Appendix X

Niobrara River Fish Tissue
Laboratory Records

Appendix X

Niobrara River Fish Tissue Laboratory Records

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client:	Crow Butte Resources	**Report Date:**	12/26/11
Project:	Marsland Baseline Box Butte Fish Tissue Samples	**Collection Date:**	08/22/11
Lab ID:	C11090375-001	**DateReceived:**	09/12/11
Client Sample ID	Box Butte Fish Tissue	**Matrix:**	Animal

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
RADIONUCLIDES - TOTAL							
Lead 210	<1E-06	uCi/kg	U	1.0E-06		E909.0	10/04/11 05:33 / eli-cs
Lead 210 precision (±)	7.0E-07	uCi/kg				E909.0	10/04/11 05:33 / eli-cs
Lead 210 MDC	1.0E-06	uCi/kg				E909.0	10/04/11 05:33 / eli-cs
Polonium 210	5.0E-07	uCi/kg		5.0E-07		E912.0	10/14/11 10:47 / ep
Polonium 210 precision (±)	4.0E-07	uCi/kg				E912.0	10/14/11 10:47 / ep
Polonium 210 MDC	5.0E-07	uCi/kg				E912.0	10/14/11 10:47 / ep
Radium 226	<2E-07	uCi/kg	U	2.0E-07		E903.0	10/31/11 17:19 / js
Radium 226 precision (±)	1.0E-07	uCi/kg				E903.0	10/31/11 17:19 / js
Radium 226 MDC	2.0E-07	uCi/kg				E903.0	10/31/11 17:19 / js
Thorium 230	1.0E-05	uCi/kg		8.0E-06		E908.0	11/29/11 16:15 / dmf
Thorium 230 precision (±)	6.0E-06	uCi/kg				E908.0	11/29/11 16:15 / dmf
Thorium 230 MDC	8.0E-06	uCi/kg				E908.0	11/29/11 16:15 / dmf
Uranium	ND	mg/kg		0.0003		SW6020	10/01/11 16:32 / sml
Uranium, Activity	<2E-07	uCi/kg		2.0E-07		SW6020	10/01/11 16:32 / sml

- See Case Narrative regarding Ra226 analysis.

Report Definitions:

RL - Analyte reporting limit.
QCL - Quality control limit.
MDC - Minimum detectable concentration
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
U - Not detected at minimum detectable concentration

LABORATORY ANALYTICAL REPORT

Prepared by Casper, WY Branch

Client:	Crow Butte Resources	**Report Date:**	08/09/12
Project:	Marsland Baseline Box Butte Fish Tissue Samples	**Collection Date:**	05/25/12
Lab ID:	C12060919-001	**DateReceived:**	06/21/12
Client Sample ID	Butte Fish Tissue	**Matrix:**	Solid

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
RADIONUCLIDES							
Lead 210	7.9E-07	uCi/kg	U			E909.0	08/03/12 11:30 / eli-cs
Lead 210 precision (±)	8.1E-07	uCi/kg				E909.0	08/03/12 11:30 / eli-cs
Lead 210 MDC	1.0E-06	uCi/kg				E909.0	08/03/12 11:30 / eli-cs
Polonium 210	2.8E-07	uCi/kg	U			E912.0	07/23/12 16:47 / plj
Polonium 210 precision (±)	1.0E-06	uCi/kg				E912.0	07/23/12 16:47 / plj
Polonium 210 MDC	2.1E-06	uCi/kg				E912.0	07/23/12 16:47 / plj
Radium 226	2.2E-07	uCi/kg				E903.0	07/31/12 00:40 / trs
Radium 226 precision (±)	1.5E-07	uCi/kg				E903.0	07/31/12 00:40 / trs
Radium 226 MDC	1.9E-07	uCi/kg				E903.0	07/31/12 00:40 / trs
Thorium 230	6.7E-08	uCi/kg	U			E908.0	07/24/12 08:54 / dmf
Thorium 230 precision (±)	5.8E-06	uCi/kg				E908.0	07/24/12 08:54 / dmf
Thorium 230 MDC	1.4E-05	uCi/kg				E908.0	07/24/12 08:54 / dmf
Uranium	0.00099	mg/kg	D	0.00040		SW6020	08/05/12 02:15 / cp
Uranium, Activity	6.7E-07	uCi/kg	D	2.7E-07		SW6020	08/05/12 02:15 / cp

- See Case Narrative regarding Po210 analysis.
- See Case Narrative regarding Th230 analysis.

Report Definitions:

RL - Analyte reporting limit.
QCL - Quality control limit.
MDC - Minimum detectable concentration
U - Not detected at minimum detectable concentration
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
D - RL increased due to sample matrix.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Crow Butte Resources
Project: Marsland Baseline Box Butte Fish Tissue Samples

Report Date: 08/09/12
Work Order: C12060919

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E903.0										Batch: RA226-6121
Sample ID: LCS-34244		Laboratory Control Sample				Run: BERTHOLD 770-1_120720A				07/31/12 00:40
Radium 226		13	pCi/g-dry		106	70	130			
Sample ID: MB-34244	3	Method Blank				Run: BERTHOLD 770-1_120720A				07/31/12 00:40
Radium 226		0.0002	pCi/g-dry							U
Radium 226 precision (±)		0.0002	pCi/g-dry							
Radium 226 MDC		0.0003	pCi/g-dry							
Sample ID: C12070171-003AMS		Sample Matrix Spike				Run: BERTHOLD 770-1_120720A				07/31/12 00:40
Radium 226		1.6	pCi/g-dry		101	70	130			
Sample ID: C12070171-003AMSD		Sample Matrix Spike Duplicate				Run: BERTHOLD 770-1_120720A				07/31/12 00:40
Radium 226		1.8	pCi/g-dry		112	70	130	8.6	24.6	

Qualifiers:

RL - Analyte reporting limit.

MDC - Minimum detectable concentration

ND - Not detected at the reporting limit.

U - Not detected at minimum detectable concentration

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Crow Butte Resources
Report Date: 08/09/12
Project: Marsland Baseline Box Butte Fish Tissue Samples
Work Order: C12060919

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E908.0										Batch: RA-TH-ISO-1655
Sample ID: C12060959-005AMS		Sample Matrix Spike				Run: EGG-ORTEC_120720C				07/24/12 08:54
Thorium 230		19.0	pCi/g-dry		81	70	130			
Sample ID: C12060959-005AMSD		Sample Matrix Spike Duplicate				Run: EGG-ORTEC_120720C				07/24/12 08:54
Thorium 230		20.3	pCi/g-dry		87	70	130	6.5	42.8	
Sample ID: LCS-34117		Laboratory Control Sample				Run: EGG-ORTEC_120720C				07/24/12 08:54
Thorium 230		1.4	pCi/g-dry		116	80	120			
Sample ID: MB-34117	3	Method Blank				Run: EGG-ORTEC_120720C				07/24/12 08:54
Thorium 230		0.02	pCi/g-dry							U
Thorium 230 precision (±)		0.02	pCi/g-dry							
Thorium 230 MDC		0.03	pCi/g-dry							
Sample ID: MB-34244	3	Method Blank				Run: EGG-ORTEC_120720C				07/24/12 08:54
Thorium 230		-4E-05	pCi/g-dry							U
Thorium 230 precision (±)		0.0007	pCi/g-dry							
Thorium 230 MDC		0.002	pCi/g-dry							

Qualifiers:

RL - Analyte reporting limit.
MDC - Minimum detectable concentration
ND - Not detected at the reporting limit.
U - Not detected at minimum detectable concentration

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QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Crow Butte Resources **Report Date:** 08/09/12

Project: Marsland Baseline Box Butte Fish Tissue Samples **Work Order:** C12060919

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E909.0										Batch: T_16759R
Sample ID: MB-16759	3	Method Blank				Run: SUB-T46565				08/03/12 02:38
Lead 210		7E-06	uCi/kg							U
Lead 210 precision (±)		6E-06	uCi/kg							
Lead 210 MDC		1E-05	uCi/kg							
Sample ID: LCS-16759		Laboratory Control Sample				Run: SUB-T46565				08/03/12 07:04
Lead 210		0.0023	uCi/kg		96	70	130			
Sample ID: C12060919-001AMS		Sample Matrix Spike				Run: SUB-T46565				08/03/12 15:57
Lead 210		0.00063	uCi/kg		102	70	130			
Sample ID: C12060919-001AMSD		Sample Matrix Spike Duplicate				Run: SUB-T46565				08/03/12 20:23
Lead 210		0.00060	uCi/kg		101	70	130	4.6	12.1	

Qualifiers:

RL - Analyte reporting limit.

MDC - Minimum detectable concentration

ND - Not detected at the reporting limit.

U - Not detected at minimum detectable concentration

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Crow Butte Resources **Report Date:** 08/09/12

Project: Marsland Baseline Box Butte Fish Tissue Samples **Work Order:** C12060919

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: E912.0										Batch: R162276
Sample ID: C12060913-003EMS		Sample Matrix Spike				Run: EGG-ORTEC_120720B				07/23/12 16:47
Polonium 210		6.2	pCi/L		84	70	130			
Sample ID: C12060913-003EMSD		Sample Matrix Spike Duplicate				Run: EGG-ORTEC_120720B				07/23/12 16:47
Polonium 210		5.8	pCi/L		78	70	130	6.3	65.2	
Sample ID: LCS-34116		Laboratory Control Sample				Run: EGG-ORTEC_120720B				07/23/12 16:47
Polonium 210		66	pCi/L		96	80	120			
Sample ID: MB-34116	3	Method Blank				Run: EGG-ORTEC_120720B				07/23/12 16:47
Polonium 210		-0.2	pCi/L							U
Polonium 210 precision (±)		2	pCi/L							
Polonium 210 MDC		4	pCi/L							
Sample ID: LCS-34240		Laboratory Control Sample				Run: EGG-ORTEC_120720B				07/23/12 16:47
Polonium 210		50	pCi/L		74	80	120			S
- LCS response is outside of the acceptance range for this analysis. Since the MS, MSD, first LCS, and all tracer recoveries are acceptable the batch is approved.										
Sample ID: MB-34240	3	Method Blank				Run: EGG-ORTEC_120720B				07/23/12 16:47
Polonium 210		ND	pCi/L							U
Polonium 210 precision (±)		2	pCi/L							
Polonium 210 MDC		4	pCi/L							

Qualifiers:

RL - Analyte reporting limit.

MDC - Minimum detectable concentration

U - Not detected at minimum detectable concentration

ND - Not detected at the reporting limit.

S - Spike recovery outside of advisory limits.

QA/QC Summary Report

Prepared by Casper, WY Branch

Client: Crow Butte Resources | **Report Date:** 08/09/12

Project: Marsland Baseline Box Butte Fish Tissue Samples | **Work Order:** C12060919

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6020										Analytical Run: ICPMS4-C_120805A
Sample ID: ICV		Initial Calibration Verification Standard								08/05/12 00:45
Uranium		0.0517	mg/L	0.00030	103	90	110			
Sample ID: ICSA		Interference Check Sample A								08/05/12 00:49
Uranium		5.82E-05	mg/L	0.00030						
Sample ID: ICSAB		Interference Check Sample AB								08/05/12 00:53
Uranium		1.67E-05	mg/L	0.00030						
Method: SW6020										Batch: 34244
Sample ID: MB-34244		Method Blank				Run: ICPMS4-C_120805A				08/05/12 01:43
Uranium		0.0001	mg/kg							
Sample ID: LCS2-34244		Laboratory Control Sample				Run: ICPMS4-C_120805A				08/05/12 01:47
Uranium		0.047	mg/kg	0.0030	94	70	130			
Sample ID: C12060919-001ADIL		Serial Dilution				Run: ICPMS4-C_120805A				08/05/12 02:19
Uranium		0.00092	mg/kg	0.0020					20	
Sample ID: C12060919-001AMS		Sample Matrix Spike				Run: ICPMS4-C_120805A				08/05/12 02:24
Uranium		0.084	mg/kg	0.00040	124	75	125			
Sample ID: C12060919-001AMSD		Sample Matrix Spike Duplicate				Run: ICPMS4-C_120805A				08/05/12 02:28
Uranium		0.082	mg/kg	0.00040	120	75	125	2.8	20	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

MDC - Minimum detectable concentration

Appendix Y

Cameco Evaluation of Site
Ventilation Systems

Appendix Y

Air Ventilation, Air Surveys and Air Exchange Measurements for Plant Facilities at Crow Butte, NE and Smith Ranch, WY

Prepared for:

Power Resources, Inc.

August 14, 2013


By:
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EXECUTIVE SUMMARY

Airflow measurements were made at Cameco's Crow Butte, NE and the Smith Ranch, WY in-situ leach uranium processing facilities to determine the airflow rate and the air exchange rate for these facilities. Prior to data collection, the facility layouts and configurations were analyzed and a plan was made for conducting physical air measurements and gathering base data to estimate flow rates and air exchange rates for these facilities. These measurements were made at selected points across the openings of the facilities using highly accurate hand-held anemometers, pitot tubes and velometers. Additional flow-rate measurements were calculated using air monitoring instruments and ventilation equipment manufacturer's information. Measurements were based on physical measurements in exhaust vents and stacks. This field data was then reduced and analyzed.

The resulting flow rates for discharges to unrestricted areas and the calculated facility air exchange rates are presented below.

Facility	Flow Rates for Discharges to Unrestricted Areas	Facility Air Exchanges/Hour
Smith Ranch, WY	56,927 cubic feet per minute	5.4
Crow Butte, NE	77,433 cubic feet per minute	4.6

The accuracy of the ventilation numbers reported is estimated at plus-or-minus 15% accuracy. Numerous inputs were considered in this statement of accuracy, such as accuracy of the instruments, accessories and various measuring devices. The range of positioning the garage-style air inlet doors (i.e., were doors open, closed or partially closed) and the resulting effect on air flow was also taken into account.

The multiple exhaust fans at both facilities results in a negative pressure inside each of the facility buildings at Smith Ranch, WY and Crow Butte, NE. In the yellow cake production process, it was noted that areas for potential radon release were enclosed with exhausting ventilation ducting, sheet metal or other material. These enclosures and the negative pressure

from the ventilation system design control and mitigate the concentration of radon emissions within each of these facilities.

Airflow, through any openings in vessels or process equipment, is from the process areas into the ventilation systems which maintain the negative pressure, thereby directing any releases from within these facilities to the ventilation exhaust ducting. Any radon emissions within these processes are thereby directed to the ventilation system ducting or fans, which further reduces the radon concentration by the addition of air induced into the ventilation exhaust fans or blowers prior to venting to the atmosphere.

This ventilation design is effective in preventing or mitigating radon releases to the workers and the public.

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APPENDICES

1.0 INTRODUCTION

The Nuclear Regulatory Commission (NRC) reviewed the gaseous and airborne particulate effluent control systems at the Crow Butte, NE and Smith Ranch, WY facilities. For air particulates related to the vacuum drying of uranium yellow cake, they concluded that Cameco meets all applicable regulatory criteria stated in 10 CFR Parts 20 and 40. With respect to radon, the NRC notes that most of the radon is vented from the process stream via exhaust ventilation that directs the radon to discharge stacks located away from building ventilation intakes. The ventilation system is designed to control worker exposure and to prevent or mitigate releases to the public to prevent or limit radiation exposure. Additional radon releases occurring during operations are infrequent. Thus, the NRC has concluded that Cameco's radon controls are adequate.

Notwithstanding these findings, in the resulting Safety Evaluation Report, the NRC found that Cameco 1) must address the discharge flow rate to the environment and 2) provide information regarding the air flow rate for the redundant exhaust fans and the air exchange rate for each facility. The NRC further noted that 3) Cameco should discuss methods for controlling radon releases. This report details the effort of gathering the requisite data and information to address items 1 through 3 described above.

This report includes measurements of flow rates for discharges to unrestricted areas and the air exchange rate for the facilities, and further describes the method(s) used to control releases to unrestricted areas.

2.0 WORK SCOPE

A portion of this effort included visiting both the Crow Butte and Smith Ranch operations. Additional information was gathered regarding the number of doors and openings to the facilities, the number and configuration of intake and exhaust ducts, the proper placement of air and flow rate measuring instruments in the exhaust stacks and ventilation ducts. Prior to data collection, contacts were made with appropriate Smith Ranch and Crow Butte personnel to more fully define the layout and configuration of these facilities.

A plan was then made for conducting physical air measurements and gathering base data to estimate a range of flow rates and air exchange rates for each of the facilities. These measurements were made at selected points across the openings of the facilities using highly-accurate hand-held anemometers, pitot tubes and velometers.

Cameco noted that during facility operations, the roll-up doors of the facility may be open or closed, depending on a number of factors. Because the exhaust from the facilities is through vents using air-induced blowers and fans, the facilities each have a negative pressure with respect to the outside atmosphere. As a result, radon is vented from process equipment in these facilities and is routed through the ventilation system for emission to the atmosphere at the exhaust stacks. Accordingly, additional air flow measurements were made in exhaust vents and stacks using air instruments, as appropriate. This field data was then reduced and analyzed.

Based on these measurements, Cameco will be able to provide flow rates for discharges to unrestricted areas and air exchange rates for the facilities. This data coupled with the existing and proposed measurements of emission concentrations will provide a technical basis to determine the radiation dose resulting from releases to unrestricted areas.

3.0 FIELD WORK EXECUTION

The following are highlights of the performed work.

3.1 FIELD INSTRUMENTS UTILIZED

A TSE (Alnor) model 9555-P wind vane anemometer and a model 964 Thermal Anemometer (TA) probe were used to make field air flow measurements. Specifications for each instrument are given below:

Table 1 – Instrument Specifications

Instrument	Range/Resolution	Accuracy	Calibration Date	Notes
TSI (Alnor) model 9555-P wind vane anemometer	50 to 6,000 feet per minute/ -1 feet per minute 0.1 degree Fahrenheit	+/- 1% of reading +/- 4 feet per minute (+/- 0.02 meters per minute)	Aug 2012	Next calibration due Aug 2013
Thermal Anemometer probe model number 964	0 to 9,999 feet per minute	+/- 3% of reading	Aug 2012	Next calibration due Aug 2013

Air measurement instruments were field calibrated for barometric pressure and humidity at the respective facilities, using the facilities' nearest weather station, while cross-referencing with the nearest Accuweather® station. The TSI (Alnor) 9555P, with the wind vane anemometer, was the base instrument used as much as practicable, due to its extraordinary accuracy (+/- 1% of readings).

3.2 FIELD WORK – SMITH RANCH, WY

April 25 -26, 2013:

Arlene Faunce, RSO; Beverly Johnson, Sr. HP tech and Plant Superintendent Erik Heide were extremely helpful in facilitating the process of taking air readings at the facility and also conveying information about the facility ventilation, which was critical in completing this field

work. Velocity readings and ancillary measurements were taken at the facility.

All velocity readings were taken with the highly accurate Anemometer, except the truck sump fan inlet, where air readings were taken with the Thermal Anemometer (TA) probe due to physical constraints (see Tables 2 and 3 below). Data was gathered for equipment at inaccessible areas from manufacturer name plate data and plant records, which were plentiful at this facility. Air surveys of the plant wall-installed fan inlets were conducted on all lower wall fans. Area determinations were based on measurements taken with a standard Stanley® metal tape measure. Digital photographs were taken at major sampling locations. These photos are located in Appendix A.

The field readings are summarized in Tables 2 and 3. Total flow rate for discharges to unrestricted areas is 56,927 cubic feet per minute (CFM), which is the sum total of the quantities provided in Tables 2 and 3.

Table 2 - Ventilation & Air Readings - Smith Ranch, WY - 4/26/13

Note: Reference Appendix A for photographs of the items listed below				
Location	**Vane (V) or Thermo Anemometer (TA) Readings (fpm)**	**Area (sq ft)**	**Quantity (cfm)**	**Temperature °F**
#1 Lower Fan	V - 1323, 1313, 1377, 1333 $\bar{V}$ = 1337	5.07	6776	71.0
#2 Upper Fan	Down for Maintenance			
#3 Lower Cooler Fan	V - 508, 482, 490, 577, 445, 439, 548, 486, 548, 522, 490, 513, 359, 432, 501, 573, 570, 573 $\bar{V}$ = 503	32.5" x 53" => 12.0 sq ft	6040	71.0
#4 Upper Fan	Down for Maintenance			
#5 Upper Fan	Down for Maintenance			
#6 Lower Fan	V - 1276, 1292, 1307, 1392 $\bar{V}$ = 1317	5.07	6676	71.4
#7 Lower Fan	V- 1026, 1016, 1099, 992, 865, 964, 934, 1019, 1164 $\bar{V}$ = 1009	44.5" x 44.75" => 13.8 sq ft	13900	71.6
Note: #'s 2, 4 & 5 upper vent fans were down for maintenance.				
Sum of Quantities: 33,392 (cfm)				

Table 3 - Ventilation & Air Readings
Information from Manufacturer's Data & Fan Curves
Smith Ranch, WY - 4/26/13

Note: Reference Appendix A for photographs of the items listed below		
Location	**Quantity (cfm)**	**Temperature °F**
#8 Upper Fan	3610	68.5
#9 Upper Fan	3610	67.0
A. T106A Fan (HF)	263	71.5
B. T100 Fan (HF)	263	71.0
C. Truck Sump Fan	5000	71.0
D. NE Shaker Fan	5000	72.3
E. SE Shaker Fan	5000	74.3
F. T20 Radon Exhaust Fan	263	71.6
G. T40 Radon Exhaust Fan	263	71.9
H. T21 Radon Exhaust Fan	263	75.3
Sum of Quantities: 23,535 (cfm)		

3.3 FIELD WORK – CROW BUTTE, NE

April 28 -29, 2013:

Meetings were held with Plant Superintendent Bruce Lemmon to facilitate data collection. This ensured the plant was covered adequately. Rhonda Grantham, RSO; Casey Yada, Sr. HP tech, and Plant Superintendent Bruce Lemmon were extremely helpful in facilitating the process of taking air readings at the facility and also conveying information about the facility ventilation, which was critical in completing this field work.

Velocity readings and ancillary physical measurements were taken inside and out of the processing plant at accessible exhaust fans and stacks. Data was gathered at inaccessible areas from manufacturer name plate data and plant records, which were plentiful at this facility.

The TSI (Alnor) 9555P was the base instrument used in these field air measurements with all velocity readings taken with the Vane Anemometer attachment (accuracy +/- 1% of readings). In this plant, there were dozens of manometers (U-tubes) in the vent lines, which were also located and read.

Digital photographs were taken at major sampling locations. These photos are located in Appendix B. The field readings are summarized in Tables 4 and 5 on the following pages. Total flow rate for discharges to unrestricted areas is 77,433 cubic feet per minute (CFM), which is the sum total of the quantities provided in Tables 4 and 5.

Table 4 - Ventilation & Air Readings - Crow Butte, NE - 4/29/13

Note: Reference Appendix B for photographs of the items listed below

Location	Vane (V) or Thermo Anemometer (TA) Readings (fpm)	Dimensions (inches)	Area (sq ft)	Quantity (cfm)	Temperature °F
#1 Pipe	V - 2952 (centerline) 3200, 2872, 2876, 3029 $\bar{V}$ = 2994	23.75" diam	3.076	9209	63.2
#2 Pipe	V - 3389 (centerline) 3200, 3595, 3740, 3046 $\bar{V}$ = 3395	22.75" diam	2.83	9610	62.4
#3 Boxed Fan	V - 574, 689, 818, 756, 930, 730, 427, 578, 818, 619, 818, 803, 656, 837, 678, 1027, 788, 780 $\bar{V}$ = 740	36.5" by 36.5" by 11" box	9.25	6845	63.0
#4 Boxed Fan	V- 634, 864, 652, 666, 709, 754, 786, 506, 490, 665, 903, 566, 710, 671, 776, 521, 487, 490 $\bar{V}$ = 658	36.5" by 36.5" by 11" box	9.25	6090	63.0
#5 Duct	V- 3369 (centerline) 3572, 2579, 2830, 3214 $\bar{V}$ = 3049	24.5" diam	3.22	9820	66.5
#9 Box Fan	V- 670, 636, 433, 602, 780, 654, 592, 672, 672, 785, 579, 691, 485, 666, 670, 212, 616, 378, 669, 482 $\bar{V}$ = 597	36.5" by 36.5" by 14" box	9.25	5523	63.9
#12 Shaker Room Blower/Exhaust	V - 3111 (centerline)	12.5" diam 0.85	0.85	2651	49.0
Sum of Quantities: 49,748 (cfm)					

Table 5 - Ventilation & Air Information from Manufacturer's Data
Crow Butte, NE - 4/29/13

Note: Reference Appendix B for photographs of the items listed below		
Location	**Quantity (cfm)**	**Temperature °F**
#6 Centifugal Pond Water Treatment Fan	4700	67.0
#7 Chem Mix Demister Fan	4700	66.1
#8 Waste Tank Blower	1500	66.1
#10 Precip Demister Fan (same unit as #8 above)	1500	62.0
#11 Shaker Deck (west)	800	63.9
#13 Eluent Tank Blower	1500	67.8
#14 Precip A Blower	185	67.8
#15 East Train Blower	6000	71.3
#16 West Tank Blower	6000	72.0
#17 Backwash Tank Demister Blower	800	70.5
Sum of Quantities: 27,685 (cfm)		

4.0 DISCUSSION AND ANALYSIS OF FIELD DATA

There are large roll-up, garage style doors at both the Smith Ranch, WY and Crow Butte, NE plant facilities. Typically, these doors have openings measuring 12' wide by 16' high. During operations at the facilities these roll-up doors may be positioned fully opened, partially opened and sometimes fully closed. On a particular day, this positioning of the doors may change for a number of reasons, like opening/closing doors for retrieval of resin, deliveries, facility temperature control and general personnel/equipment access.

Field air velocity measurements were taken at both plant facilities to determine the effect of air flow with the opening and closing of the garage style roll-up doors. As the doors were moved to various positions, it was noted that air velocity (and also air flow) measurements did not vary more than approximately 10%, which is comparable to typical variations in air flow operation over the course of time. This field data shows that when the roll-up doors were closed there were alternate and adequately-sized openings for air flow to continue. These openings include louvers, vents, doors and other openings that allowed air flow.

Field air measurements confirmed that the facilities have an effective ventilation design and control system consisting of parallel installations of multiple blowers and fans that exhaust air from the facilities. The configuration of intake and exhaust ducts is adequate with respect to their opening size and location. The air intakes of the facilities are located such that the intake ducts intake fresh air, well away from the plant air exhausts, so air recirculation was not an issue.

The multiple exhaust fans at both facilities results in a negative pressure inside each of the facility buildings at Smith Ranch, WY and Crow Butte, NE. Airflow, through any openings in vessels or process equipment, is from the process areas into the ventilation systems, which maintains negative pressure, positive flow and control of releases. Negative pressure vacuum dryers are used to contain and control radon emissions, which are then reduced in concentration by the induced air flow within the ventilation exhaust system and vented to the atmosphere. These vacuum dryers are much more effective in radon control compared with

the former hearth style of dryer design. At each of these two facility buildings, there were 17 blowers or exhaust fans which exhaust air from facility process areas. The ventilation systems at both of these facilities exhaust to outside the facility buildings and draw in fresh air from a location at a sufficient distance from the exhaust locations. This design minimizes recirculation of the fresh air ventilation system and help control potential releases. The field data and measurements of these 34 blowers or exhaust fans are shown in Section 3.0 of this report.

This negative pressure present in the facilities is a control feature for radon emissions. In the yellow cake production process, it was noted that points for potential radon release were enclosed with exhaust ventilation ducting, sheet metal or other items to contain and direct radon emissions to the exhaust ventilation system where possible. Accordingly, radon emissions are controlled where possible within these facilities and their concentrations are reduced by the induced air flow from the ventilation exhaust fans or blowers, and vented to the atmosphere.

Based on the physical measurements taken in the field, the air exchange rates for the two facilities are presented in the following table:

Table 6 – Facility Air Exchanges

Facility	Air Exchanges / Day	Air Exchanges / Hour
Smith Ranch, WY	129	5.4
Crow Butte, NE	111	4.6

An additional objective of the field work was to provide flow rates for discharges to unrestricted areas. These flow rates, for the Smith Ranch, WY and Crow Butte, NE plant facilities are presented in the following table:

Table 7 - Flow Rates for Discharges to Unrestricted Areas

Facility	Flow Rates for Discharges to Unrestricted Areas	Facility Volume
Smith Ranch, WY	56,927 cubic feet per minute	632,050 cubic feet
Crow Butte, NE	77,433 cubic feet per minute	1,000,565 cubic feet

5.0 CONCLUSIONS

Field air measurements and data were taken and air volumes calculated for the Smith Ranch, WY and Crow Butte, NE plant facilities. The discharge flow rate to the environment at the two Cameco facilities was calculated utilizing direct field measurements and data taken at the facility.

Facility	Flow Rates for Discharges to Unrestricted Areas	Facility Volume
Smith Ranch, WY	56,927 cubic feet per minute	632,050 cubic feet
Crow Butte, NE	77,433 cubic feet per minute	1,000,565 cubic feet

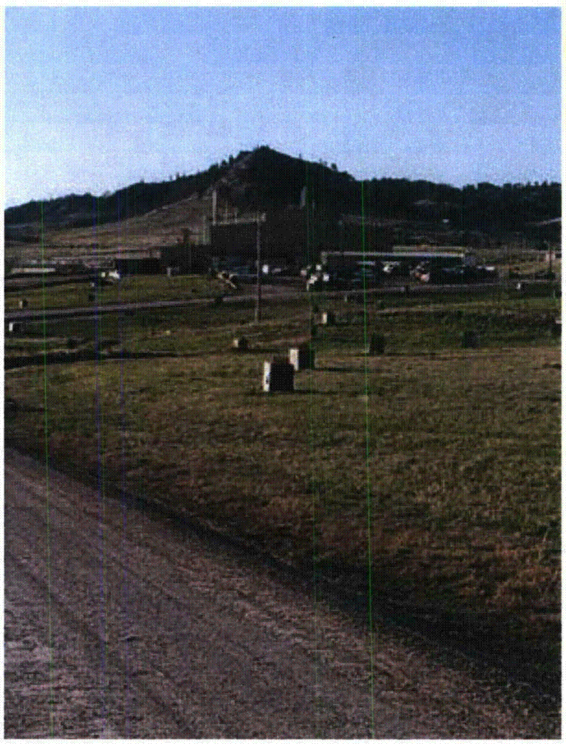
The air exchange rate for the facility was calculated utilizing field data review and analysis.

Facility	Air Exchanges / Day	Air Exchanges / Hour
Smith Ranch, WY	129	5.4
Crow Butte, NE	111	4.6

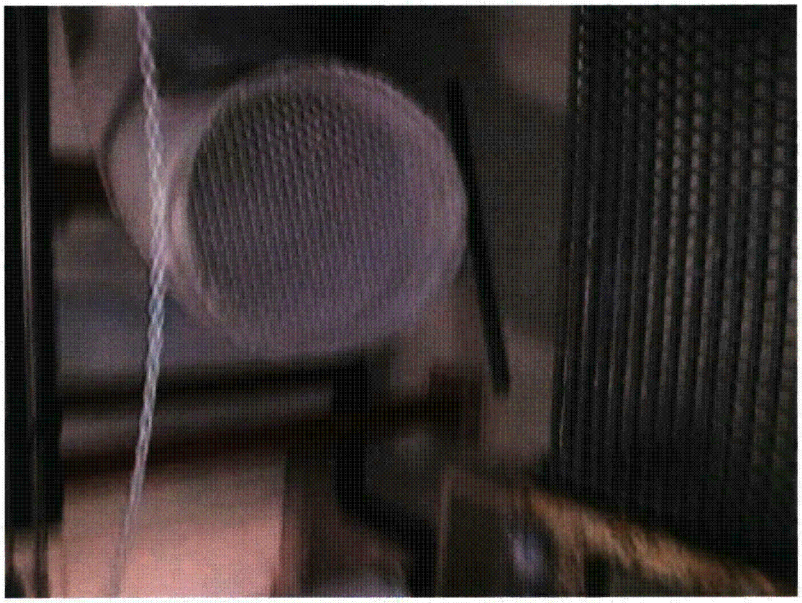
The accuracy of the ventilation numbers reported is estimated plus-or-minus 15% accuracy. Numerous inputs were considered in this estimated range, such as accuracy of the instruments, accessories and various measuring devices. Also the range of positioning of the garage-style air inlet doors (i.e., if the doors were open, closed or partially closed) and its effect on air flow was also taken into account to estimate the accuracy of the presented ventilation numbers.

The multiple exhaust fans at both facilities results in a negative pressure inside each of the facility buildings at Smith Ranch, WY and Crow Butte, NE. In the yellow cake production process, it was noted that points for potential radon release were enclosed with exhausting ventilation ducting, sheet metal or other material. Radon emissions were contained and their concentrations were reduced. Airflow, through any openings in vessels or process equipment, is from the process areas into the ventilation systems thus maintaining negative pressure and positive flow inside the ventilation system and controlling releases. Radon emissions are typically controlled and their concentrations are reduced by the induced air flow from ventilation exhaust fans or blowers, and vented to the atmosphere. This general design was found to be effective in preventing or mitigating radon releases to the public.

Cameco Crow Butte (CB)

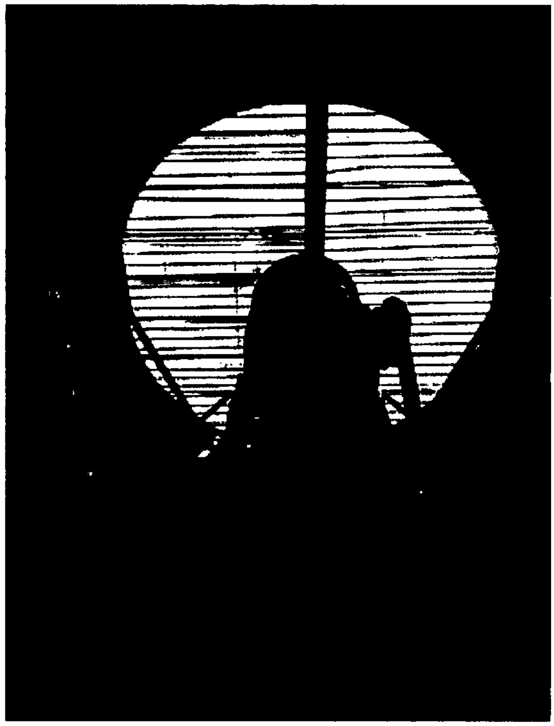


CB Facility View from Front Entrance

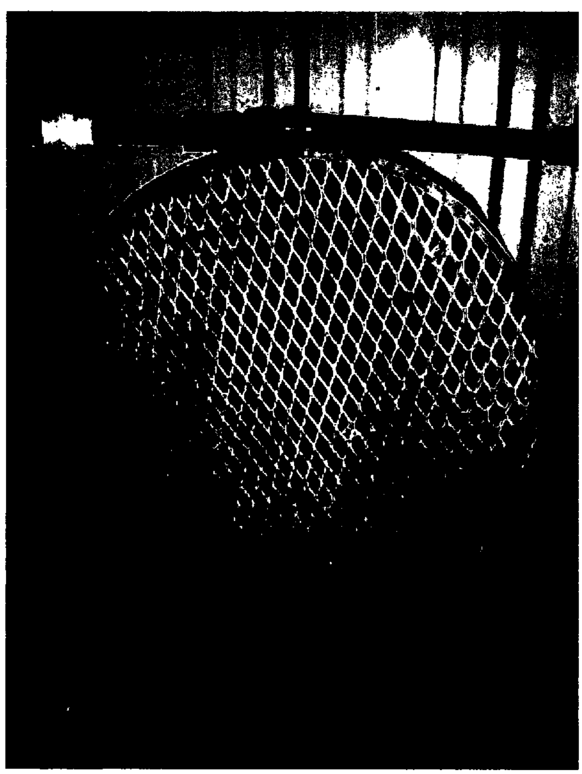


#1 High Gamma Field Exhaust Pipe

#3 Box Fan

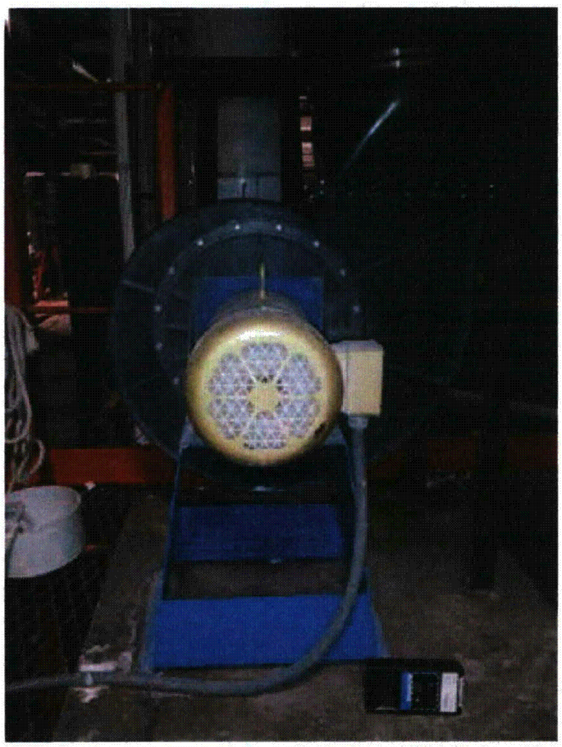


#4 Box Fan

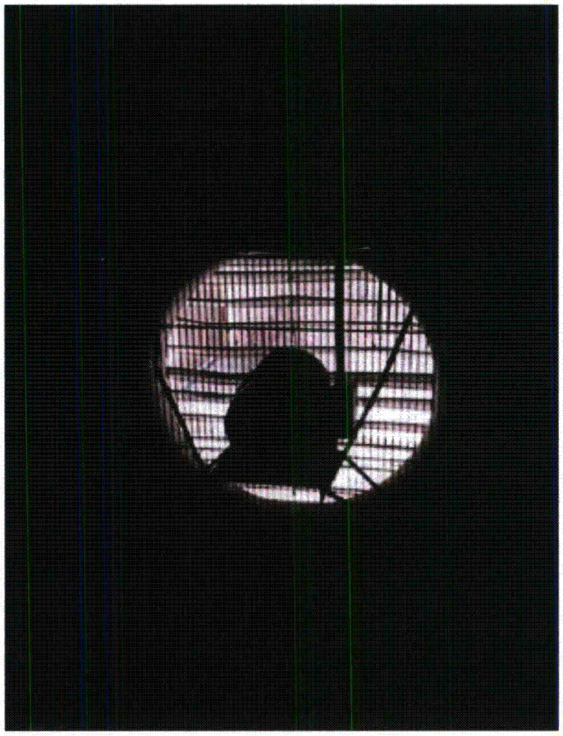


#5 Duct

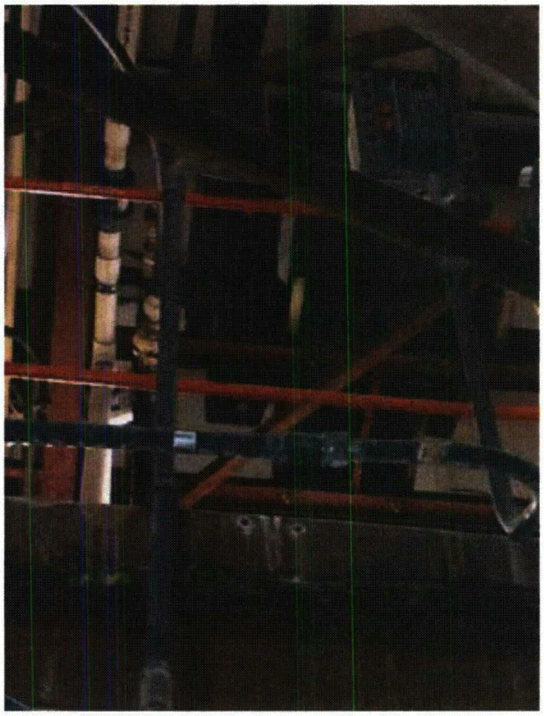
#6 Pond Water Treatment Demister Fan



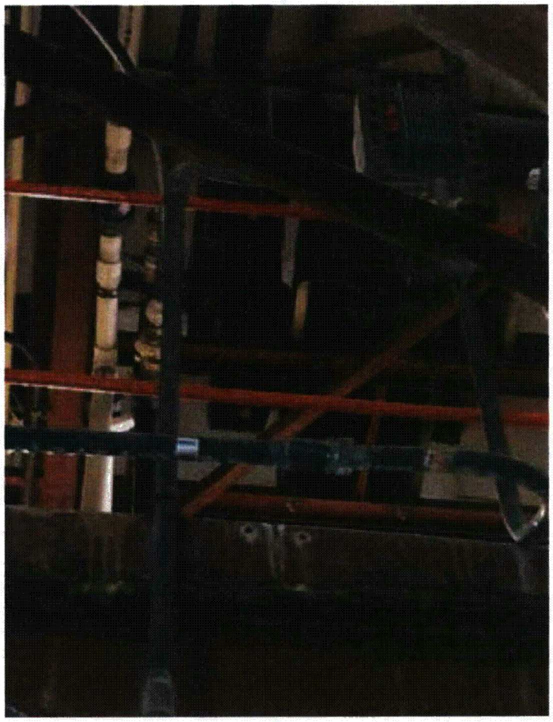
#7 Chemical Mix Tank Demister



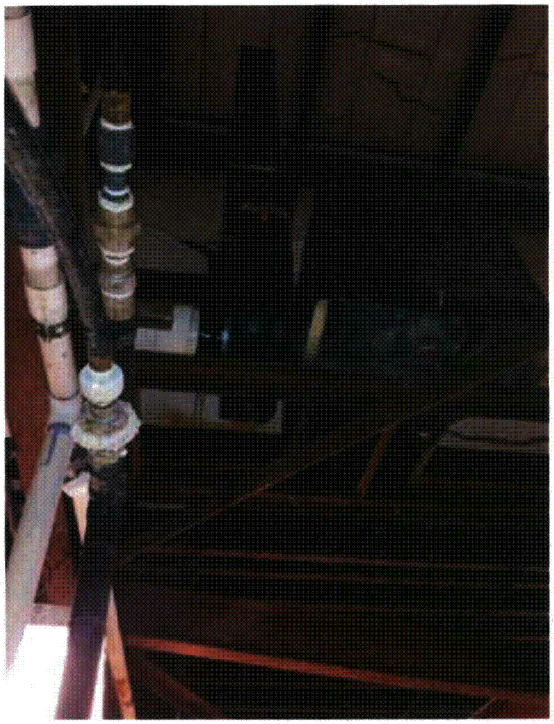
#9 Box Fan



#10 Demister Fan



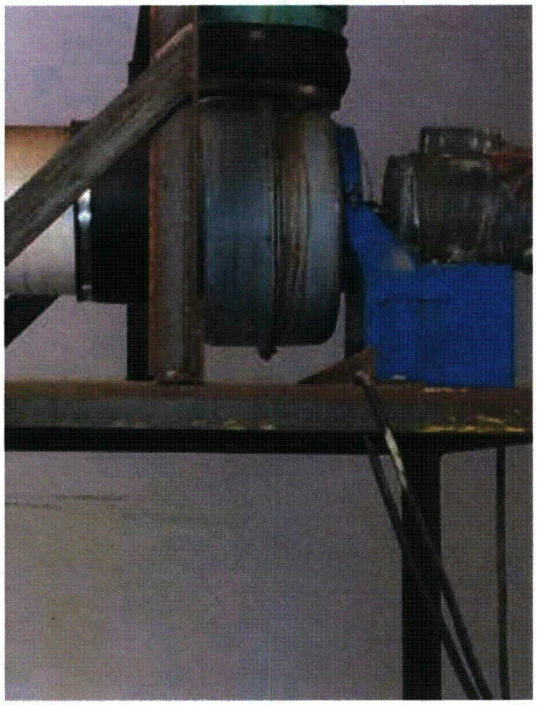
#10 Precip Demister Fan



#11 Shaker Deck Exhaust Blower

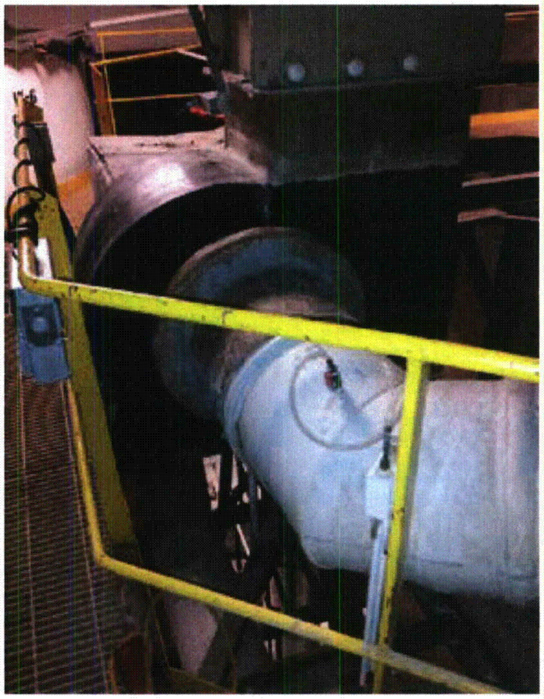
#12 Shaker Room Exhaust Pipe

#13 Effluent Blower



#14 Precip Blower

#15 East Train Blower

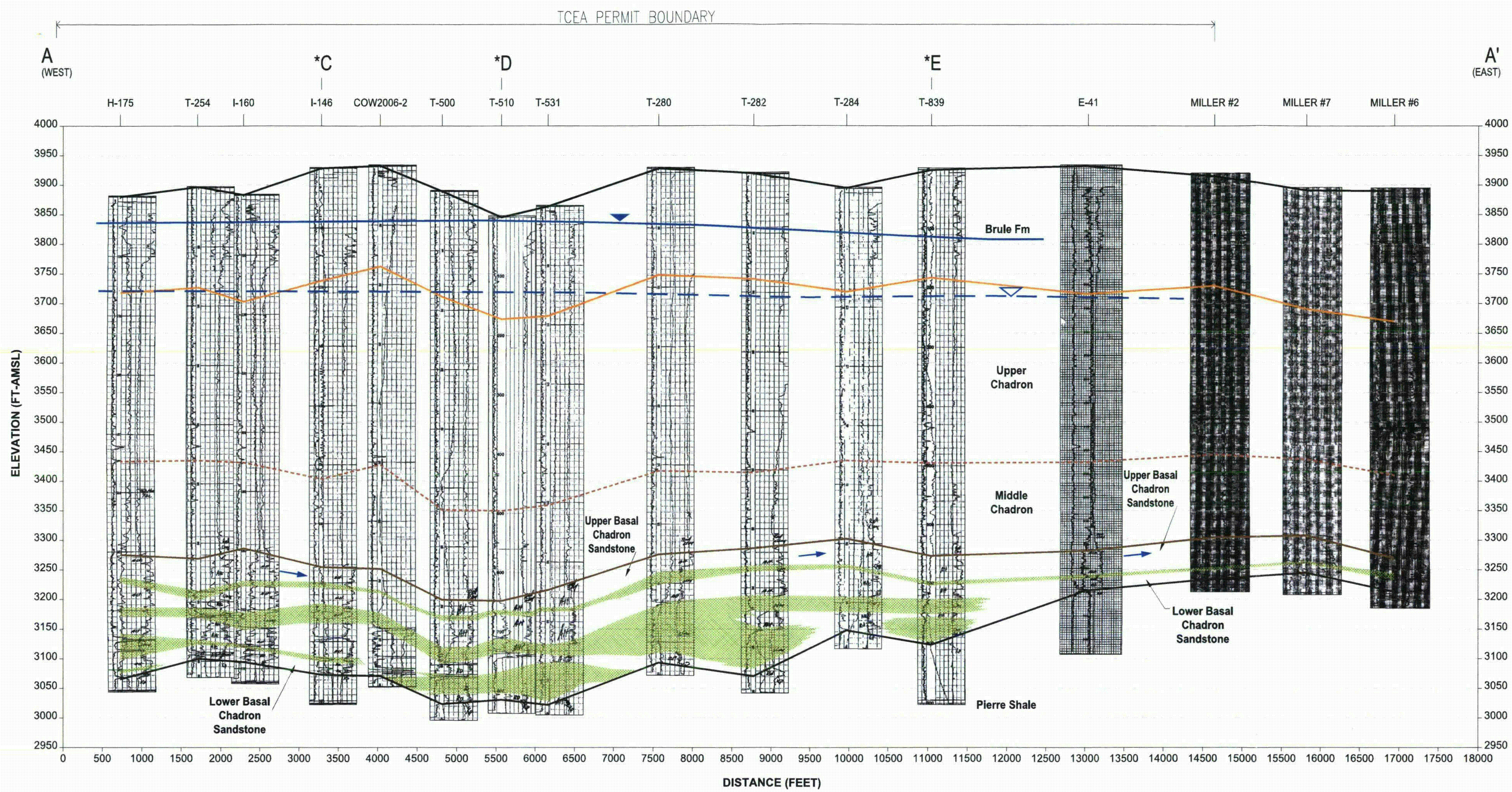


#16 West Train Blower

#17 Backwash Tank Demister Blower

Appendix Z

Three Crow Expansion Area
Cross Sections



Notes:

1) Geologic units that underlie the Pierre Shale are not shown.

2) For locations where the Upper/Middle Chadron Fm was not observed in e-logs, the contact between the Upper Chadron Fm and the Middle Chadron Fm was extrapolated based on known occurrence, and is shown as dashed lines.

* Letter indicates location of intersecting cross-section lines shown on Figure 4.

Legend:

- Topographic Surface
- Top of Upper Chadron
- Top of Middle Chadron
- Top of Basal Chadron Sandstone
- Interbedded Clay
- Top of Pierre Shale
- Water Table (Brule Fm) - 1/22/10 & 2/08/10
- Potentiometric Surface (Basal Chadron Sandstone) - 1/22/10
- Groundwater Flow Direction

0 100' 200'
VERTICAL GRAPHIC SCALE

0 750' 1,500'
HORIZONTAL GRAPHIC SCALE

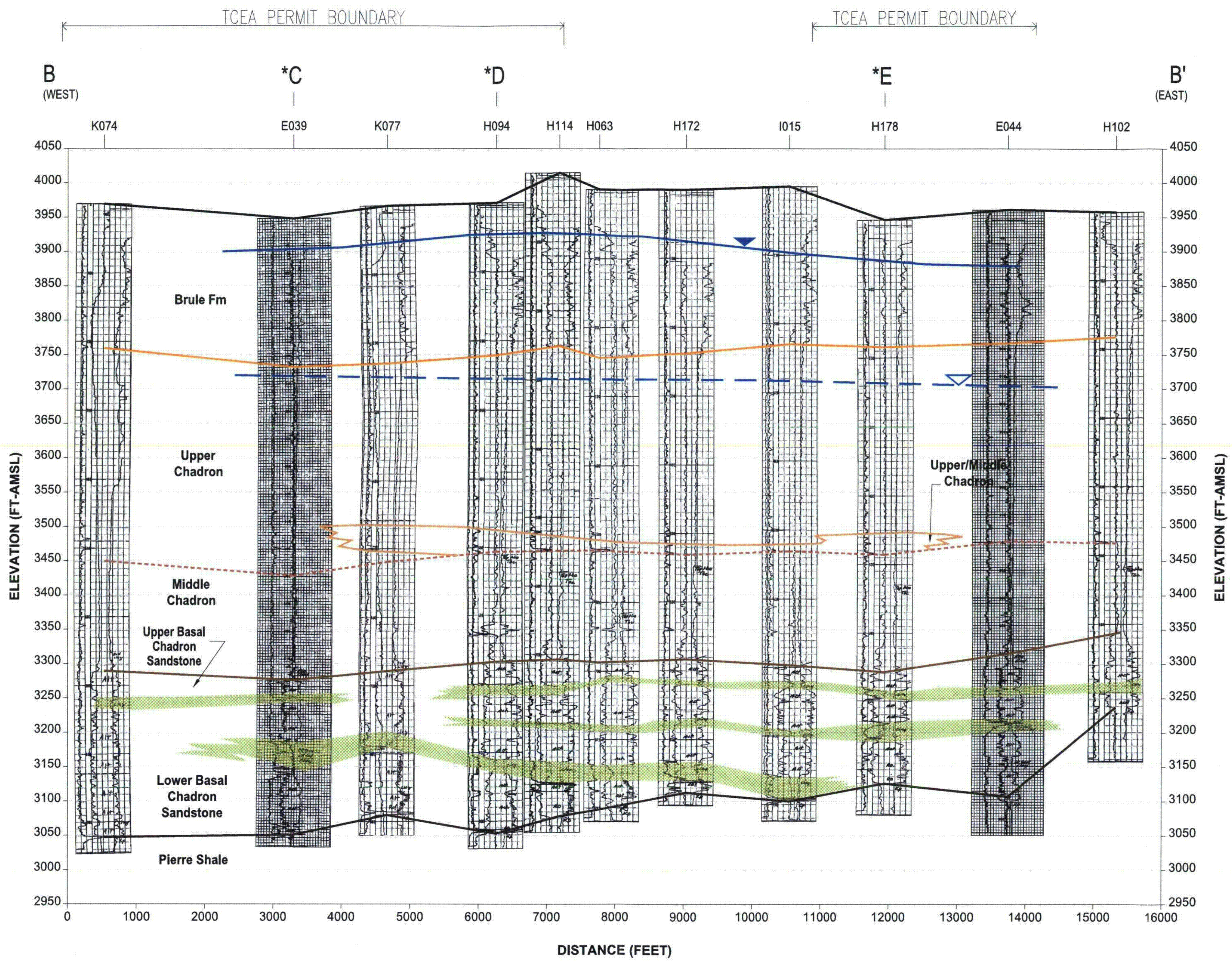
CROW BUTTE RESOURCES, INC.

FIGURE 5a
THREE CROW STRUCTURAL CROSS-SECTION: A-A'

PROJECT: CO001396 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

PATH: K:\CBR_Projects\CO001396_ThreeCrow\1_ACAD\e-transmit\XS_AA.dwg LAYOUT: AE_AA SAVED DATE/TIME: 3/27/2010 10:17 PM



Notes:

1) Geologic units that underlie the Pierre Shale are not shown.

2) For locations where the Upper/Middle Chadron Fm was not observed in e-logs, the contact between the Upper Chadron Fm and the Middle Chadron Fm was extrapolated based on known occurrence, and is shown as dashed lines.

* Letter indicates location of intersecting cross-section lines shown on Figure 4.

Legend:

- Topographic Surface
- Top of Upper Chadron
- Top of Upper/Middle Chadron
- Top of Middle Chadron
- Top of Basal Chadron Sandstone
- Interbedded Clay
- Top of Pierre Shale
- Water Table (Brule Fm) - 1/22/10
- Potentiometric Surface (Basal Chadron Sandstone) - 1/22/10 & 2/08/10
- Groundwater Flow Direction

0 100' 200'
VERTICAL GRAPHIC SCALE

0 1,000' 2,000'
HORIZONTAL GRAPHIC SCALE

CROW BUTTE RESOURCES, INC.

FIGURE 5b
THREE CROW STRUCTURAL CROSS-SECTION: B-B'

PROJECT: CO001396 MAPPED BY: JC CHECKED BY: MS

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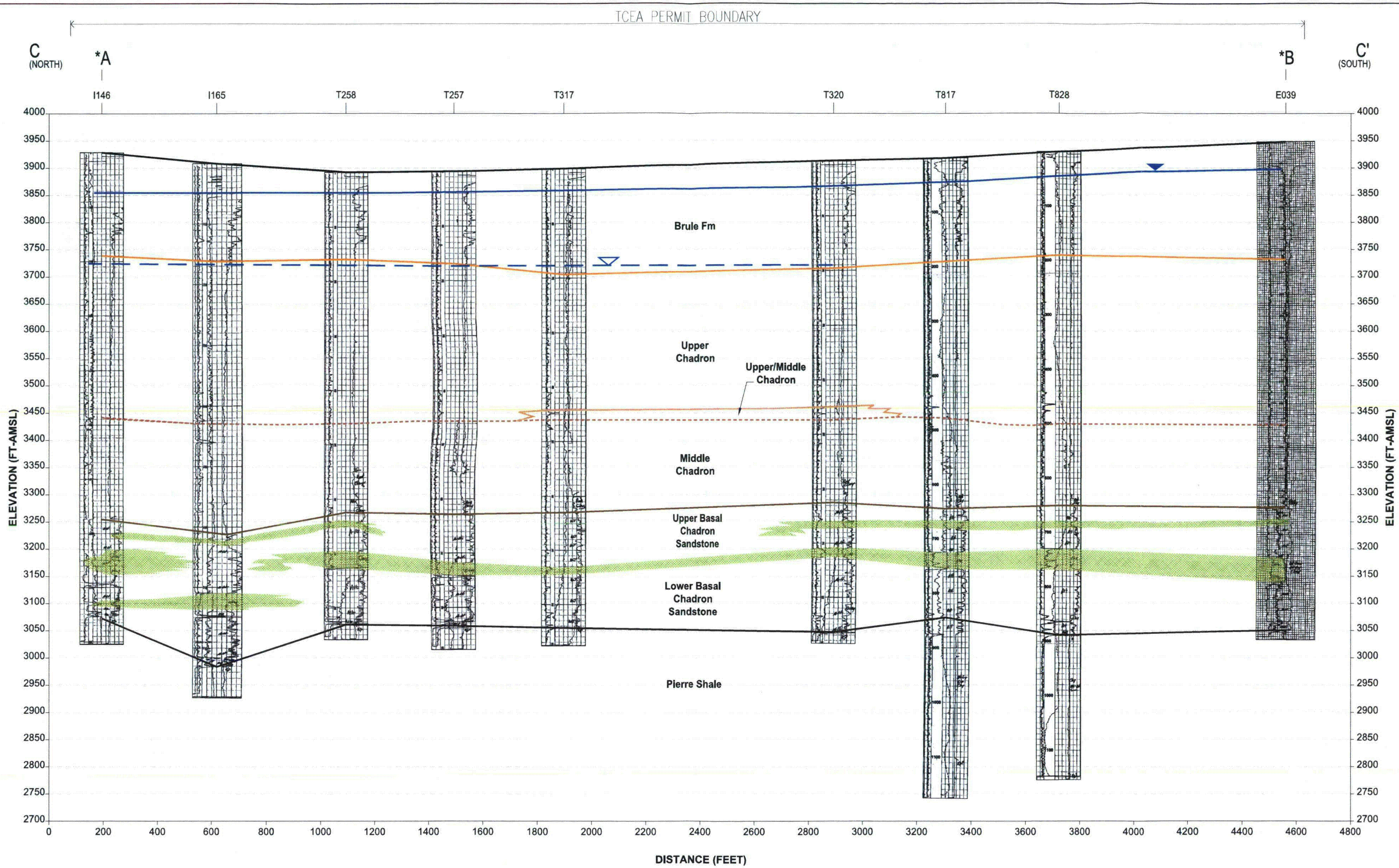

Notes:

1) Geologic units that underlie the Pierre Shale are not shown.

2) For locations where the Upper/Middle Chadron Fm was not observed in e-logs, the contact between the Upper Chadron Fm and the Middle Chadron Fm was extrapolated based on known occurrence, and is shown as dashed lines.

* Letter indicates location of intersecting cross-section lines shown on Figure 4.

Legend:

- Topographic Surface
- Top of Upper Chadron
- Top of Upper/Middle Chadron
- Top of Middle Chadron
- Top of Basal Chadron Sandstone
- Interbedded Clay
- Top of Pierre Shale
- Water Table (Brule Fm) - 1/22/10
- Potentiometric Surface (Basal Chadron Sandstone) - 1/22/10 & 2/08/10

0 100' 200'
VERTICAL GRAPHIC SCALE

0 200' 400'
HORIZONTAL GRAPHIC SCALE

CROW BUTTE RESOURCES, INC.

FIGURE 5c
THREE CROW STRUCTURAL CROSS-SECTION: C-C'

PROJECT: CO001396 MAPPED BY: JC CHECKED BY: MS

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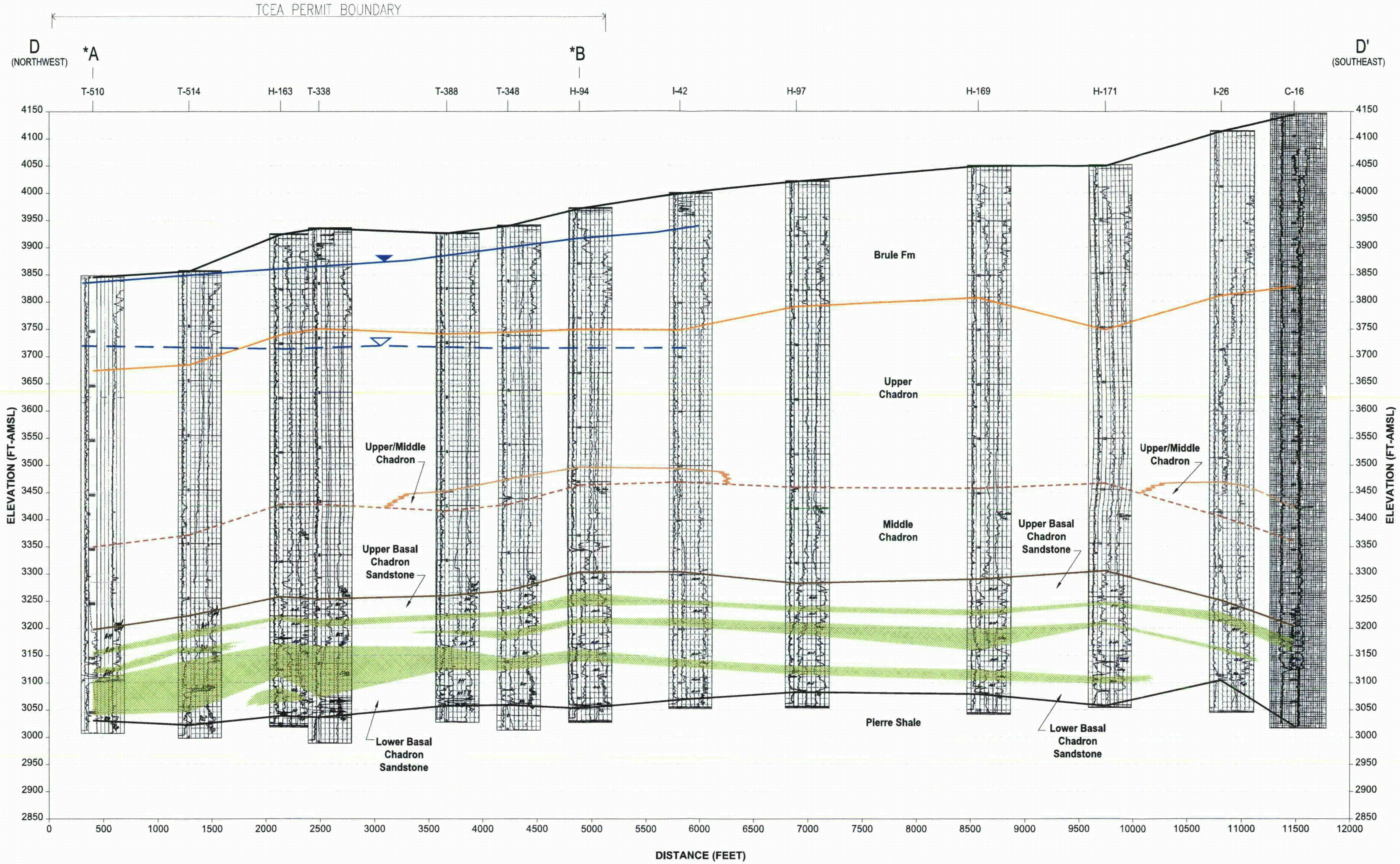
www.arcadis-us.com

PATH: K:\CBR_Projects\CO001396_ThreeCrow\1_ACAD\e-transmit\XS_CC.dwg LAYOUT: AE_CC SAVED DATE/TIME: 3/24/2010 5:08 PM



Notes:

1) Geologic units that underlie the Pierre Shale are not shown.

2) For locations where the Upper/Middle Chadron Fm was not observed in e-logs, the contact between the Upper Chadron Fm and the Middle Chadron Fm was extrapolated based on known occurrence, and is shown as dashed lines.

* Letter indicates location of intersecting cross-section lines shown on Figure 4.

Legend:

- Topographic Surface
- Top of Upper Chadron
- Top of Upper/Middle Chadron
- Top of Middle Chadron
- Top of Basal Chadron Sandstone
- Interbedded Clay
- Top of Pierre Shale
- Water Table (Brule Fm) - 1/22/10 & 2/08/10
- Potentiometric Surface (Basal Chadron Sandstone) - 1/22/10
- Groundwater Flow Direction

0 100' 200' VERTICAL GRAPHIC SCALE

0 500' 1,000' HORIZONTAL GRAPHIC SCALE

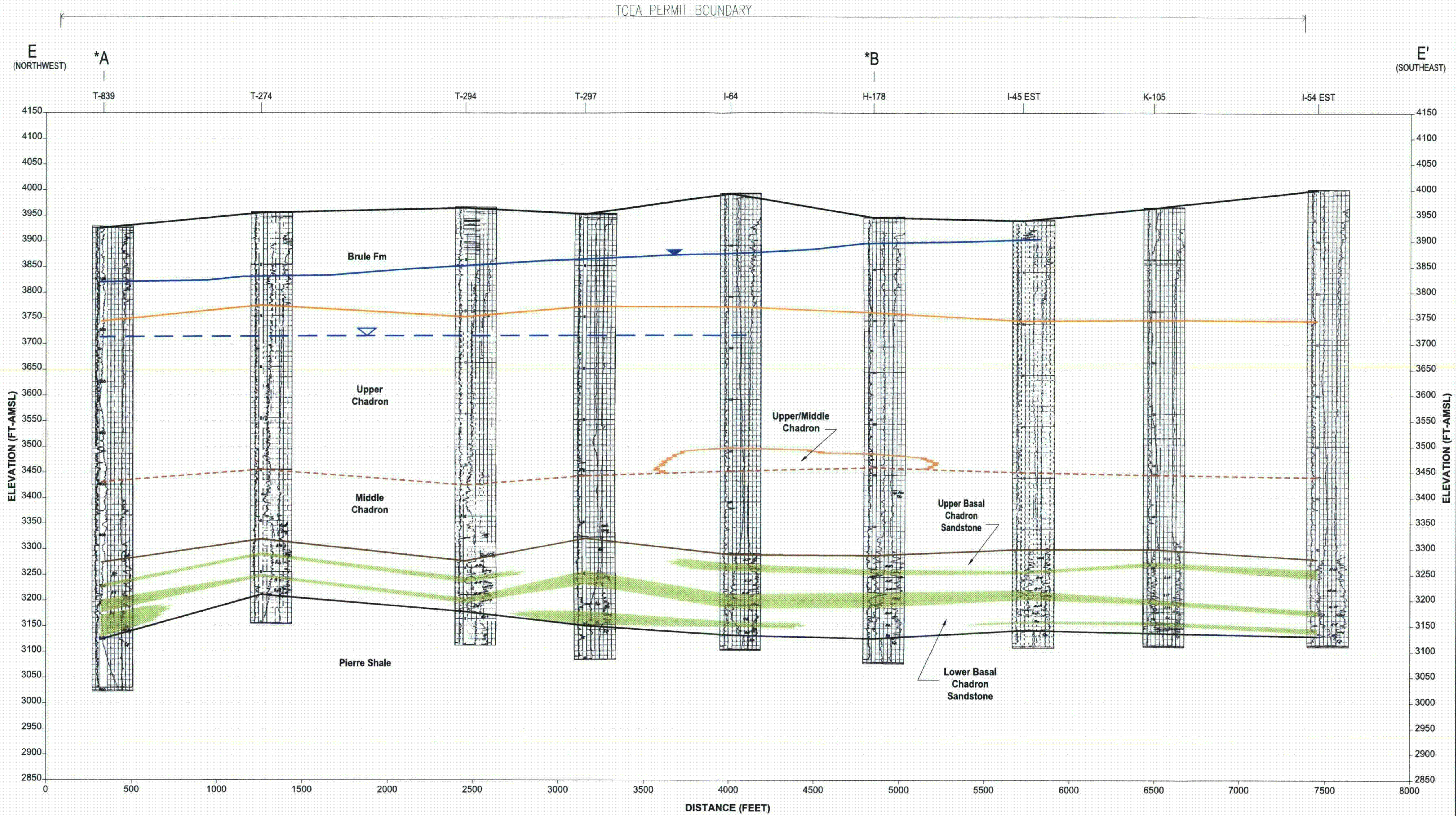
CROW BUTTE RESOURCES, INC.

FIGURE 5d
THREE CROW STRUCTURAL CROSS-SECTION: D-D'

PROJECT: CO001396 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

PATH: K:\CBR_Projects\CO001396_ThreeCrow\1_ACAD\e-transmit\XS_DD.dwg LAYOUT: AE SAVED DATE/TIME: 3/27/2010 10:48 PM



Notes:

1) Geologic units that underlie the Pierre Shale are not shown.

2) For locations where the Upper/Middle Chadron Fm was not observed in e-logs, the contact between the Upper Chadron Fm and the Middle Chadron Fm was extrapolated based on known occurrence, and is shown as dashed lines.

* Letter indicates location of intersecting cross-section lines shown on Figure 4.

Legend:

- Topographic Surface
- Top of Upper Chadron
- Top of Upper/Middle Chadron
- Top of Middle Chadron
- Top of Basal Chadron Sandstone
- Interbedded Clay
- Top of Pierre Shale
- Water Table (Brule Fm) - 1/22/10
- Potentiometric Surface (Basal Chadron Sandstone) - 1/22/10 & 2/08/10

VERTICAL GRAPHIC SCALE: 0, 100', 200'

HORIZONTAL GRAPHIC SCALE: 0, 500', 1,000'

CROW BUTTE RESOURCES, INC.

FIGURE 5e
THREE CROW STRUCTURAL CROSS-SECTION: E-E'

PROJECT: CO001396 MAPPED BY: JC CHECKED BY: MS

ARCADIS
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Highlands Ranch, CO 80129
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PATH: K:\CBR_Projects\CO001396_ThreeCrow\1_ACAD\e-transmit\XS_EE.dwg LAYOUT: AE SAVED DATE/TIME: 3/24/2010 5:03 PM

APPENDIX AA

Appendix AA

MEA Agricultural Well Impact Analysis

AQUI-VER, INC

Hydrogeology, Water Resources & Data Services

Mr. Doug Pavlick
Cameco Resources
Crow Butte Facility
P.O. Box 169
Crawford, NE 69339

December 10, 2013

Re: Marsland Expansion Area (MEA) Agricultural Well Impact Analysis

As requested, we have completed an analysis of the potential hydrologic impacts to local irrigation wells resulting from a hypothetical shallow casing leak in the overlying aquifer at the MEA In-Situ Recovery (ISR) wellfields. Our analysis is in response to U.S. Nuclear Regulatory Commission (NRC) Technical Report RAI 15(a), which requested "an analysis of the hydraulic effects that nearby agricultural wells may have on the migration potential of MEA regulated material releases in the overlying groundwater zone toward these wells".

INTRODUCTION AND SCOPE

Cameco has conducted a local well inventory which identified local agricultural, domestic, and stock watering wells in and near the MEA (Figure 1, Appendix A, Technical Report). Of particular significance to this assessment is well 732, which is a high capacity irrigation well located in the shallow Arikaree/Brule aquifer approximately 2500 feet east of the nearest MEA ISR wellfield pattern area. This assessment focuses on the hydrologic influence of well 732 on a hypothetical material release (e.g. shallow casing leak) at the MEA ISR wellfields. In order to accomplish this task, the following basic analyses were performed:

- Hydrological and geological data for the shallow Arikaree/Brule aquifer were compiled and summarized as the basis for an analytical groundwater flow model of the shallow aquifer at the MEA and vicinity.
- The maximum average pumping rate for irrigation well 732 was computed from an annual permitted water use of 14 inches per acre (215 acres of irrigated land) and a typical 5-month irrigation season (mid-April to mid-September).
- The drawdown and capture zone of irrigation well 732 was simulated using the groundwater flow model and particle tracking techniques to assess whether a hypothetical shallow casing leak from the MEA wellfields could potentially impact the irrigation well.
- the adequacy of the current shallow groundwater monitoring well network was assessed and recommendations made to insure adequate protection of irrigation and domestic wells from a shallow release of regulated material at MEA wellfields.

IRRIGATION WELL CONSTRUCTION AND OPERATION

Well 732 supplies water to two center pivots totaling 215 acres of irrigated land. Permit documents for well 732 indicate an original pumping rate of 1300 gallons per minute (gpm). However, recent discussions with Upper Niobrara White Natural Resource District (UNWNRD) personnel indicate the actual operating pumping rate is approximately 800 gpm. The well is cased to a depth of 140 feet, with an open screened interval extending from 140 to 280 feet below grade (well bottom).

Given a permitted annual water application rate of 14 inches per acre and 215 acres of irrigated land, the maximum permitted water use for well 732 is 251 acre-ft/year. Assuming a 5-month irrigation season extending from mid-April to mid-September, this equates to a maximum continuous pumping rate of 373 gpm during the growing season. Because the actual operating pumping rate of well 732 is approximately 800 gpm, we can infer well 732 pumps at a rate of 800 gpm for a maximum of 11 hours each day during the 5-month growing season.

HYDROGEOLOGY AND GROUNDWATER MODEL PARAMETER ESTIMATES

Irrigation and domestic wells in the vicinity of the MEA are completed primarily within the shallow Arikaree/Brule aquifer, which is part of the High Plains Aquifer System of northwestern Nebraska[1]. The Arikaree/Brule aquifer at the MEA is hydraulically separated from the underlying Basal Chadron production aquifer by more than 400 feet of claystone and siltstone of the middle Chadron and upper Chadron Formations.

Water level elevation data compiled from shallow Arikaree formation monitoring wells and shallow Brule formation monitoring wells at the MEA indicate water levels and hydraulic gradients in the Arikaree and Brule are very similar, indicating a high degree of hydraulic communication and water-table (unconfined) conditions (Attachment A). Thus, the Arikaree and Brule Formations comprise a single, hydraulically-connected shallow aquifer at the MEA.

Depending on well construction and the depth of wells installed in the Arikaree/Brule aquifer, local groundwater conditions can vary from unconfined to semi-confined conditions (consistent with the observation of first water encountered at static water level depth and a hydraulically-connected shallow aquifer system). In areas with relatively deep irrigation wells that could be described as semi-confined under non-pumping conditions, groundwater becomes fully unconfined shortly after significant pumping begins (e.g. semi-confined to unconfined conversion) due to lowering of the local water table as pumping progresses. For these reasons, groundwater within the Arikaree/Brule aquifer at the MEA was simulated as an unconfined aquifer.

---

[1] Geohydrology of the High Plains Aquifer in Parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming, U.S. Geological Survey Professional Paper 1400-B, High Plains RASA project, 1984, 63p.

Aquifer properties of the Arikaree/Brule aquifer for this analysis were estimated from 1) grain-size distribution data collected from Cameco shallow Arikaree/Brule monitoring wells within the MEA, 2) specific capacity estimates from irrigation well 732, and 3) published regional hydrogeologic studies of the Arikaree/Brule aquifer. The following is a summary of hydrologic properties of the Arikaree/Brule aquifer at and near the MEA:

- the hydraulic conductivity of the Arikaree/Brule aquifer calculated from grain-size distribution analysis of sandy samples (> 45% sand by weight) obtained from shallow MEA monitoring wells varies from an average of 1.6 ft/day to a maximum of 8.2 ft/day (Attachment B).
- the hydraulic conductivity of the Arikaree/Brule aquifer was calculated from specific capacity estimates[2] for irrigation well 732, as given by:

  $$T = 1500 * Q/s, \text{ and} \quad (1)$$

  $$K = T/b \quad (2)$$

  where T is the aquifer transmissivity (gpd/ft), K is the hydraulic conductivity, b is the aquifer thickness (200 feet at well 732), Q is the pumping rate (800 gpm), and s is the maximum available drawdown limited by well/pump depth, (assumed to be approximately 160 feet at irrigation well 732). Given these assumptions, the hydraulic conductivity of the Arikaree/Brule aquifer is approximately 5.0 ft/day.
- regional studies[1,3] of the Arikaree/Brule aquifer indicate hydraulic conductivities near the MEA are less than 25 ft/day, consistent with grain-size and specific capacity estimates. These studies also indicate a specific yield of 0.15 to 0.20 is appropriate for the Arikaree/Brule aquifer at the MEA.
- The hydraulic gradient in the shallow Arikaree/Brule aquifer in the vicinity of well 732 is approximately 0.004 (calculated from water level maps presented in Attachment C).

IRRIGATION WELL IMPACT ANALYSIS

For purposes of this analysis, we have assumed a conservative (worse-case) scenario in which irrigation well 732 pumps the maximum allowable amount of groundwater (251 acre-ft/year) and a hypothetical shallow casing leak occurs at some time along the downgradient portion of the adjacent ISR wellfields at the MEA.

---

[2] Driscoll (1986), Groundwater and Wells, second edition, equation 16.15 modified for unconfined conditions.

[3] Reed, E.C., and Pitkin, R. (unpublished). Table of hydraulic conductivity values for the High Plains Aquifer by grain-size classification, northwest Nebraska, Conservation and Survey Division, University of Nebraska.

To accomplish this task, an analytical groundwater flow model was used to simulate groundwater flow in the shallow Arikaree/Brule aquifer at the MEA. Particle-tracking techniques were used to illustrate the 30-year capture zone of irrigation well 732 to assess whether a hypothetical shallow casing leak from the MEA wellfields could potentially impact the irrigation well.

Two scenarios were simulated to ensure the range of possible hydrologic conditions at the site were adequately addressed. A high transmissivity (high K) scenario was simulated in order to produce a capture zone having the highest groundwater velocity (maximum chemical travel time). The low transmissivity (low K) scenario was simulated to produce a capture zone having the greatest width to ensure the area of potential impact was adequately addressed. Input parameters for the groundwater flow model were conservatively assigned as follows:

Hydraulic Conductivity (K) – 8.2 ft/day (high transmissivity scenario), 1.6 ft/day (low transmissivity scenario)

Aquifer Thickness - 202 feet

Regional Hydraulic Gradient (I) – 0.004 to the southeast

Specific Yield – 0.15

Aquifer Porosity – 0.15

Pumping Rate – 373 gpm for 5 months continuously, off for 7 months, each year.

RESULTS AND CONCLUSIONS

The water level drawdown in well 732 after 5 months of continuous pumping for high and low transmissivity scenarios are provided in Figures 2 and 3, respectively. Assuming maximum water use, approximately 0.1 to 0.7 feet of drawdown is predicted to occur at the end of each irrigation season in the nearest shallow monitor wells (AOW-9/BOW-9) due to operation of well 732.

The 30-year capture zone of well 732 was computed using reverse particle-tracking techniques. Figures 4 and 5 illustrate the capture zone of well 732 after 30 years for high and low transmissivity scenarios, respectively. Based on the results of this analysis, MEA wellfields are not located within the capture zone of irrigation well 732. A shallow casing leak within the MEA wellfields will not impact irrigation well 732 at any time in the future given similar operating conditions.

Given the location of other irrigation and domestic wells in the area (Figure 1, Appendix A Technical Report) and configuration of the worse-case capture zone (well 732), it is reasonable to conclude there are no other wells outside the MEA boundary that will be impacted by a potential release of MEA regulated material to the shallow aquifer. Therefore, the current MEA

shallow groundwater monitoring network is adequate to ensure the protection of human health and environment.

RECOMMENDATIONS

This study relies on limited information currently available concerning the hydrology of the shallow Arikaree/Brule aquifer and local irrigation well operations. Cameco currently plans to conduct continuous monitoring of groundwater elevations in shallow Arikaree/Brule monitoring wells in an effort to better characterize the shallow aquifer and quantify the hydrologic influence (e.g. drawdown) of local agricultural well pumping in the MEA during the 2014 irrigation season. At the end of the 2014 irrigation season, Cameco will use this information to calibrate and verify the groundwater model and confirm the conclusions of this study remain valid.

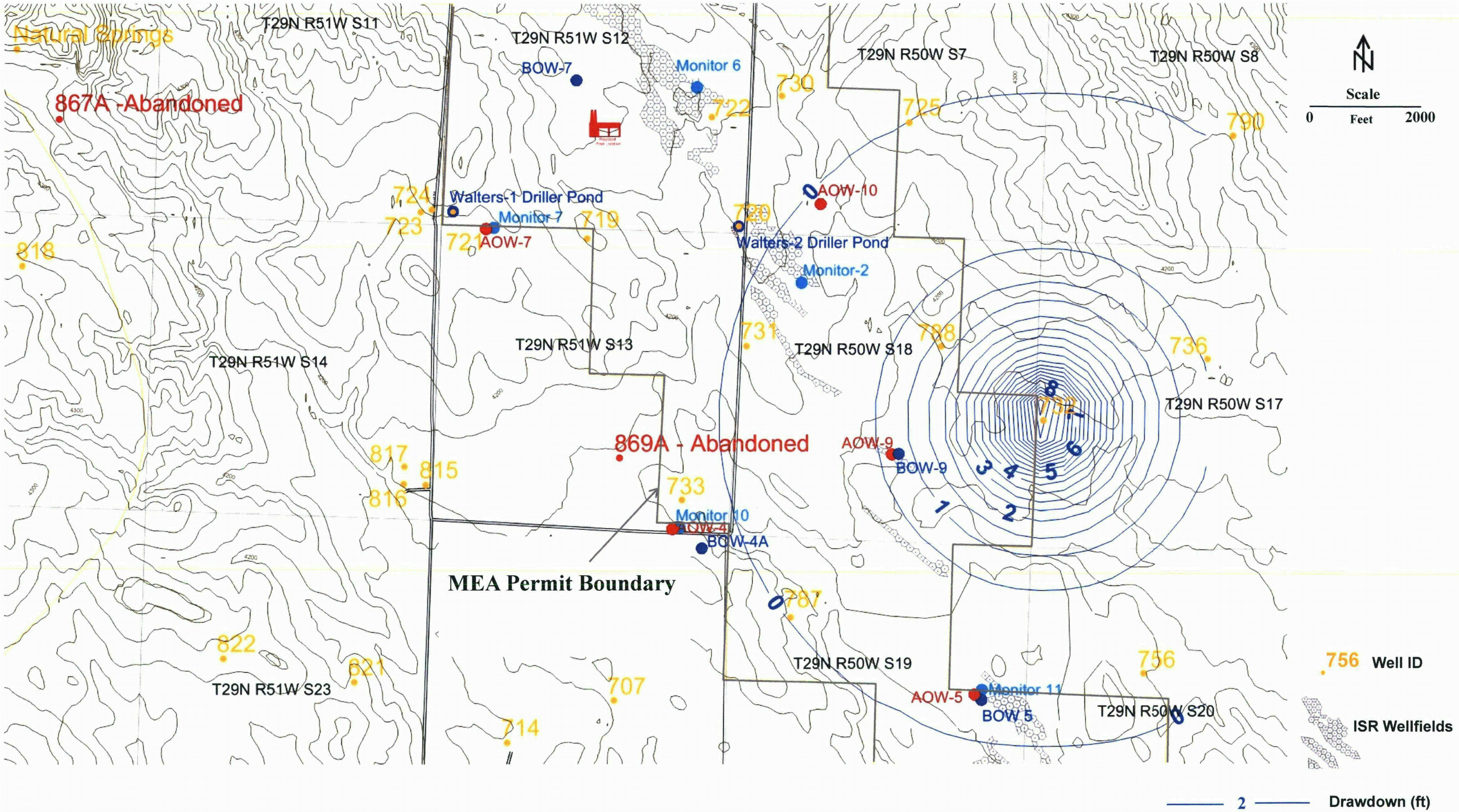
Please contact me directly if you have questions or comments concerning this report at 720-242-9510 Ext. 1#.

Sincerely,

AQUI-VER, INC

Robert Lewis

Robert L. Lewis, P.G.
Principal Hydrogeologist



AQUI-VER, INC.

Hydrogeology, Water Resources & Data Services

Projected Drawdown in Arikaree/Brule Aquifer
End of 5-month Irrigation Season

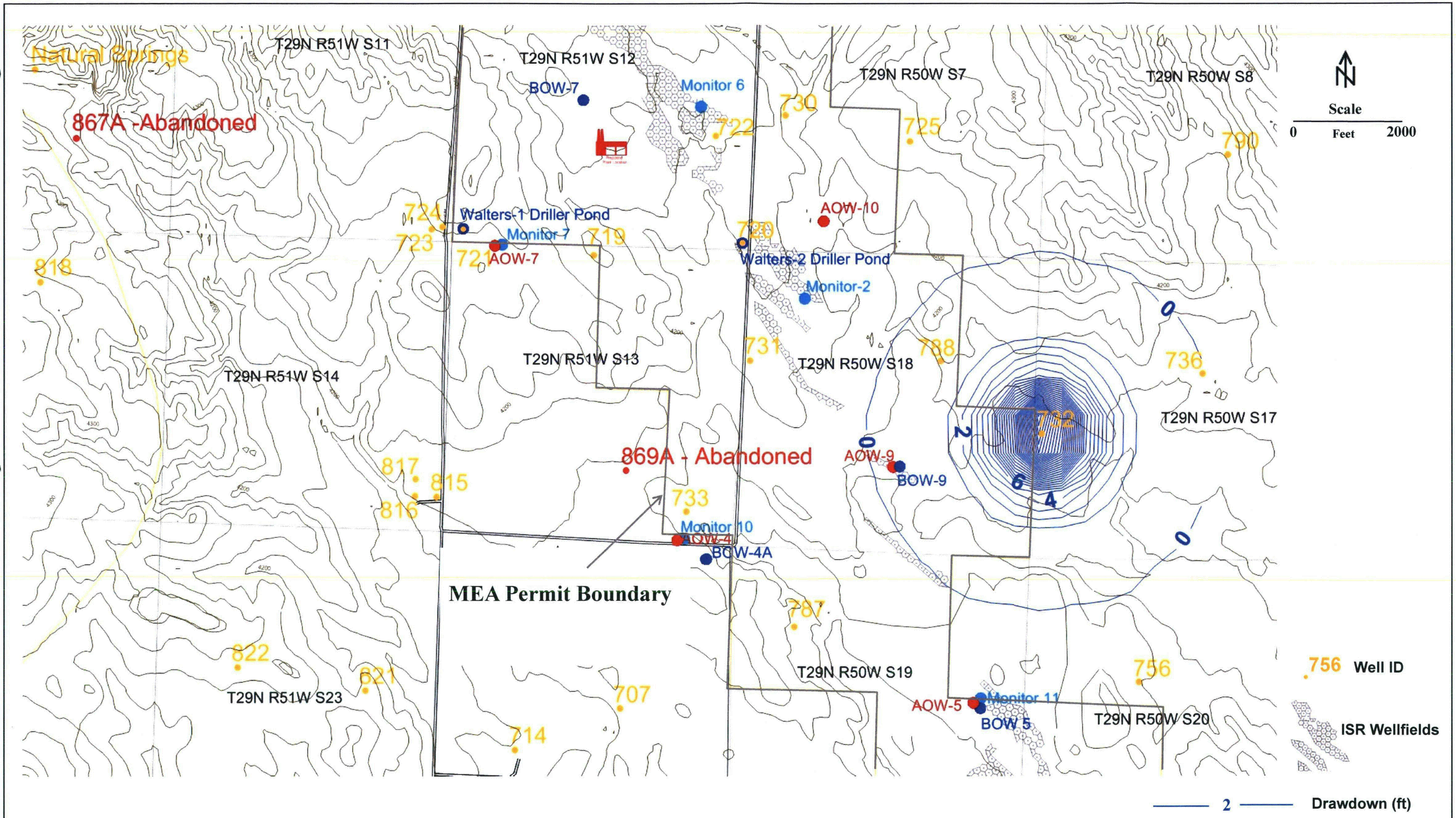
High Transmissivity Scenario

Crow Butte Project, Marsland Expansion Area,
Dawes County, NE

Cameco

FIGURE:

2



AQUI-VER, INC.

Hydrogeology, Water Resources & Data Services

Projected Drawdown in Arikaree/Brule Aquifer
End of 5-month Irrigation Season

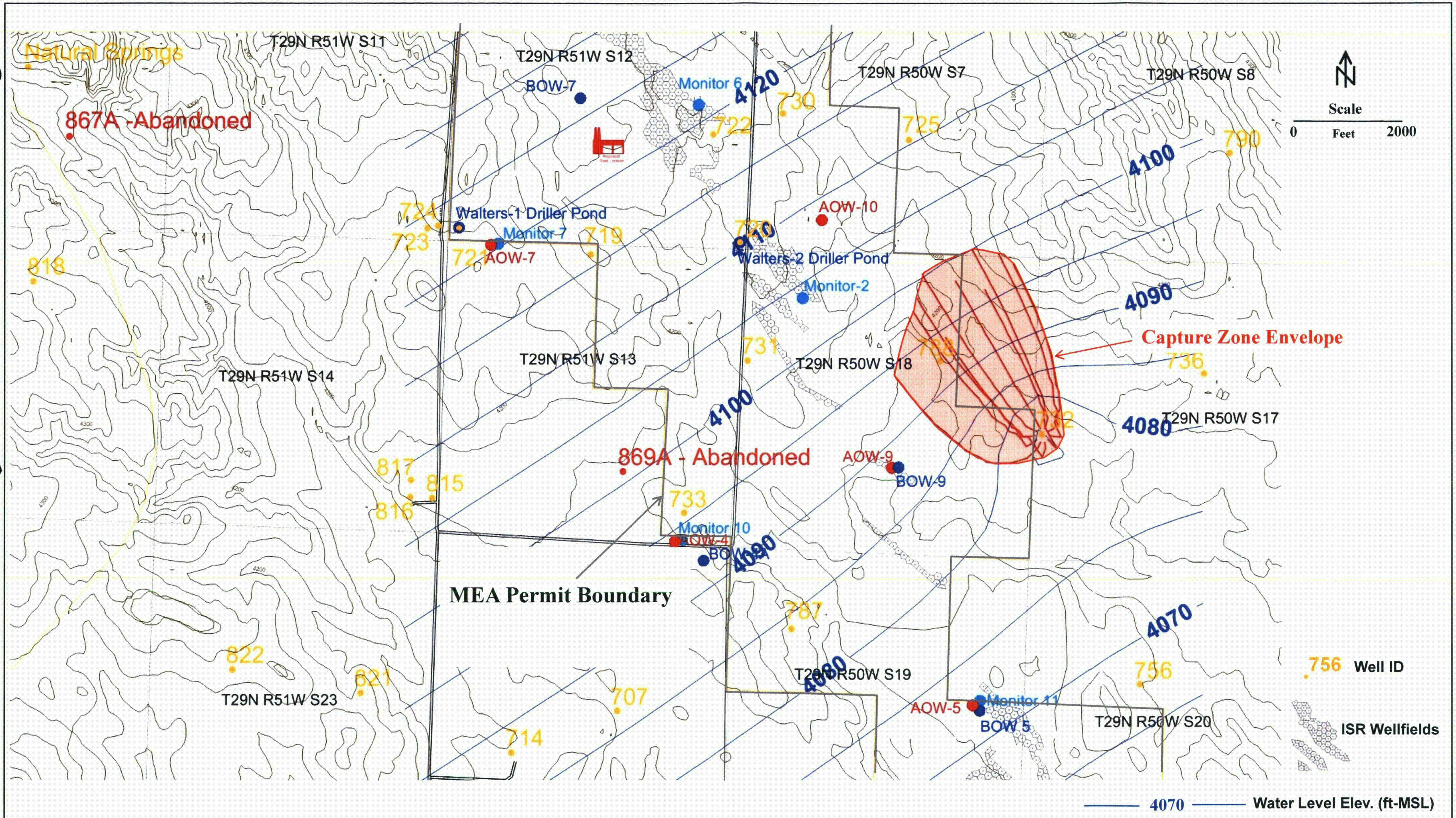
Low Transmissivity Scenario

Crow Butte Project, Marsland Expansion Area,
Dawes County, NE

Cameco

FIGURE:

3



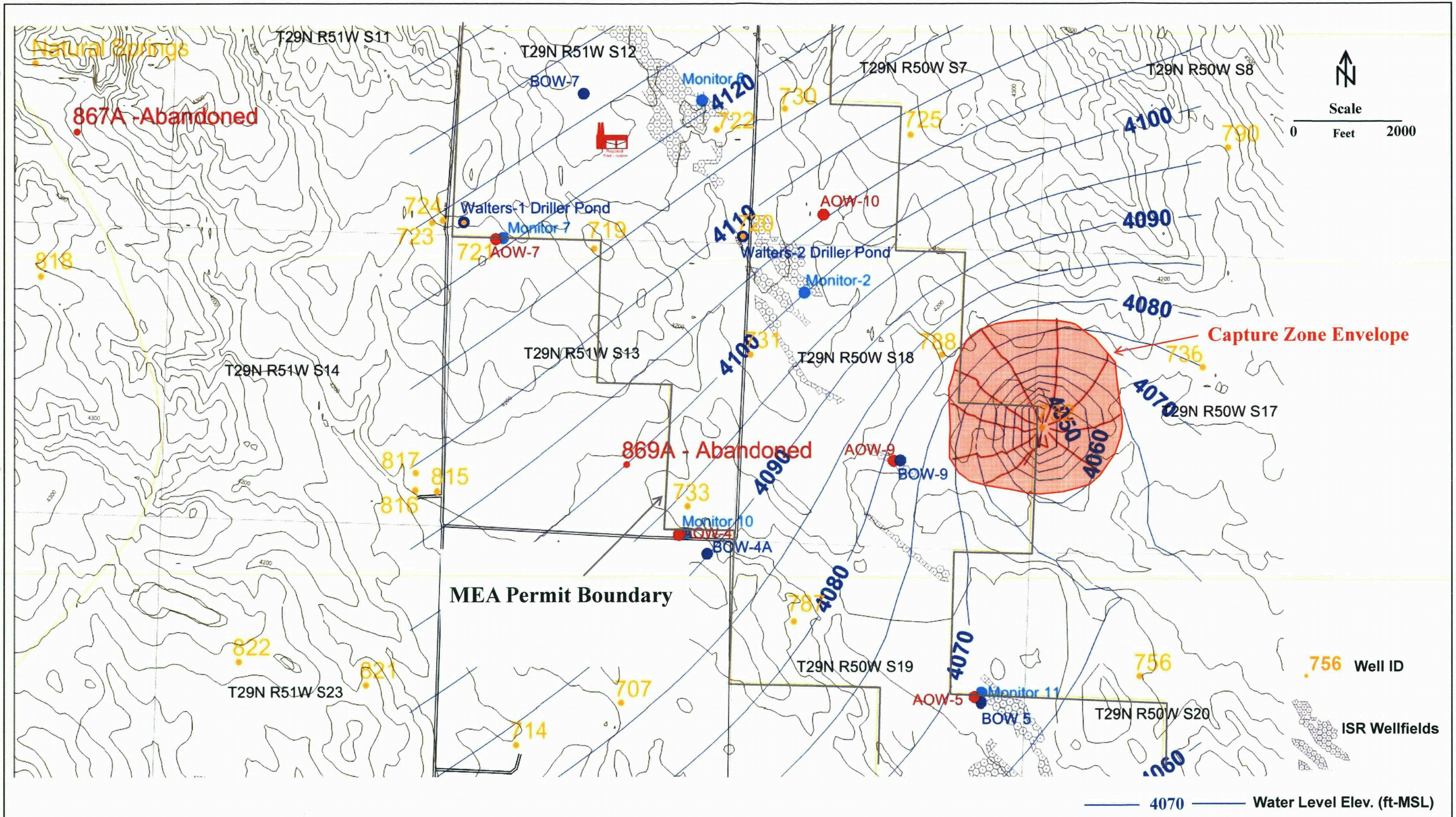
AQUI-VER, INC.
Hydrogeology, Water Resources & Data Services

30-Year Capture Zone of Irrigation Well 732
High Transmissivity Scenario

Crow Butte Project, Marsland Expansion Area,
Dawes County, NE

Cameco

FIGURE:
4



AQUI-VER, INC.
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30-Year Capture Zone of Irrigation Well 732
Low Transmissivity Scenario

Crow Butte Project, Marsland Expansion Area,
Dawes County, NE

Cameco

FIGURE:
5

AQUI-VER, INC
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ATTACHMENT A

WATER LEVEL MONITORING DATA

4700 Wadsworth Boulevard # 400, Wheat Ridge, CO 80030 PH: 720-242-9510 FAX: 720-246-2156

Water Levels - Arikaree Group, Brule Formation and Basal Sandstone of Chadron Formation

Well	TOC Elevation (ft amsl)	2/22/11 Water Level (ft TOC)	2/22/11 Groundwater Elevation (ft amsl)	10/17/13 Water Level (ft TOC)	10/17/13 Groundwater Elevation (ft amsl)
ARIKAREE GROUP					
AOW-1	4261.64	--	--	126.4	4135.24
AOW-3	4351.97	--	--	142.2	4209.77
AOW-4	4161.91	--	--	87.3	4074.61
AOW-5	4125.42	--	--	72.0	4053.42
AOW-6	4068.60	--	--	20.0	4048.60
AOW-7	4243.94	--	--	DRY	4093.94
AOW-8	4365.02	--	--	71.7	4293.32
AOW-9	4146.41	--	--	74.9	4071.51
AOW-10	4198.60	--	--	113.3	4085.30
AOW-11	4091.02	--	--	35.4	4055.62
BRULE FORMATION					
BOW 2010-1	4260.10	125.74	4134.36	124.9	4135.20
BOW 2010-2	4324.96	150.03	4174.93	151.4	4173.56
BOW 2010-3	4352.80	137.20	4215.60	139.6	4213.20
BOW-2010-4	4163.13	86.65	4076.48	--	--
BOW 2010-4A	--	--	--	93.7	4069.43
BOW 2010-5	4127.88	71.19	4056.69	74.0	4053.88
BOW 2010-6	4100.43	49.30	4051.13	50.3	4050.13
BOW-2010-7	4248.37	--	--	155.6	4092.77
BOW-2010-8	4369.29	--	--	74.0	4295.29
BOW-2013-9	4145.90	--	--	74.6	4071.30
BOW-2013-10	4197.84	--	--	113.8	4084.04
BOW-2013-11	4091.87	--	--	37.4	4054.47
BASAL SANDSTONE OF CHADRON FORMATION					
CPW-2010-1	4261.35	551.63	3709.72	565.3	3696.05
CPW-2010-1A	4263.28	--	--	567.0	3696.28
Monitor 1	4103.28	387.65	3715.63	399.4	3703.88
Monitor 2	4199.50	484.99	3714.51	500.3	3699.20
Monitor 3	4261.40	550.90	3710.50	565.5	3695.90
Monitor 4A	4329.72	618.09	3711.64	634.3	3695.42
Monitor 5	4340.80	628.87	3711.93	645.4	3695.40
Monitor 6	4216.40	502.80	3713.60	518.2	3698.20
Monitor 7	4246.28	531.20	3715.08	548.0	3698.28
Monitor 8	4355.90	644.97	3710.93	660.5	3695.40
Monitor 9	4367.02	656.54	3710.48	669.7	3697.32
Monitor 10	4163.99	449.01	3714.98	465.0	3698.99
Monitor 11	4128.07	412.74	3715.33	427.9	3700.17

NOTES:

Groundwater elevations for the Brule Formation and Basal Chadron Sandstone are based on depth to water measurements.

TOC = top of casing

ft TOC = feet below top of casing

ft amsl = feet above mean sea level

DRY = measurable water not present in well at time of sampling

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ATTACHMENT B

HYDRAULIC CONDUCTIVITY OF THE ARIKAREE/BRULE AQUIFER CALCULATED FROM GRAIN-SIZE ANALYSES

4700 Wadsworth Boulevard # 400, Wheat Ridge, CO 80030 PH: 720-242-9510 FAX: 720-246-2156

Hydraulic Conductivity of the Arikaree/Brule Formation Samples from Grain-Size Analyses (from ARCADIS U.S., Inc, personal communication)

	Geomean of K (cm/sec)	STD	Max K (cm/sec)	Min K (cm/sec)	# of Samples
Arikaree (all samples)	1.38E-04	9.27E-04	2.9E-03	2.3E-05	10
Arikaree (sand >45% by weight)	6.86E-04	1.22E-03	2.9E-03	1.0E-04	4
Brule (all samples)	9.22E-05	6.15E-05	2.3E-04	2.6E-05	12
Brule (sand >45% by weight)	2.31E-04	--	2.3E-04	--	1
Combined Arikaree and Brule (all samples)	1.11E-04	6.44E-04	2.9E-03	2.3E-05	22
Combined Arikaree and Brule (sand >45% by weight)	5.52E-04	1.14E-03	2.9E-03	1.0E-04	5

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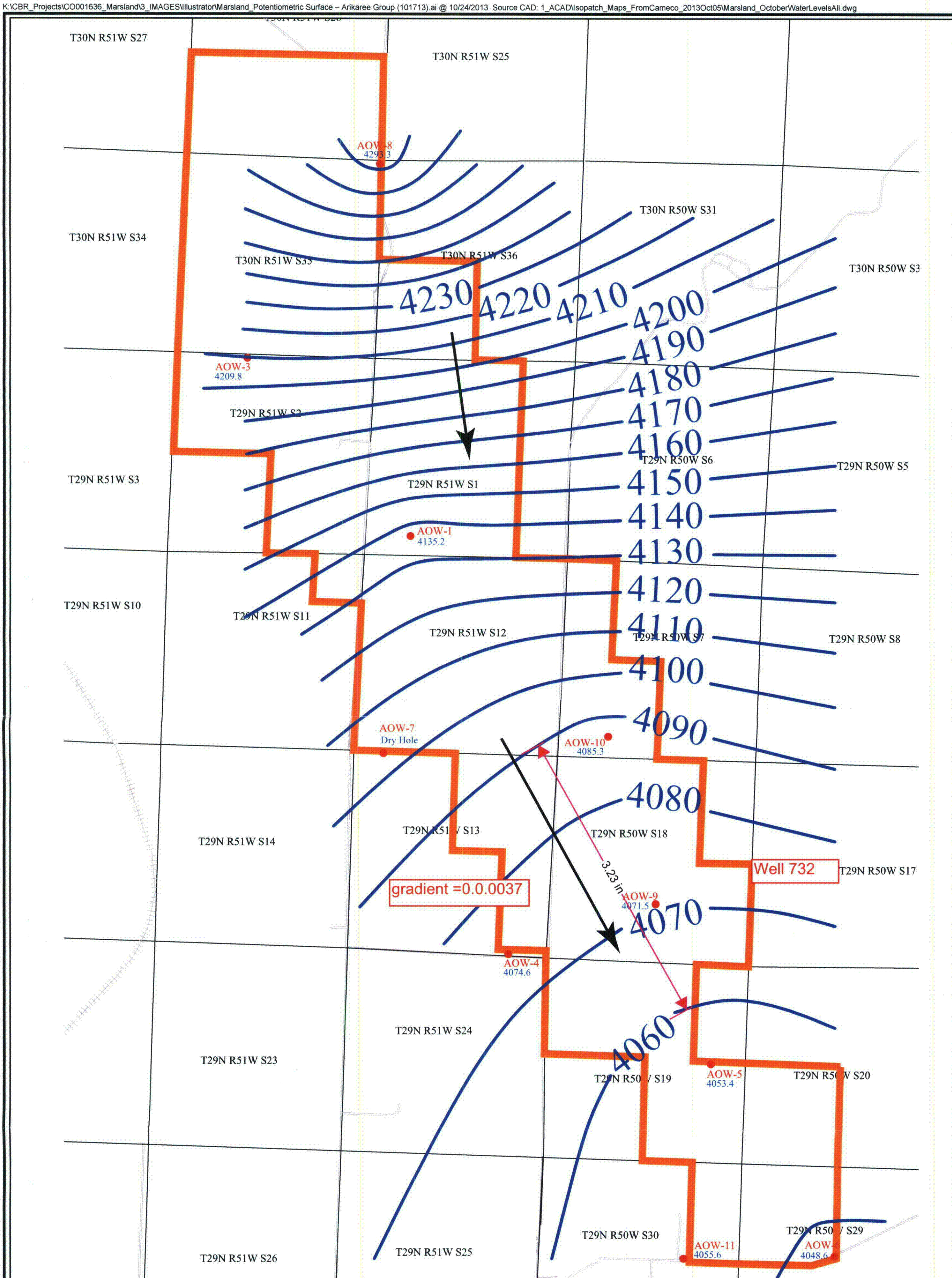
ATTACHMENT C

WATER LEVEL CONTOUR MAPS AND HYDRAULIC GRADIENT CALCULATIONS

4700 Wadsworth Boulevard # 400, Wheat Ridge, CO 80030 PH: 720-242-9510 FAX: 720-246-2156

K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\Marsland_Potentiometric Surface – Arikaree Group (101713).ai @ 10/24/2013 Source CAD: 1_ACAD\Isopatch_Maps_FromCameco_2013Oct05\Marsland_OctoberWaterLevelsAll.dwg



LEGEND

- Proposed Marsland Expansion Area
- AOW-5 — Arikareen Group Well and Well ID
- 4053.4 — Water Level (FT-AMSL)
- Groundwater Elevation Contour (FT-AMSL)
- Groundwater Flow Direction
- Road
- Railroad

FT-AMSL = Feet Above Mean Sea Level

N

1 in = 1,250 Feet (0, 1,250, 2,500)

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

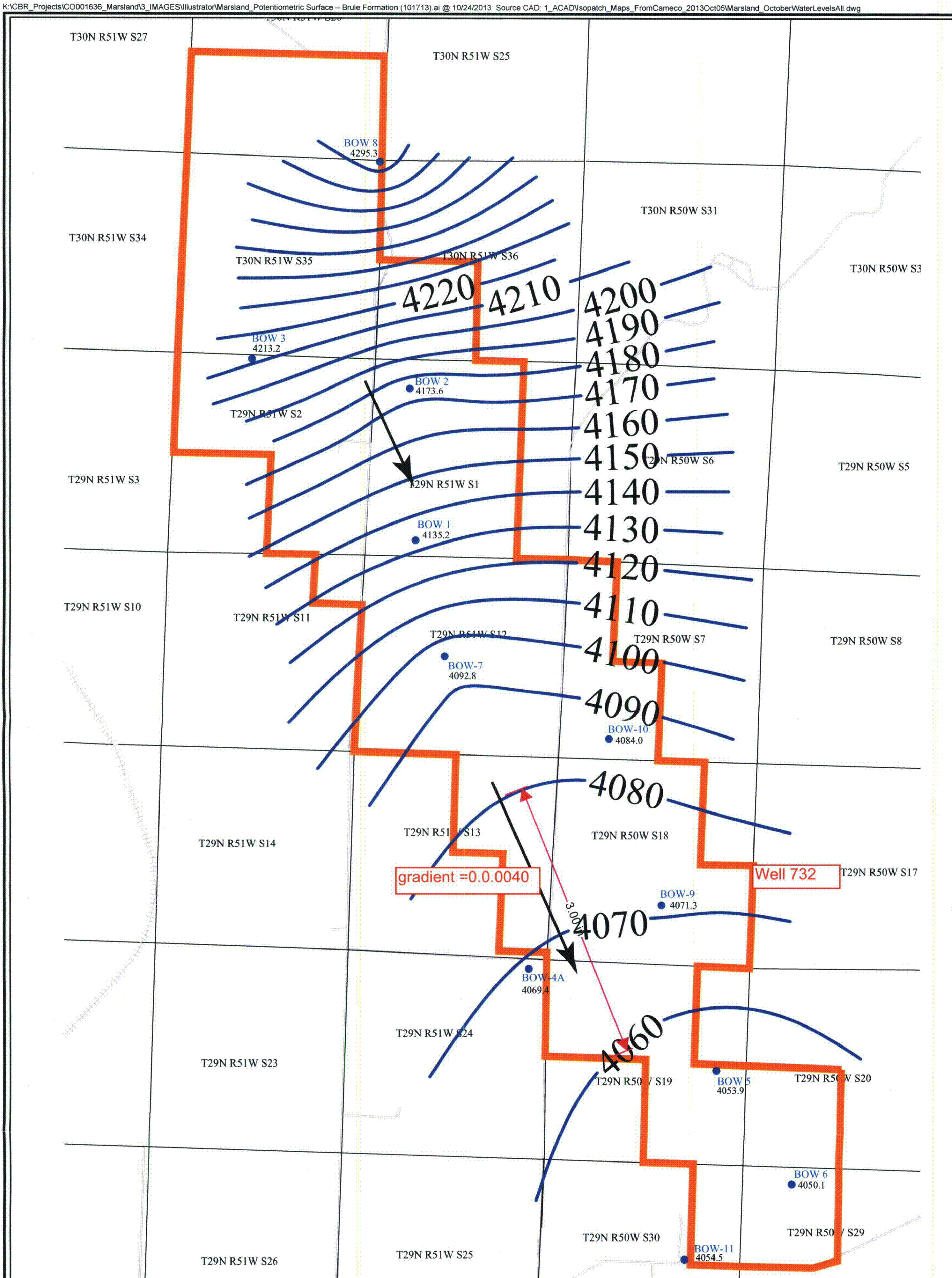
CROW BUTTE RESOURCES, INC.

FIGURE C-1
POTENTIOMETRIC SURFACE
ARIKAREE GROUP (10/17/13)

PROJECT: CO001636 | FORMATTED BY: JC | CHECKED BY: JA

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

K:\CBR_Projects\CO001636_Marsland\3_IMAGES\Illustrator\Marsland_Potentiometric Surface – Brule Formation (101713).ai @ 10/24/2013 Source CAD: 1_ACAD\Isopatch_Maps_FromCameco_2013Oct05\Marsland_OctoberWaterLevelsAll.dwg



LEGEND

- Proposed Marsland Expansion Area
- BOW-5 — Brule Formation Well and Well ID
- 4053.9 — Water Level (FT-AMSL)
- Groundwater Elevation Contour (FT-AMSL)
- Groundwater Flow Direction
- Road
- Railroad

FT-AMSL = Feet Above Mean Sea Level

N
1.00 in
0 1,250 2,500
Feet

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

CROW BUTTE RESOURCES, INC.

FIGURE C-2
POTENTIOMETRIC SURFACE
BRULE FORMATION (10/17/13)

PROJECT: CO001636 | FORMATTED BY: JC | CHECKED BY: JA

ARCADIS
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Highlands Ranch, CO 80129
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THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

Crow Butte Resources, Inc.
Figure 4
Three Crow
Cross-Section
Location Map

WITHIN THIS PACKAGE... OR, BY SEARCHING USING THE DOCUMENT/REPORT

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