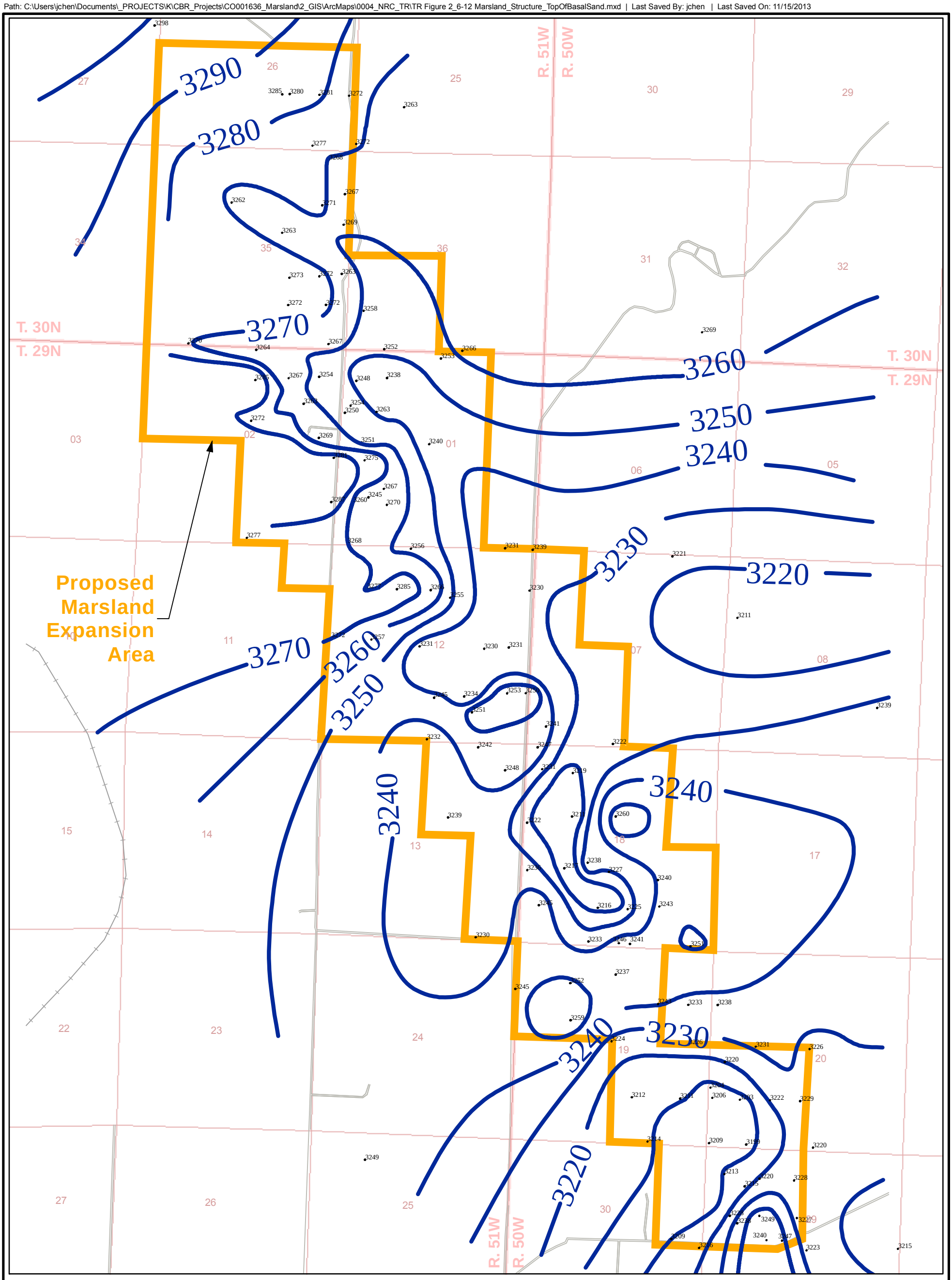
Crow Butte Resources, Inc.

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

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

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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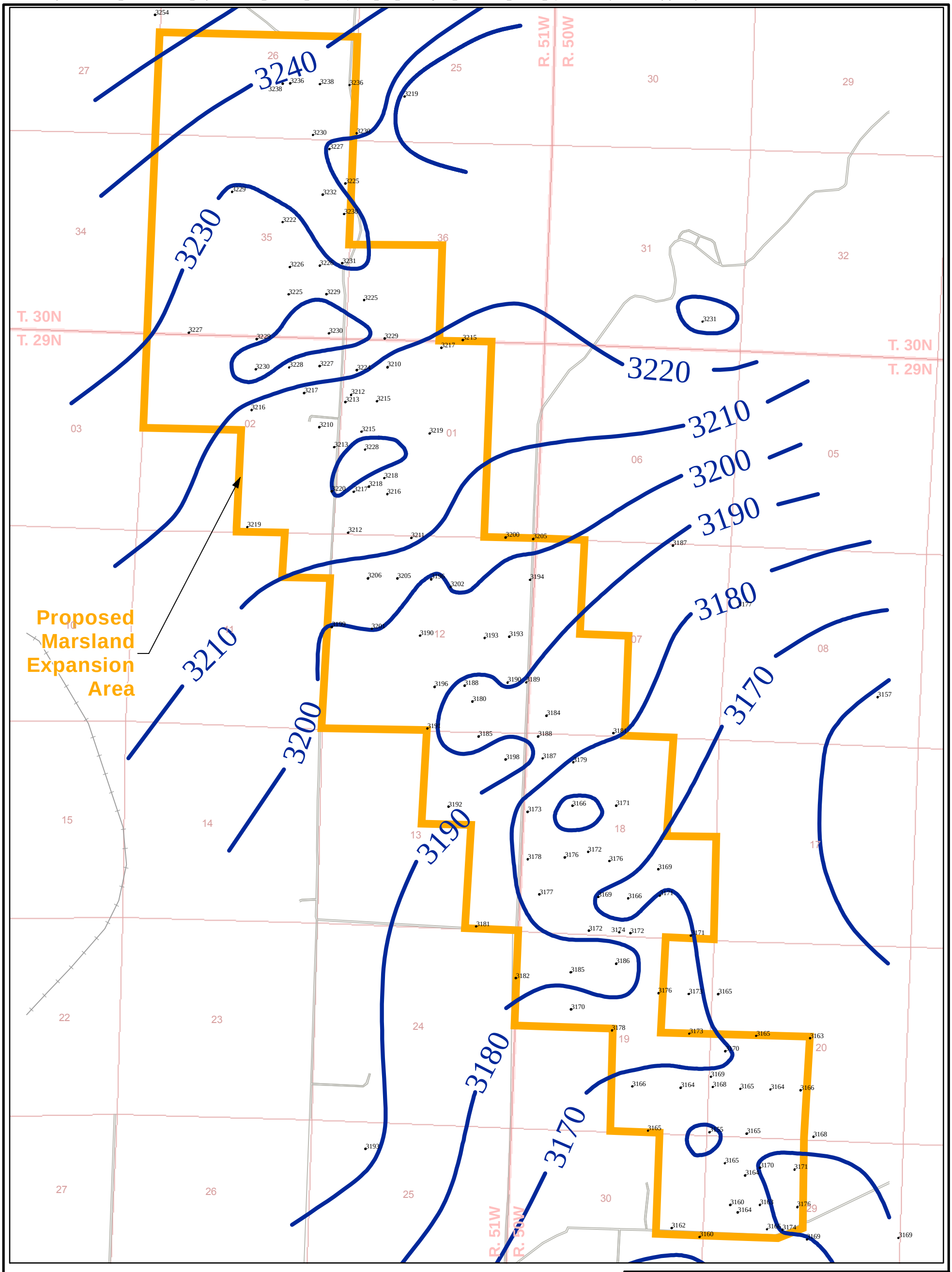
Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_6-13 Marsland_Structure_TopOfPierre.mxd | Last Saved By: jchen | Last Saved On: 11/15/2013



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

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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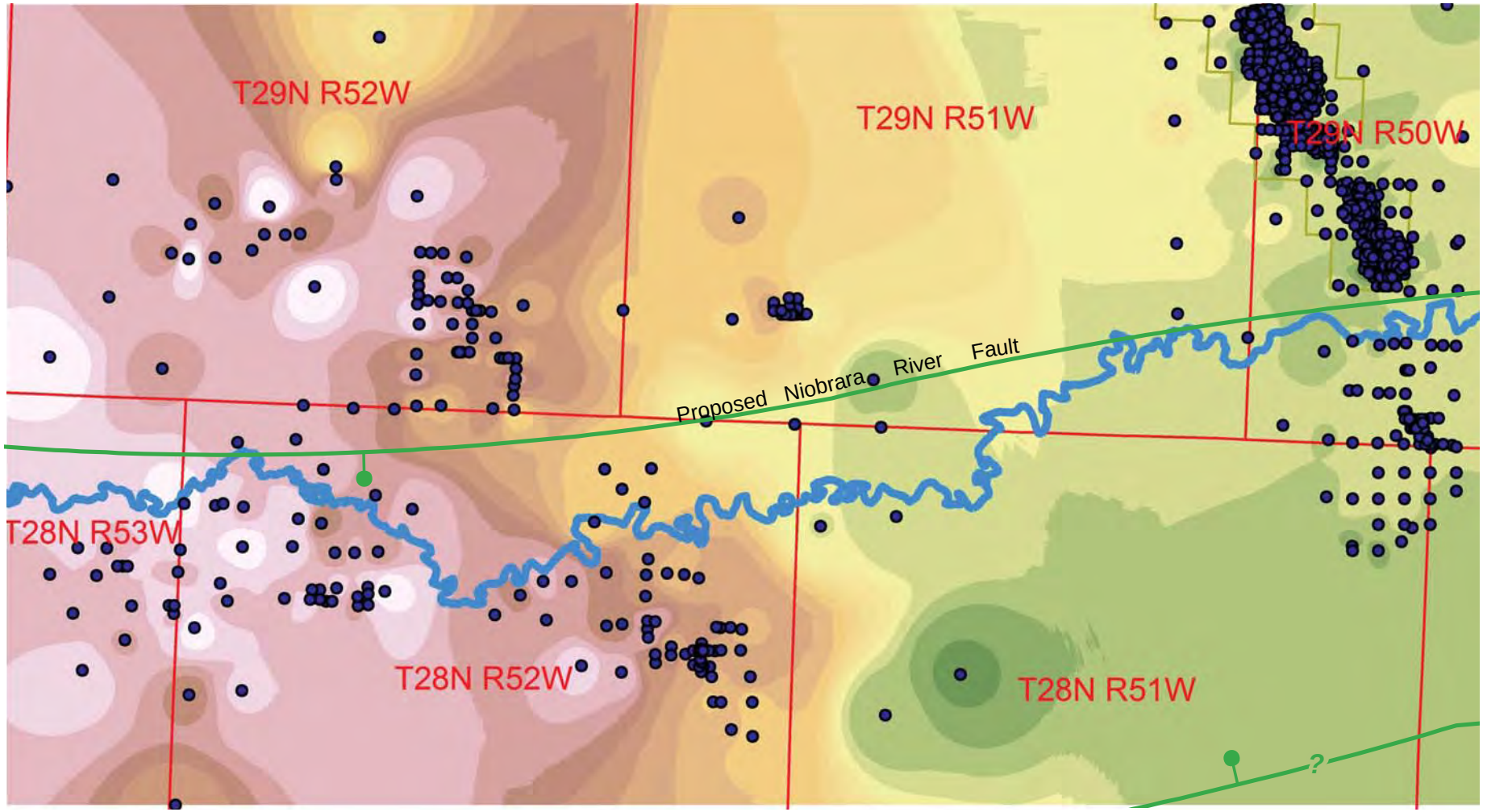

LEGEND

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

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

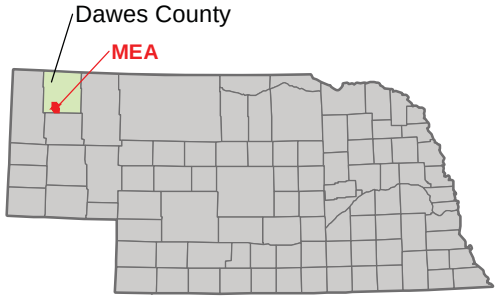

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FIGURE 2.6-14
REGIONAL STRUCTURE CONTOUR MAP – TOP OF PIERRE SHALE

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

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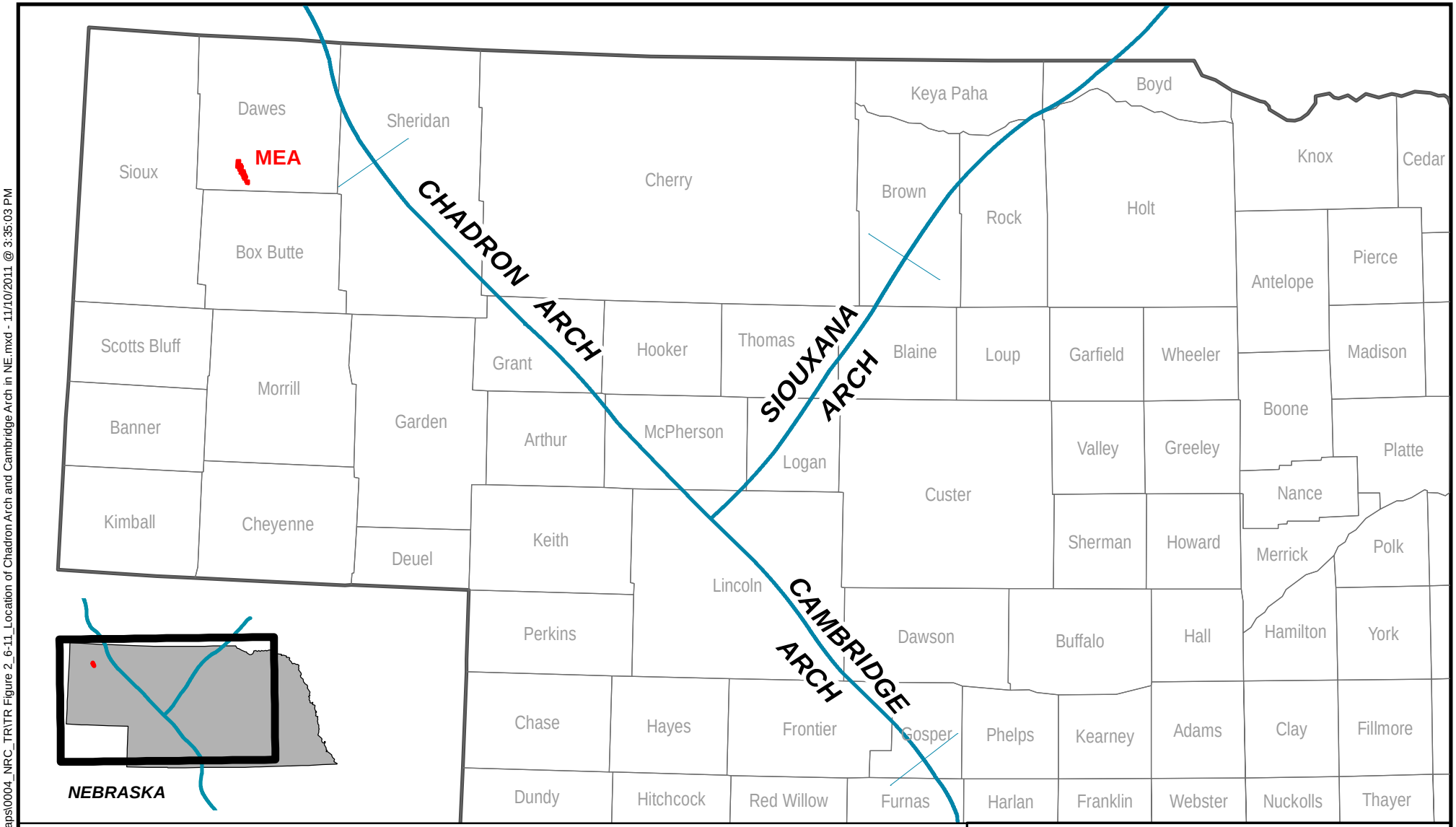
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2_6-14 Regional Structure Contour Map – Top of Pierre Shale.ai @12/15/2013



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

CROW BUTTE RESOURCES, INC.

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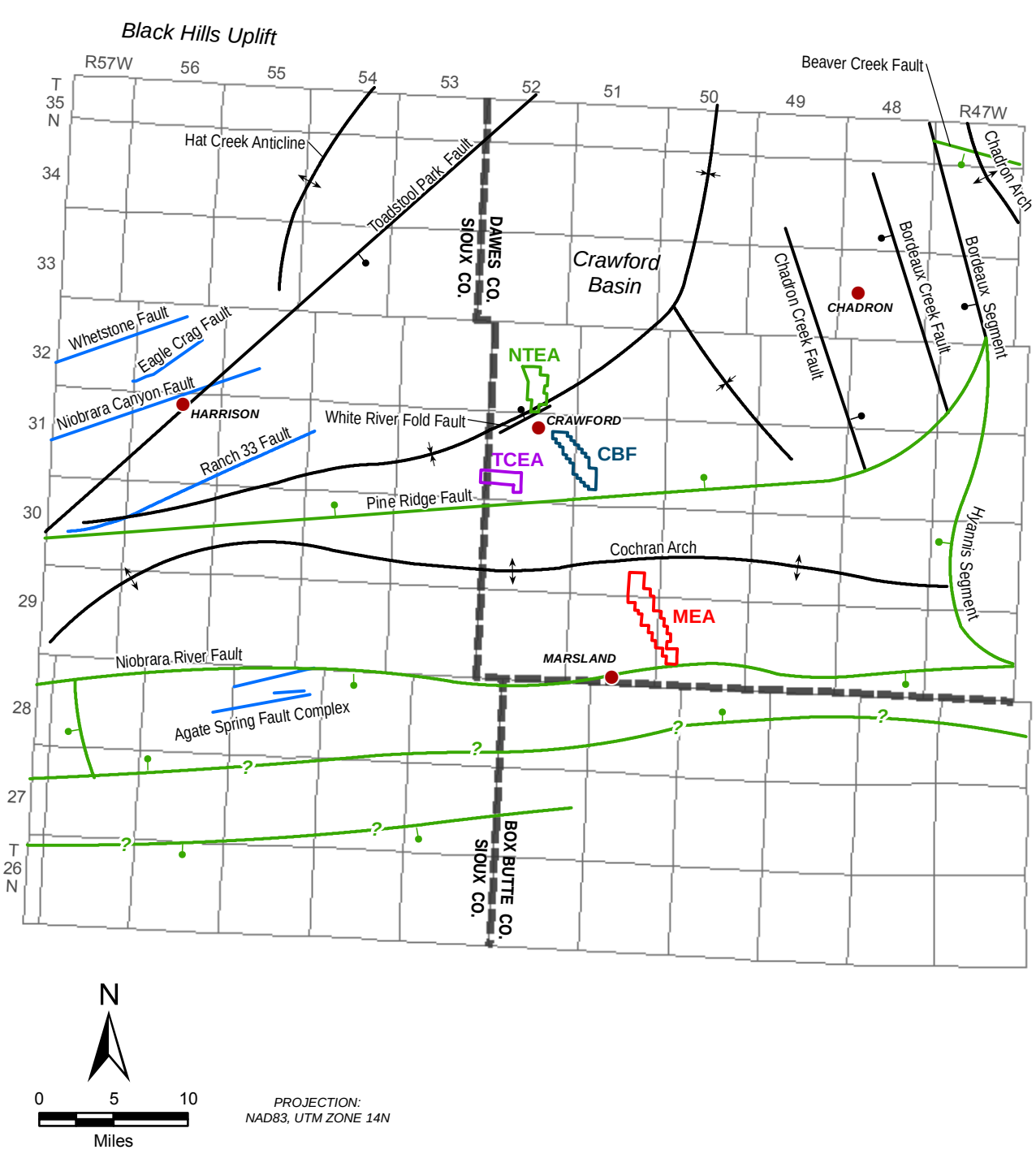
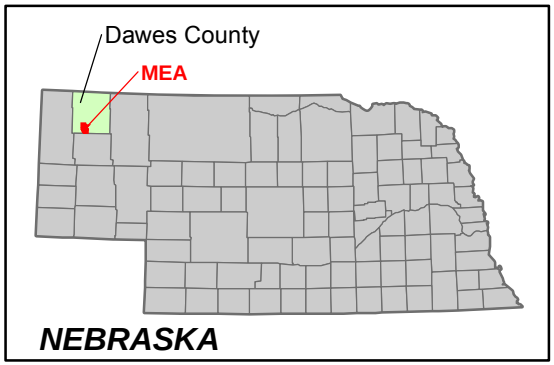
K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TRYTR Figure 2_6-11_Location of Chadron Arch and Cambridge Arch in NE.mxd - 11/10/2011 @ 3:35:03 PM





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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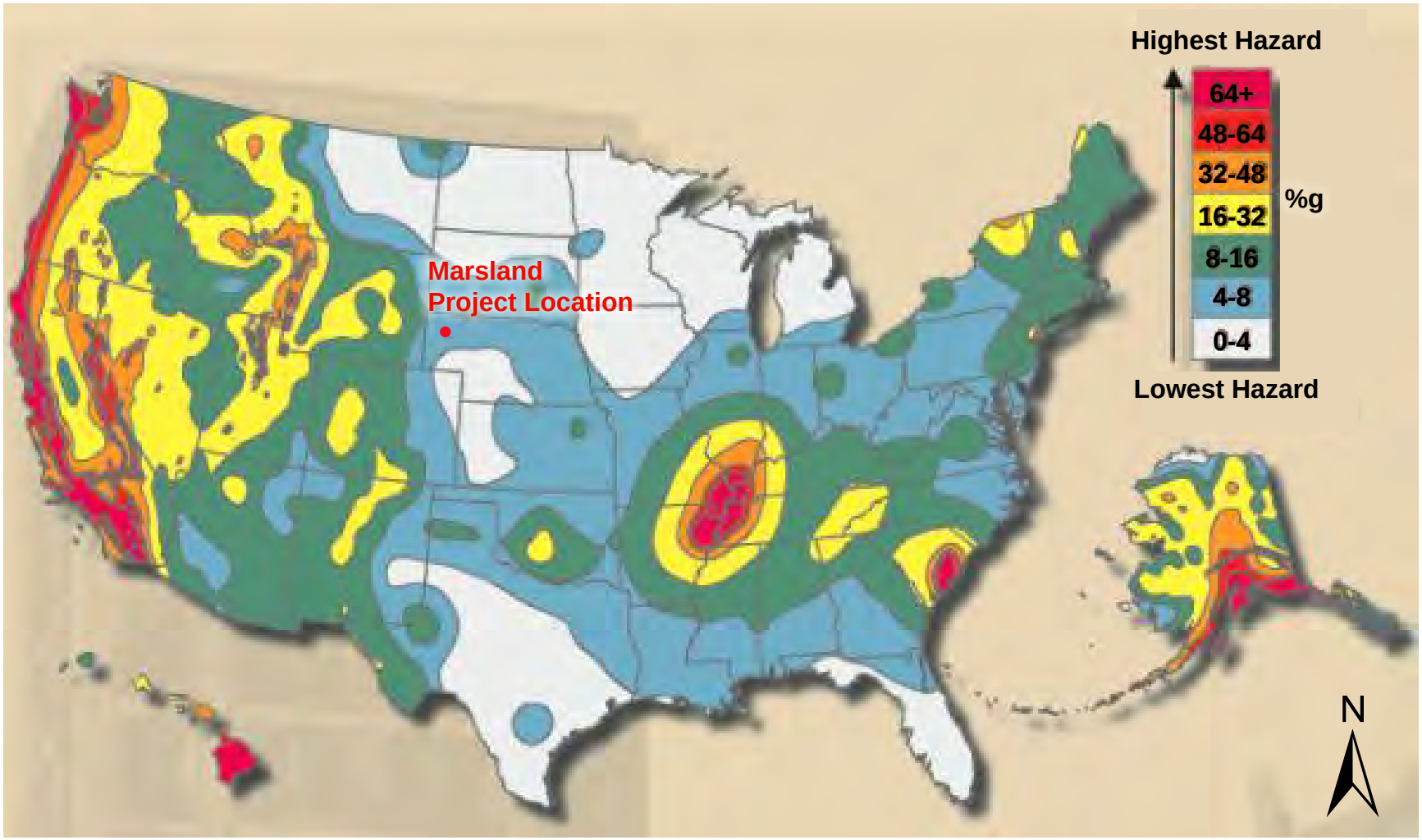

SOURCE: SD 2008

CROW BUTTE RESOURCES, INC.

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

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

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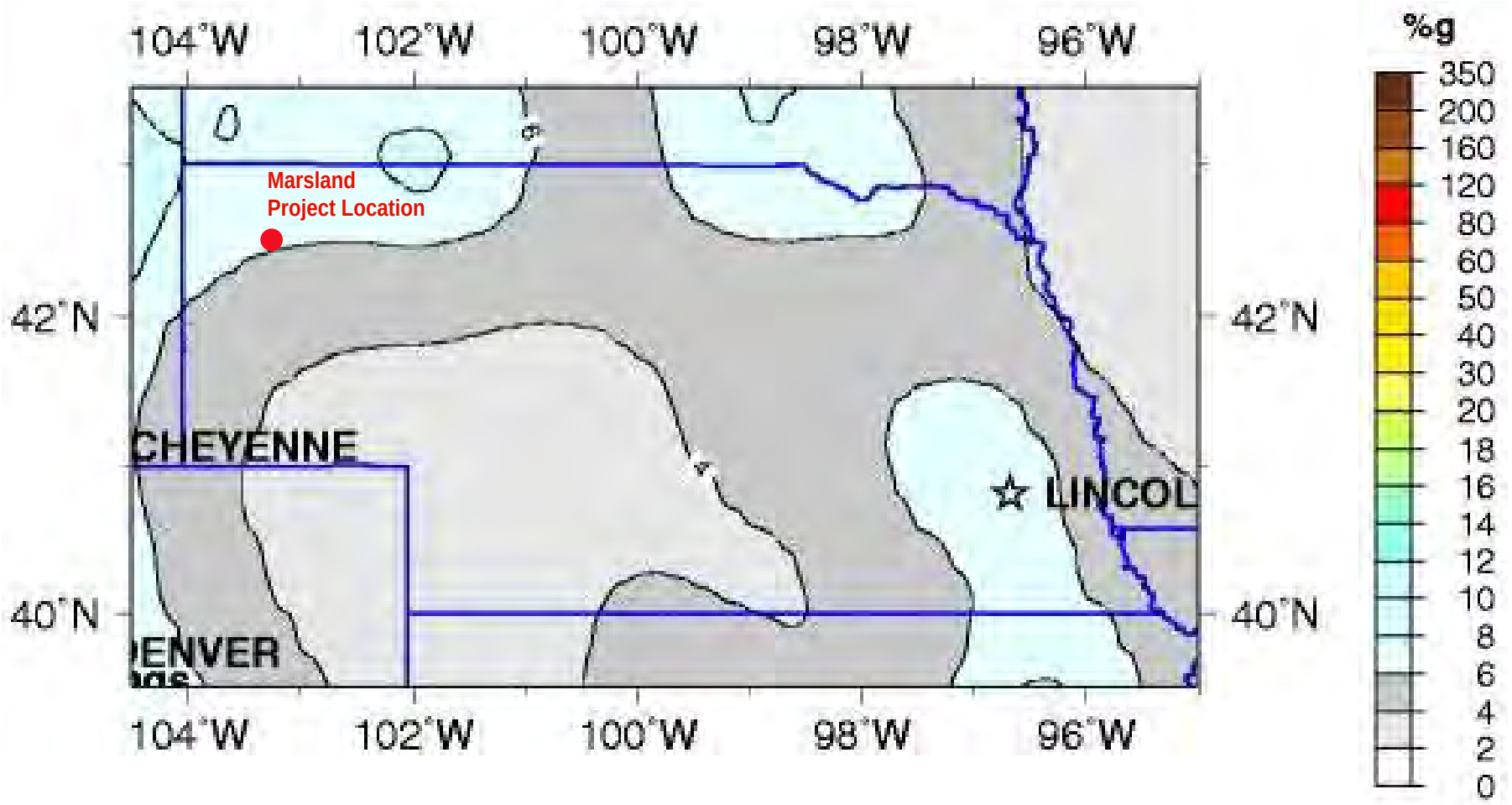

Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years
Site: NEHRP B-C boundary
National Seismic Hazard Mapping Project (Peterson, M.D. 2008)

N

SOURCE: USGS 20009a

CROW BUTTE RESOURCES, INC.

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

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

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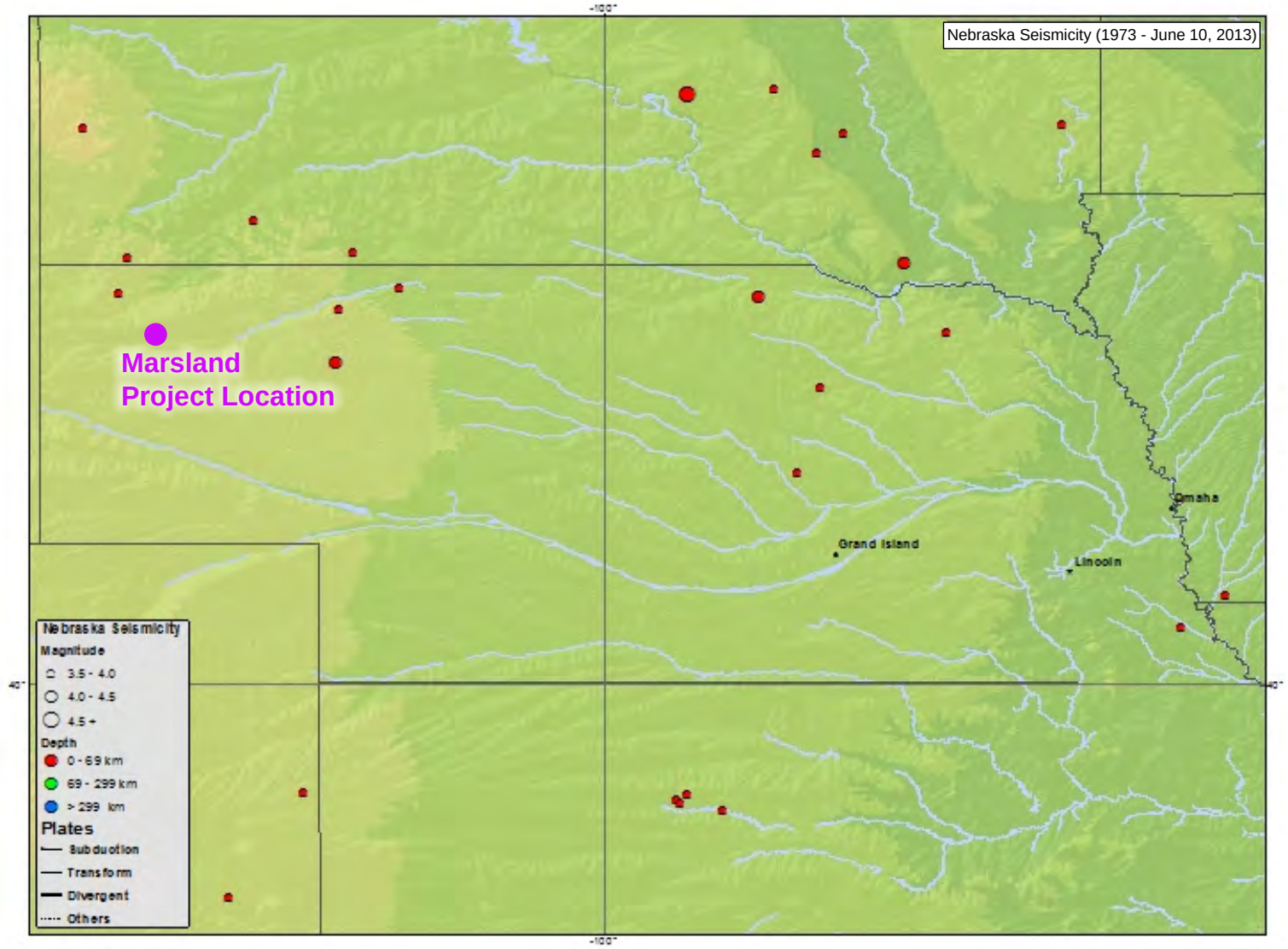

N

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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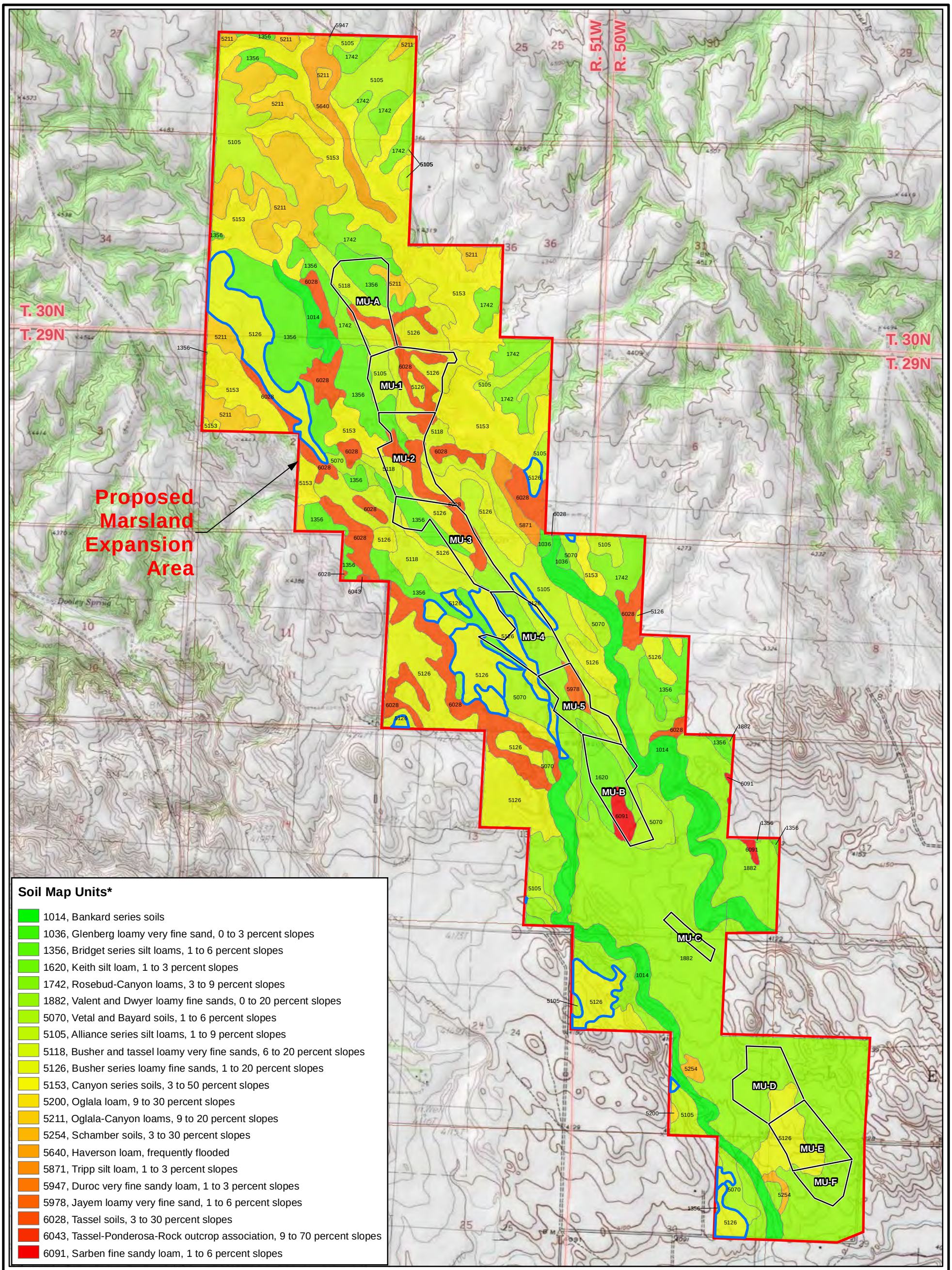

Soil Map Units*

- 1014, Bankard series soils
- 1036, Glenberg loamy very fine sand, 0 to 3 percent slopes
- 1356, Bridget series silt loams, 1 to 6 percent slopes
- 1620, Keith silt loam, 1 to 3 percent slopes
- 1742, Rosebud-Canyon loams, 3 to 9 percent slopes
- 1882, Valent and Dwyer loamy fine sands, 0 to 20 percent slopes
- 5070, Vetal and Bayard soils, 1 to 6 percent slopes
- 5105, Alliance series silt loams, 1 to 9 percent slopes
- 5118, Busher and tassel loamy very fine sands, 6 to 20 percent slopes
- 5126, Busher series loamy fine sands, 1 to 20 percent slopes
- 5153, Canyon series soils, 3 to 50 percent slopes
- 5200, Oglala loam, 9 to 30 percent slopes
- 5211, Oglala-Canyon loams, 9 to 20 percent slopes
- 5254, Schamber soils, 3 to 30 percent slopes
- 5640, Haverson loam, frequently flooded
- 5871, Tripp silt loam, 1 to 3 percent slopes
- 5947, Duroc very fine sandy loam, 1 to 3 percent slopes
- 5978, Jayem loamy very fine sand, 1 to 6 percent slopes
- 6028, Tassel soils, 3 to 30 percent slopes
- 6043, Tassel-Ponderosa-Rock outcrop association, 9 to 70 percent slopes
- 6091, Sarben fine sandy loam, 1 to 6 percent slopes

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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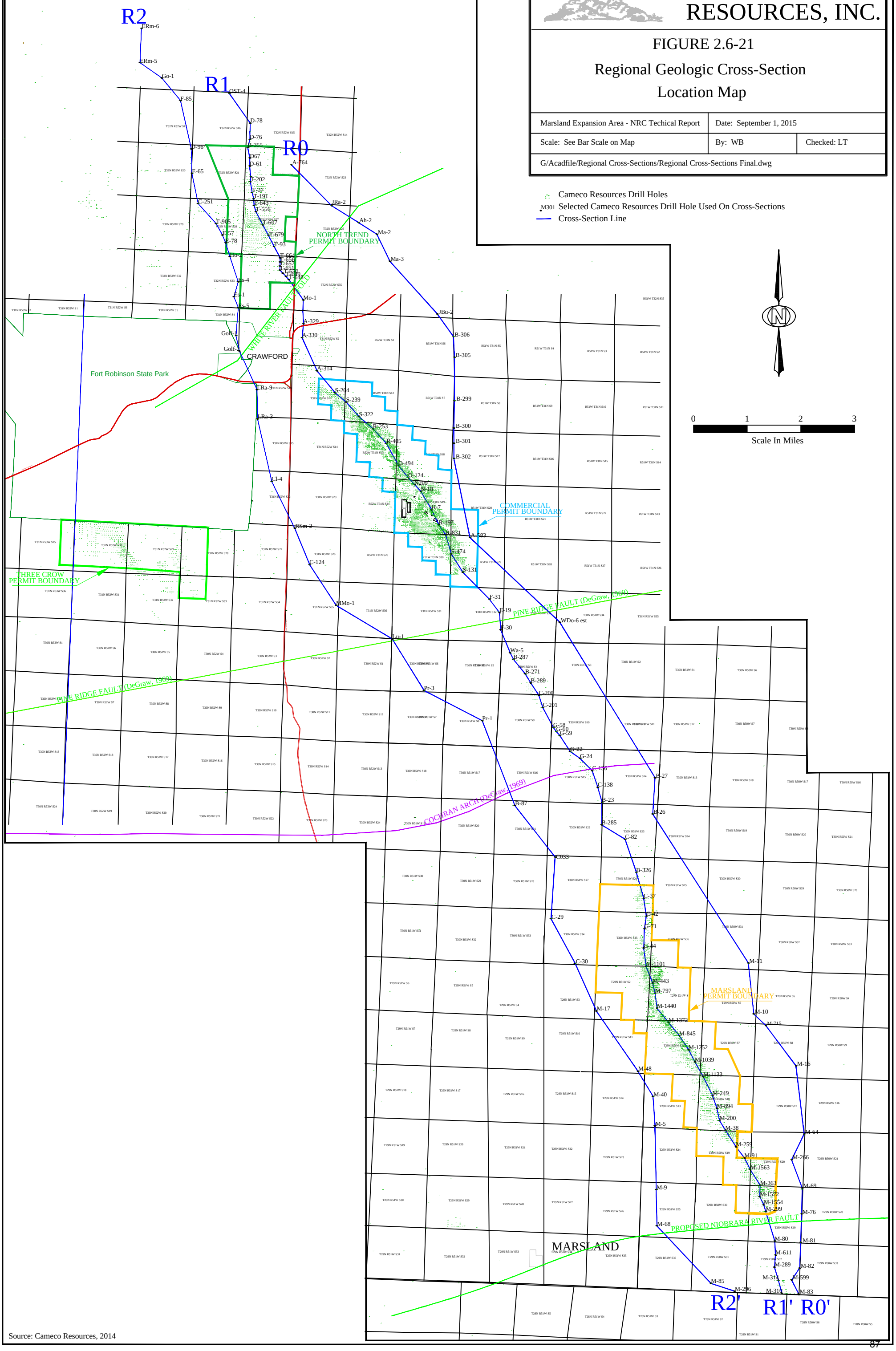
FIGURE 2.6-21

Regional Geologic Cross-Section Location Map

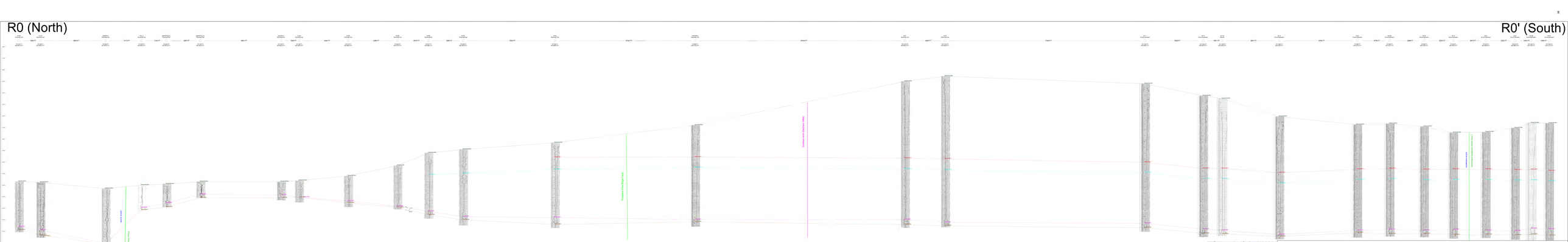
Marsland Expansion Area - NRC Techical Report	Date: September 1, 2015	
Scale: See Bar Scale on Map	By: WB	Checked: LT
G/Acadfile/Regional Cross-Sections/Regional Cross-Sections Final.dwg		



Source: Cameco Resources, 2014

R0 (North)

R0' (South)



Crawford Basin Geologic Structure

Cameco Resources

Crow Butte Operation

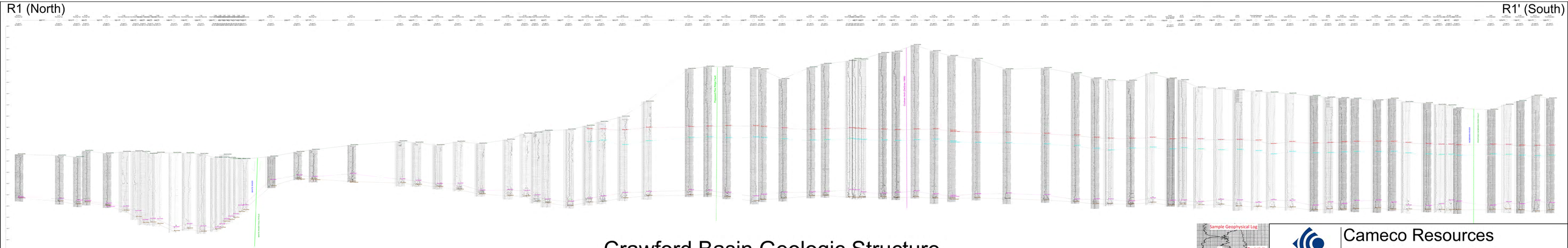
Cross Section R0 - R0'

Figure **2.6-22**

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

R1 (North)

R1' (South)



Crawford Basin Geologic Structure

Cameco Resources

Crow Butte Operation

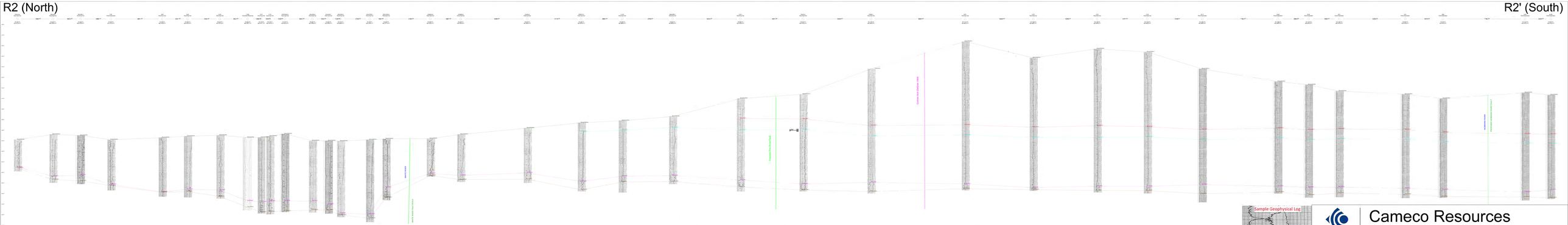
Cross Section R1 - R1'

Figure **2.6-23**

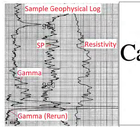
Date: SEPTEMBER 2015	Department: Land & Evaluation	Vertical Exaggeration = 10X

R2 (North)

R2' (South)



Crawford Basin Geologic Structure



Cameco

Cameco Resources

Crow Butte Operation

Cross Section R2 - R2'

Figure **2.6-24**

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

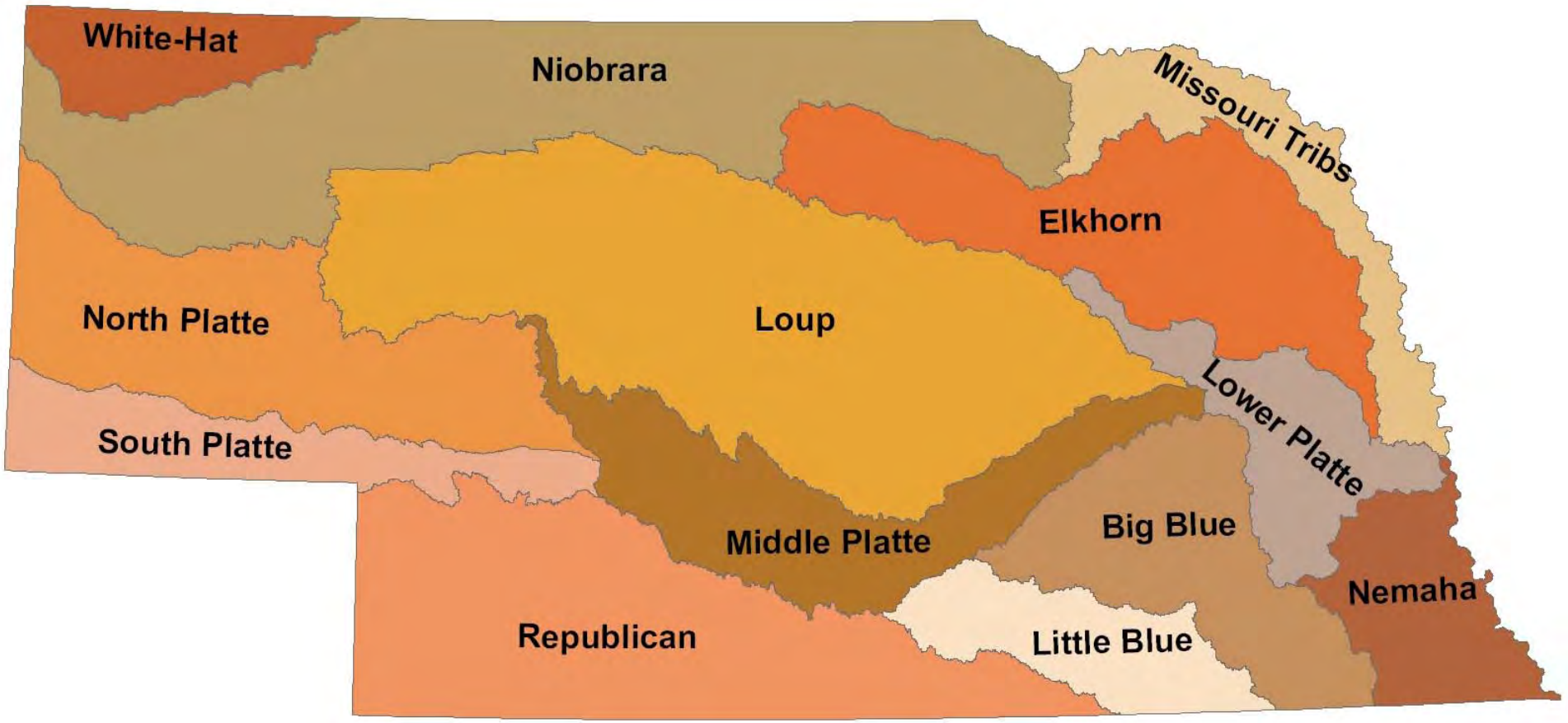


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FIGURE 2.7-1
NEBRASKA'S MAJOR RIVER BASINS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

Source: NDEQ, 2010

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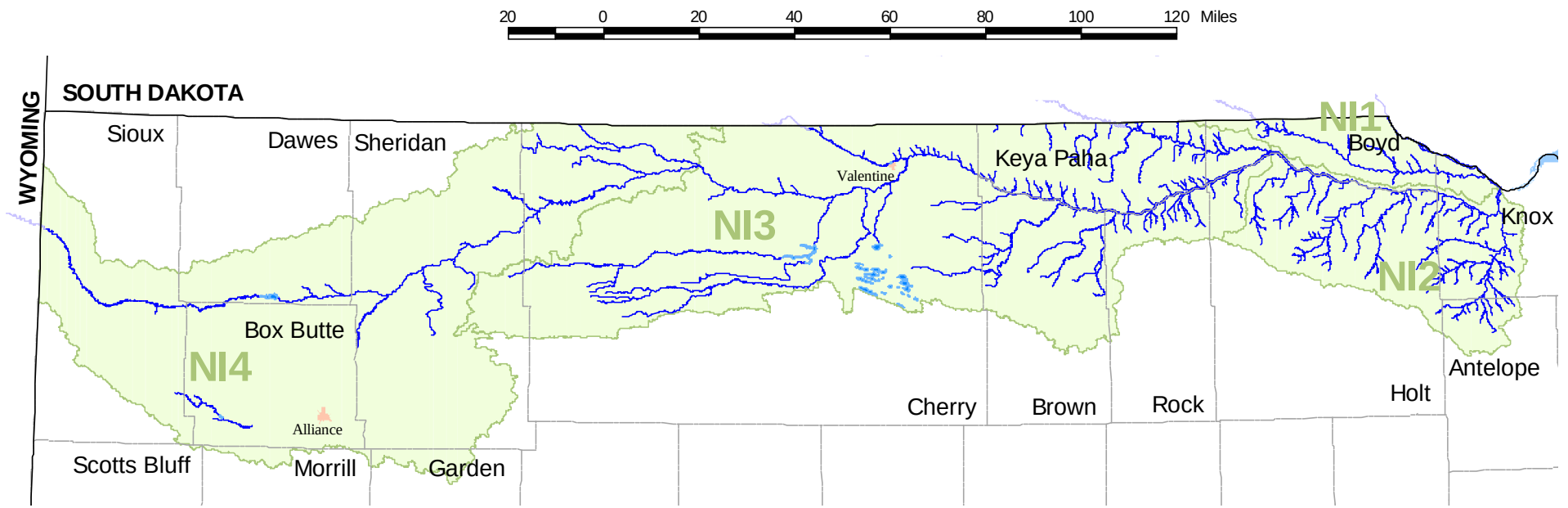

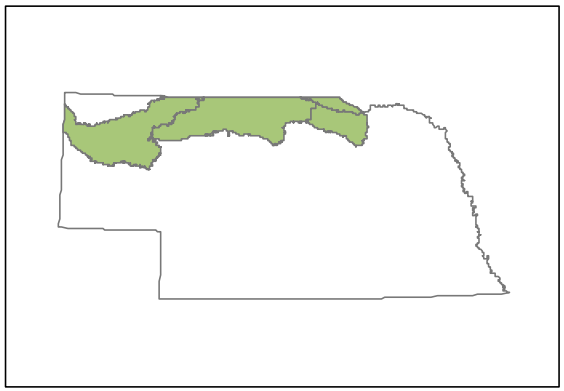

N

CROW BUTTE RESOURCES, INC.

FIGURE 2.7-2
NIOBRARA RIVER BASIN
(AND SUBBASINS)

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

Source: NDEQ, 2009

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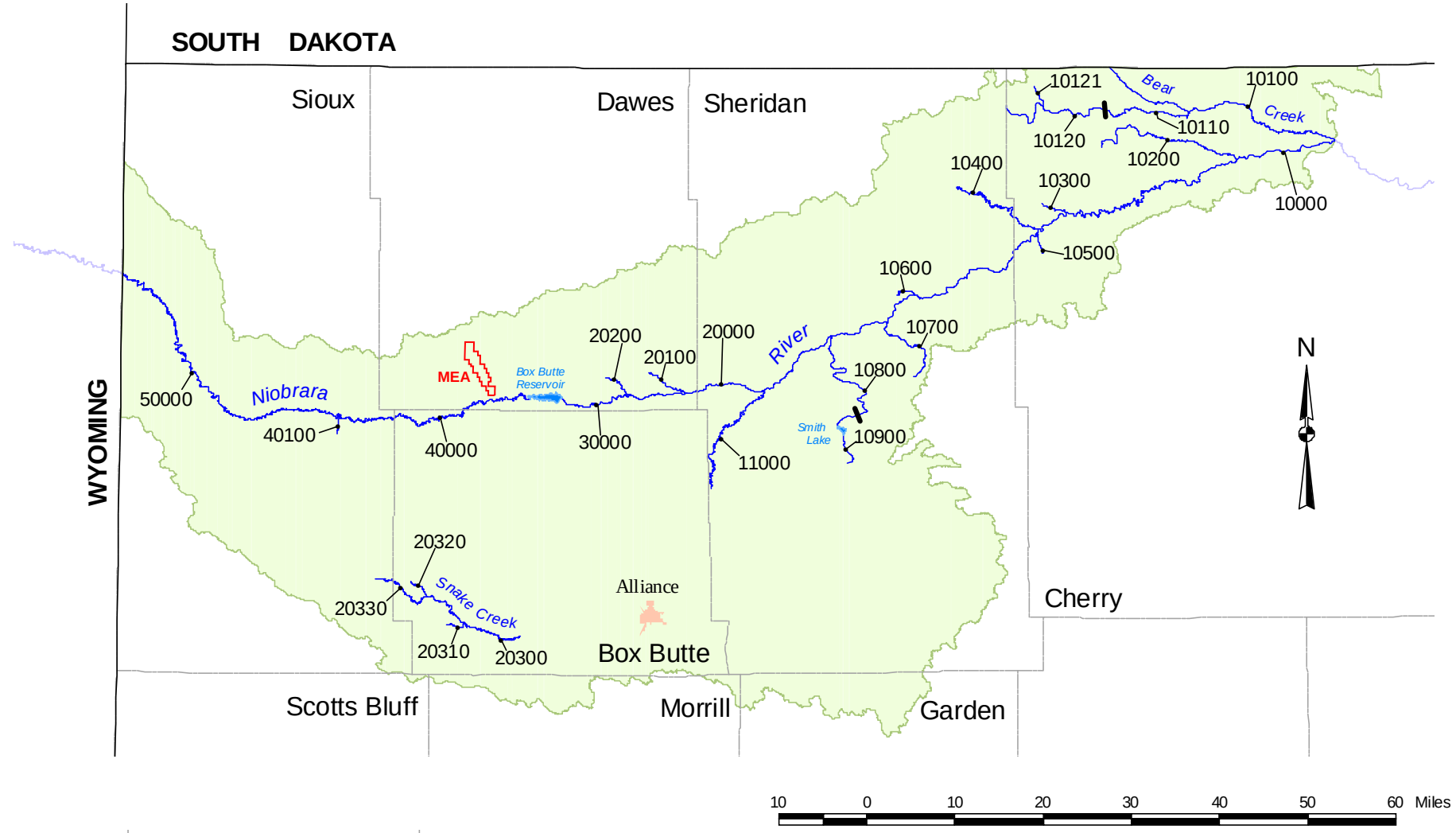
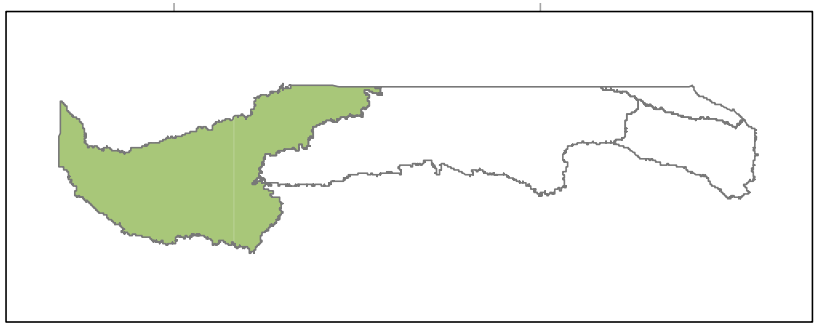
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2_7-2 Niobrara River Basin and Subbasins.ai @ 10/15/2011





Source: NDEQ, 2009

CROW BUTTE RESOURCES, INC.

FIGURE 2.7-3
NIOBRARA RIVER SUBBASIN N14

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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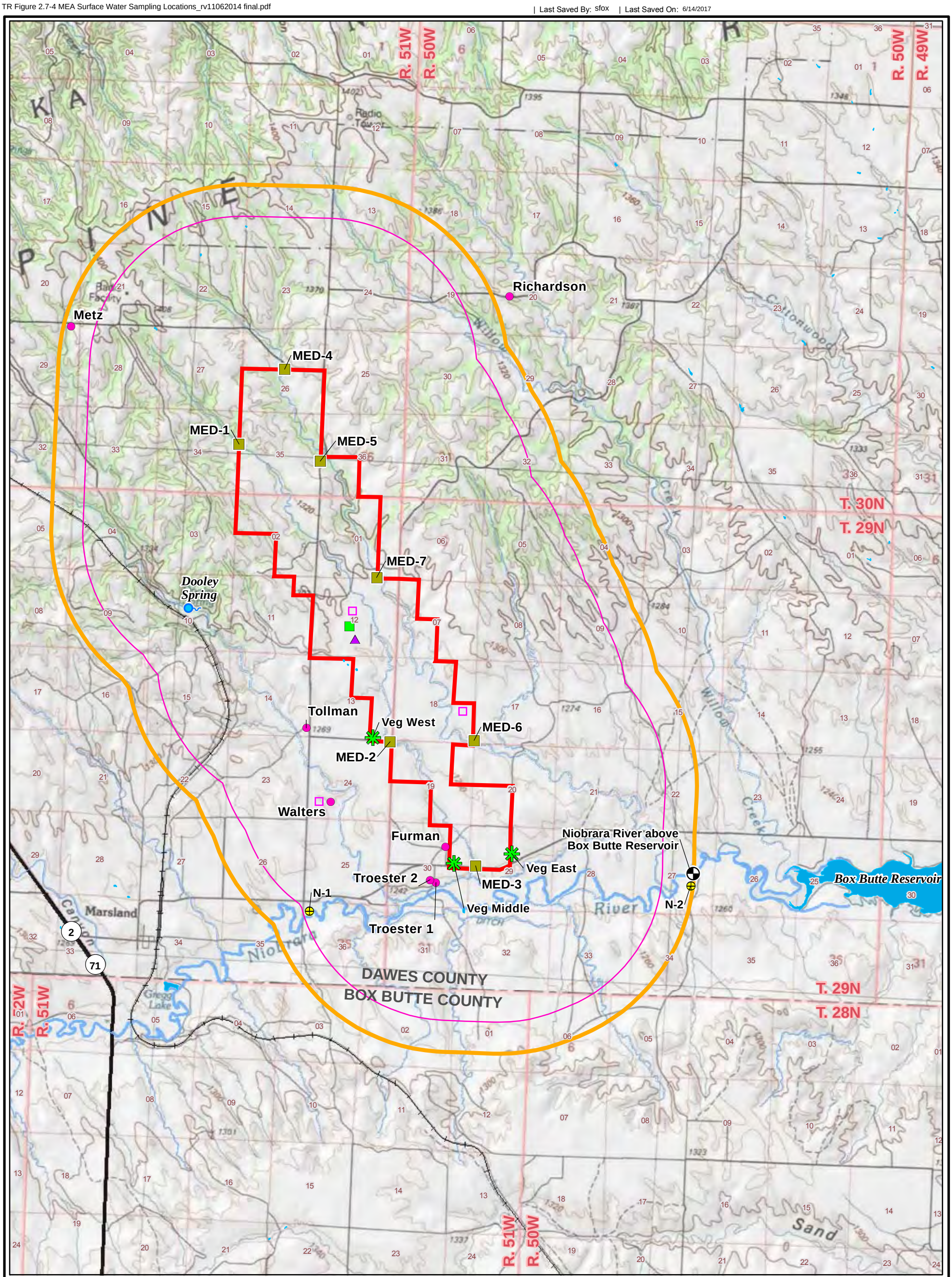
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\IllustratorNTR Figure 2_7-3 Niobrara River Subbasin N14.ai @ 04/06/2012

TR Figure 2.7-4 MEA Surface Water Sampling Locations_rv11062014 final.pdf | Last Saved By: sfox | Last Saved On: 6/14/2017



LEGEND

- Proposed Marsland Expansion Area
- 2.25-Mile Area of Review (AOR)
- 3 Kilometer AOR for Crops
- Livestock Sampling Location
- Garden Soil Sampling Location
- Vegetation Sampling Location
- Proposed Marsland Satellite Facility Site
- CBR Surface Water/ Sediment Sampling Location
- Marsland Ephemeral Drainage (MED) Sediment and Surface Runoff Sampling Point
- Crop Sampling Location
- USGS/NDNR 06454500 and NDEQ SNI4NIOBR402 Gaging Station
- Natural Spring
- Reservoir/Lake/Pond
- Perennial River
- Ephemeral Drainage
- Railroad
- StateHighway

Note: Fish sampling for radiological analysis occurs in headwaters of Box Butte Reservoir.

N

0 0.5 1

Miles

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

CROW BUTTE RESOURCES, INC.

FIGURE 2.7-4
SAMPLING LOCATIONS

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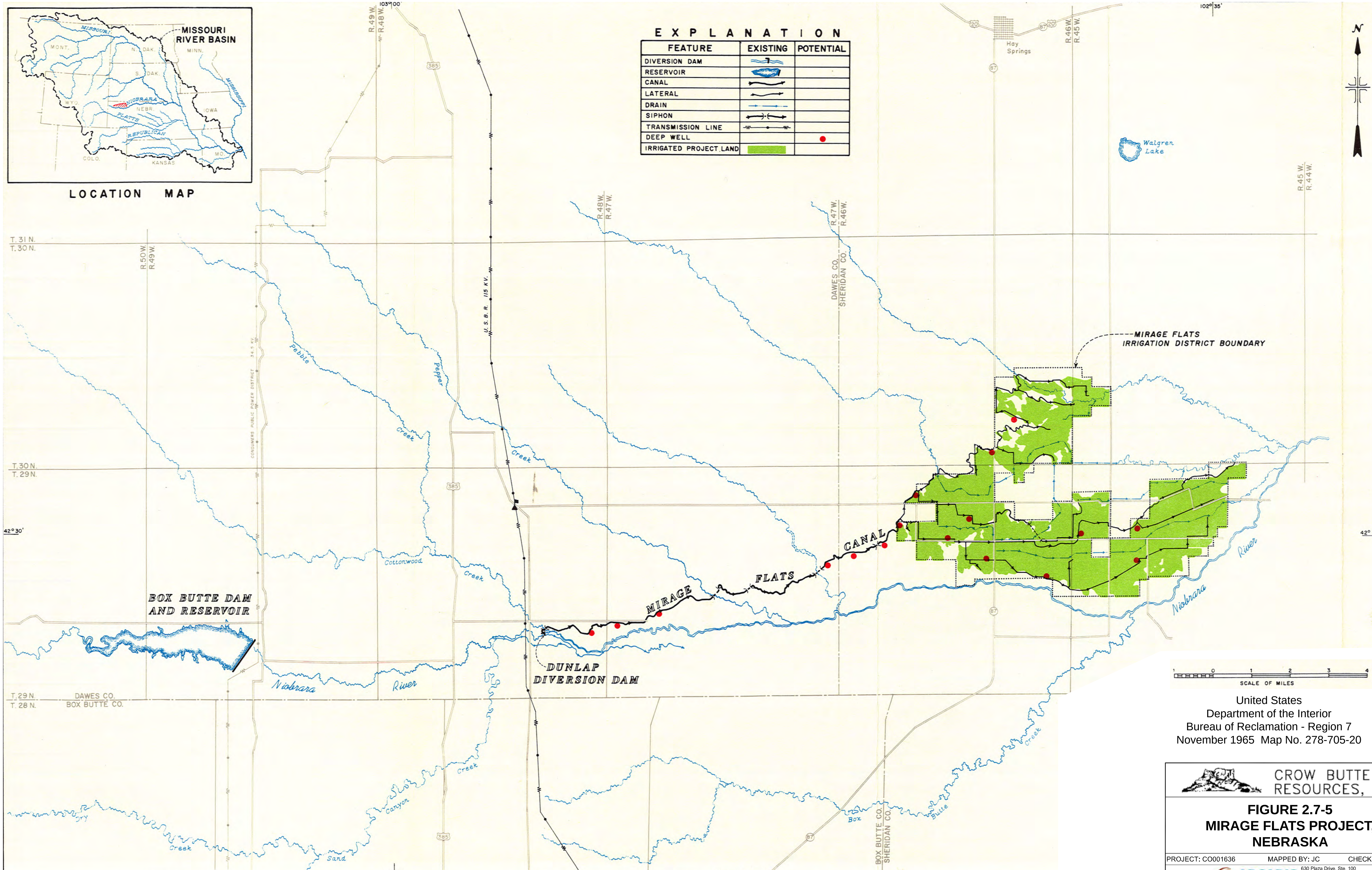
MISSOURI RIVER BASIN
LOCATION MAP
EXPLANATION
FEATURE
EXISTING
POTENTIAL
DIVERSION DAM
RESERVOIR
CANAL
LATERAL
DRAIN
SIPHON
TRANSMISSION LINE
DEEP WELL
IRRIGATED PROJECT LAND
MIRAGE FLATS IRRIGATION DISTRICT BOUNDARY
BOX BUTTE DAM AND RESERVOIR
DUNLAP DIVERSION DAM
MIRAGE FLATS CANAL
Niobrara River
Hay Springs
Walgren Lake
U.S.B.R. 115 KV.
DAWES CO.
SHERIDAN CO.
BOX BUTTE CO.
T. 31 N.
T. 30 N.
T. 29 N.
T. 28 N.
SCALE OF MILES

United States
Department of the Interior
Bureau of Reclamation - Region 7
November 1965 Map No. 278-705-20

CROW BUTTE RESOURCES, INC.

FIGURE 2.7-5
MIRAGE FLATS PROJECT, NEBRASKA

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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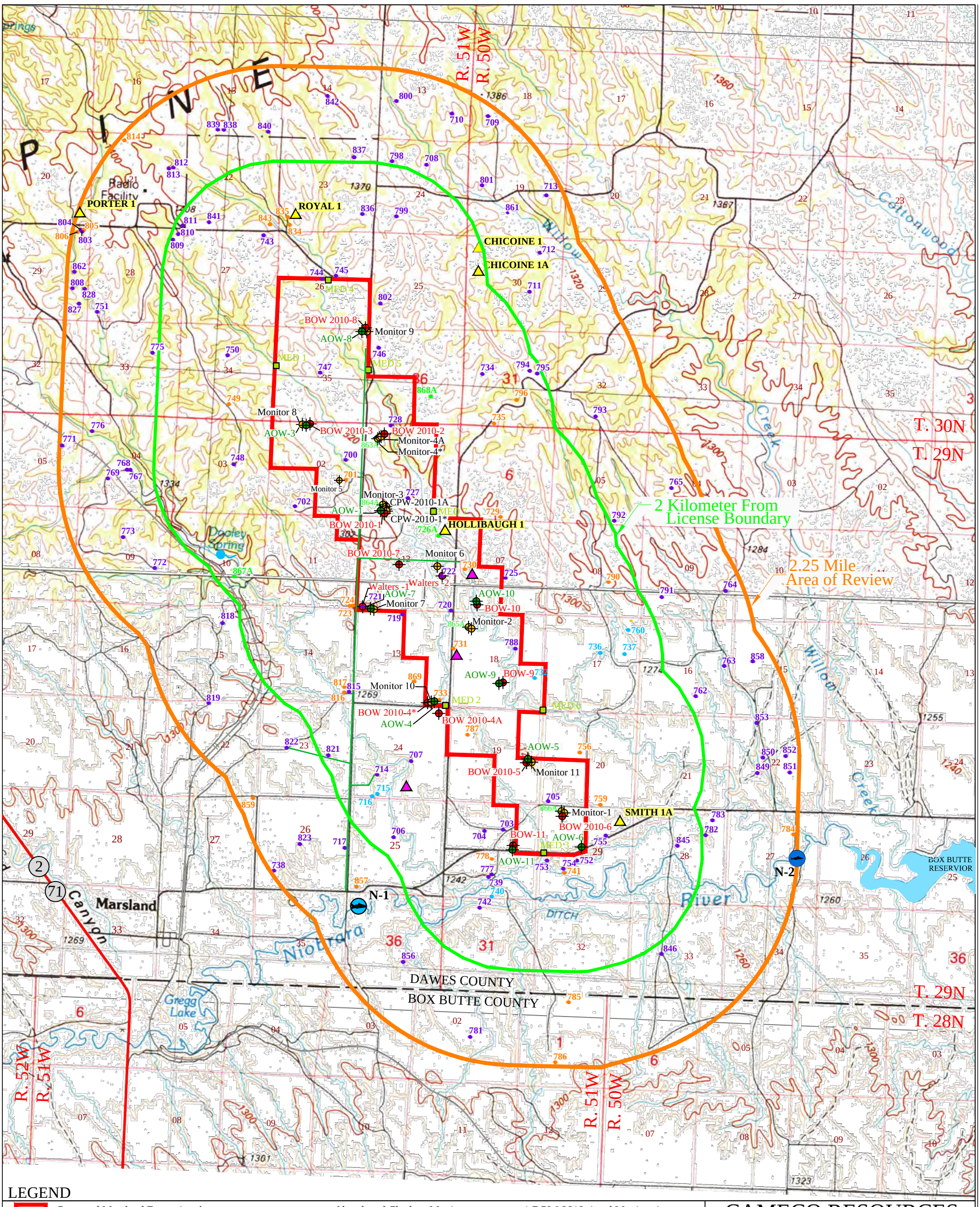
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 2.7-5 Mirage Flats Project_11x17Landscape.ai @ 10/15/2011



LEGEND

- Proposed Marsland Expansion Area
- Area of Review (AOR)
- 2 Kilometer Boundary From License Boundary
- Surface Water/Fish Sampling Location
- Ephemeral Drainage Sediment Sampling Point
- Natural Spring

Pumping Test Monitoring Wells

- Monitor-1 — Basal Sandstone of the Chadron Formation Well and Well ID
- BOW-2010-1 — Brule Formation Well and Well ID
- AOW-1 — Arikaree Group Well and Well ID
- 866A — Abandoned Chadron Monitor Well and Well ID
- Sand/Gravel pit, Inactive
- Oil/Gas Test holes

Private Water Supply Wells

- 781 — Active Well and Well ID
- 786 — Inactive Well and Well ID
- 732 — Seasonal Well and Well ID
- 726A — Abandoned Well and Well ID
- Powerline
- Railroad

* BOW-2010-4 and Monitor 4 are inactive and scheduled to be abandoned.

N

0 2000 4000 6000 FEET

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

CAMECO RESOURCES
CROW BUTTE OPERATIONS

Figure 2.7-6

MAJOR SURFACE FEATURES/STRUCTURES WITHIN AOR AS PER TITLE 122, CHAPTER 11, SECTION 006.09

File C:\Users\ca200049\Desktop\Marsland Permitting\NRC TR Figure 2.7-6.dwg

K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_7-7 Pumping Test Well Locations.mxd - 5/13/2012 @ 2:41:05 AM

R. 51W
R. 50W
T. 30N
T. 29N
Monitor-8
BOW-2010-3
BOW-2010-2
Monitor-4A
Monitor-5
Monitor-3
CPW-2010-1
CPW-2010-1A
BOW-2010-1
Monitor-6
Walters-1
Driller Pond
Monitor-7
Walters-2
Driller Pond
Monitor-2
Pumping Test Area
Proposed
Marsland
Expansion
Area

LEGEND

Pumping Test Monitoring Wells

- Basal Chadron Sandstone Well
- Basal Chadron Sandstone Well (Pumping Well)
- Brule Formation Well
- Proposed Marsland Expansion Area
- Pumping Test Area
- Intermittent Stream/River

N

0 1,250 2,500

Feet

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

CROW BUTTE RESOURCES, INC.

FIGURE 2.7-7
MARSLAND EXPANSION AREA
PUMPING TEST WELL LOCATIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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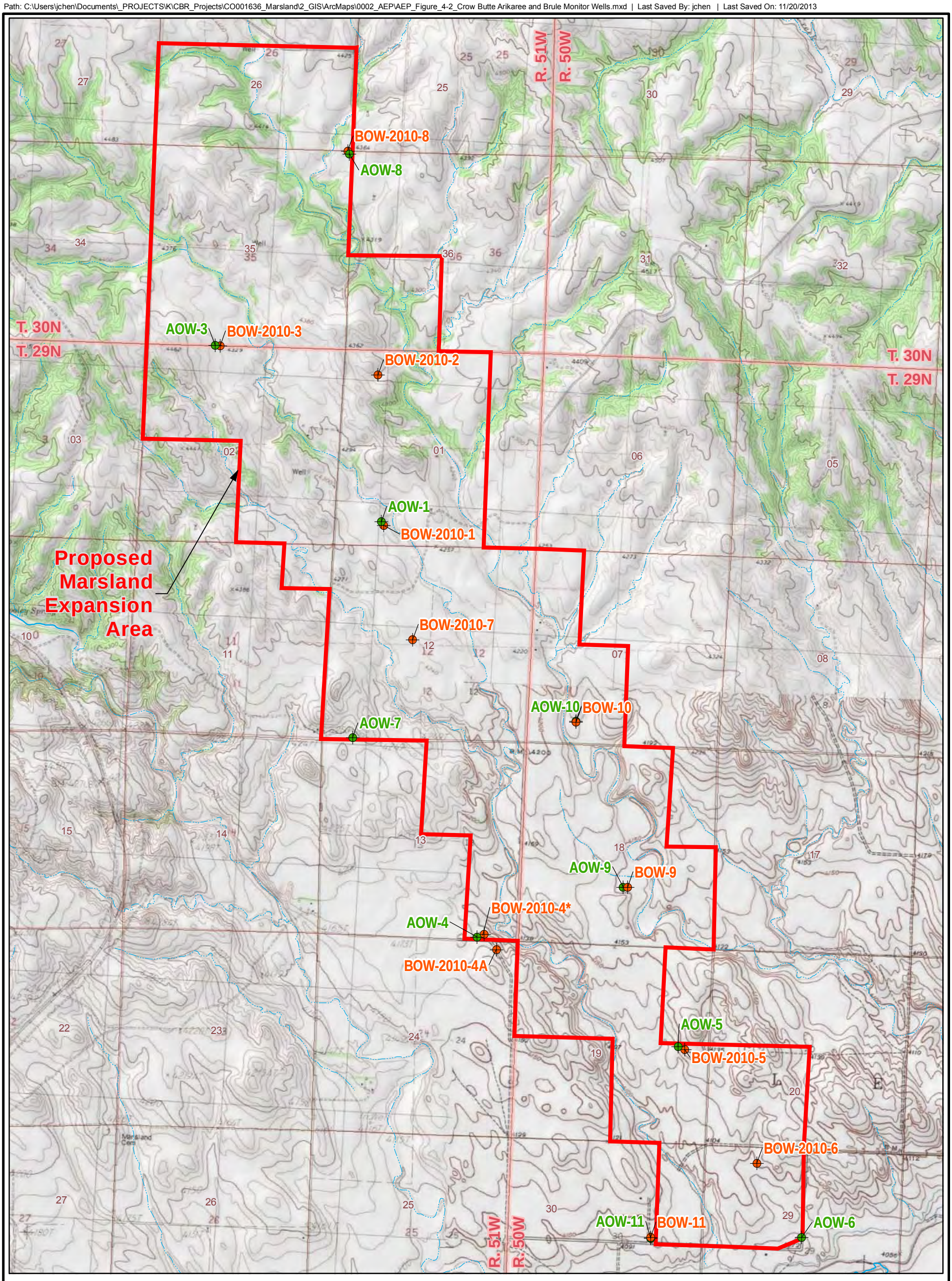
Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0002_AEP\AEP_Figure_4-2_Crow Butte Arikaree and Brule Monitor Wells.mxd | Last Saved By: jchen | Last Saved On: 11/20/2013



LEGEND

- Arikaree Group Well
- Brule Formation Well
- Proposed Marsland Expansion Area
- Intermittent Stream/River

* BOW-2010-4 is inactive and scheduled to be abandoned.

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

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Figure 2.7-8
MARSLAND
ARIKAREE AND BRULE MONITOR WELLS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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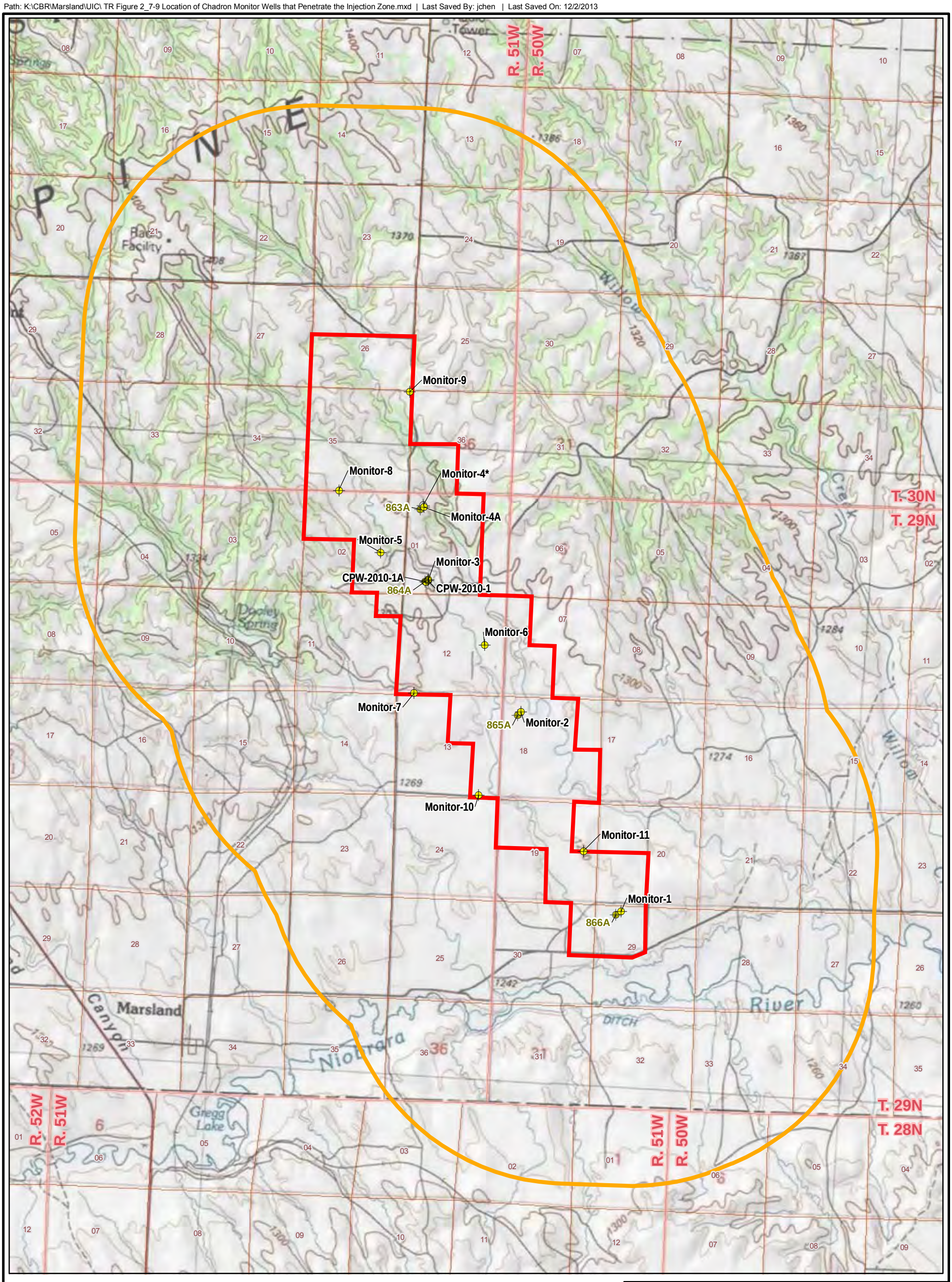
Path: K:\CBR\Marsland\UIC\ TR Figure 2_7-9 Location of Chadron Monitor Wells that Penetrate the Injection Zone.mxd | Last Saved By: jchen | Last Saved On: 12/2/2013



LEGEND

- Proposed Marsland Expansion Area
- Area of Review (AOR)

Pumping Test Monitoring Wells

- Monitor-5 — Active Basal Sandstone of the Chadron Formation Well and Well ID
- Monitor-4* — Inactive Basal Sandstone of the Chadron Formation Well and Well ID
- 865A — Abandoned Chadron Monitor Well and Well ID

N

0 0.5 1

Miles

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

CROW BUTTE RESOURCES, INC.

FIGURE 2.7-9
LOCATION OF MEA ACTIVE, INACTIVE AND ABANDONED CHADRON MONITOR WELLS THAT PENETRATE THE INJECTION ZONE

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: AH

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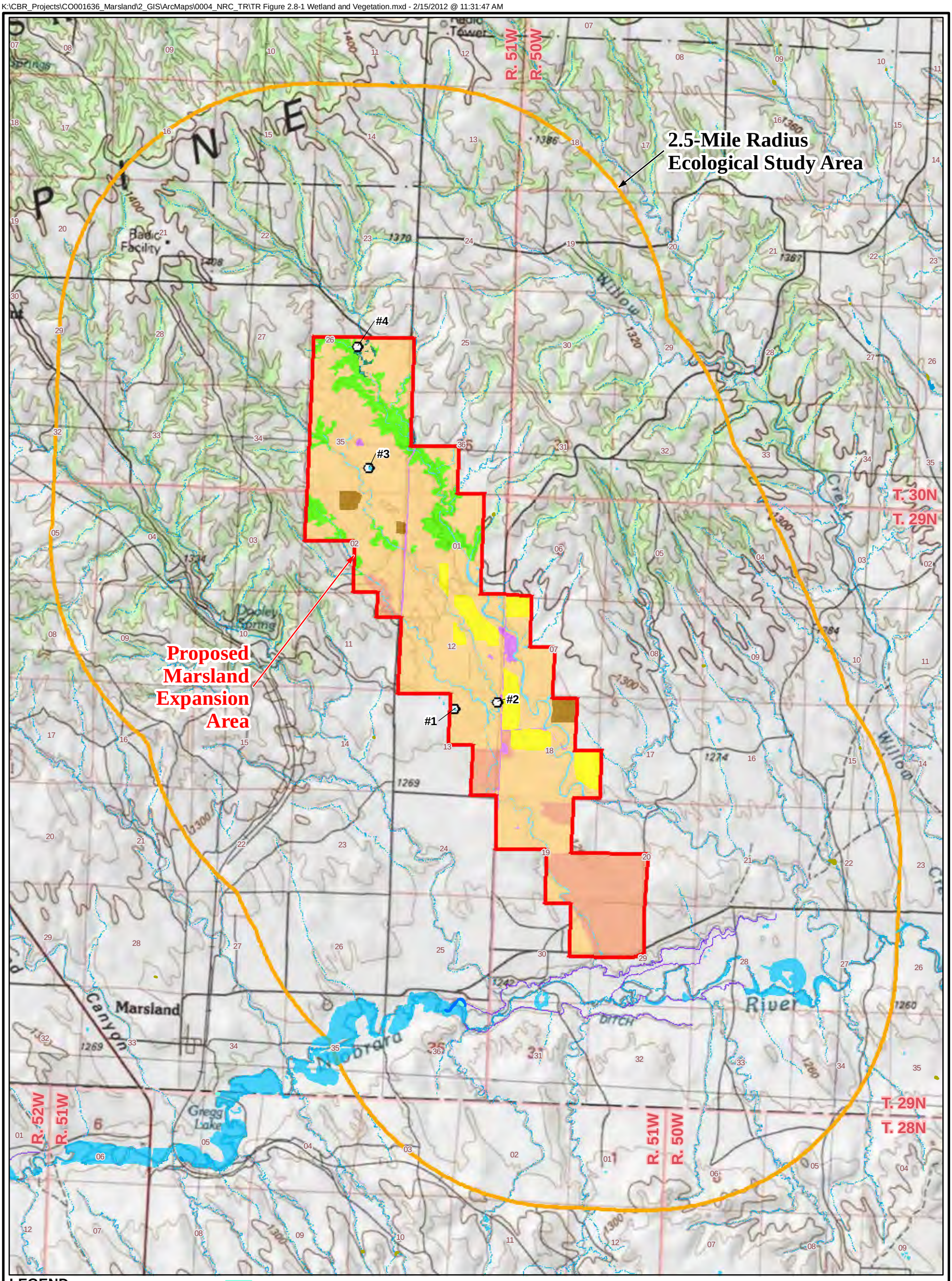
K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2.8-1 Wetland and Vegetation.mxd - 2/15/2012 @ 11:31:47 AM



LEGEND

- Proposed Marsland Expansion Area
- Ecological Study Area (ESA)
- Wetland Assessment Site

NHD Flowline

- Canal Ditch
- Intermittent Stream/River
- Perennial Stream/River

NWI Wetland Type

- Freshwater Emergent Wetland
- Riverine
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Other

Vegetation Type

- Mixed-Grass Prairie
- Range Rehabilitation
- Degraded Rangeland
- Cultivated
- Structure Biotope
- Mixed Conifer
- Deciduous Streambank Forest
- Drainage

N

0 3,000 6,000

Feet

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

CROW BUTTE RESOURCES, INC.

FIGURE 2.8-1
WETLAND AND VEGETATION

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: AH

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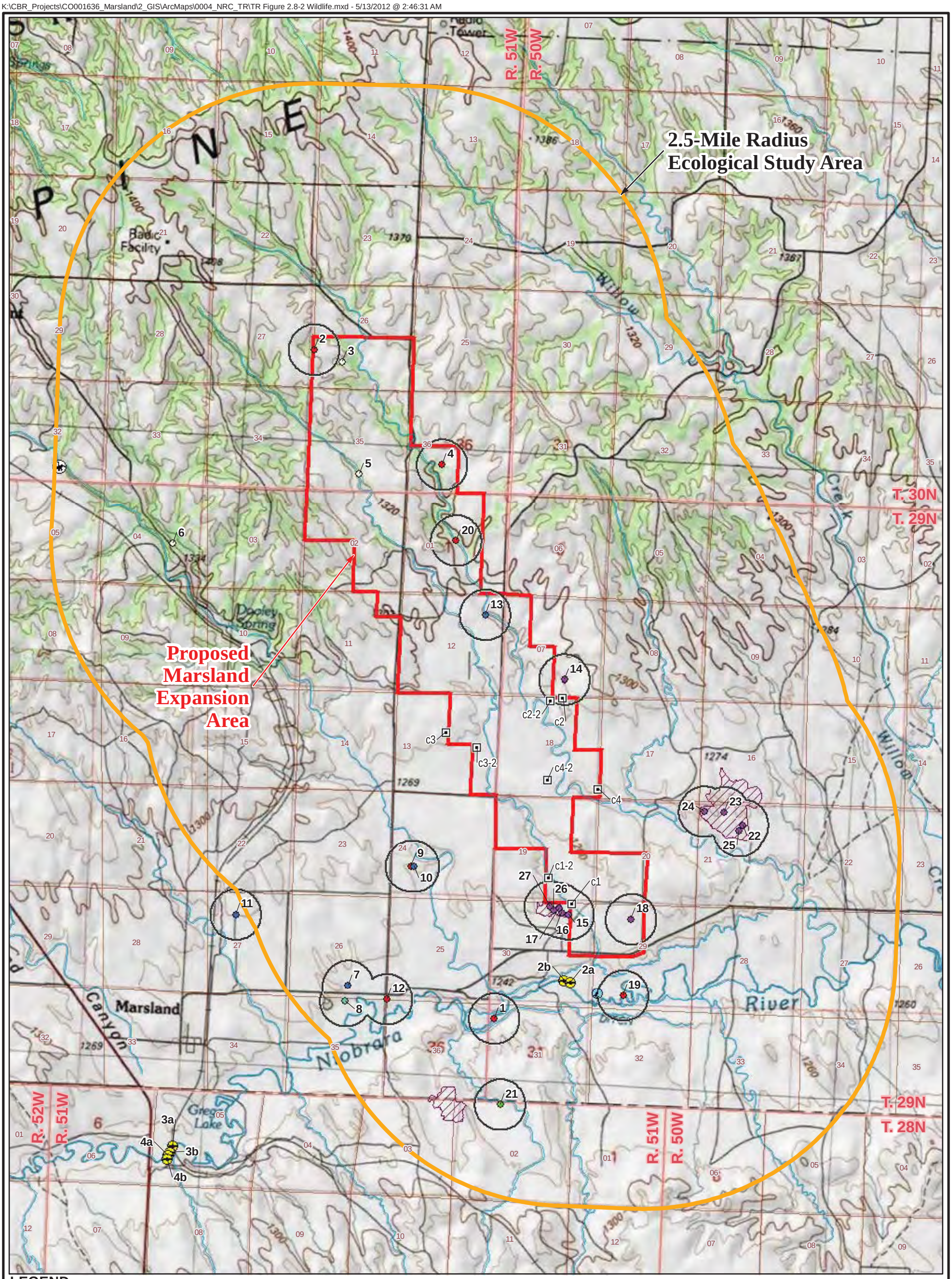
K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2.8-2 Wildlife.mxd - 5/13/2012 @ 2:46:31 AM



LEGEND

- Ecological Study Area (ESA)
- Fish Sampling Location
- Great Blue Heron Rookery
- Remote Camera Location
- Winter Bald Eagle Sighting
- Prairie Dog Colony
- Proposed Marsland Expansion Area

Raptor Nests

- Burrowing Owl
- Ferruginous Hawk
- Great Horned Owl
- Red-Tailed Hawk
- Swainson's Hawk
- Unknown Raptor
- 0.25-Mile Buffer of Active Raptor Nest
- River/Stream

N

0 3,000 6,000

Feet

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

CROW BUTTE RESOURCES, INC.

FIGURE 2.8-2
WILDLIFE MAP

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: AH

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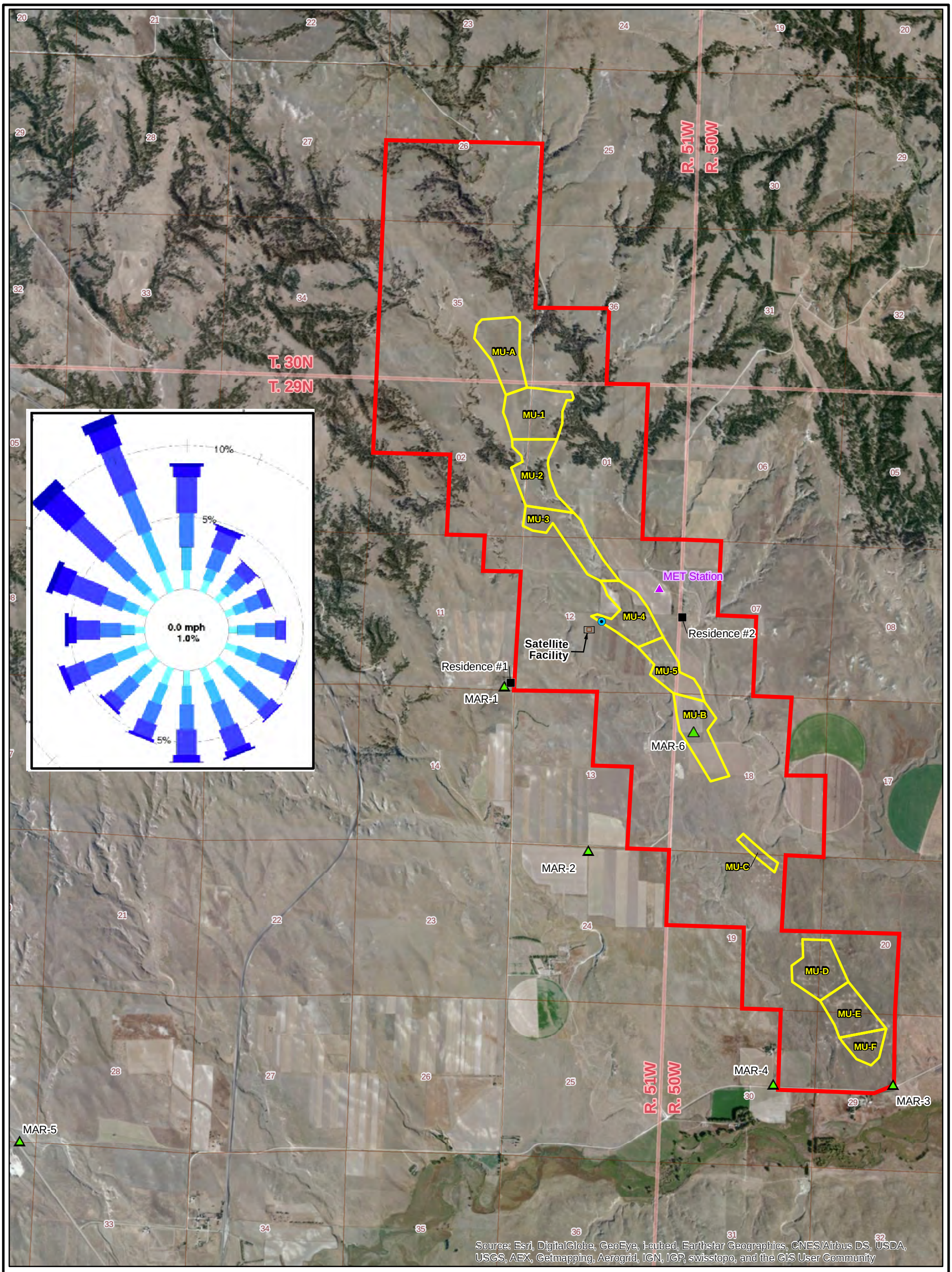
Figure 2.9-1 Marsland Expansion Area Preoperational/Preconstruction Monitoring Program Timeline

Task	Start	Finish	2013												2014												2015					
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Surface Water (Niobrara River N-1 & N-2)	Sep-13	Sep-14																														
Surface Water (Ephemeral Drainages)	Apr-13	Continuing																														
Vegetation (Forage)	Jun-13	Sep-13																														
Food (Fish)	May-14	Sep-14																														
Food (Livestock)	Mar-14	Mar-14																														
Food (Crops/Alternate Soil Sampling)	Aug-13	Aug-13																														
Soil	Jun-14	Nov-14																														
Sediment (MED-1 through MED-6)	Oct-13	May-14																														
Sediment (MED-7)	Oct-14	Apr-15																														
Direct Radiation	May-14	Nov-14																														

Samples will be collected when water flow becomes available

Sampling completed



LEGEND

- Proposed Deep Disposal Well
- Pre-operational Baseline/ Operational Air Sampling Station
- Residence
- Mine Unit
- Proposed Marsland Expansion Area

Map Updated on: 10/9/2014

N

0 3,000 6,000

Feet

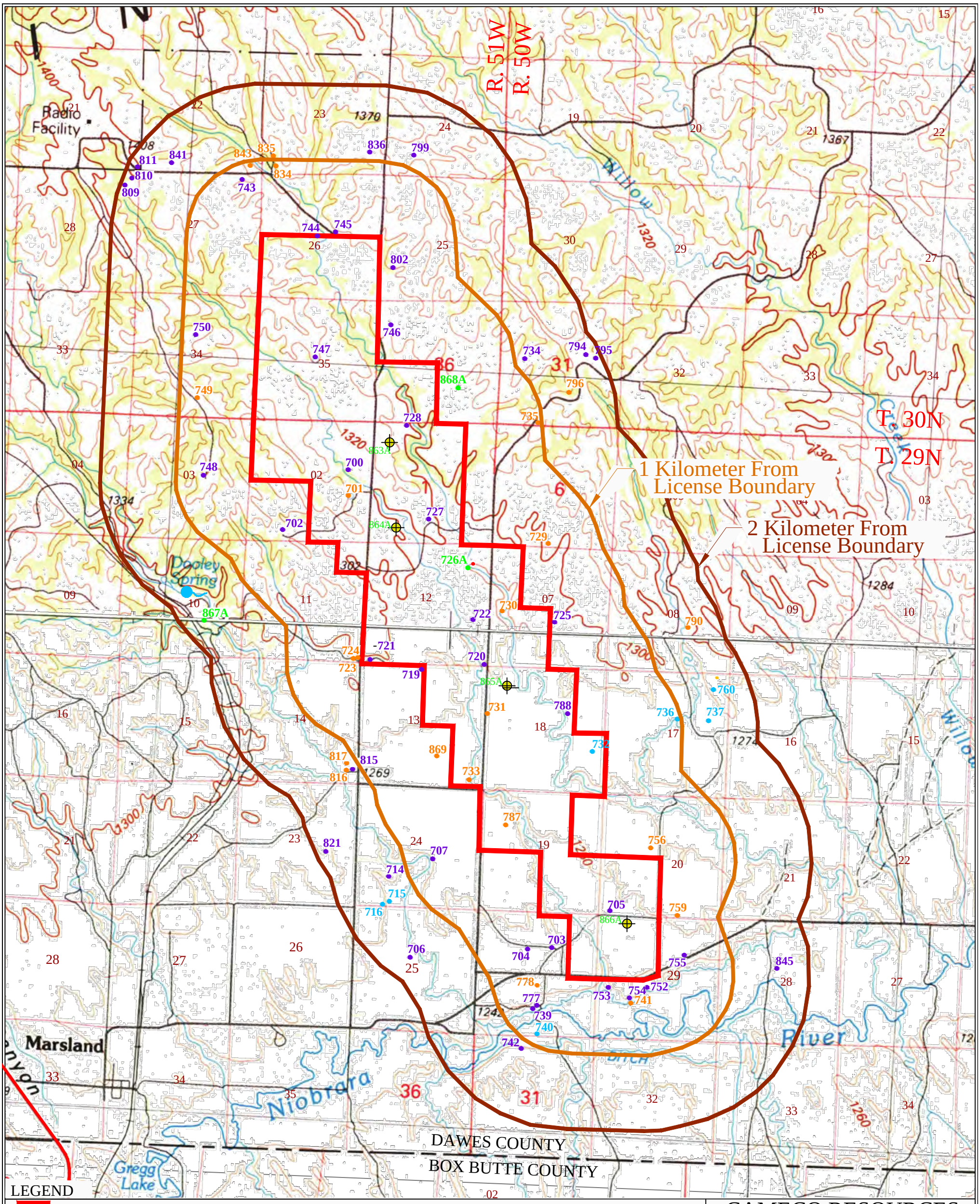
PROJECTION: NAD1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: USDA NAIP IMAGERY 2010

CROW BUTTE RESOURCES, INC.

FIGURE 2.9-2
LOCATION OF ENVIRONMENTAL AIR SAMPLING STATIONS AT MARSLAND EXPANSION AREA

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 (MEA)
- 1 Kilometer Radius of MEA
- 2 Kilometer Radius of MEA
- Natural Spring

Private Water Supply Wells

- 781 Active Well and Well ID
- 786 Inactive Well and Well ID
- 732 Seasonal Well and Well ID
- 726A Abandoned Well and Well ID

N

0 2000 4000 6000 FEET

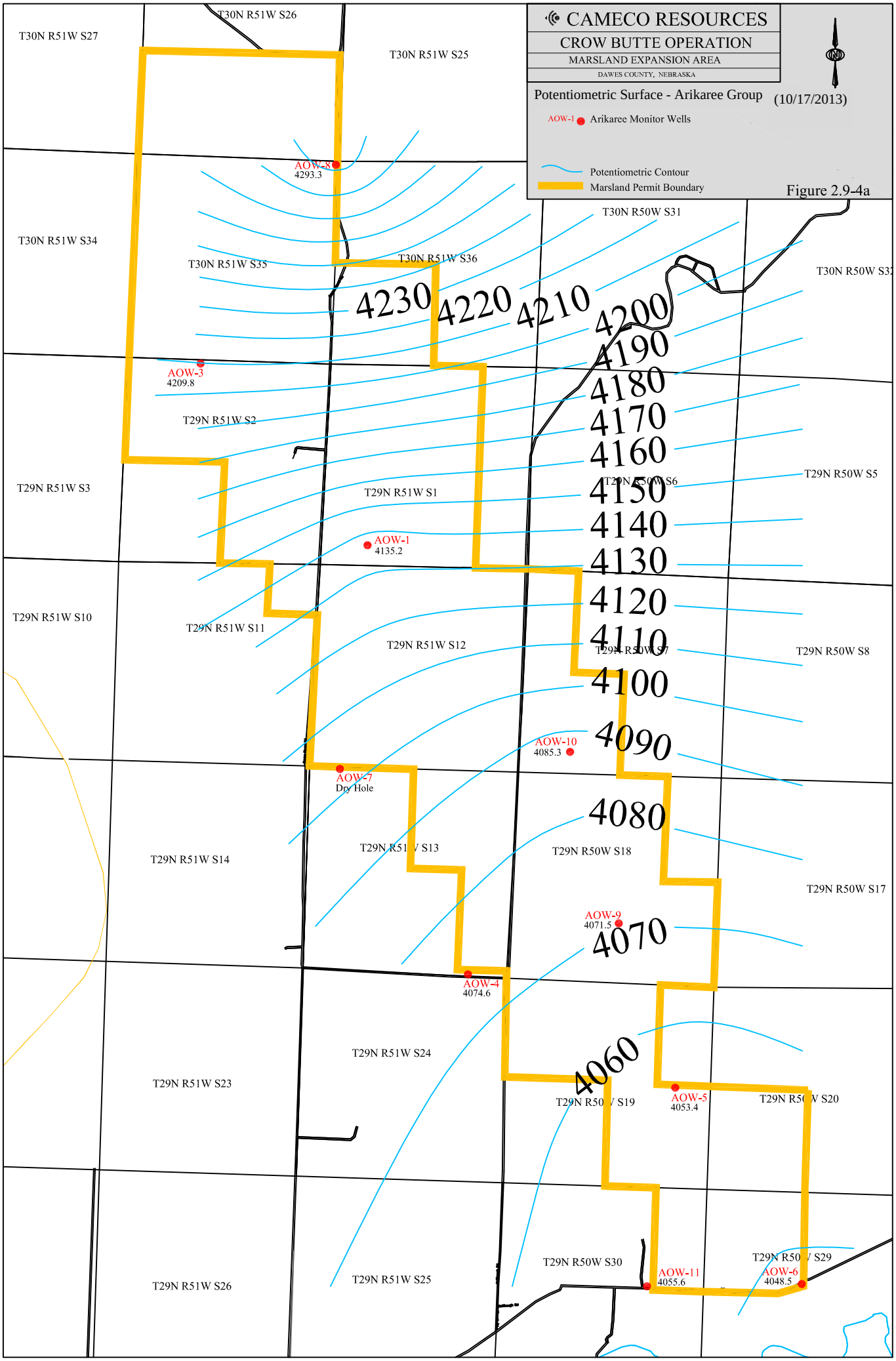
PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: US TOPO MAPS – USGS

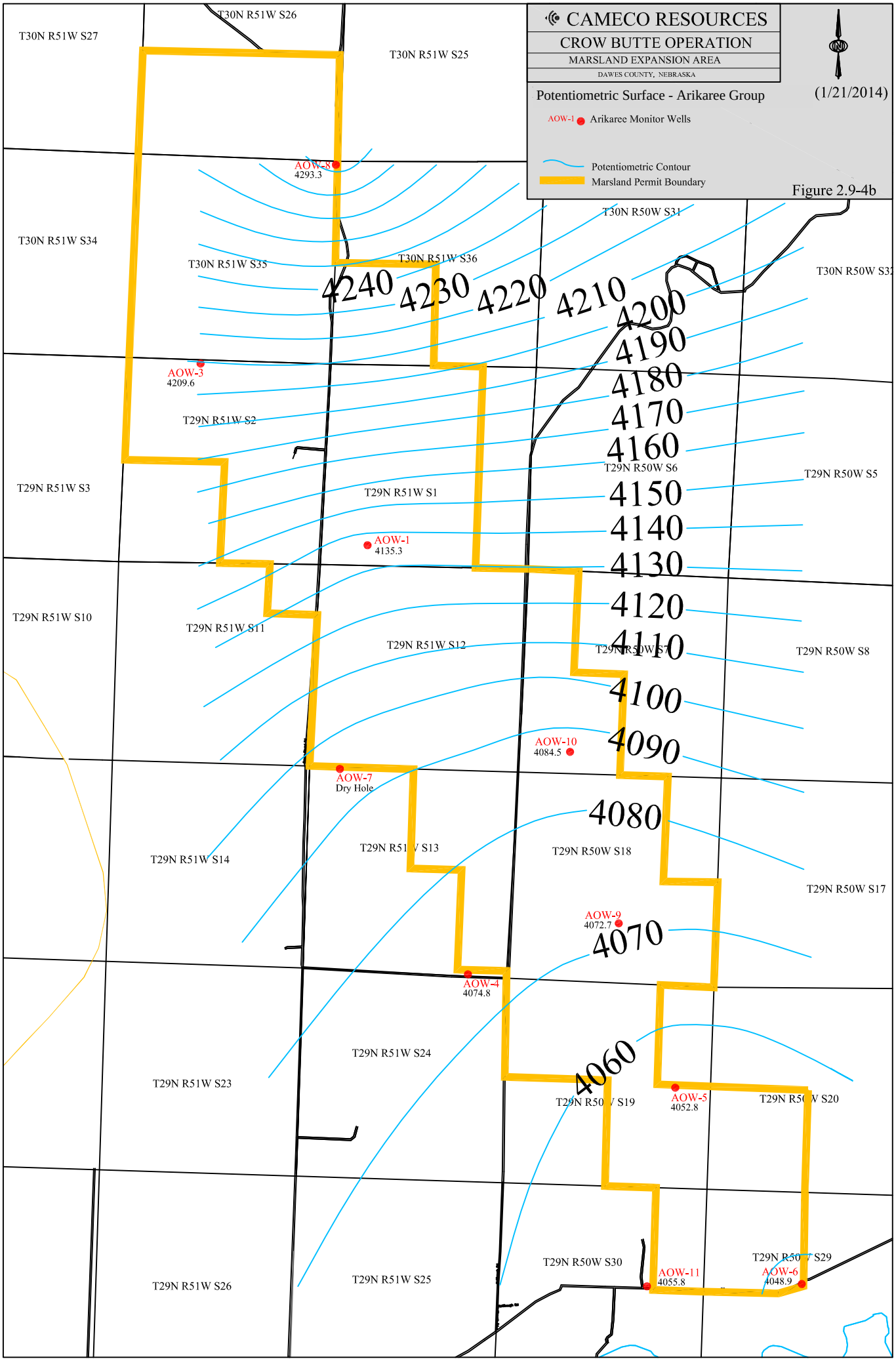
CAMECO RESOURCES
CROW BUTTE OPERATIONS

Figure 2.9-3

PRIVATE WELLS LOCATED WITHIN ONE AND TWO KILOMETERS OF THE MEA LICENSE BOUNDARY

File C:\Users\ca200049\Desktop\Marsland Permitting\NRC TR Figure 2.9-3.dwg


CAMECO RESOURCES
CROW BUTTE OPERATION
MARSLAND EXPANSION AREA
DAWES COUNTY, NEBRASKA
Potentiometric Surface - Arikaree Group
(10/17/2013)
AOW-1 Arikaree Monitor Wells
Potentiometric Contour
Marsland Permit Boundary
Figure 2.9-4a
T30N R51W S26
T30N R51W S27
T30N R51W S25
T30N R51W S34
T30N R51W S35
T30N R51W S36
T30N R50W S31
T30N R50W S32
AOW-8
4293.3
4230
4220
4210
4200
4190
4180
4170
4160
4150
4140
4130
4120
4110
4100
4090
4080
4070
4060
AOW-3
4209.8
T29N R51W S2
T29N R51W S3
T29N R51W S1
T29N R50W S6
T29N R50W S5
AOW-1
4135.2
T29N R51W S10
T29N R51W S11
T29N R51W S12
T29N R50W S7
T29N R50W S8
AOW-10
4085.3
AOW-7
Dry Hole
T29N R51W S14
T29N R51W S13
T29N R50W S18
T29N R50W S17
AOW-9
4071.5
AOW-4
4074.6
T29N R51W S24
T29N R51W S23
T29N R50W S19
AOW-5
4053.4
T29N R50W S20
T29N R50W S30
AOW-11
4055.6
T29N R50W S29
AOW-6
4048.5
T29N R51W S26
T29N R51W S25


CAMECO RESOURCES
CROW BUTTE OPERATION
MARSLAND EXPANSION AREA
DAWES COUNTY, NEBRASKA
Potentiometric Surface - Arikaree Group
(1/21/2014)
AOW-1 Arikaree Monitor Wells
Potentiometric Contour
Marsland Permit Boundary
Figure 2.9-4b
T30N R51W S27
T30N R51W S26
T30N R51W S25
T30N R51W S34
T30N R51W S35
T30N R51W S36
T30N R50W S31
T30N R50W S32
T29N R51W S3
T29N R51W S2
T29N R51W S1
T29N R50W S6
T29N R50W S5
T29N R51W S10
T29N R51W S11
T29N R51W S12
T29N R50W S7
T29N R50W S8
T29N R51W S14
T29N R51W S13
T29N R50W S18
T29N R50W S17
T29N R51W S24
T29N R51W S23
T29N R50W S19
T29N R50W S20
T29N R51W S26
T29N R51W S25
T29N R50W S30
T29N R50W S29
AOW-8
4293.3
AOW-3
4209.6
AOW-1
4135.3
AOW-10
4084.5
AOW-7
Dry Hole
AOW-9
4072.7
AOW-4
4074.8
AOW-5
4052.8
AOW-11
4055.8
AOW-6
4048.9
4240
4230
4220
4210
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4150
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4130
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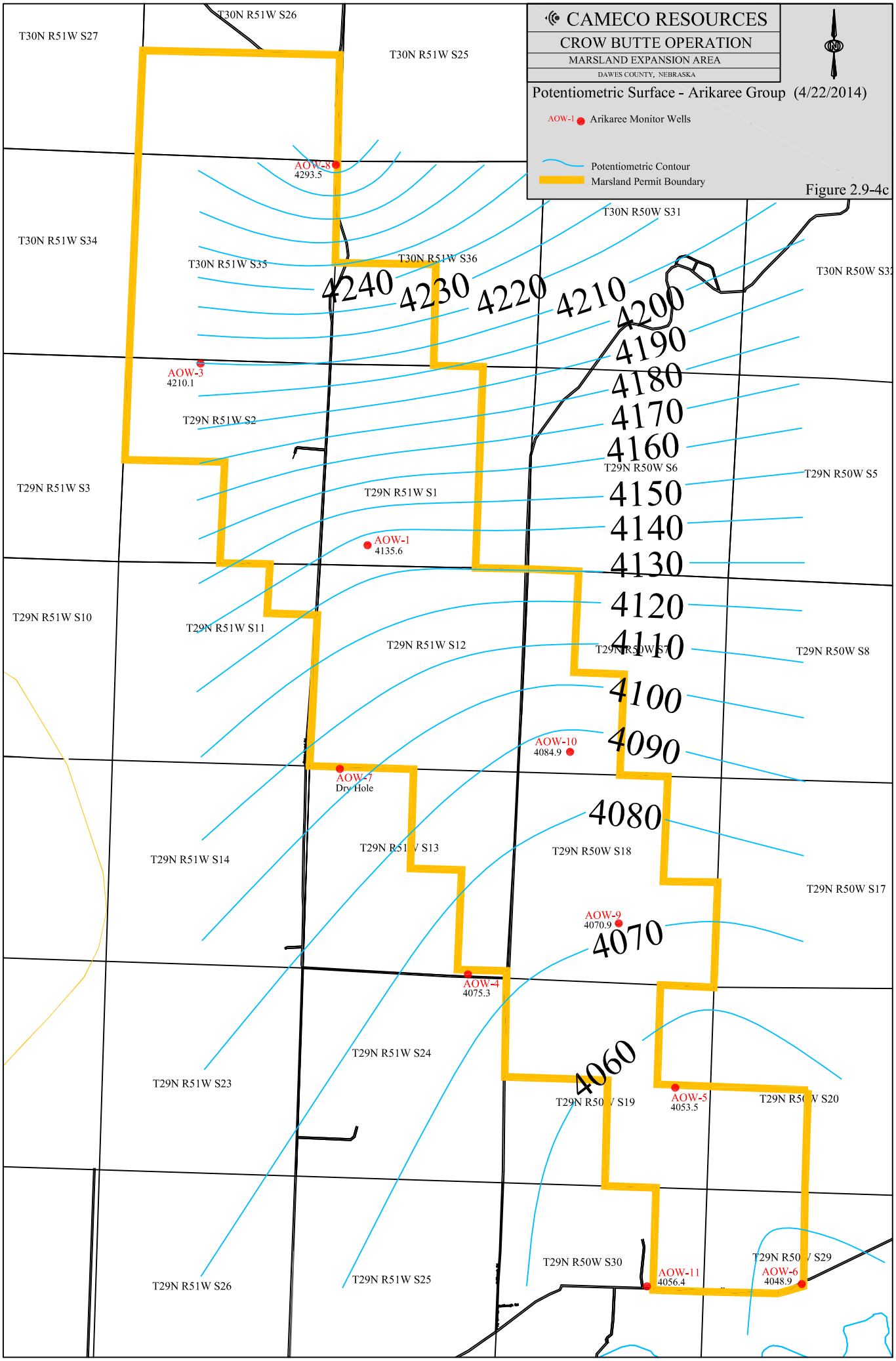
CAMECO RESOURCES
CROW BUTTE OPERATION
MARSLAND EXPANSION AREA
DAWES COUNTY, NEBRASKA
Potentiometric Surface - Arikaree Group (4/22/2014)
AOW-1 Arikaree Monitor Wells
Potentiometric Contour
Marsland Permit Boundary
Figure 2.9-4c
T30N R51W S26
T30N R51W S27
T30N R51W S25
T30N R51W S34
T30N R51W S35
T30N R51W S36
T30N R50W S31
T30N R50W S32
AOW-8
4293.5
AOW-3
4210.1
T29N R51W S2
T29N R51W S3
T29N R51W S1
T29N R50W S6
T29N R50W S5
AOW-1
4135.6
T29N R51W S10
T29N R51W S11
T29N R51W S12
T29N R50W S7
T29N R50W S8
AOW-10
4084.9
AOW-7
Dry Hole
T29N R51W S14
T29N R51W S13
T29N R50W S18
T29N R50W S17
AOW-9
4070.9
AOW-4
4075.3
T29N R51W S24
T29N R51W S23
T29N R50W S19
AOW-5
4053.5
T29N R50W S20
T29N R51W S26
T29N R51W S25
T29N R50W S30
AOW-11
4056.4
T29N R50W S29
AOW-6
4048.9
4240
4230
4220
4210
4200
4190
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4170
4160
4150
4140
4130
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4110
4100
4090
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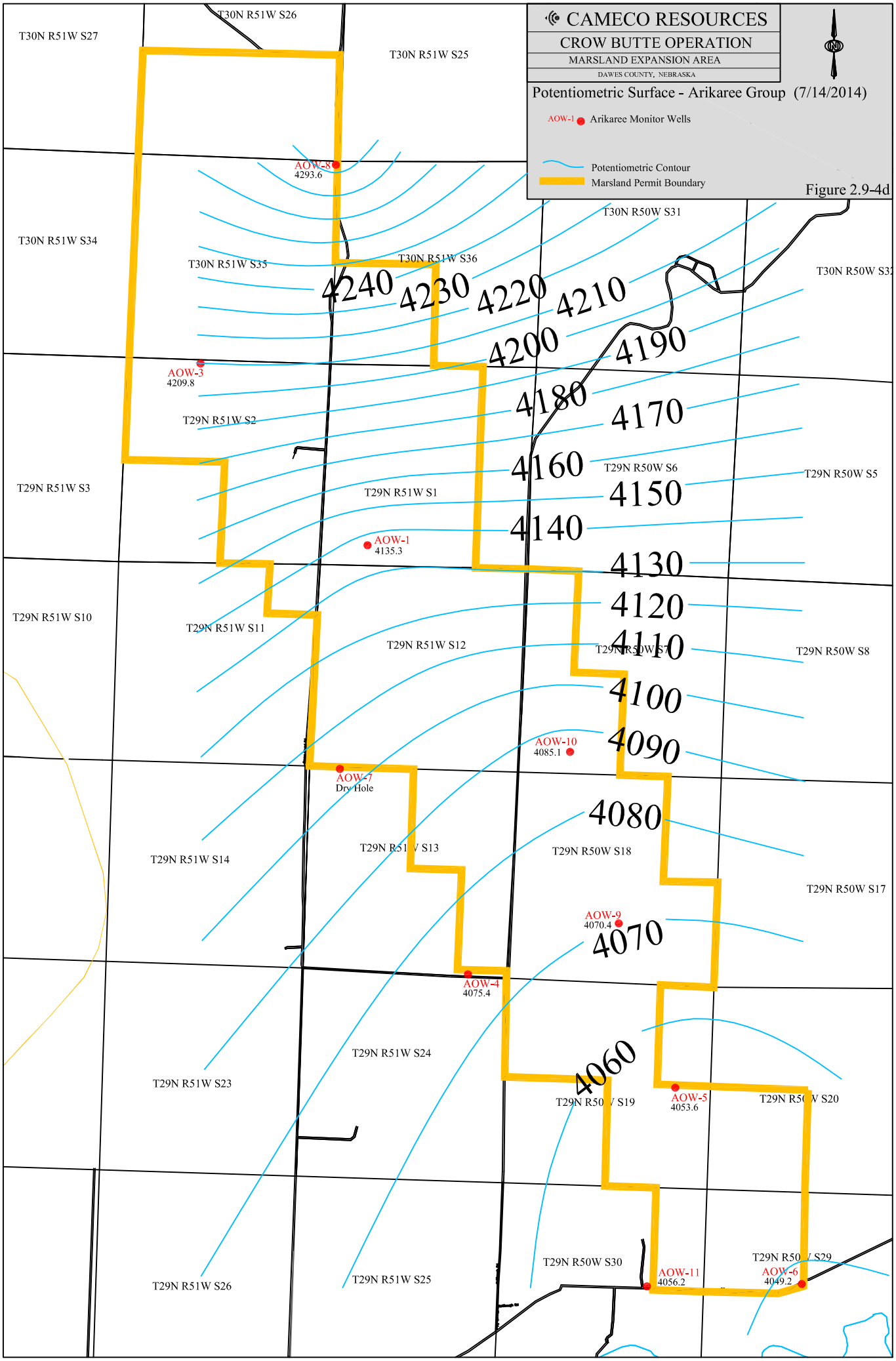
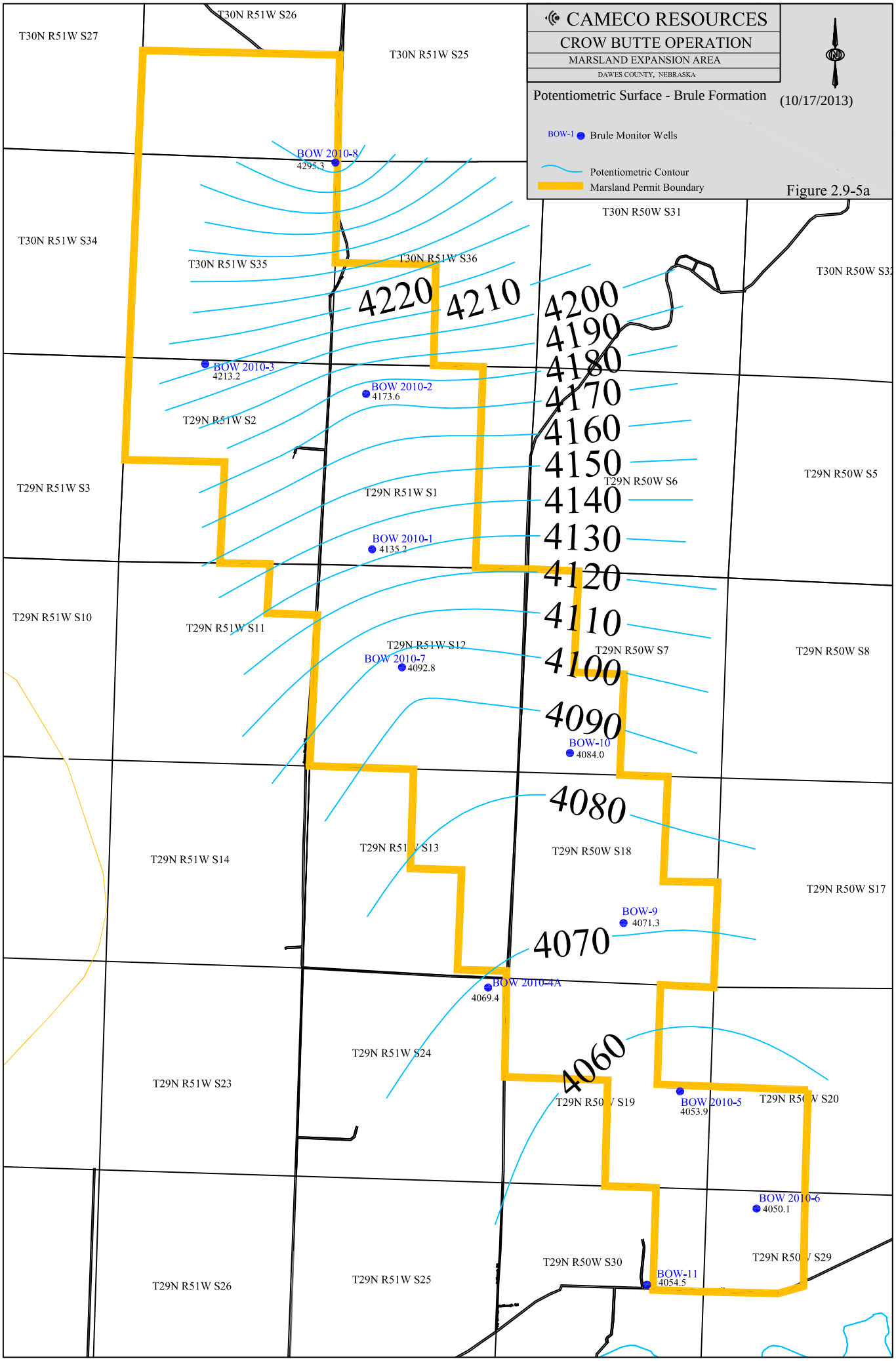
4060


CAMECO RESOURCES
CROW BUTTE OPERATION
MARSLAND EXPANSION AREA
DAWES COUNTY, NEBRASKA
Potentiometric Surface - Arikaree Group (7/14/2014)
AOW-1 Arikaree Monitor Wells
Potentiometric Contour
Marsland Permit Boundary
Figure 2.9-4d
T30N R51W S26
T30N R51W S27
T30N R51W S25
T30N R51W S34
T30N R51W S35
T30N R51W S36
T30N R50W S31
T30N R50W S32
AOW-8
4293.6
4240
4230
4220
4210
4200
4190
4180
4170
4160
4150
4140
4130
4120
4110
4100
4090
4080
4070
4060
AOW-3
4209.8
T29N R51W S2
T29N R51W S3
T29N R51W S1
T29N R50W S6
T29N R50W S5
AOW-1
4135.3
T29N R51W S10
T29N R51W S11
T29N R51W S12
T29N R50W S7
T29N R50W S8
AOW-10
4085.1
AOW-7
Dry Hole
T29N R51W S14
T29N R51W S13
T29N R50W S18
T29N R50W S17
AOW-9
4070.4
AOW-4
4075.4
T29N R51W S24
T29N R51W S23
T29N R50W S19
AOW-5
4053.6
T29N R50W S20
T29N R50W S30
AOW-11
4056.2
T29N R50W S29
AOW-6
4049.2
T29N R51W S26
T29N R51W S25


CAMECO RESOURCES
CROW BUTTE OPERATION
MARSLAND EXPANSION AREA
DAWES COUNTY, NEBRASKA
Potentiometric Surface - Brule Formation
(10/17/2013)
BOW-1 Brule Monitor Wells
Potentiometric Contour
Marsland Permit Boundary
Figure 2.9-5a
T30N R51W S27
T30N R51W S26
T30N R51W S25
T30N R50W S31
T30N R51W S34
T30N R51W S35
T30N R51W S36
T30N R50W S32
T29N R51W S2
T29N R51W S3
T29N R51W S1
T29N R50W S6
T29N R50W S5
T29N R51W S10
T29N R51W S11
T29N R51W S12
T29N R50W S7
T29N R50W S8
T29N R51W S14
T29N R51W S13
T29N R50W S18
T29N R50W S17
T29N R51W S24
T29N R51W S23
T29N R50W S19
T29N R50W S20
T29N R51W S26
T29N R51W S25
T29N R50W S30
T29N R50W S29
BOW 2010-8
4295.3
BOW 2010-3
4213.2
BOW 2010-2
4173.6
BOW 2010-1
4135.2
BOW 2010-7
4092.8
BOW-10
4084.0
BOW-9
4071.3
BOW 2010-4A
4069.4
BOW 2010-5
4053.9
BOW 2010-6
4050.1
BOW-11
4054.5
4220
4210
4200
4190
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4170
4160
4150
4140
4130
4120
4110
4100
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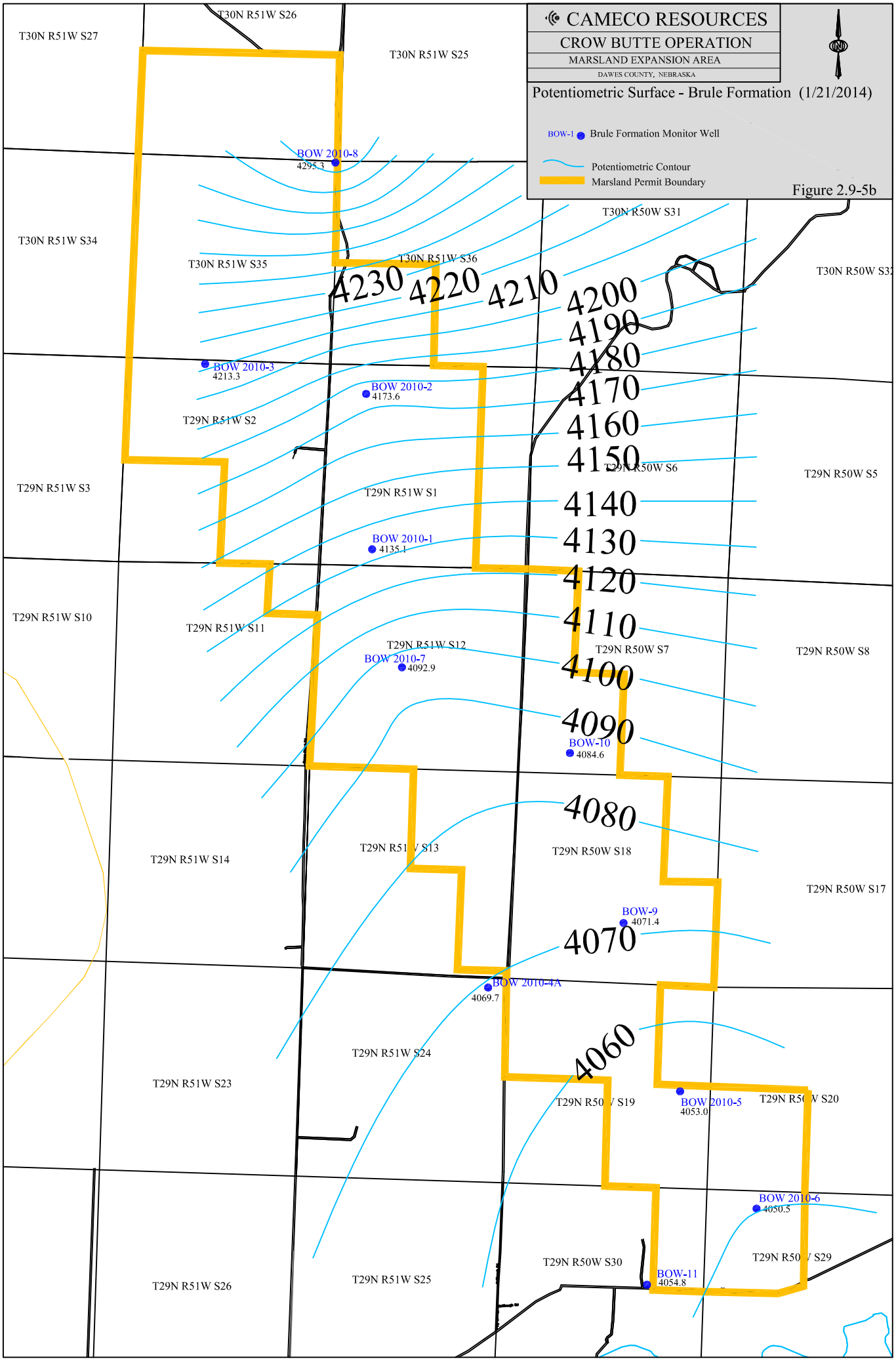
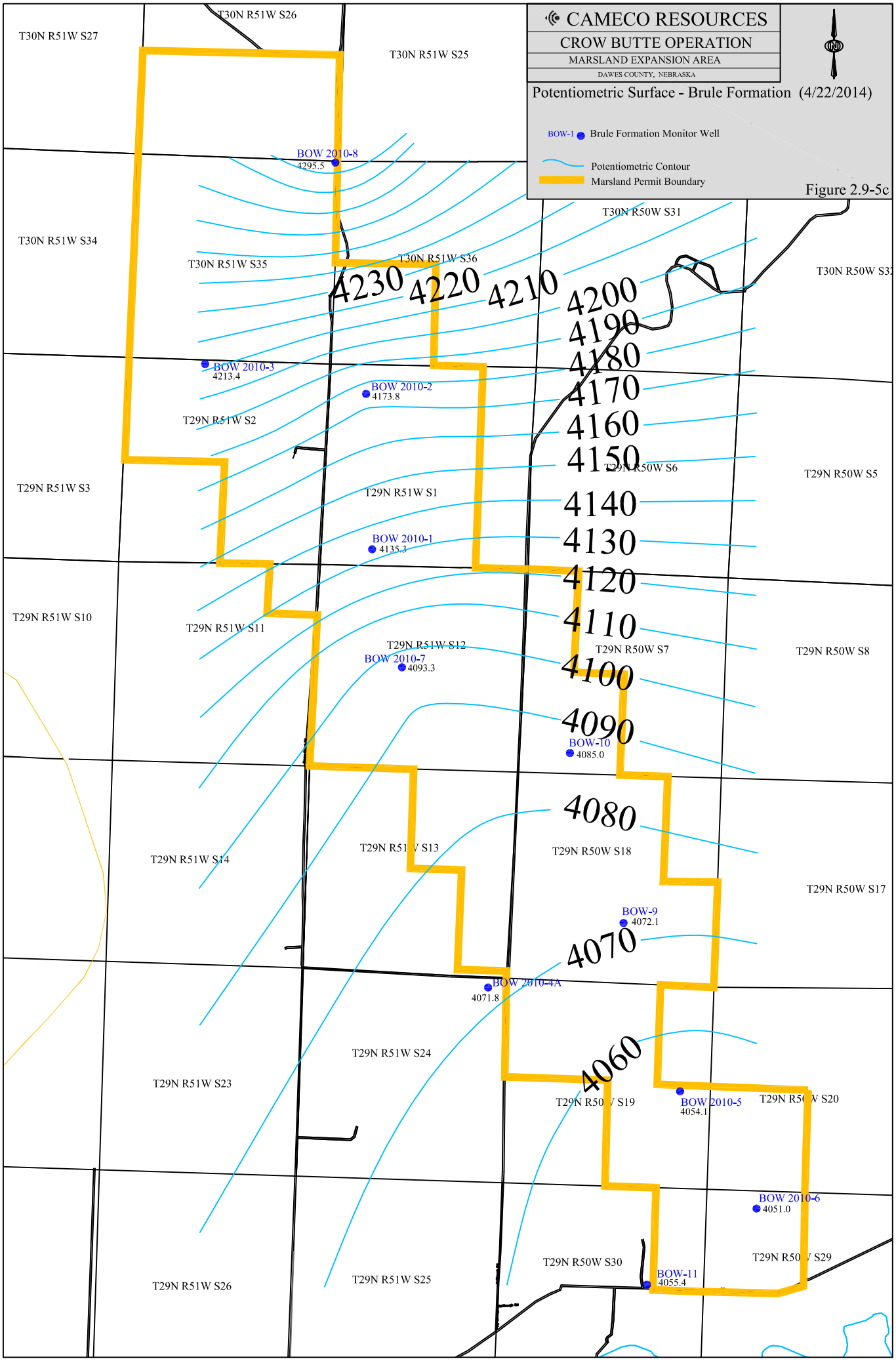
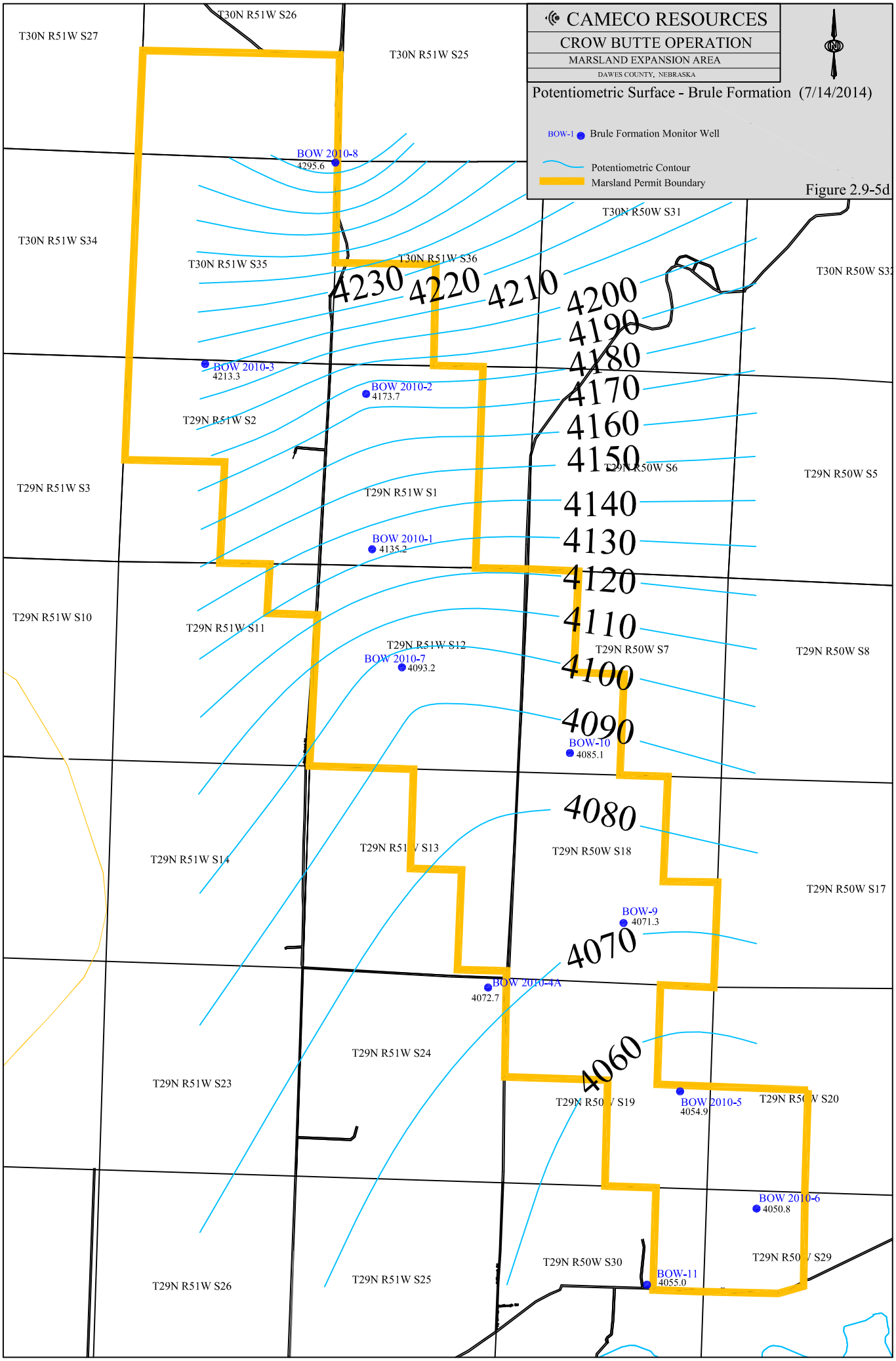
4080
4070
4060


CAMECO RESOURCES
CROW BUTTE OPERATION
MARSLAND EXPANSION AREA
DAWES COUNTY, NEBRASKA
Potentiometric Surface - Brule Formation (1/21/2014)
BOW-1 Brule Formation Monitor Well
Potentiometric Contour
Marsland Permit Boundary
Figure 2.9-5b
T30N R51W S26
T30N R51W S27
T30N R51W S25
T30N R51W S34
T30N R51W S35
T30N R51W S36
T30N R50W S31
T30N R50W S32
BOW 2010-8
4295.3
4230
4220
4210
4200
4190
4180
4170
4160
4150
4140
4130
4120
4110
4100
4090
4080
4070
4060
BOW 2010-3
4213.3
BOW 2010-2
4173.6
T29N R51W S2
T29N R51W S3
T29N R51W S1
T29N R50W S6
T29N R50W S5
BOW 2010-1
4135.1
T29N R51W S10
T29N R51W S11
T29N R51W S12
T29N R50W S7
T29N R50W S8
BOW 2010-7
4092.9
BOW-10
4084.6
T29N R51W S14
T29N R51W S13
T29N R50W S18
T29N R50W S17
BOW-9
4071.4
BOW 2010-4A
4069.7
T29N R51W S24
T29N R51W S23
T29N R50W S19
BOW 2010-5
4053.0
T29N R50W S20
BOW 2010-6
4050.5
T29N R50W S30
T29N R50W S29
BOW-11
4054.8
T29N R51W S26
T29N R51W S25


CAMECO RESOURCES
CROW BUTTE OPERATION
MARSLAND EXPANSION AREA
DAWES COUNTY, NEBRASKA
Potentiometric Surface - Brule Formation (4/22/2014)
BOW-1 Brule Formation Monitor Well
Potentiometric Contour
Marsland Permit Boundary
Figure 2.9-5c
T30N R51W S26
T30N R51W S27
T30N R51W S25
T30N R51W S34
T30N R51W S35
T30N R51W S36
T30N R50W S31
T30N R50W S32
BOW 2010-8
4295.5
4230
4220
4210
4200
4190
4180
4170
4160
4150
4140
4130
4120
4110
4100
4090
4080
4070
4060
BOW 2010-3
4213.4
BOW 2010-2
4173.8
T29N R51W S2
T29N R51W S3
T29N R51W S1
T29N R50W S6
T29N R50W S5
BOW 2010-1
4135.3
T29N R51W S10
T29N R51W S11
T29N R51W S12
T29N R50W S7
T29N R50W S8
BOW 2010-7
4093.3
BOW-10
4085.0
T29N R51W S14
T29N R51W S13
T29N R50W S18
T29N R50W S17
BOW-9
4072.1
BOW 2010-4A
4071.8
T29N R51W S24
T29N R51W S23
T29N R50W S19
BOW 2010-5
4054.1
T29N R50W S20
BOW 2010-6
4051.0
T29N R50W S30
T29N R50W S29
BOW-11
4055.4
T29N R51W S26
T29N R51W S25


CAMECO RESOURCES
CROW BUTTE OPERATION
MARSLAND EXPANSION AREA
DAWES COUNTY, NEBRASKA
Potentiometric Surface - Brule Formation (7/14/2014)
BOW-1 Brule Formation Monitor Well
Potentiometric Contour
Marsland Permit Boundary
Figure 2.9-5d
T30N R51W S26
T30N R51W S27
T30N R51W S25
T30N R51W S34
T30N R51W S35
T30N R51W S36
T30N R50W S31
T30N R50W S32
BOW 2010-8
4295.6
BOW 2010-3
4213.3
BOW 2010-2
4173.7
T29N R51W S2
T29N R51W S3
T29N R51W S1
T29N R50W S6
T29N R50W S5
BOW 2010-1
4135.2
T29N R51W S10
T29N R51W S11
T29N R51W S12
T29N R50W S7
T29N R50W S8
BOW 2010-7
4093.2
BOW-10
4085.1
T29N R51W S14
T29N R51W S13
T29N R50W S18
T29N R50W S17
BOW-9
4071.3
BOW 2010-4A
4072.7
T29N R51W S24
T29N R51W S23
T29N R50W S19
BOW 2010-5
4054.9
T29N R50W S20
BOW 2010-6
4050.8
T29N R50W S30
T29N R50W S29
BOW-11
4055.0
T29N R51W S26
T29N R51W S25
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4220
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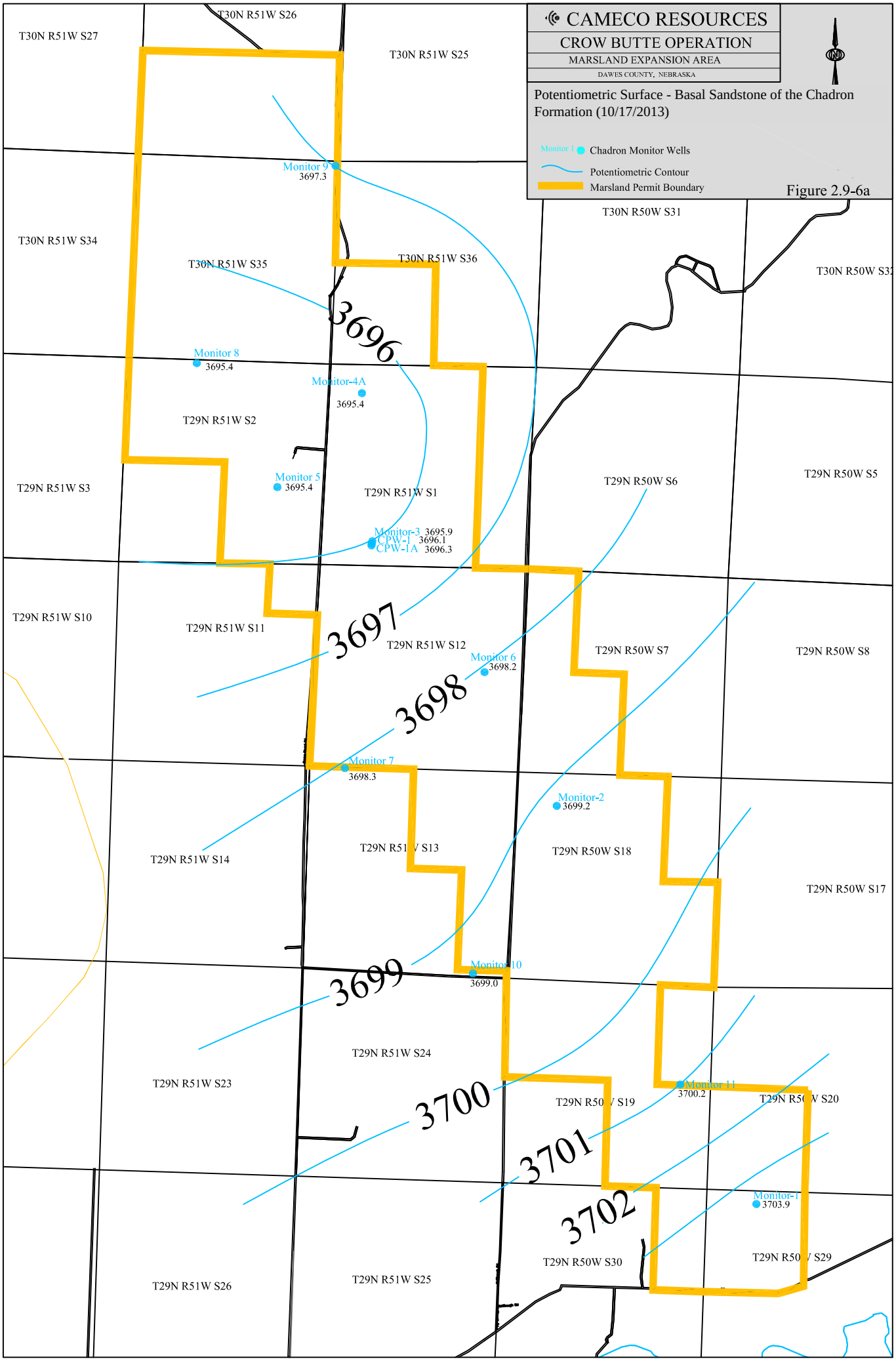
CAMECO RESOURCES
CROW BUTTE OPERATION
MARSLAND EXPANSION AREA
DAWES COUNTY, NEBRASKA
Potentiometric Surface - Basal Sandstone of the Chadron Formation (10/17/2013)
Monitor 1 Chadron Monitor Wells
Potentiometric Contour
Marsland Permit Boundary
Figure 2.9-6a
T30N R51W S26
T30N R51W S27
T30N R51W S25
T30N R50W S31
T30N R51W S34
T30N R51W S35
T30N R51W S36
T30N R50W S32
Monitor 9
3697.3
3696
Monitor 8
3695.4
Monitor-4A
3695.4
T29N R51W S2
T29N R51W S3
Monitor 5
3695.4
T29N R51W S1
T29N R50W S6
T29N R50W S5
Monitor-3 3695.9
CPW-1 3696.1
CPW-1A 3696.3
T29N R51W S10
T29N R51W S11
3697
T29N R51W S12
T29N R50W S7
T29N R50W S8
Monitor 6
3698.2
3698
Monitor 7
3698.3
Monitor-2
3699.2
T29N R51W S14
T29N R51W S13
T29N R50W S18
T29N R50W S17
Monitor 10
3699.0
3699
T29N R51W S24
T29N R51W S23
3700
T29N R50W S19
Monitor 11
3700.2
T29N R50W S20
3701
Monitor-1
3703.9
3702
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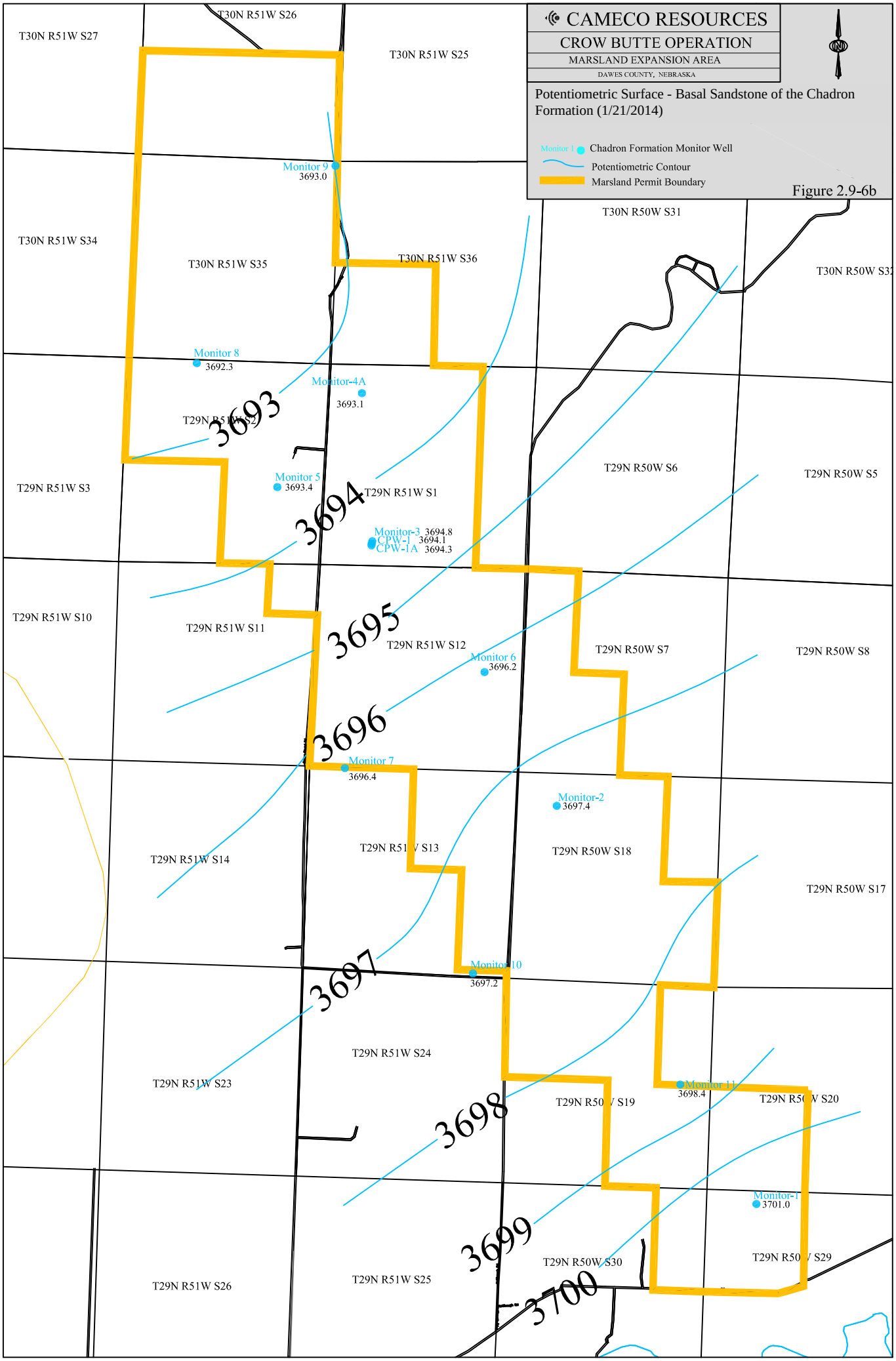
T29N R51W S26
T29N R51W S25


CAMECO RESOURCES
CROW BUTTE OPERATION
MARSLAND EXPANSION AREA
DAWES COUNTY, NEBRASKA
Potentiometric Surface - Basal Sandstone of the Chadron Formation (1/21/2014)
Monitor 1 Chadron Formation Monitor Well
Potentiometric Contour
Marsland Permit Boundary
Figure 2.9-6b
T30N R51W S26
T30N R51W S27
T30N R51W S25
T30N R50W S31
T30N R51W S34
T30N R51W S35
T30N R51W S36
T30N R50W S32
Monitor 9
3693.0
Monitor 8
3692.3
Monitor-4A
3693.1
3693
T29N R51W S2
T29N R51W S3
Monitor 5
3693.4
T29N R51W S1
T29N R50W S6
T29N R50W S5
3694
Monitor-3 3694.8
CPW-1 3694.1
CPW-1A 3694.3
T29N R51W S10
T29N R51W S11
T29N R51W S12
3695
Monitor 6
3696.2
T29N R50W S7
T29N R50W S8
3696
Monitor 7
3696.4
Monitor-2
3697.4
T29N R51W S14
T29N R51W S13
T29N R50W S18
T29N R50W S17
Monitor 10
3697.2
3697
T29N R51W S24
T29N R51W S23
Monitor 11
3698.4
T29N R50W S19
T29N R50W S20
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Monitor-1
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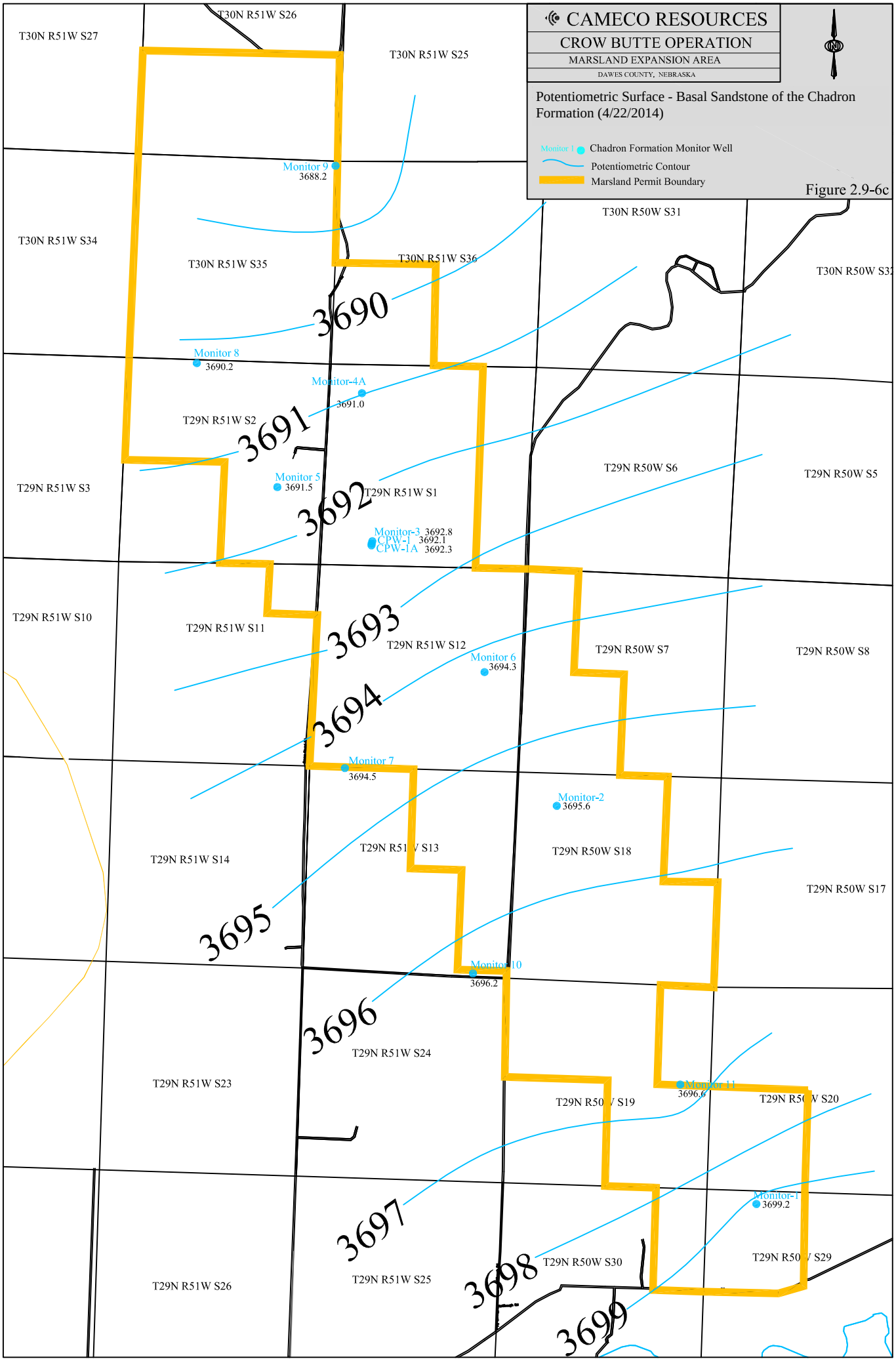
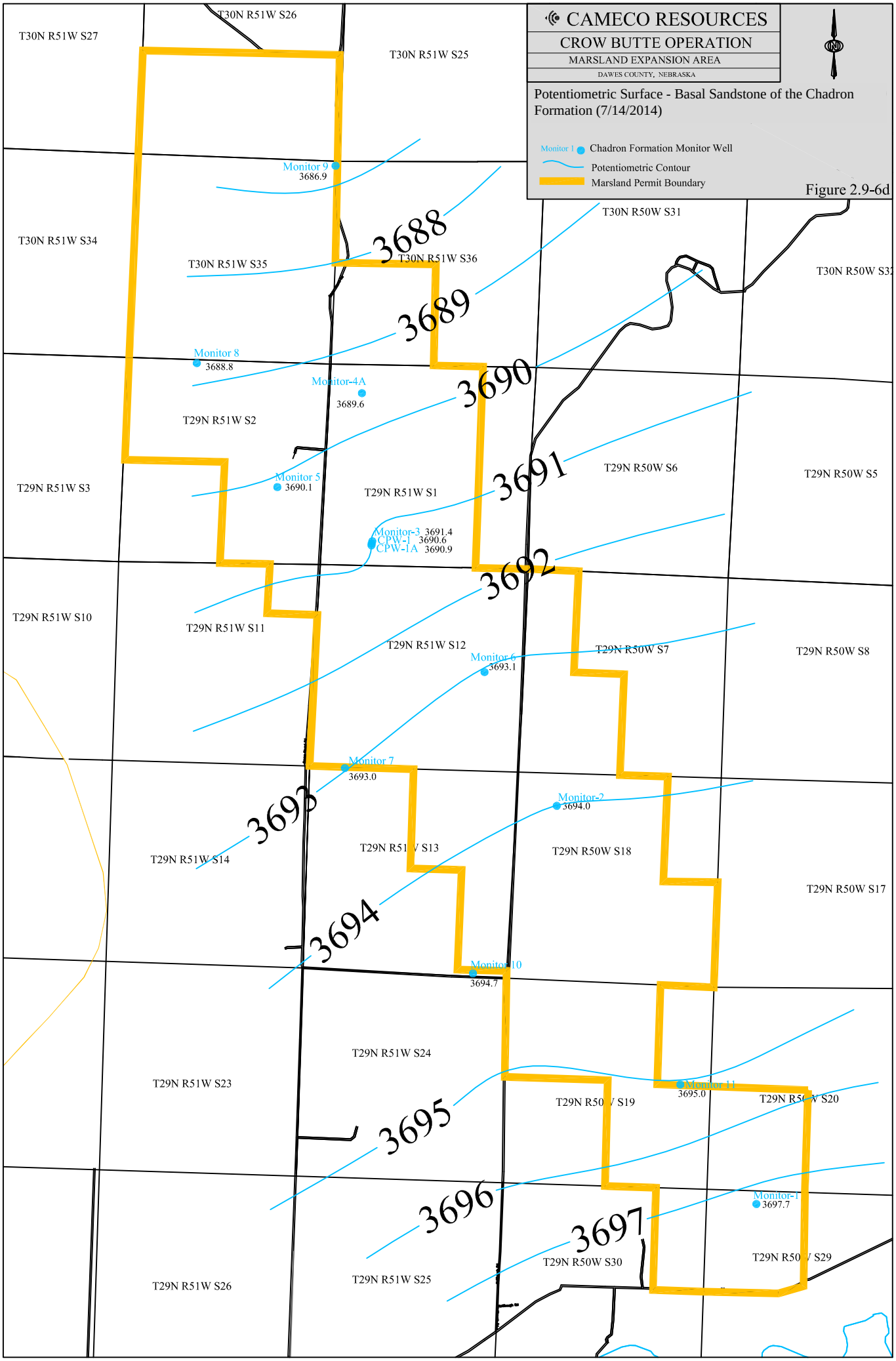
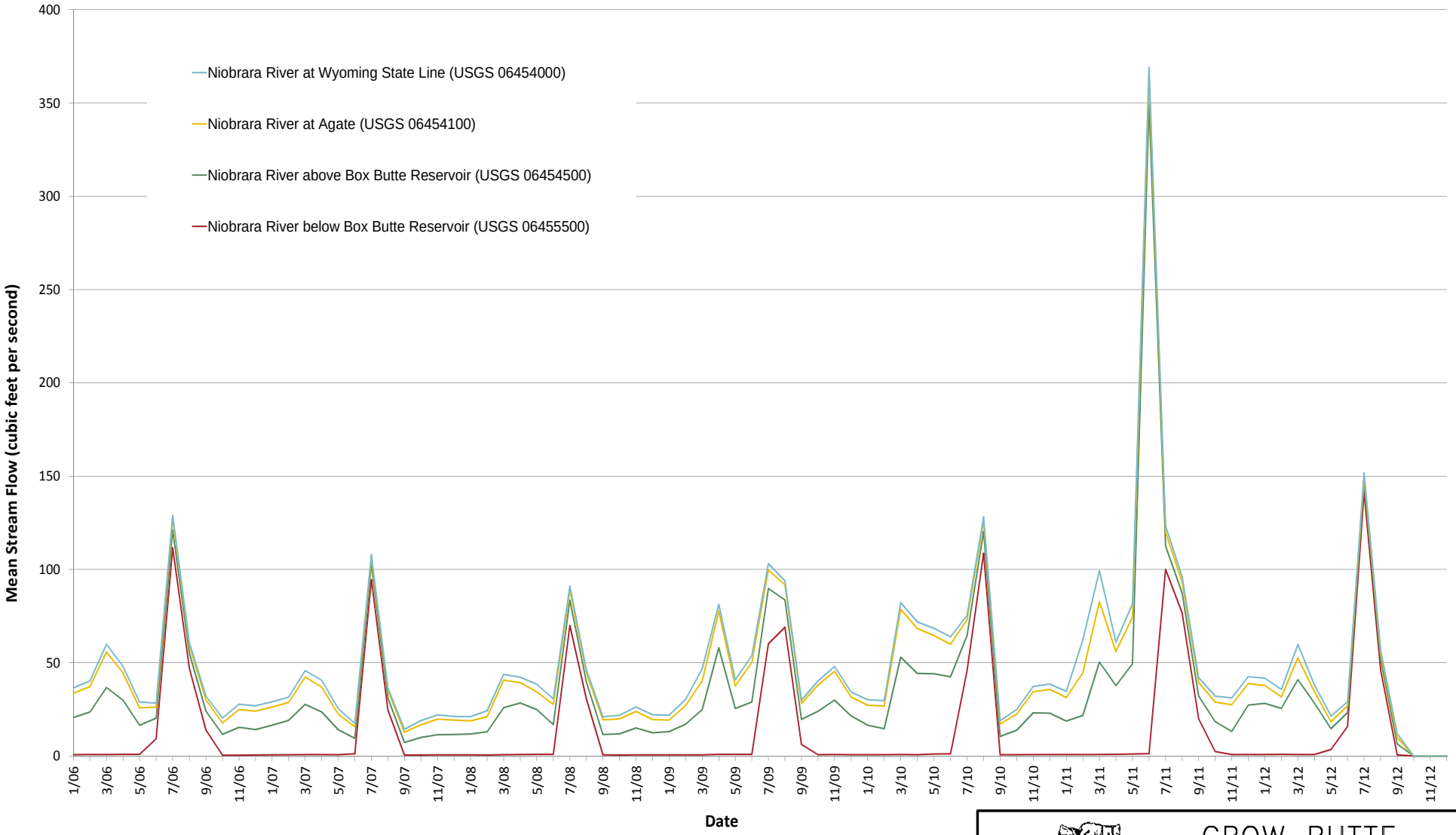
3700


CAMECO RESOURCES
CROW BUTTE OPERATION
MARSLAND EXPANSION AREA
DAWES COUNTY, NEBRASKA
Potentiometric Surface - Basal Sandstone of the Chadron Formation (4/22/2014)
Monitor 1 Chadron Formation Monitor Well
Potentiometric Contour
Marsland Permit Boundary
Figure 2.9-6c
T30N R51W S26
T30N R51W S27
T30N R51W S25
T30N R50W S31
T30N R51W S34
T30N R51W S35
T30N R51W S36
T30N R50W S32
Monitor 9
3688.2
3690
Monitor 8
3690.2
Monitor-4A
3691.0
3691
T29N R51W S2
T29N R51W S3
Monitor 5
3691.5
3692
T29N R51W S1
T29N R50W S6
T29N R50W S5
Monitor-3 3692.8
CPW-1 3692.1
CPW-1A 3692.3
T29N R51W S10
T29N R51W S11
3693
T29N R51W S12
Monitor 6
3694.3
T29N R50W S7
T29N R50W S8
3694
Monitor 7
3694.5
Monitor-2
3695.6
T29N R51W S14
T29N R51W S13
T29N R50W S18
T29N R50W S17
3695
Monitor 10
3696.2
3696
T29N R51W S24
T29N R51W S23
Monitor 11
3696.6
T29N R50W S19
T29N R50W S20
Monitor-1
3699.2
3697
T29N R51W S26
T29N R51W S25
3698
T29N R50W S30
T29N R50W S29
3699


CAMECO RESOURCES
CROW BUTTE OPERATION
MARSLAND EXPANSION AREA
DAWES COUNTY, NEBRASKA
Potentiometric Surface - Basal Sandstone of the Chadron Formation (7/14/2014)
Monitor 1 Chadron Formation Monitor Well
Potentiometric Contour
Marsland Permit Boundary
Figure 2.9-6d
T30N R51W S26
T30N R51W S27
T30N R51W S25
T30N R51W S34
T30N R51W S35
T30N R51W S36
T30N R50W S31
T30N R50W S32
Monitor 9
3686.9
3688
3689
3690
3691
3692
3693
3694
3695
3696
3697
Monitor 8
3688.8
Monitor-4A
3689.6
T29N R51W S2
Monitor 5
3690.1
T29N R51W S3
T29N R51W S1
T29N R50W S6
T29N R50W S5
Monitor-3 3691.4
CPW-1 3690.6
CPW-1A 3690.9
T29N R51W S10
T29N R51W S11
T29N R51W S12
Monitor-6
3693.1
T29N R50W S7
T29N R50W S8
Monitor 7
3693.0
Monitor-2
3694.0
T29N R51W S14
T29N R51W S13
T29N R50W S18
T29N R50W S17
Monitor 10
3694.7
T29N R51W S24
T29N R51W S23
Monitor 11
3695.0
T29N R50W S19
T29N R50W S20
Monitor-1
3697.7
T29N R51W S26
T29N R51W S25
T29N R50W S30
T29N R50W S29



Source: Williams.2013; Table F.1-3

CROW BUTTE RESOURCES, INC.

FIGURE 2.9-7
UPPER NIOBRARA RIVER AVERAGE FLOWS AT USGS/NDNR STREAM GAGING STATIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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Path: C:\Users\jchen\Documents_PROJECTS\K\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\TR Figure 2_9-8 USGS GagingStations and NDEQ Sampling Locations for Niobrara River.mxd | Last Saved By: jchen | Last Saved On: 12/2/2013

Niobrara River at WY-NE State Line
USGS/NDNR 06454000

Niobrara River at Agate
USGS/NDNR 06454100

Niobrara River above Box Butte Reservoir
USGS/NDNR 06454500
NDEQ SNI4NIOBR402

Niobrara River below Box Butte Reservoir
USGS/NDNR 06455500
NDEQ SNI4NIOBRA20

Box Butte Reservoir from Niobrara River
USGS/NDNR 06455000

T32N R57W T32N R56W T32N R55W T32N R54W T32N R53W T32N R52W T32N R51W T32N R50W T32N R49W
T31N R57W T31N R56W T31N R55W T31N R54W T31N R53W T31N R52W T31N R51W T31N R50W T31N R49W
T30N R57W T30N R56W T30N R55W T30N R54W T30N R53W T30N R52W T30N R51W T30N R50W T30N R49W
T29N R57W T29N R56W T29N R55W T29N R54W T29N R53W T29N R52W T29N R51W T29N R50W T29N R49W
T28N R58W T28N R57W T28N R56W T28N R55W T28N R54W T28N R53W T28N R52W T28N R51W T28N R49W
T27N R58W T27N R57W T27N R56W T27N R55W T27N R54W T27N R53W T27N R52W T27N R51W T27N R49W

Harrison
US-20
Fort Robinson State Park
1270 m
1229 m
1179 m
1187 m
Chadron State Park
SIOUX
DAWES
Agate Fossil Beds National Monument
Niobrara River
Marsland
Box Butte Reservoir State Rec Area
DAWES
BOX BUTTE
ROYVILLE FLAT
NE-71-Dodge-Rd

LEGEND

- USGS/NDNR Stream Gaging Station and NDEQ Sampling Location
- Niobrara River
- Proposed Marsland Expansion Area
- Area of Review (AOR)

PROJECTION: NAD 1983, STATE PLANE NEBRASKA NORTH FIPS 2600
SOURCE: TOPOGRAPHIC MAP, SERVICED BY ESRI ARCGIS ONLINE

N

0 2 4
Miles

CROW BUTTE RESOURCES, INC.

FIGURE 2.9-8
USGS/NDNR STREAM GAGING STATIONS AND NDEQ SAMPLING LOCATIONS FOR NIOBRARA RIVER

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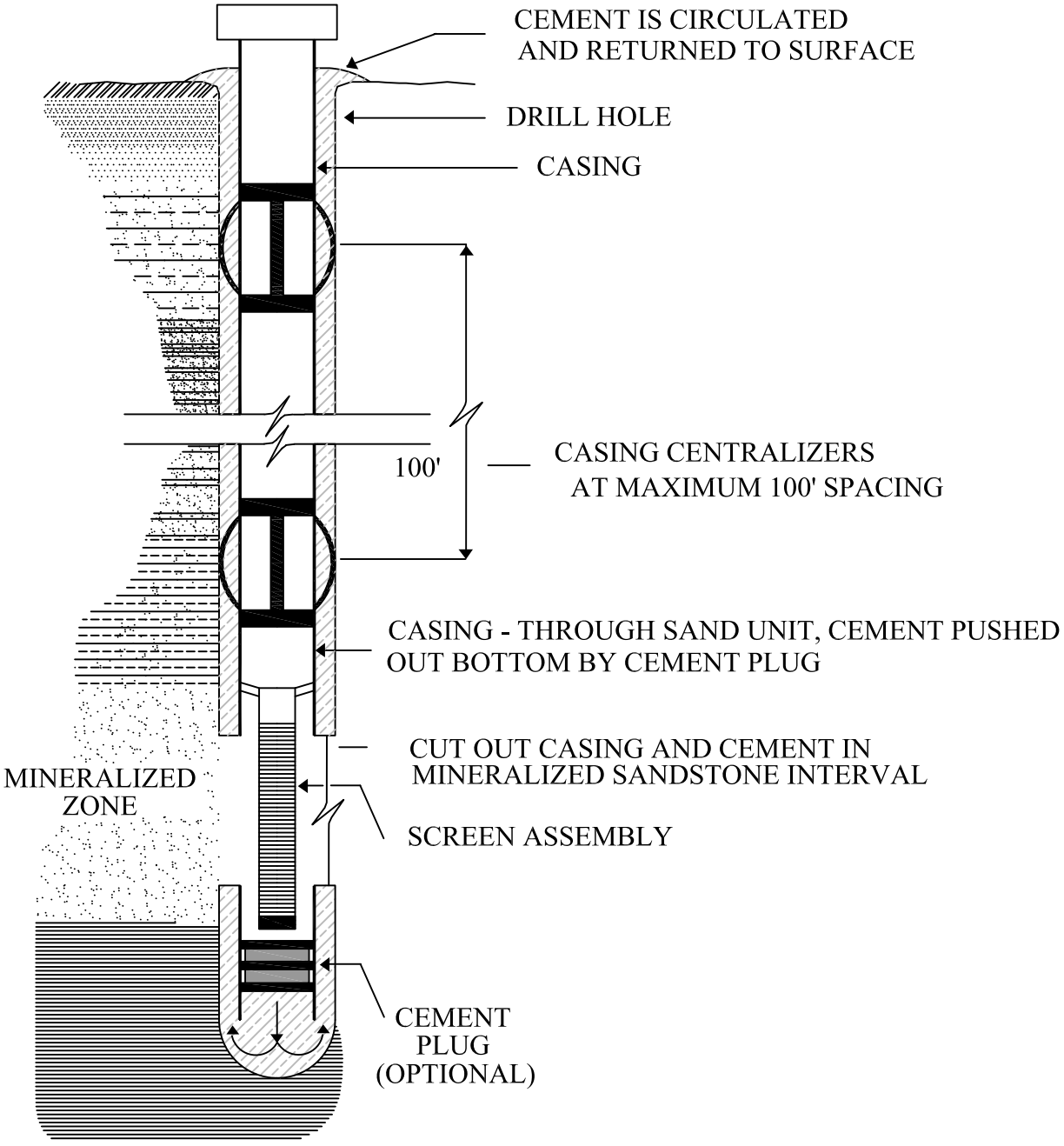

CROW BUTTE RESOURCES, INC.

FIGURE 3.1-1

TYPICAL MINERALIZED ZONE COMPLETION FOR INJECTION/PRODUCTION WELLS

METHOD NO.1

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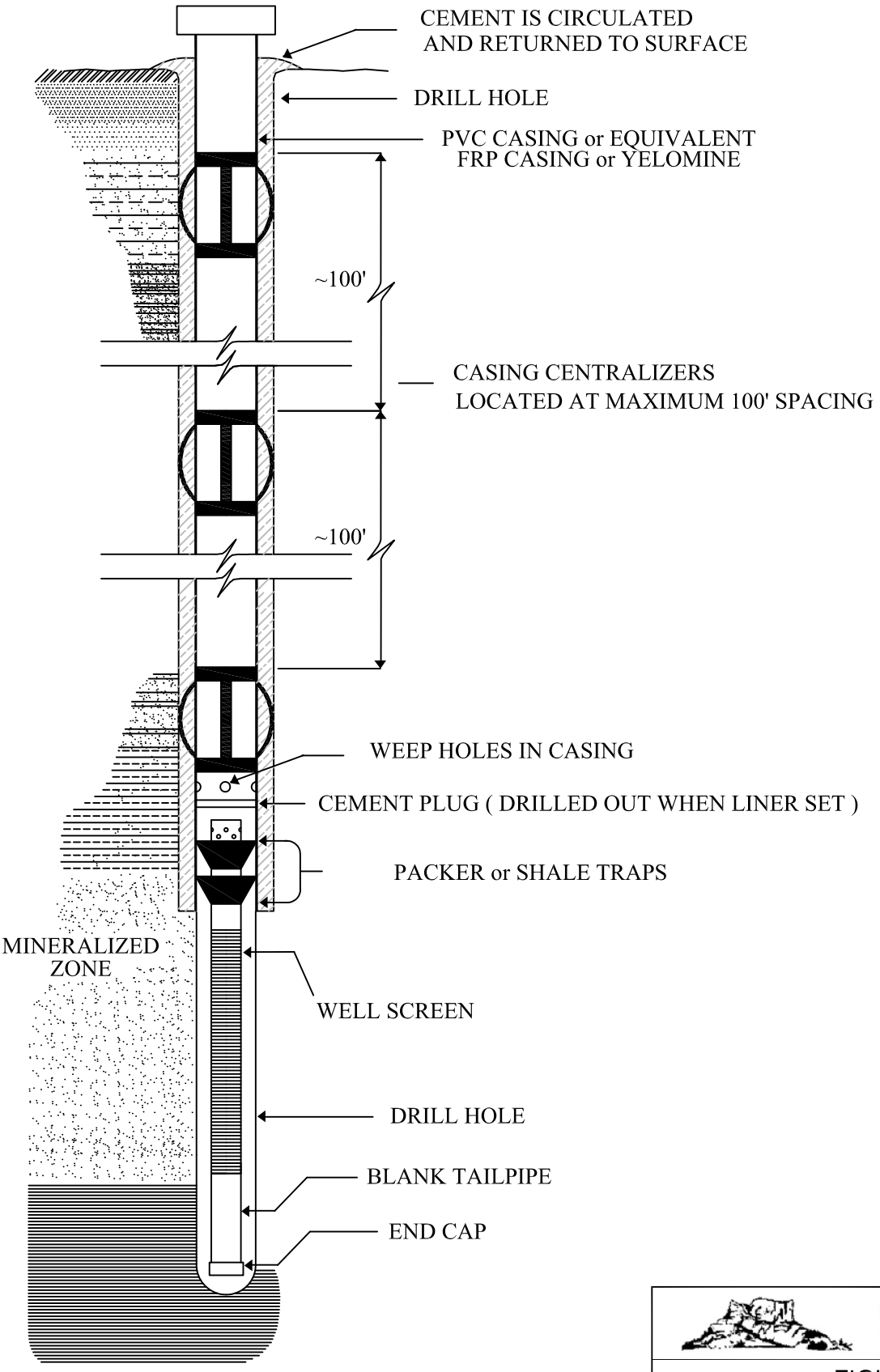

CROW BUTTE RESOURCES, INC.

FIGURE 3.1-2

TYPICAL LINER COMPLETION FOR MONITOR OR INJECTION/PRODUCTION WELLS

METHOD NO.2

PROJECT: CO001396.02 MAPPED BY: JC CHECKED BY: JEC

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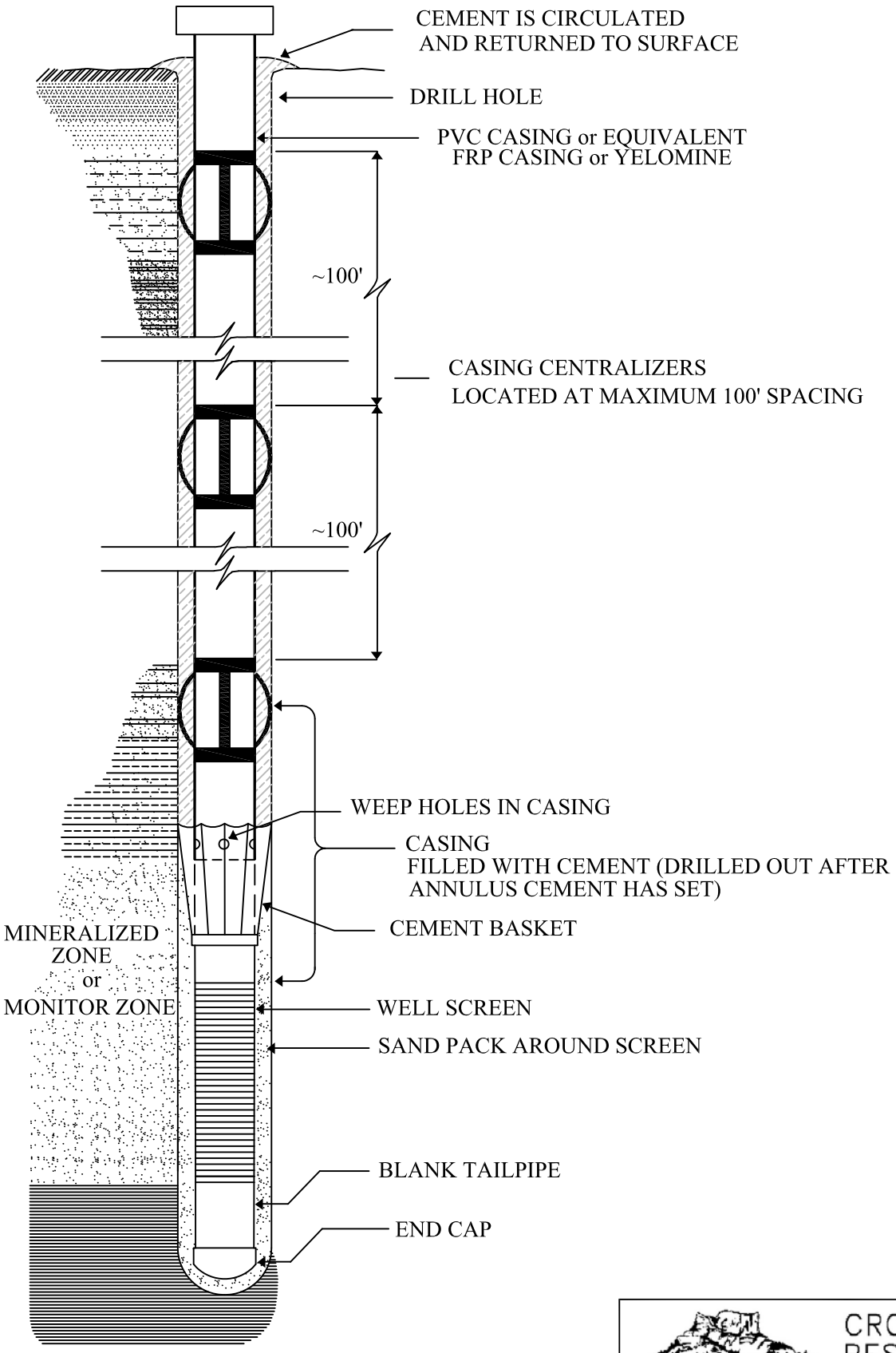

CROW BUTTE RESOURCES, INC.

FIGURE 3.1-3

TYPICAL CEMENT BASKET COMPLETION FOR MONITOR OR INJECTION/PRODUCTION WELLS

METHOD NO.3

PROJECT: CO001396.02 MAPPED BY: JC CHECKED BY: JEC

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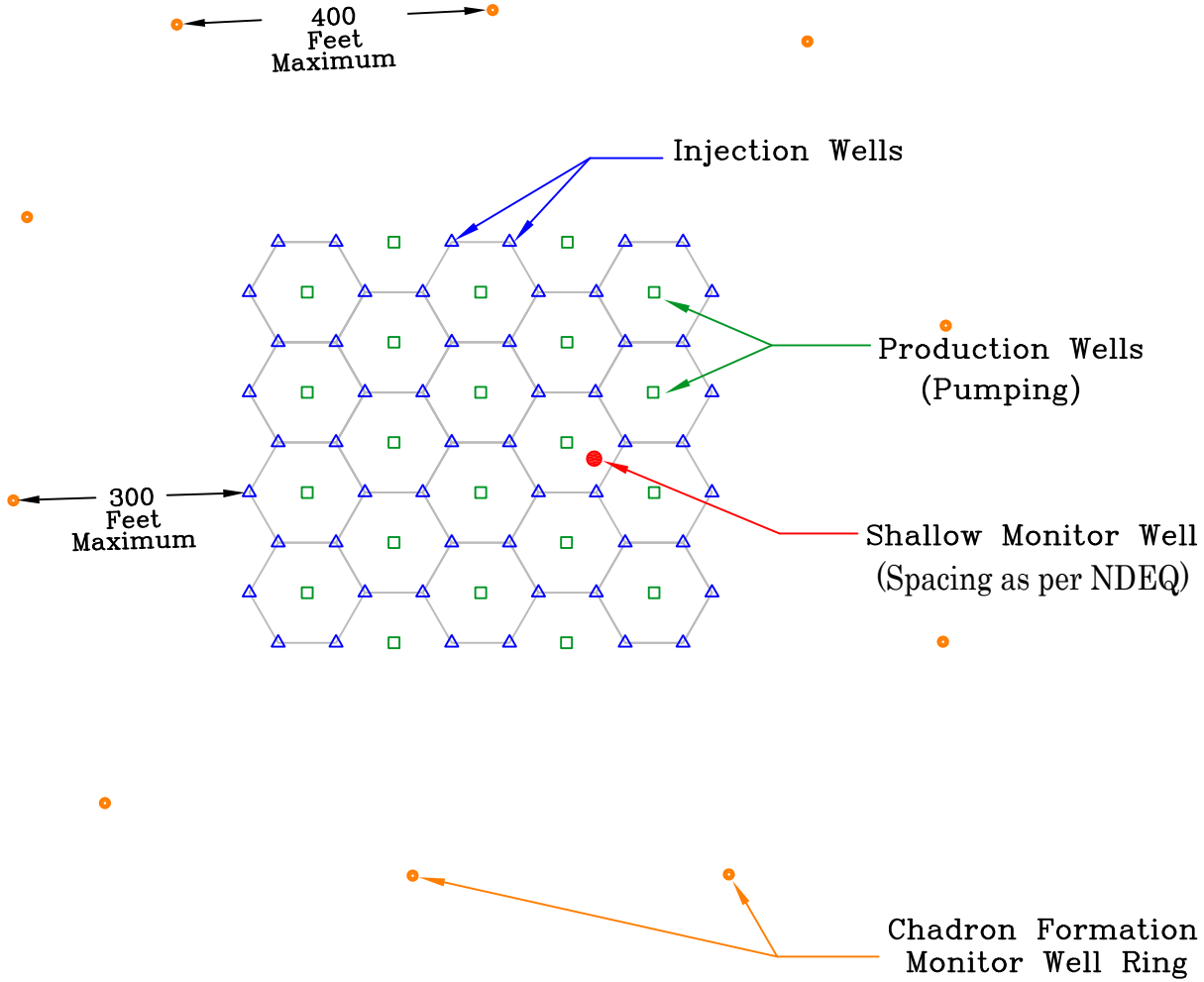

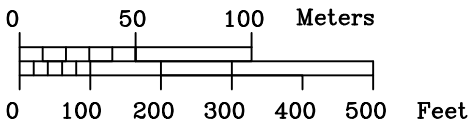

CROW BUTTE RESOURCES, INC.

FIGURE 3.1-4

TYPICAL WELLFIELD LAYOUT

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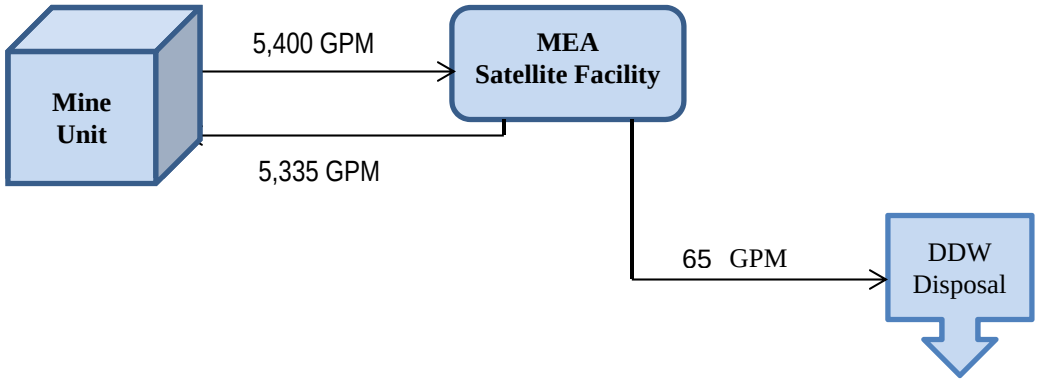
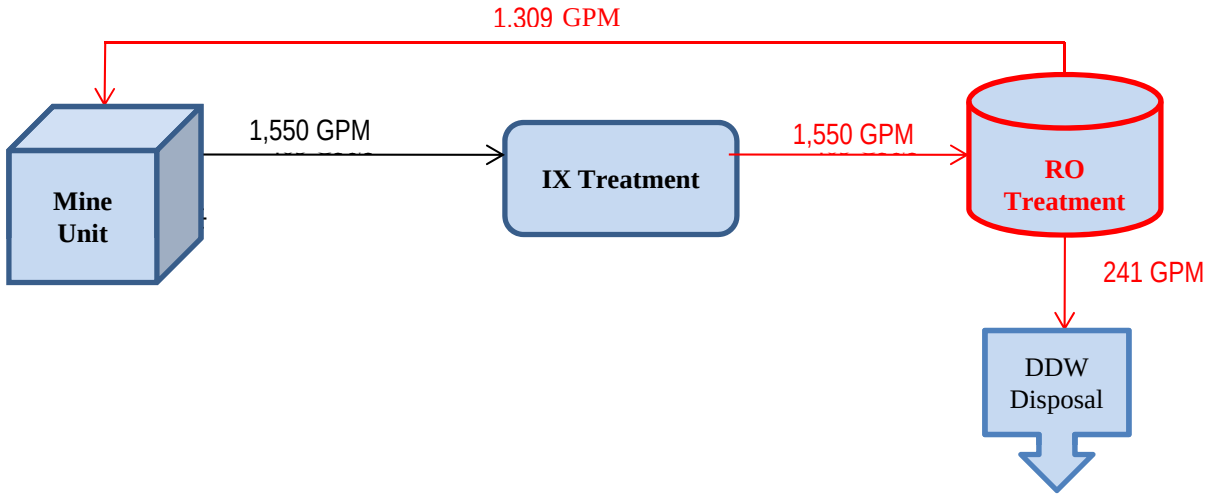


Water Balance Flow Example for Production



Water balance Flow Example: Restoration – IX Treatment & RO Treatment Phase

CROW BUTTE RESOURCES, INC.

FIGURE 3.1-5
WATER BALANCE FOR MARSLAND FACILITY

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

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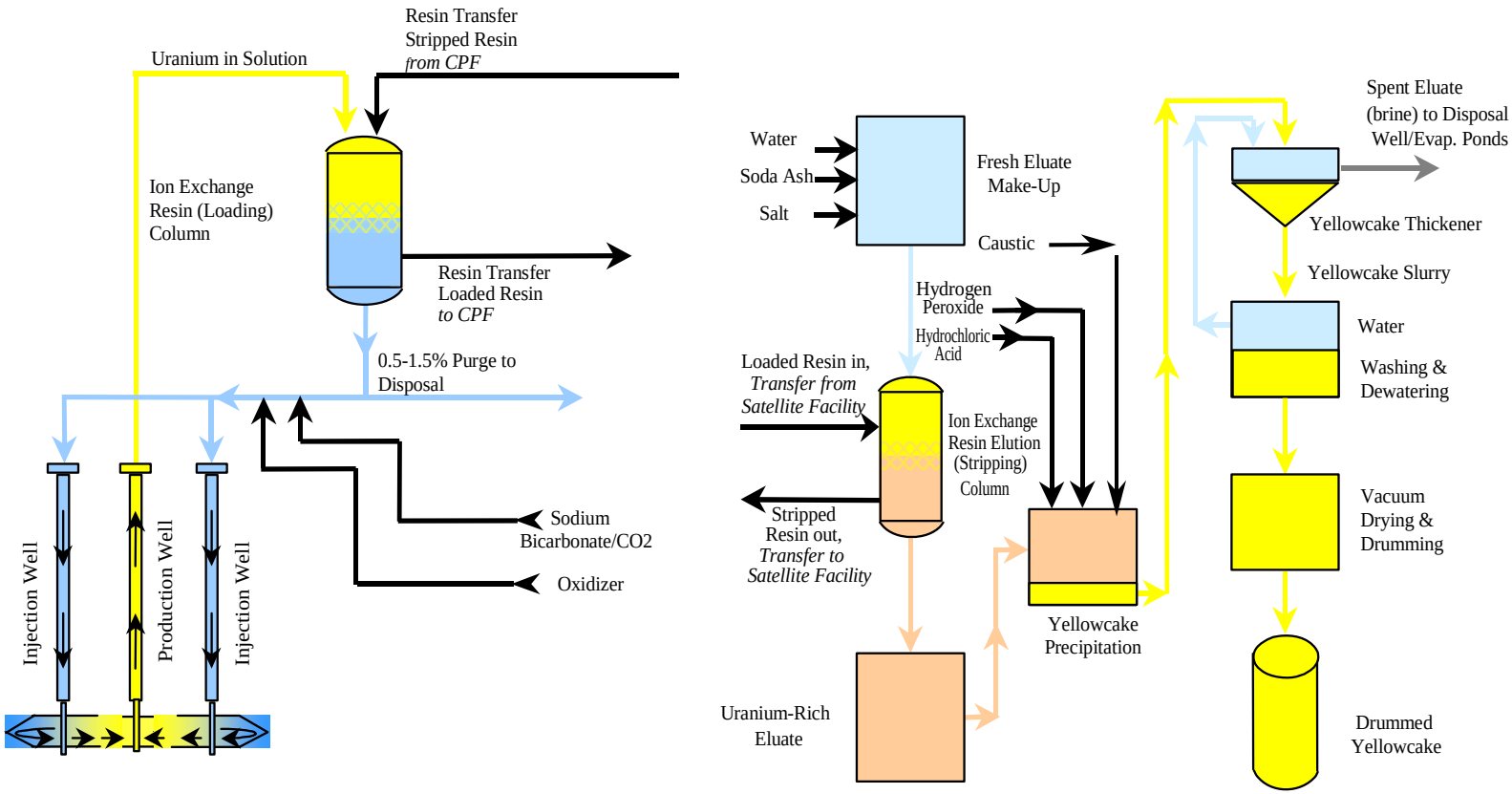
Satellite Facility (Uranium Extraction)

Current CBR Production Facility (CPF) (Uranium Recovery)



CROW BUTTE RESOURCES, INC.

FIGURE 3.1-6
MARSLAND EXPANSION AREA
SATELLITE FACILITY AND
CURRENT CBR PRODUCTION FACILITY
PROCESS FLOW DIAGRAM

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

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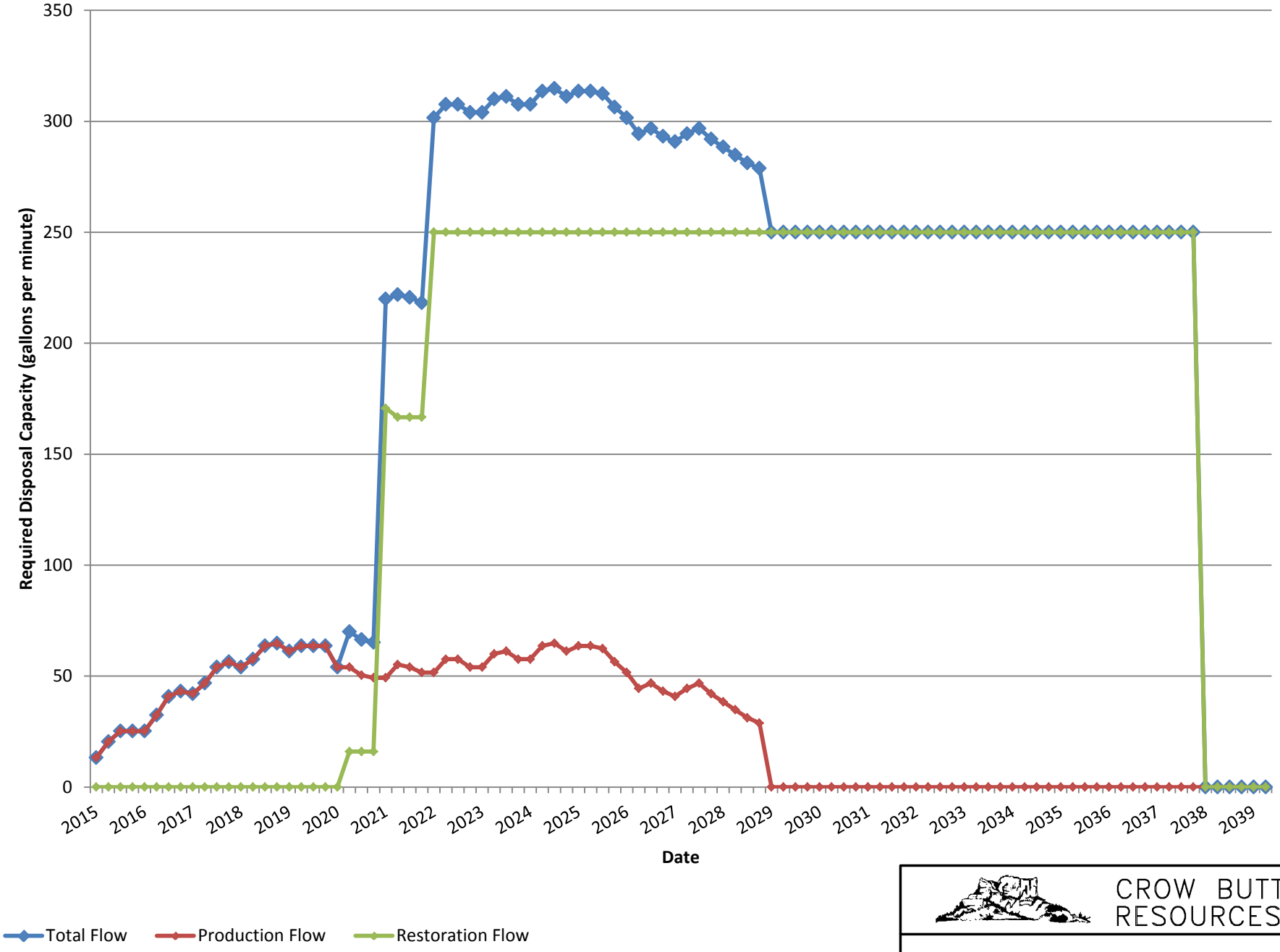
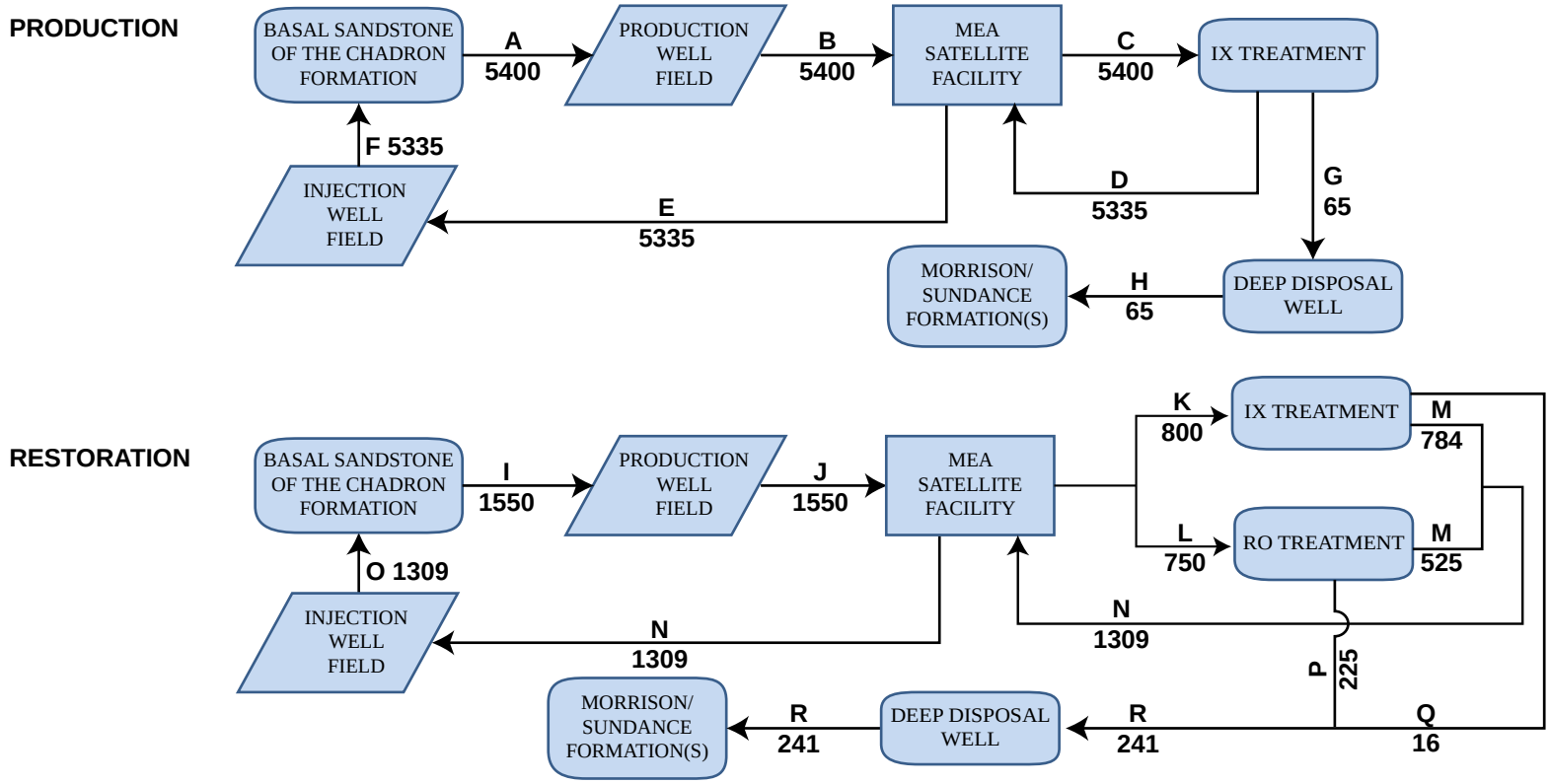


CROW BUTTE RESOURCES, INC.

FIGURE 3.1-7
DISPOSAL WATER BALANCE
MARSLAND EXPANSION AREA

K:\CBR_Projects\CO001636_Marsland\3_IMAGES\IllustratorNTR Figure 3_1-7 Disposal Water Balance.ai @ 06/11/2013



Stream ID	Description
A	Extraction from Basal Sandstone of the Chadron Formation 850-1,200 ft bgs
B	Extraction solution piped from production well field to satellite facility
C	Sent for IX Treatment
D	Recovered solution
E	Recovered solution piped from satellite facility to injection well field
F	Injection into Basal Sandstone of the Chadron Formation
G	Production bleed (1.2%) sent to deep disposal well
H	Injection into Morrison/Sundance Formations 3,400-3,700 ft bgs
I	Extraction from Basal Sandstone of the Chadron Formation
J	Extraction solution piped from production well field to satellite facility
K	Sent for IX Treatment
L	Sent for RO Treatment
M	Recovered solution
N	Recovered solution piped from satellite facility to injection well field
O	Injection into Basal Sandstone of the Chadron Formation
P	RO Bleed sent to deep disposal well
Q	IX Bleed sent to deep disposal well
R	Injection into Morrison/Sundance Formations

NOTES:
1. Balanced for maximum flow rates projected to occur during 3Q 2024.
2. All flow rates are in gallons per minute.

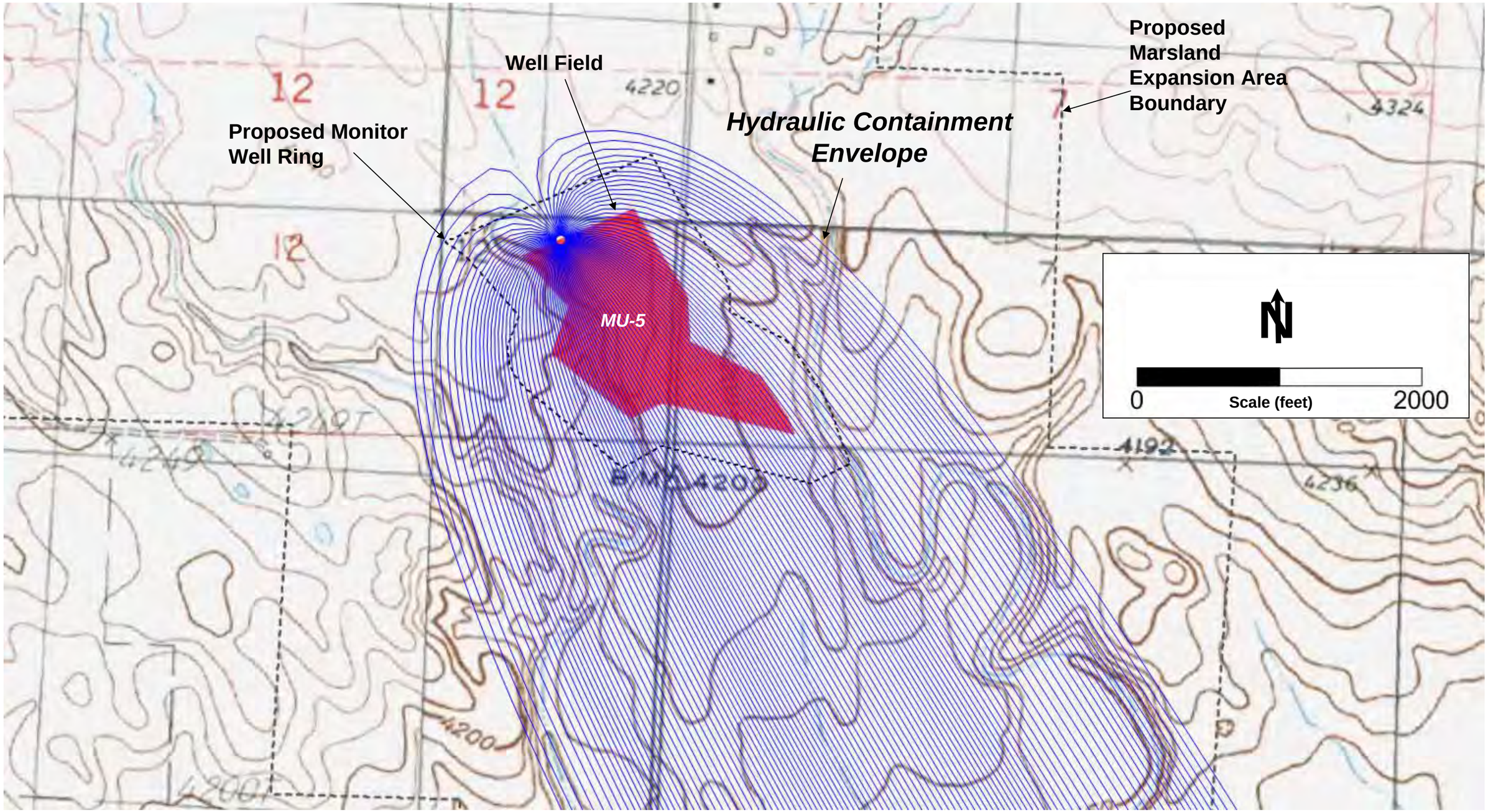
ABBREVIATIONS:

IX Ion Exchange
RO Reverse Osmosis
MEA Marsland Expansion Area

CROW BUTTE RESOURCES, INC.

FIGURE 3.1-8
MARSLAND EXPANSION AREA
WATER BALANCE AND
PROCESS FLOW DIAGRAM

September 2015



Source: AQUI-VER, INC., 5/30/2013

CROW BUTTE RESOURCES, INC.

FIGURE 3.1-9
MARSLAND HYDRAULIC CONTAINMENT ANALYSES

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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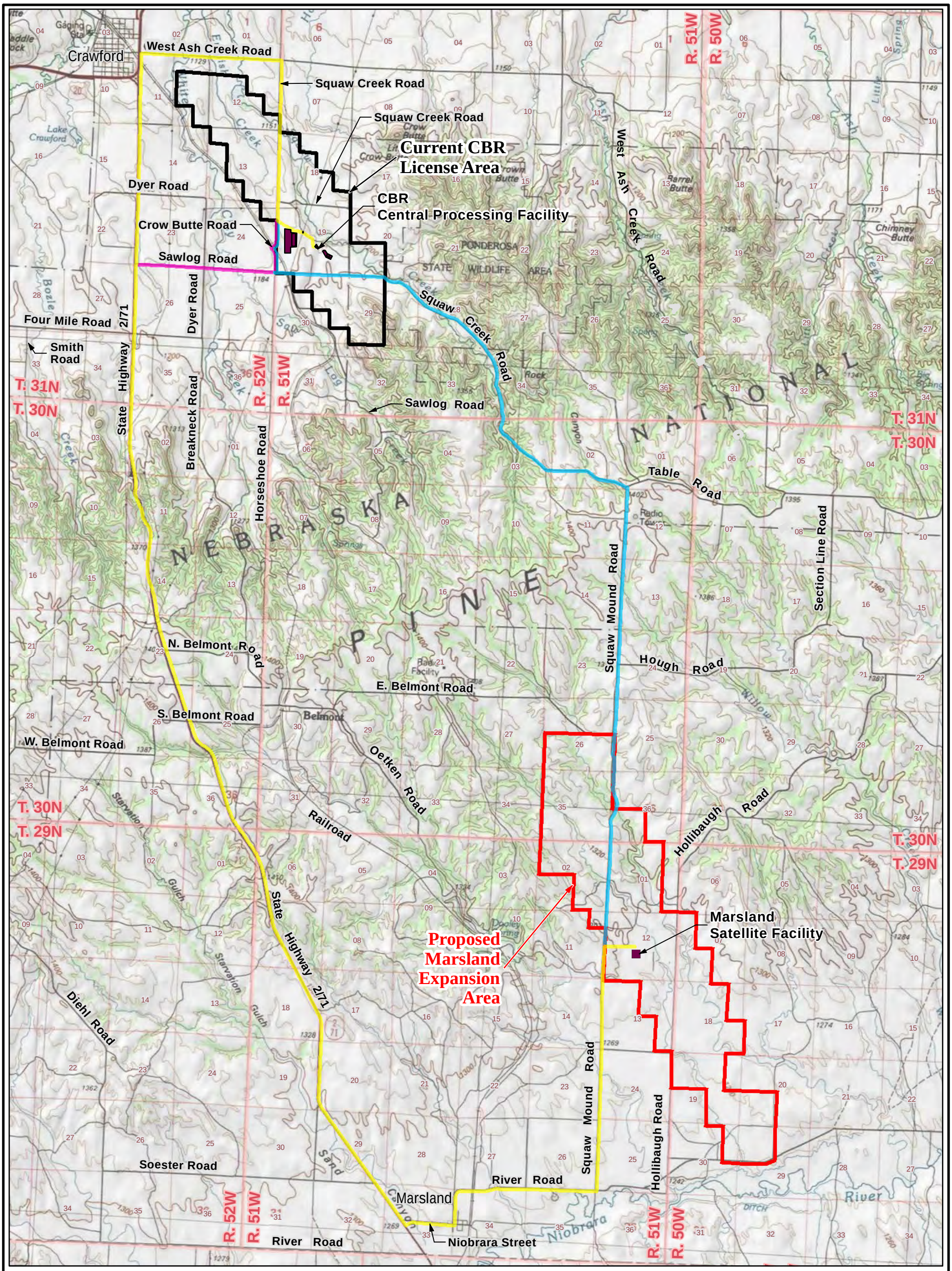
K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\TR Figure 3_1-9 Marsland Hydraulic Containment Analyses.ai @ 12/02/2013



LEGEND

- Primary Access Route
- Alternative Route A
- Alternative Route B

N

0 3,500 7,000

Feet

PROJECTION: NAD1927, STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: USA TOPO MAPS, SERVICED BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

FIGURE 4.2-1
PROPOSED ACCESS ROUTE BETWEEN MARSLAND EXPANSION AREA SATELLITE FACILITY AND CROW BUTTE CENTRAL PROCESSING FACILITY

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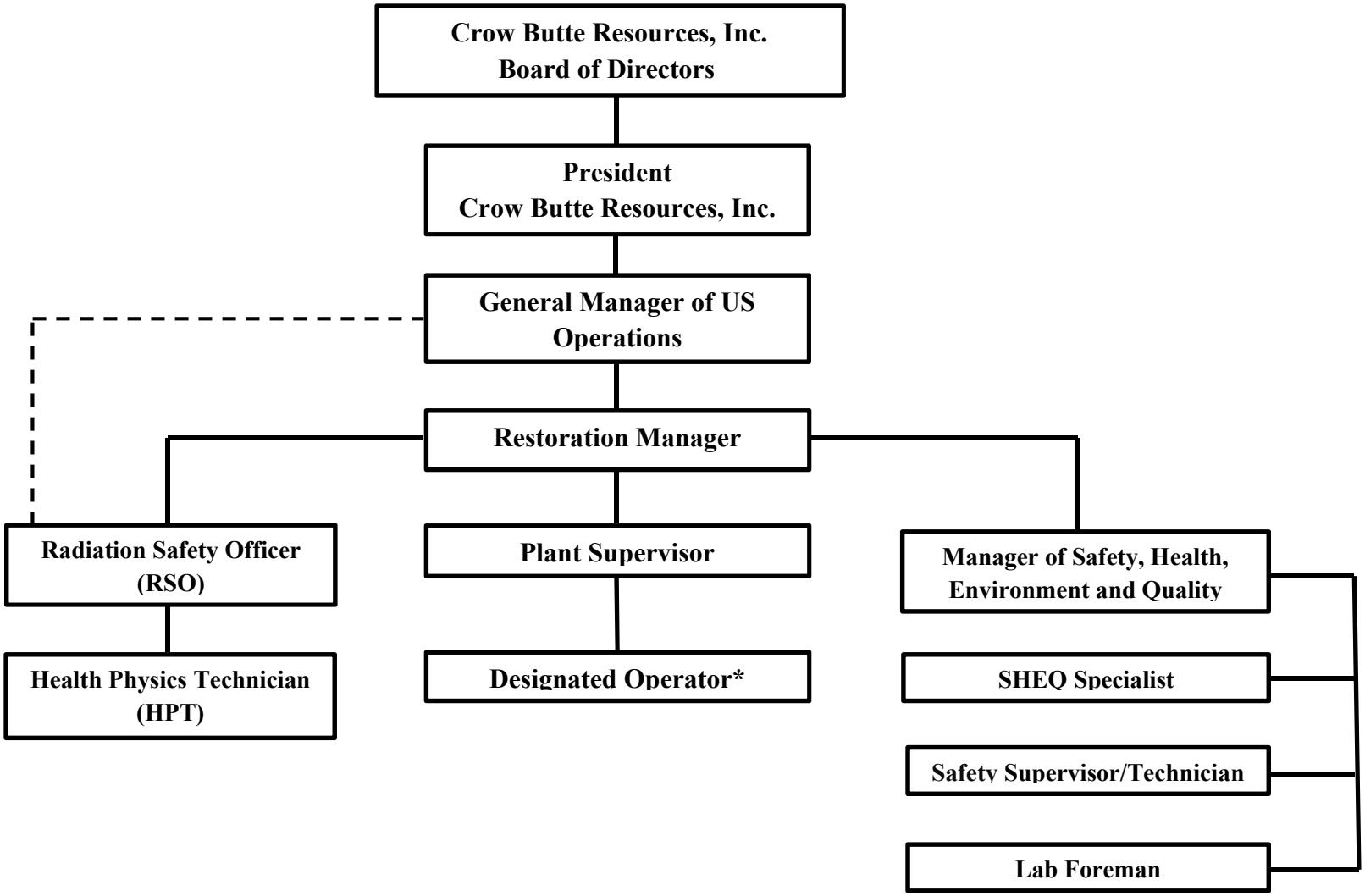
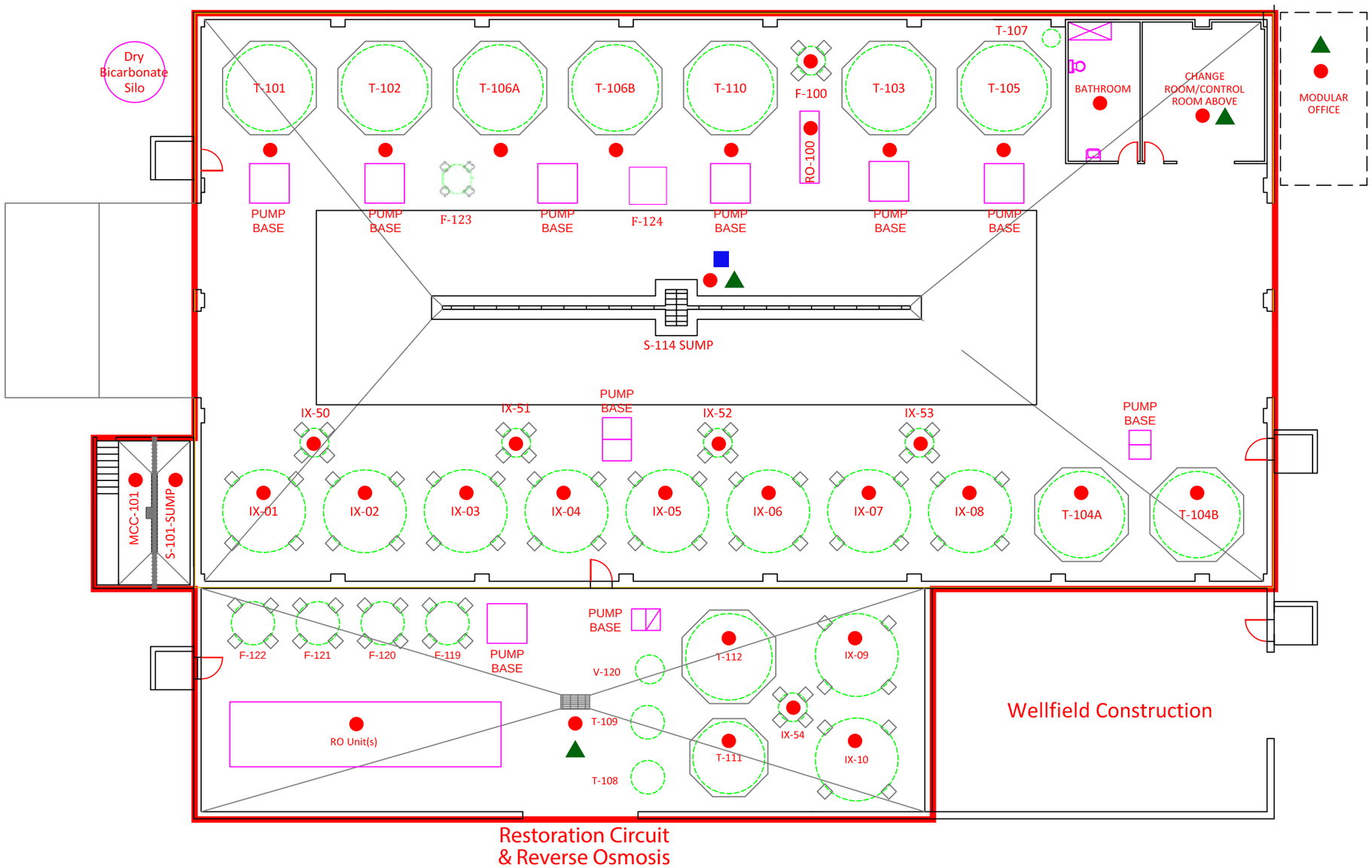
Figure 5.1-1: Crow Butte Resources Organizational Chart



*Qualifications for Designated Operator described in Marsland Expansion Area Technical Report, Section 5.5.4



Tank (# Each)	Description
IX-01 through 08	Ion Exchange
IX-50 through 54	Ion Exchange Resin Trap
IX-09 through 10	Restoration IX Column
T-101	Bicarbonate Mix
T-102	Bicarbonate Storage
T-103	Reverse Osmosis Feed
T-104A	Resin Transfer
T-104B	Resin Transfer
T-105	Water supply/Make-up Water
T-106A	Wastewater
T-106B	Wastewater
T-107	Water Pressure Tank
T-108	Sodium Sulfide Day
T-109	Sodium Sulfide Mix
T-110	Well Work Over Fluid
T-111	RO Cleaning Tank
T-112	Permeate Tank
F-119 through 122	RO Filter
V-120	Degaser
F-100	Sock filters
MCC-101	Injection pumps on trunk lines to wellfield
RO-100	RO Pump Base
F-123	Filter
F-124	Belt Filter

Legend:

- Gamma Survey Location
- Radon Testing Location
- Airborne Particulate Survey Location
- Restricted Area

Notes:

1. Illustration only, not to scale.
2. Adapted from Cameco Resources, 2011.

CROW BUTTE RESOURCES, INC.

FIGURE 5.7-2
PROPOSED OPERATIONAL RADIOLOGICAL MONITORING LOCATIONS FOR SATELLITE FACILITY

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: JEC

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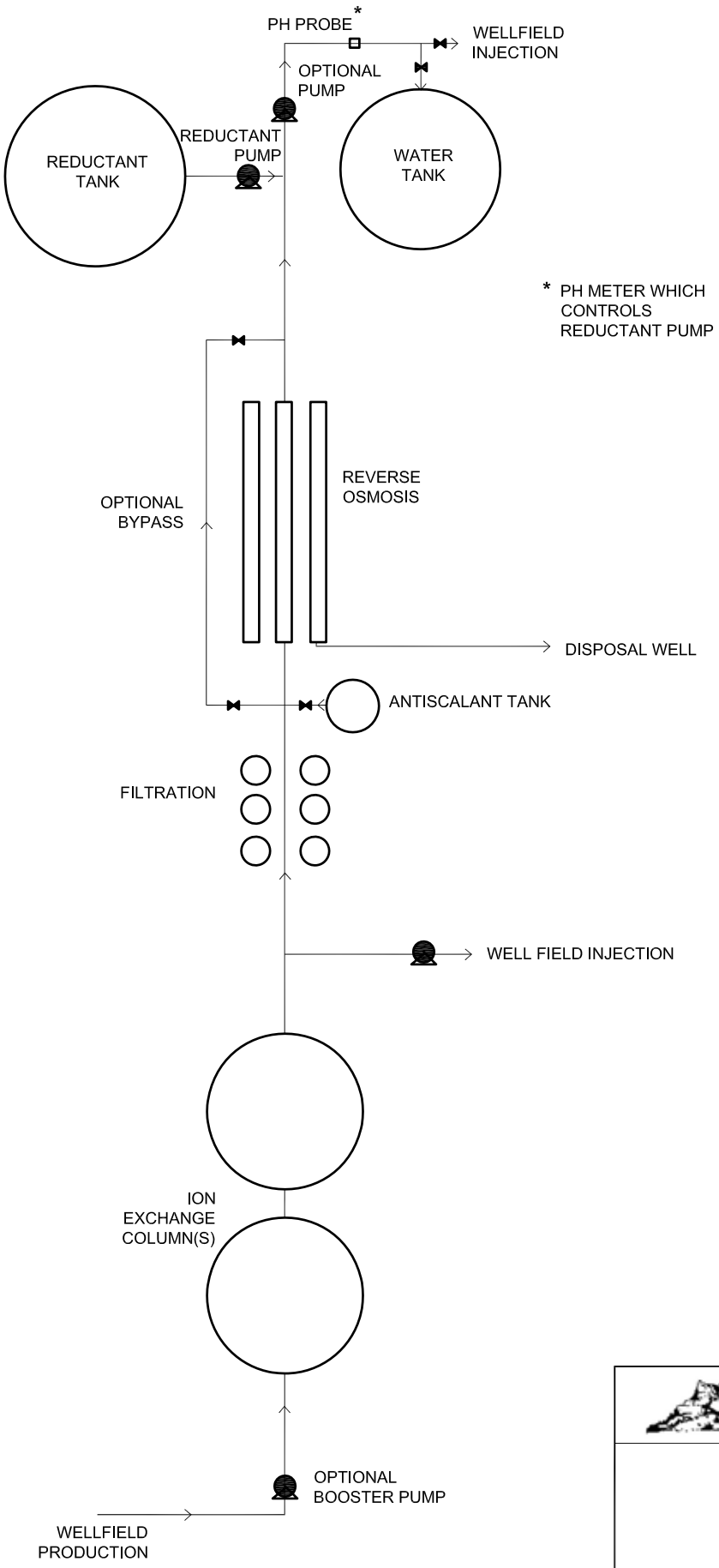

CROW BUTTE RESOURCES, INC.

FIGURE 6.1-1
RESTORATION PROCESS FLOW DIAGRAM

PROJECT: CO001396.02 MAPPED BY: JC CHECKED BY: JEC

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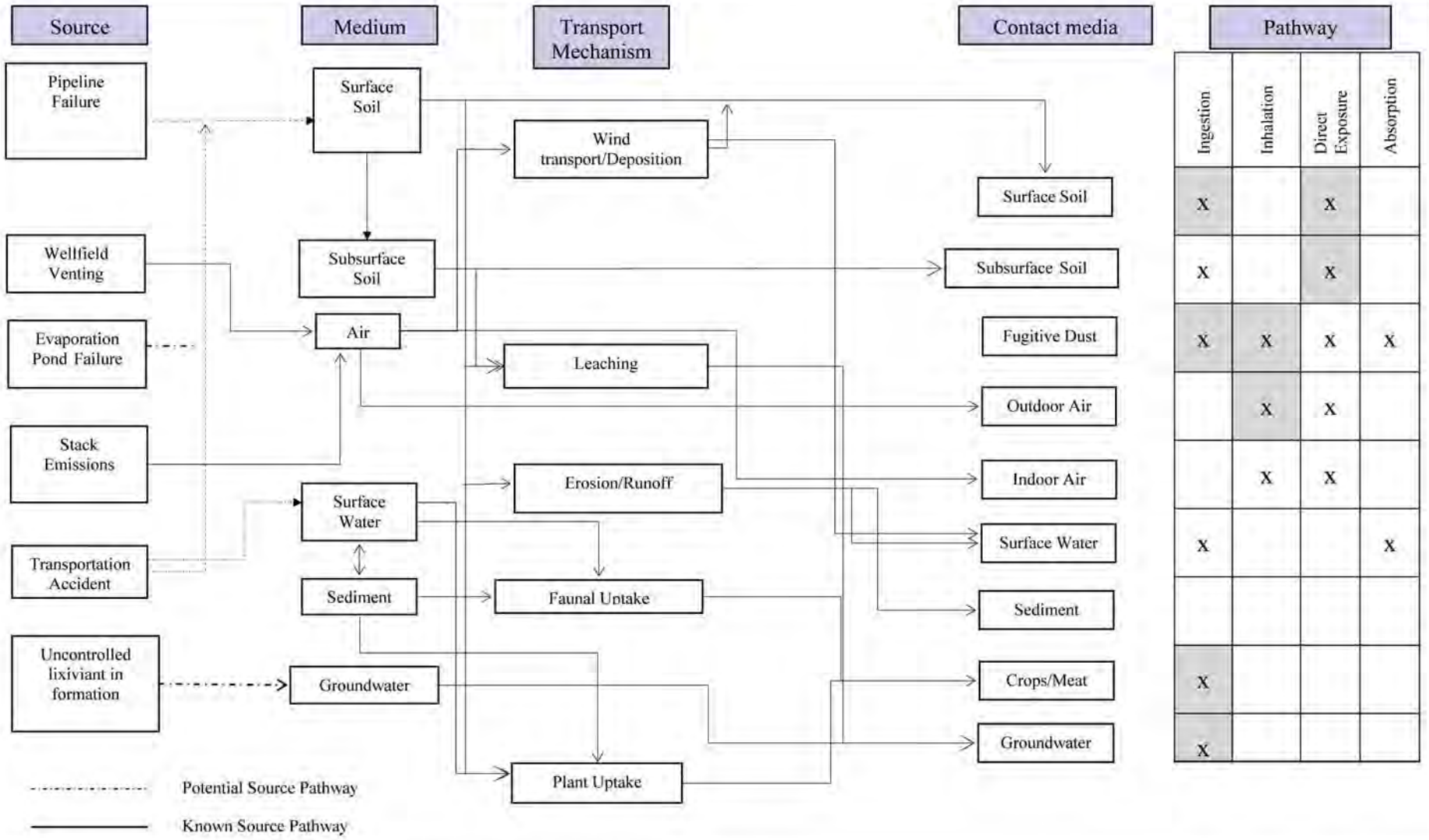

Note: X depicts the pathway that outlines the route which radiological emissions may follow to reach the public.
Gray shading depicts predominant pathway.

CROW BUTTE RESOURCES, INC.

FIGURE 7.3-1
MARSLAND
HUMAN EXPOSURE PATHWAYS FOR KNOWN AND POTENTIAL SOURCES OF RADIOLOGICAL EMISSIONS

PROJECT: CO001396.00001 MAPPED BY: JC CHECKED BY: LW

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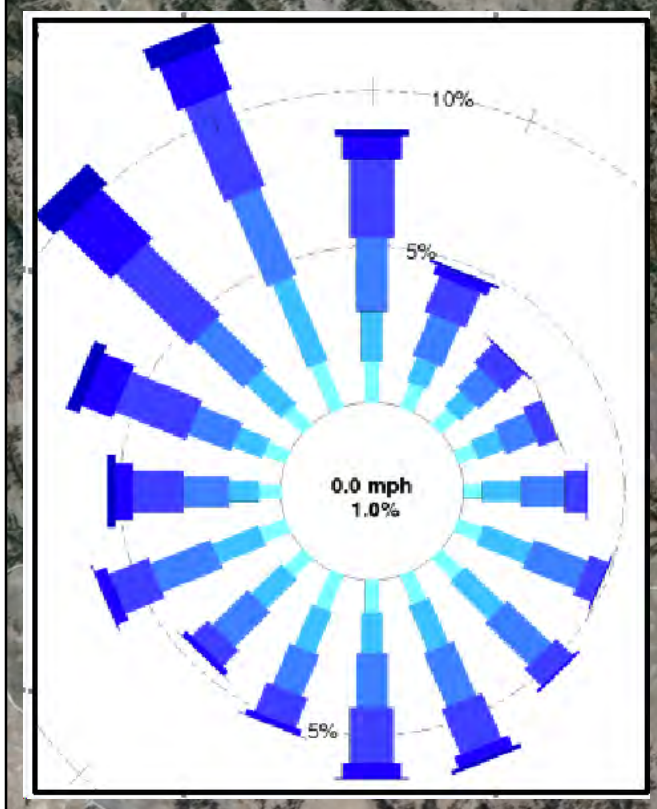
Path: K:\CBR_Projects\CO001636_Marsland\2_GIS\ArcMaps\0004_NRC_TR\Arcadis Marsland Figure 7.3-2 Mildos Receptors Residences and Designated MEA License Boundary Locations.mxd | Date: 10/9/2014 | User: CA044585



North Boundary DOSE #1
(18)

North Boundary DOSE #2
(17)

Residence #7
(10)

MU-A

Unoccupied #2
(13)

MU-1

Unoccupied #1
(32)

Residence #6
(9)

MU-2

MU-3

MET Station

West Boundary DOSE
(42)

Residence #2
(27)

MU-4

Residence #1
(18)

SAT Facility

East Boundary DOSE
(16)

MU-5

MAR-1

MAR-6

Marsland
License Boundary

South Boundary DOSE
(55)

MU-B

Residence #3
(10)

MU-C

MAR-2

Residence #4
(7)

MU-D

MU-E

Residence #5
(9)

MU-F

MAR-3

Residence #8
(5)

MAR-4

MAR-5

Residence #9
(7)

Residence #10
(6)

Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

LEGEND

- Air Sample Station
- Boundary Dose Point
- Residence (Occupiable)
- Unoccupied Structure (Unoccupiable)
- Proposed Satellite Plant Location
- MEA Met Station
- Project Boundary
- Mine Unit
- (10) MEA Mildos Estimated Radiation Dose Rate (in mrem/yr)

MEA = Marsland Expansion Area
mrem = millirems per year

Map Updated on: 10/9/2014

N

0 2,000 4,000

Feet

PROJECTION: NAD1983, STATE PLANE NEBRASKA NORTH, FIPS 2600
SOURCES: USDA NAIP IMAGERY 2010

CROW BUTTE RESOURCES, INC.

FIGURE 7.3-2
MILDOS RECEPTORS
RESIDENCES AND DESIGNATED MEA
LICENSE BOUNDARY LOCATIONS

PROJECT: CO001636 MAPPED BY: JC CHECKED BY: MS

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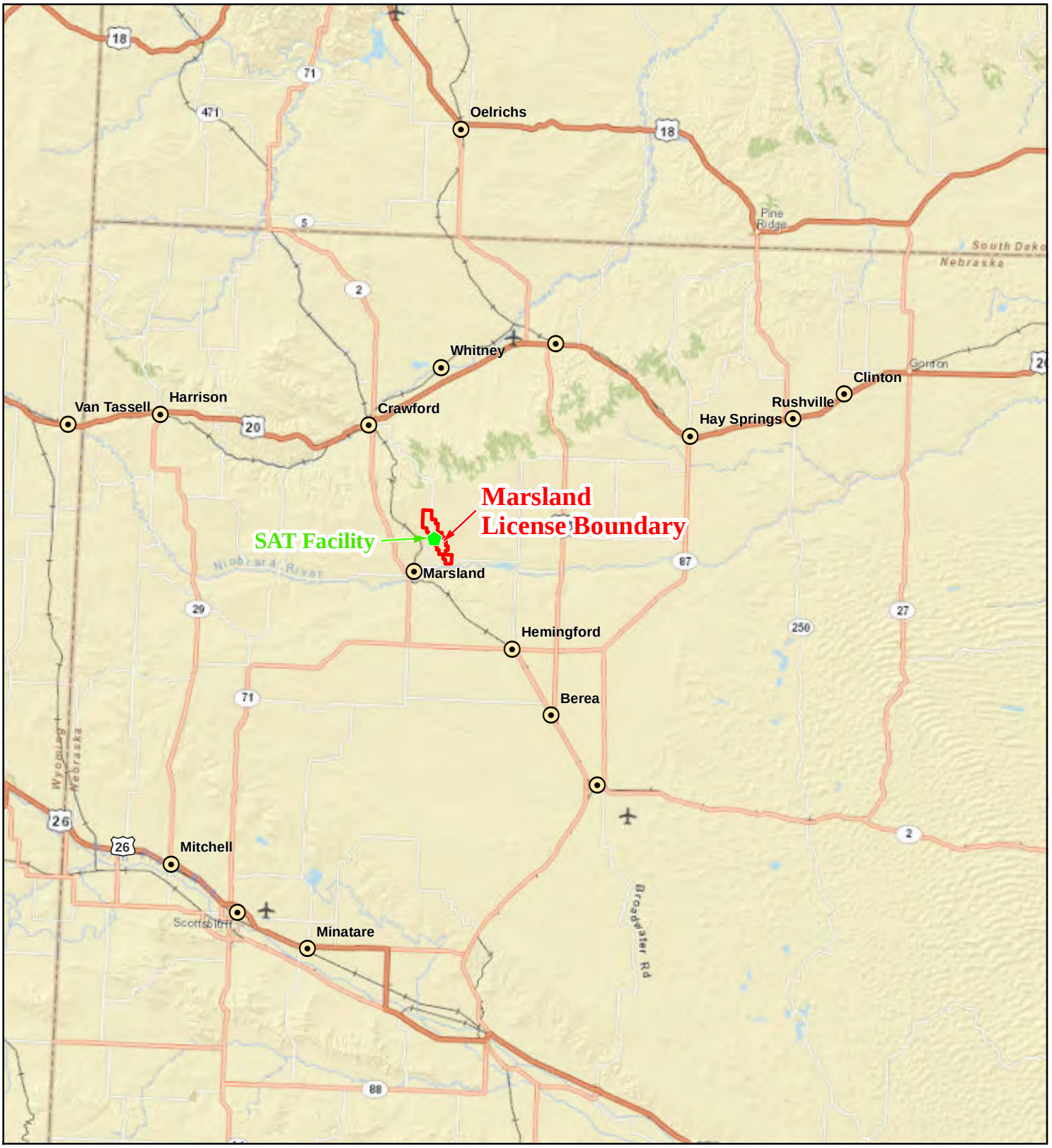

PROJECTION: NAD 1927, STATE PLANE NEBRASKA NORTH, FIPS 2601
SOURCES: WORLD STREET MAP SERVICED BY ESRI ARCGIS ONLINE

CROW BUTTE RESOURCES, INC.

FIGURE 7.3-3
MILDOS RECEPTORS
CITIES AND TOWNS IN REGION
AROUND MEA

PROJECT: CO001636 MAPPED BY: BB CHECKED BY: J. CEARLEY

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