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: CBR022

Exhibit Title: Regional Pumping Test Plan (Sept. 27, 2010)

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CAMECO RESOURCES

Regional Pumping Test Plan
Crow Butte Marsland Expansion Area

September 27, 2010

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1. INTRODUCTION AND PURPOSE

The Crow Butte Project is a uranium in-situ recovery (ISR) mine located in the vicinity of Crawford, Nebraska. The mine was developed to recover uranium from the Basal Chadron Sandstone. During the initial permitting and development of the Crow Butte mine, four pumping tests (referred to as Tests #1 though #4) were performed in the current Class III Underground Injection Control (UIC) Permit (NE0122611) area. The tests were performed to: 1) confirm confinement of the ore-bearing aquifer, and 2) assess the hydraulic characteristics of the Basal Chadron Sandstone. Subsequent pumping tests (#5 though #7) were performed to characterize the Basal Chadron Sandstone in the North Trend and Three Crow expansion areas.

Cameco Resources intends to submit an NRC License amendment application to conduct ISR operations in the Marsland expansion area, which is located approximately seven miles southwest of the current Class III UIC permit area and about four miles northeast of Marsland, Nebraska (**Figure 1**). As part of the application, a regional groundwater pumping test will be completed to demonstrate confinement between the Basal Chadron Sandstone and the overlying Brule Formation within the planned mining area. Additional detailed testing on a well-field specific basis (e.g., mine-unit scale drawdown tests to demonstrate communication between the production and monitoring wells and further verify confinement) will be performed in accordance with NUREG 1569 at a later date and prior to initiation of mining operations.

This pumping test plan has been prepared to: (1) provide test design and field procedures planned for the Marsland Pumping Test #8 to the NDEQ, and (2) present the methods of analysis that will be used with regard to determining the hydraulic characteristics of the mining zone and radius of influence of the pumping test. The test will be performed by pumping a well completed in the Basal Chadron Sandstone while monitoring changes in groundwater levels (drawdown) in the pumping well, seven monitoring wells in the Basal Chadron Sandstone, and three monitoring wells in the overlying Brule Formation (**Figure 2**).

2. GENERAL SITE STRATIGRAPHY

The subsurface geology and stratigraphy of the Marsland area is based on preliminary test hole drilling conducted at the Marsland property and correlation of regional geologic formations observed at the current Class III permit area and proposed expansion areas. A generalized stratigraphic section and well completion intervals for the Marsland area is provided in **Table 1**. A cross-section location map is provided in **Figure 3**. Geologic cross-sections are included in **Figures 4 through 9**. Structure contour maps of the top of the Basal Chadron Sandstone and underlying Pierre Shale are included in **Figures 10 and 11**, respectively. Isopach maps depicting the thickness of the Basal Chadron Sandstone and overlying Upper/Middle Chadron confining unit are included in **Figures 12 and 13**, respectively.

Table 1 - Generalized Stratigraphic Section, Marsland Expansion Area

Depth (feet bgs)	**Geologic Description**
0 – 25	Topsoil and alluvial deposits
25 - 150	Arikaree Formation – calcareous sandstone, siltstone and claystone (no wells)
150 -300	Brule Formation – interbedded siltstone and clayey sandstone (BOW wells)
300 - 1000	Upper/Middle Chadron Formation – siltstone and claystone confining unit (no wells)
1000 -1050	Basal Chadron Sandstone – CPW and Monitor wells
1050+	Pierre Shale (no wells)

Ore-grade uranium deposits underlying the Marsland expansion area are located in the Basal Chadron Sandstone, which averages 50 feet in thickness (typically 40 feet net sand) and occurs at depths ranging from 900 to more than 1100 feet below ground surface. Ore-grade deposits are generally located along a northwest-southeast trend in the Basal Chadron Sandstone. The width of the mineralized zone is generally less than 1500 feet along this trend. Ore-grade deposits are located primarily in the lower portion of the Sandstone, although ore-grade deposits may occur locally throughout the section. Based on drilling to date, the highest concentration of mineralization is located in the north, northcentral, and southern portion of the expansion area.

The Basal Chadron Sandstone does not contain distinct clay layers that can be correlated over significant distances, and therefore represents a single sand "package" with some interbedded clay lenses. The Upper/Middle Chadron Formation (confining unit), consisting primarily of clay, claystone and siltstone, and separates the Basal Chadron Sandstone from the overlying Brule Formation. The Upper/Middle Chadron confining unit is approximately 700 feet thick in the Marsland area. The overlying Brule Formation consists primarily of interbedded siltstone and clayey sandstone and is approximately 150 feet thick in the Marsland area. The Brule Formation is overlain locally by the Arikaree Formation, a calcareous sandstone with interbedded siltstone and claystone generally less than 150 feet thick in the Marsland area.

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No significant sands have been identified within the Upper/Middle Chadron Formation that can be correlated over any significant distance. Hence, wells installed in the overlying Brule Formation will be monitored as overlying aquifers during the pumping test.

3. SUMMARY OF PREVIOUS TESTING RESULTS

A total of seven pumping tests have been performed in the Basal Chadron Sandstone for the Crow Butte Project, including four tests (Tests #1, #2, #3, and #4) in the current Class III permit area, two tests at the North Trend Expansion Area (Tests #5 and #6), and one test at the Three Crow Expansion Area (Test #7). **Table 2** summarizes the previous testing results.

Table 2 - Previous Testing Results, Basal Chadron Sandstone

Parameter	Class III Permit Area Tests #1 - #3 (mean)	Class III Permit Area Test #4 (south)	North Trend Tests #5 and #6 (mean)	Three Crow Test # 7 (mean)
Transmissivity (ft^2/day)	363	826	60	480
Hyd. Conductivity (ft/day)	9.3	20.6	2.3	7.5
Storativity	9.7×10^{-5}	9.0×10^{-5}	5.3×10^{-5}	8.8×10^{-5}

Results of previous testing indicate the Basal Chadron Sandstone is relatively homogeneous and isotropic within the current Class III UIC permit area (e.g. the hydraulic conductivity is reasonably uniform with respect to location and direction), although higher values of hydraulic conductivity (permeability) are observed in the southern portion of the Class III UIC permit area (Test #4).

In the Three Crow area, values of hydraulic conductivity, transmissivity, and storage are similar to the permitted Class III UIC area, although the Basal Chadron Sandstone at Three Crow is divided locally into Upper and Lower Basal Sand units. The stratigraphy of the Basal Chadron Sandstone in the North Trend area is more complex and anisotropic than observed at other test locations.

Preliminary drilling at Marsland to date suggests that the hydraulic properties of the Basal Chadron Sandstone are similar to the permitted Class III UIC permit area. Preliminary best estimates of transmissivity and hydraulic conductivity of the Basal Chadron Sandstone used for planning of Marsland Pumping Test #8 are 400 ft^2/day and 8 ft/day, respectively.

4. MONITORING WELL SELECTION AND INSTALLATION

To conduct Marsland Pumping Test #8, Cameco Resources installed six new wells and redeveloped two existing wells in the Basal Chadron Sandstone (Marsland CPW-1, Marsland Monitor-2 through Marsland Monitor-8), and installed three new wells in the Brule Formation (Marsland BOW-1 through Marsland BOW-3). Because the underlying Pierre Shale is over 1,500 feet thick, no underlying monitoring wells were warranted. The wells are located in sections 1, 2, and 12 of Township 29 North Range 51 West and section 18 of Township 29 North Range 50 West. The depth to water in the Basal Chadron Sandstone is approximately 450 feet bgs.

Table 3 summarizes well construction details for all test wells. The nature and thickness of the subsurface formations encountered during the installation of monitoring wells are representative of the stratigraphic section presented in **Table 1**. Monitoring wells were located at various distances and directions from the pumping well (Marsland CPW-1) such that sufficient drawdown would be observed to allow hydraulic properties of the Basal Chadron Sandstone to be determined over the entire test area.

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Table 3 – Marsland Pumping Test #8 Well Completion Details

Well ID	Distance to Pumping Well	Northing	Easting	Section	Twp/Rng	TOC Elevation (feet amsl)	Ground Surface Elevation (feet amsl)	Total Depth (feet bgs)	Well Diameter (OD) (Inches)	Screen Slot Size (inches)	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	Screen Intervals (feet bgs)
Basal Chadron Pumping Well													
Marsland CPW-1	0	1121542	446258	1	T29N/R51W	TBD	4,260	1,070	4.95	0.020	1015	1048	1015-1048
Basal Chadron Observation Wells													
Marsland Monitor-2	8,356	1126362	439432	18	T29N/R50W	TBD	4,190	1,027	4.95	0.020	970	1010	970-1010
Marsland Monitor-3	40	1121542	446298	1	T29N/R51W	TBD	4,260	1,069	4.95	0.020	1016	1043	1016-1043
Marsland Monitor-4	3,824	1121292	450074	1	T29N/R51W	TBD	4,320	1,134	4.95	0.020	1088	1110	1088-1110
Marsland Monitor-5	2,372	1119574	447583	1	T29N/R51W	TBD	4,320	1,120	4.95	0.020	1070	1120	1070-1120
Marsland Monitor-6	4,792	1124639	442601	12	T29N/R51W	TBD	4,220	1,050	4.95	0.020	990	1023	990-1023
Marsland Monitor-7	5,739	1120114	440700	12	T29N/R51W	TBD	4,260	1,050	4.95	0.020	1000	1043	1000-1013, 1023-1043
Marsland Monitor-8	7,702	1115496	451029	2	T29N/R51W	TBD	4,460	1,180	4.95	0.020	1085	1125	1085-1125
Brule Observation Wells													
Marsland BOW-1	40	1121542	446218	1	T29N/R51W	TBD	4,260	370	4.95	0.020	285	365	285-305, 325-365
Marsland BOW-2	3,804	1121292	450054	1	T29N/R51W	TBD	4,320	400	4.95	0.020	339	399	339-369, 389-399
Marsland BOW-3	7,689	1115496	451009	2	T29N/R51W	TBD	4,460	415	4.95	0.020	345	415	345-365, 385-415

5. TESTING EQUIPMENT AND PRE-TEST DESIGN

Marsland Pumping Test #8 will be performed using a 4-inch diameter 10 horsepower electrical submersible pump powered by a portable generator. The pump will be set in well Marsland CPW-1 at an approximate depth of 600 feet, or 150 feet below the static water level. Flow from the pump will be controlled with a manual valve and surface flow measured with two Halliburton Model MC-2 flow/totalizer meters (or equivalent) and recorded. Per NDEQ direction, discharge water will be collected in frac tanks and trucked to the Crow Butte facility for disposal.

Water levels in the monitoring wells and the pumping well will be measured and recorded with dedicated In-Situ brand TROLL® 500 and Troll® 700-series pressure transducers/dataloggers equipped with vented cables (for barometric pressure compensation). The dataloggers will be programmed to automatically calibrate prior to the test, record an initial reference water level elevation (head), and measure and record water levels according to a linear time schedule. The pressure rating for the transducers will range from 30 to 100 pounds per square inch. A separate barometric pressure transducer/datalogger will be deployed in an observation well to allow correction of water level measurements due to barometric pressure fluctuations during the test period.

Prior to the pre-test monitoring period, the testing equipment will be installed and checked for proper operation. To assess background water level fluctuations, baseline water level data and barometric pressure data will be recorded for at least one week prior to the pumping period (pre-test period). Water level and barometric pressure measurements will be collected using pressure transducers/dataloggers throughout the pre-test period, pumping period, and post-test monitoring period, and will be supplemented with manual water level measurements periodically as an additional QA/QC measure.

6. TESTING AND ANALYTICAL PROCEDURES

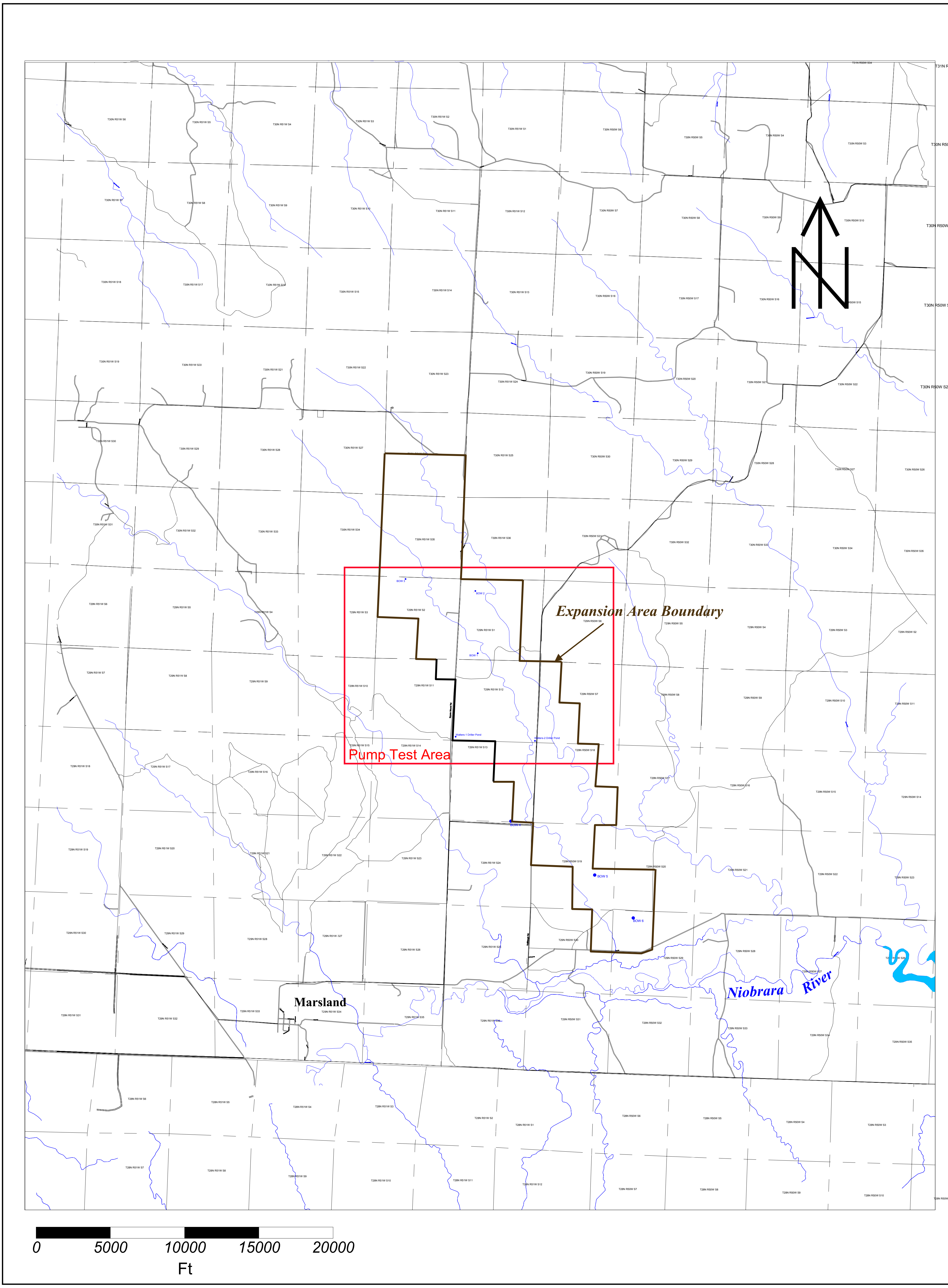
The pump will be started and maintained at a constant rate of approximately 35-40 gpm for an estimated period of three to seven days. A test of this rate and duration should result in a radius of influence (ROI) in excess of 5000 feet, with drawdown of approximately 0.5 feet at the most distant monitoring well location (8,350 feet). A test of this magnitude would be sufficient to impact a large portion of the proposed Marsland expansion area. It is anticipated that the recovery period will be monitored until approximately 50 to 70 percent recovery has been achieved. Cameco anticipates the Marsland Pumping Test #8 will be conducted in mid to late October 2010 given a 3 to 4 week period for NDEQ review and approval of this pumping test plan.

Conventional analytical techniques (i.e., log-log, semi-log, and distance-drawdown methods developed by Theis, Jacob, and Cooper and Jacob, respectively) appropriate for confined aquifers will be used to evaluate the response of the aquifer to pumping and recovery, and to assess the hydraulic characteristics of the Basal Chadron Sandstone. Other analytical methods (e.g., Hantush, Neumann) will be employed if warranted. The analyses will be facilitated using AQTESOLV software developed by HydroSOLVE, Inc.

7. TECHNICAL REPORT

A Technical Report will be submitted to the NDEQ summarizing the methods, results, and conclusions of Marsland Pumping Test #8. The technical report will include, at a minimum, the following information:

- Site description and pumping test configuration,
- Construction details for pumping and observation wells,
- Description of site stratigraphy and hydrogeology,
- Geologic cross-sections,
- Description of pumping test equipment,
- Discussion of pumping test performance and methods used for data analysis,
- Presentation of results of the pumping test, including best estimates of transmissivity, hydraulic conductivity, and storage coefficient for the all monitoring wells and the pumped well,
- Type-curve match for each monitoring well used to develop best estimates of aquifer parameters
- Assessment demonstrating confinement of the ore-bearing aquifer,
- Contour map showing drawdown observed at the end of the pumping period,
- Calculation of radius of influence, and
- Compilation of water level (drawdown) and barometric pressure data for all wells, including pre-test, pumping test, and recovery data



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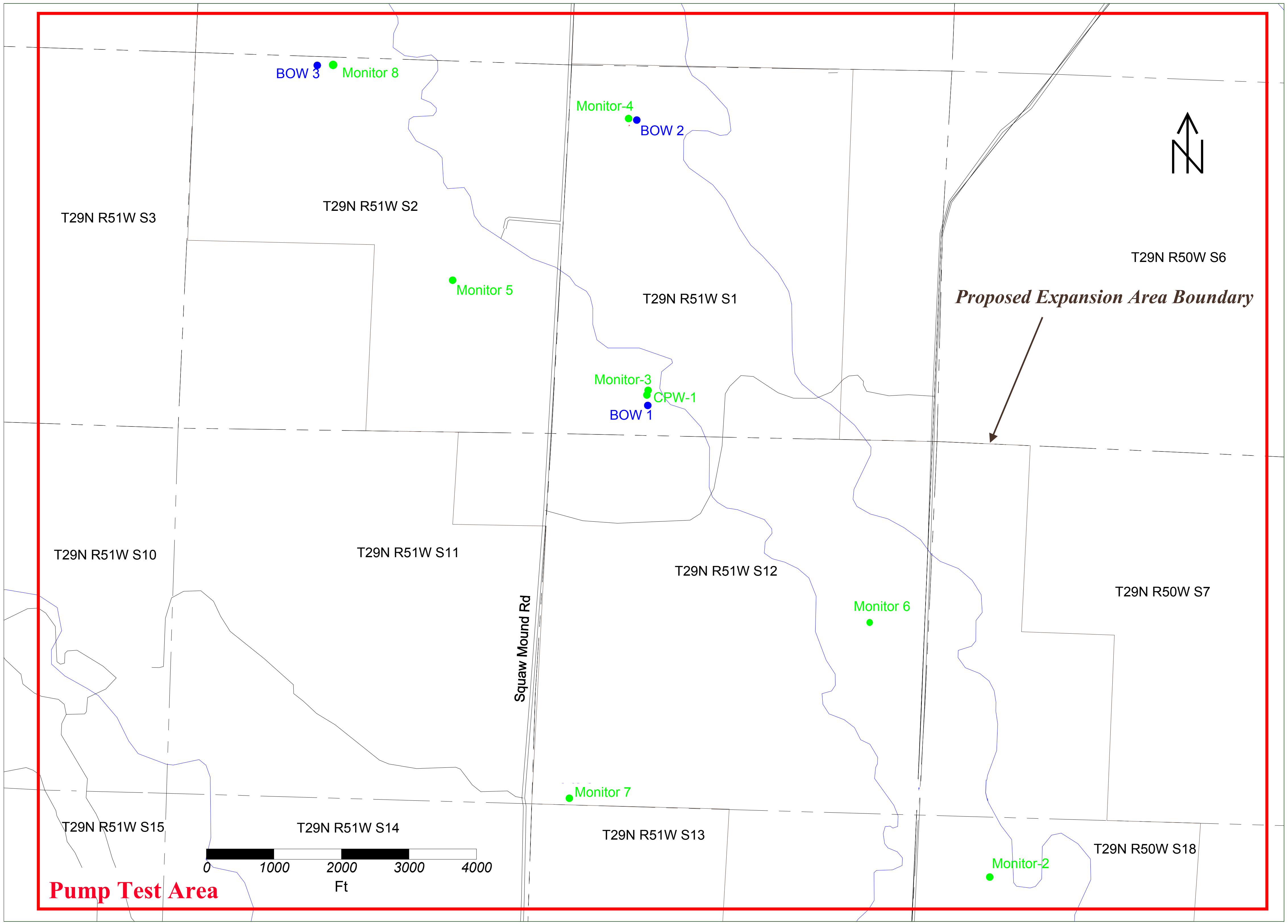
Marsland Expansion Area and Vicinity

Date: 9/2010

Project: Marsland Pumping Test Plan

Figure 1



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Marsland Pumping Test #8 Well Locations

Date: 9/2010

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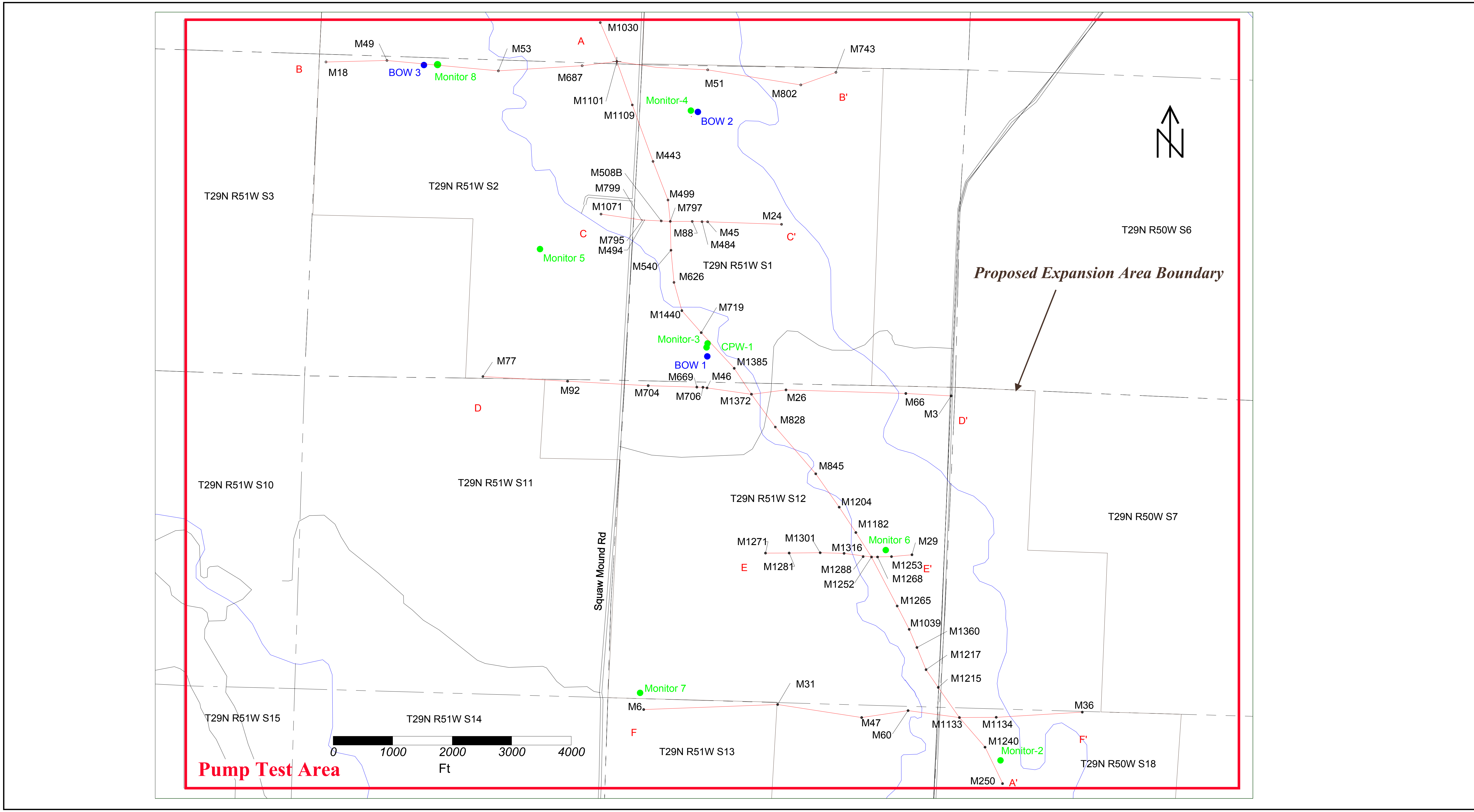
Figure 2



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Cross-Section Location Map

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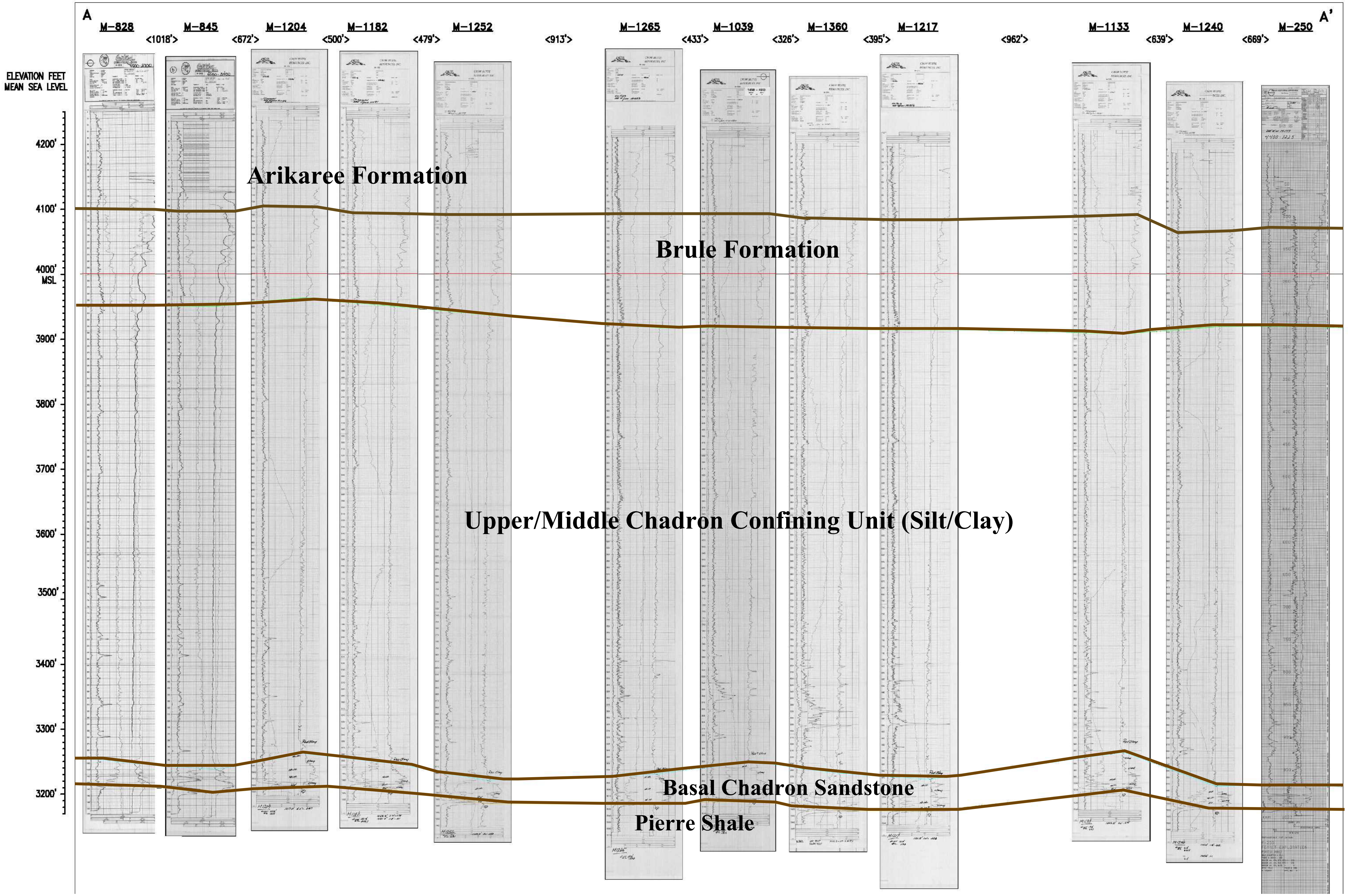
Figure 3



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Cross-Section A-A'

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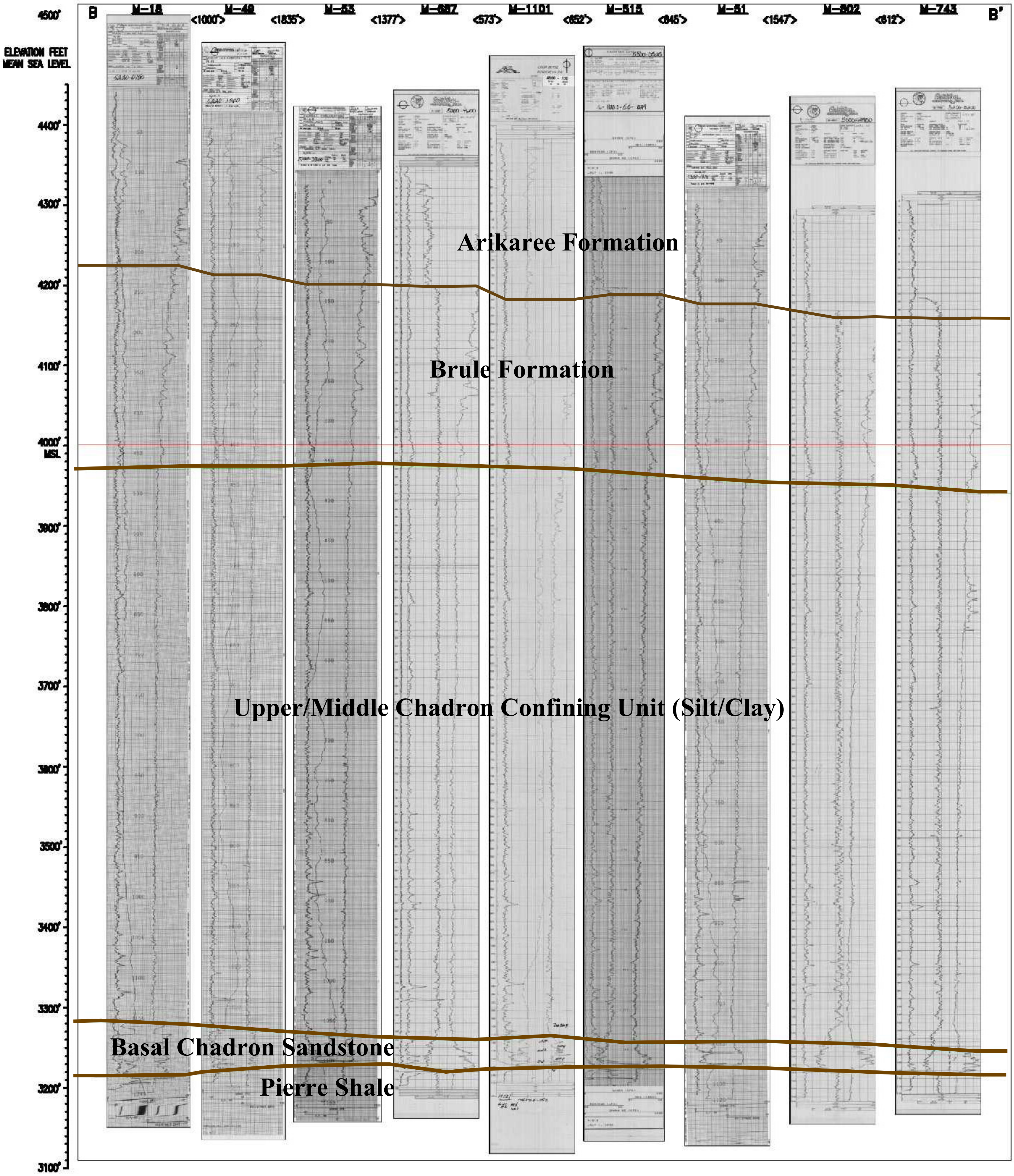
Figure 4



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Cross-Section B-B'

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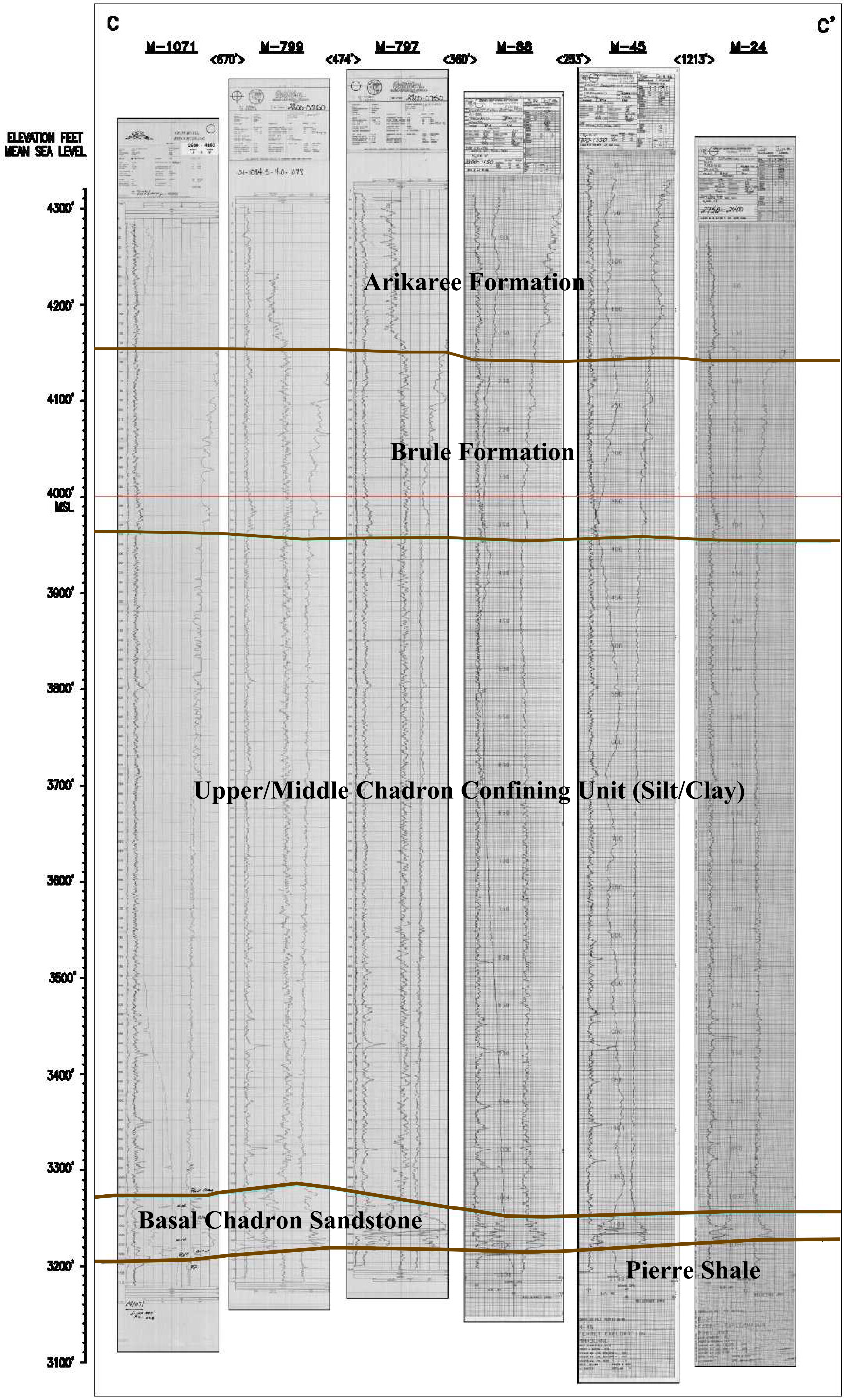
Figure 5



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Cross-Section C-C'

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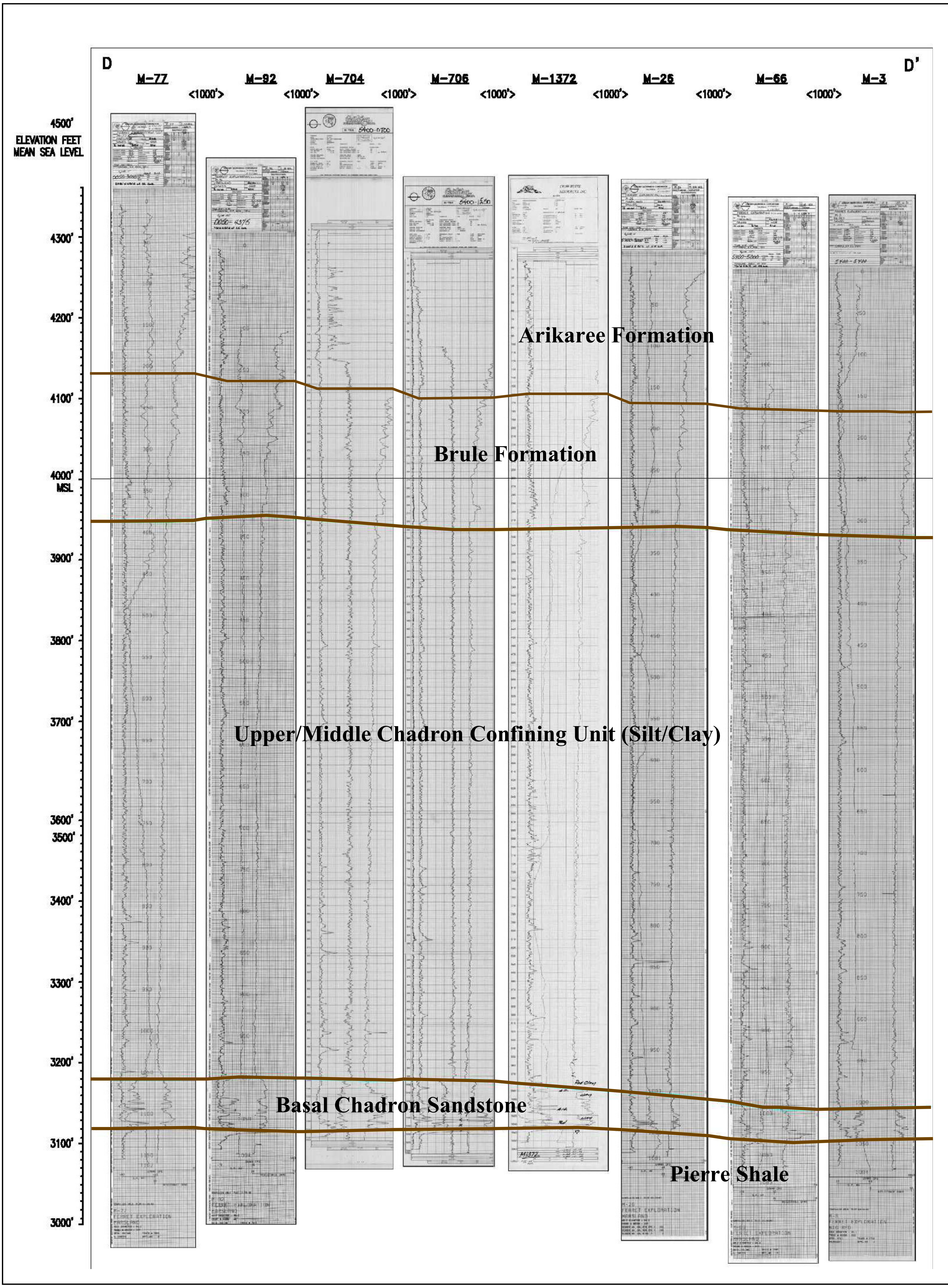
Figure 6



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Cross-Section D-D'

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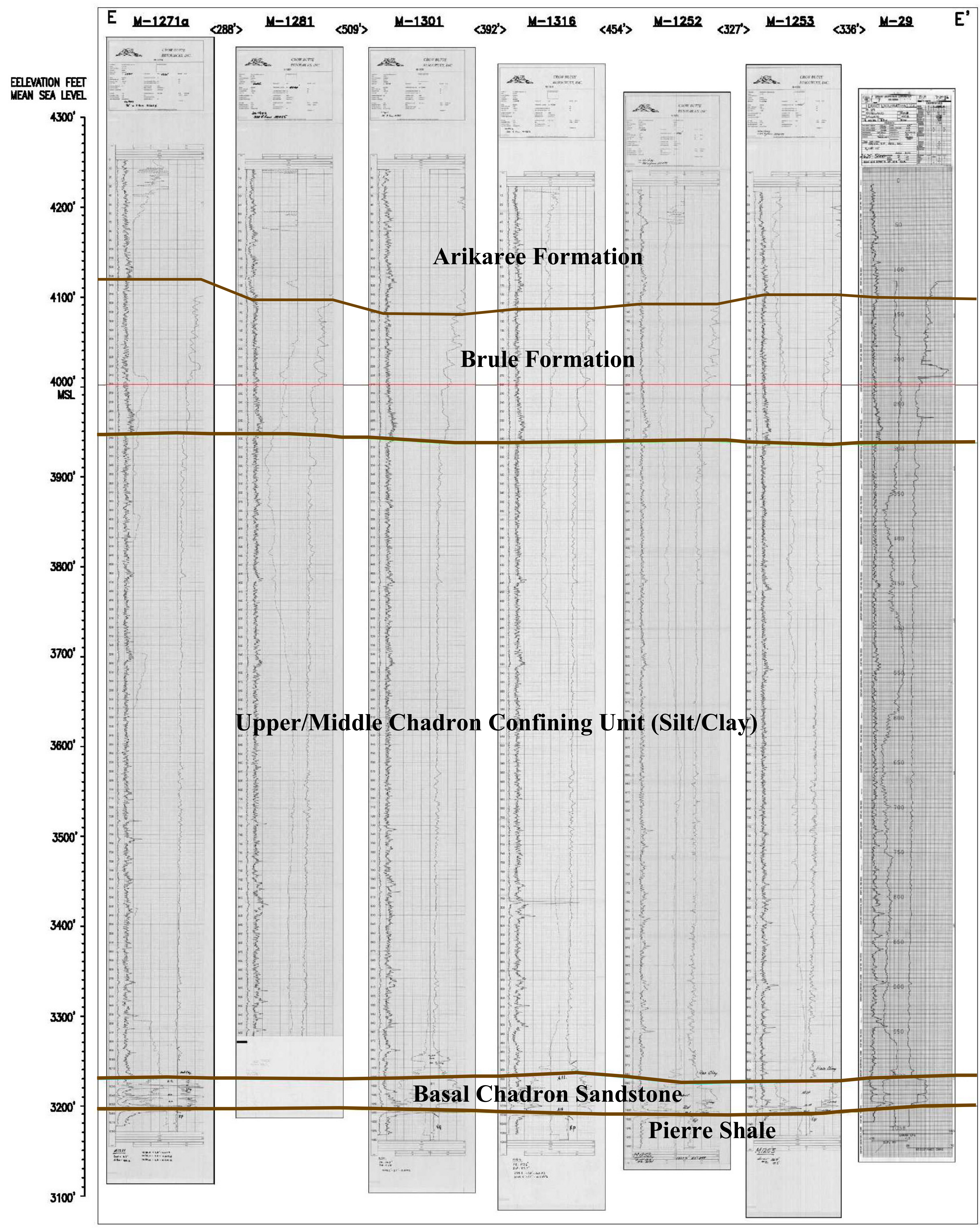
Figure 7



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Cross-Section E-E'

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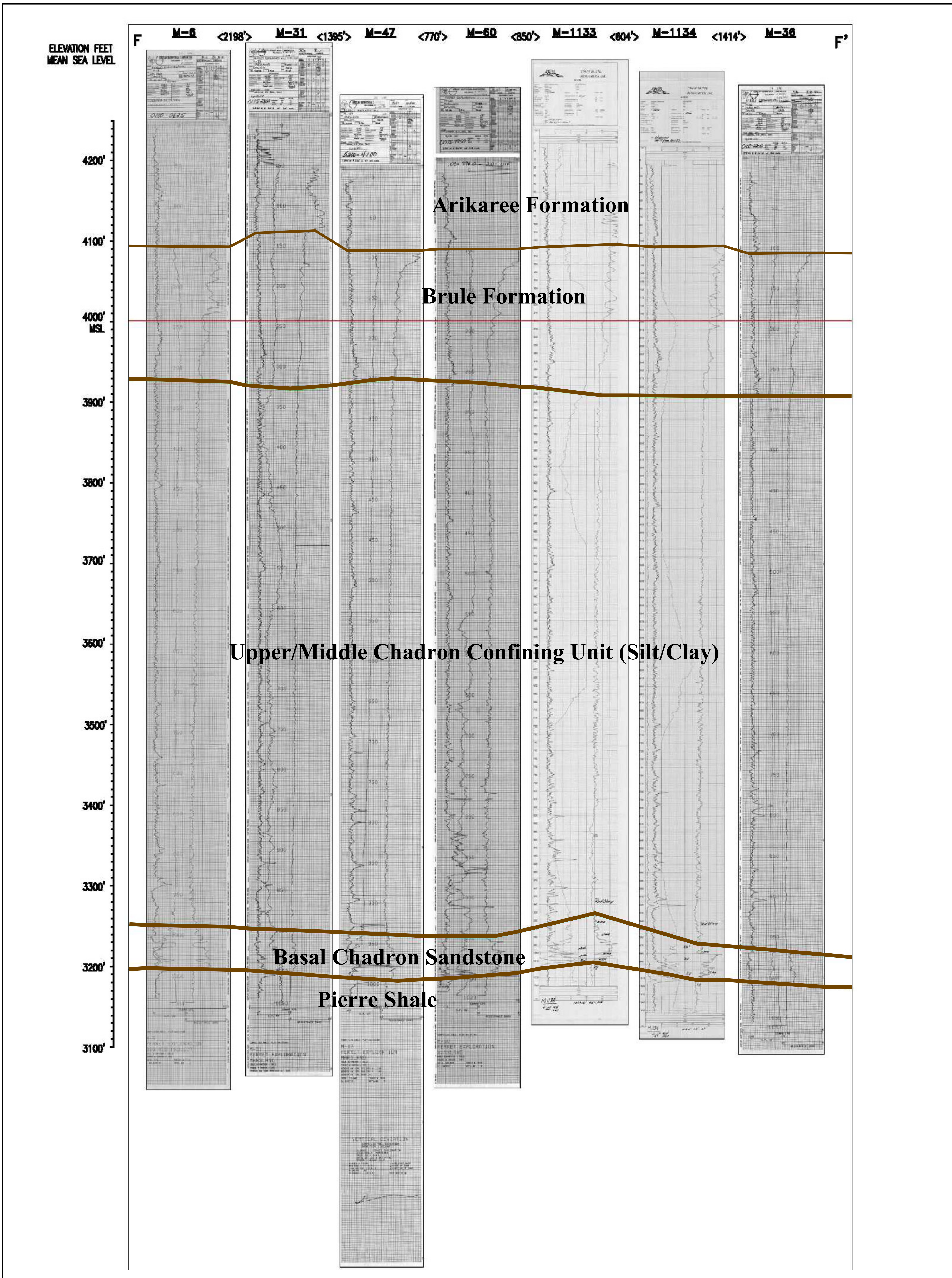
Figure 8



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Cross-Section F-F'

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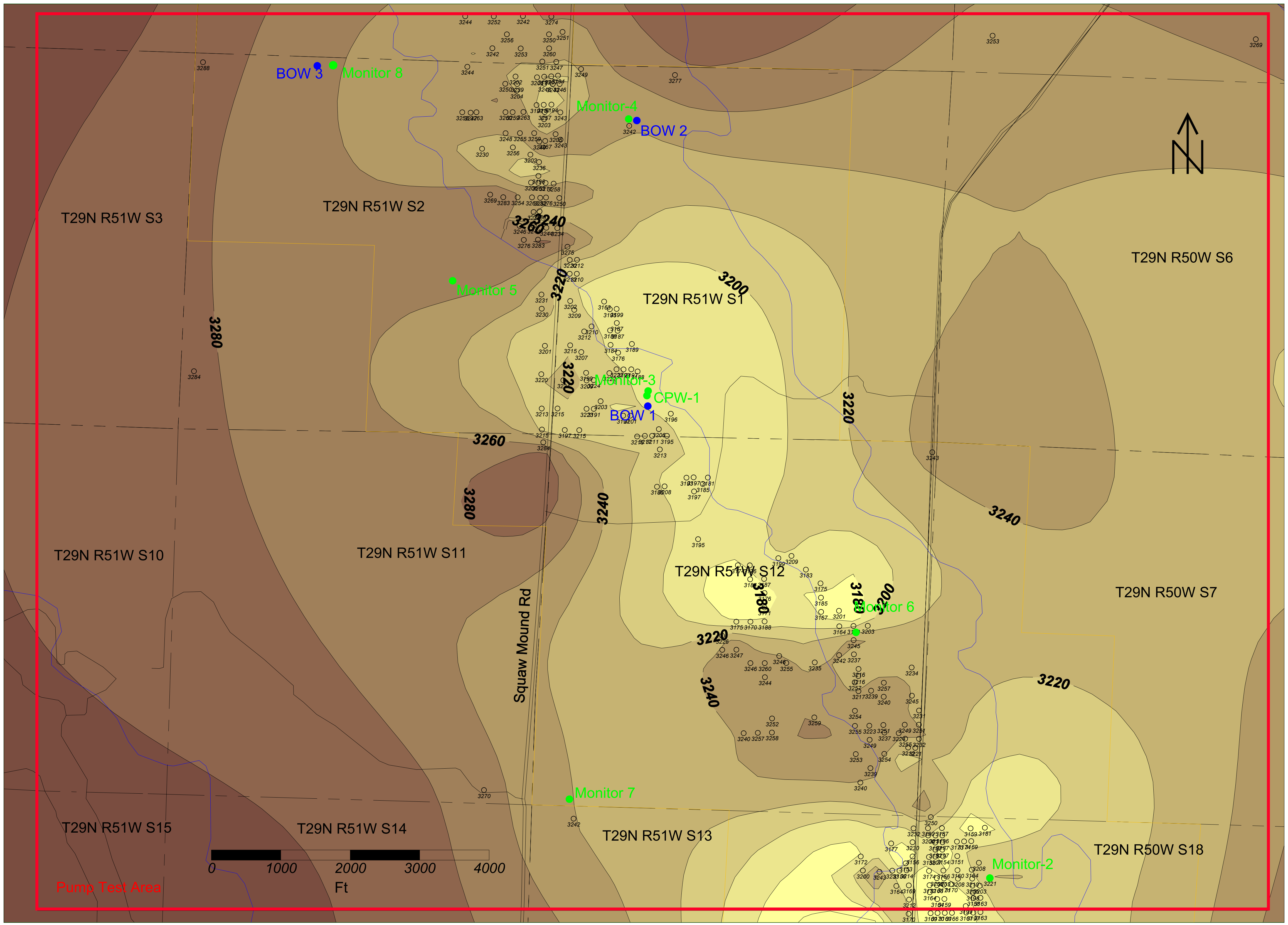
Figure 9



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Structure Contour Map
Top of the Basal Chadron Sandstone (ft-MSL)

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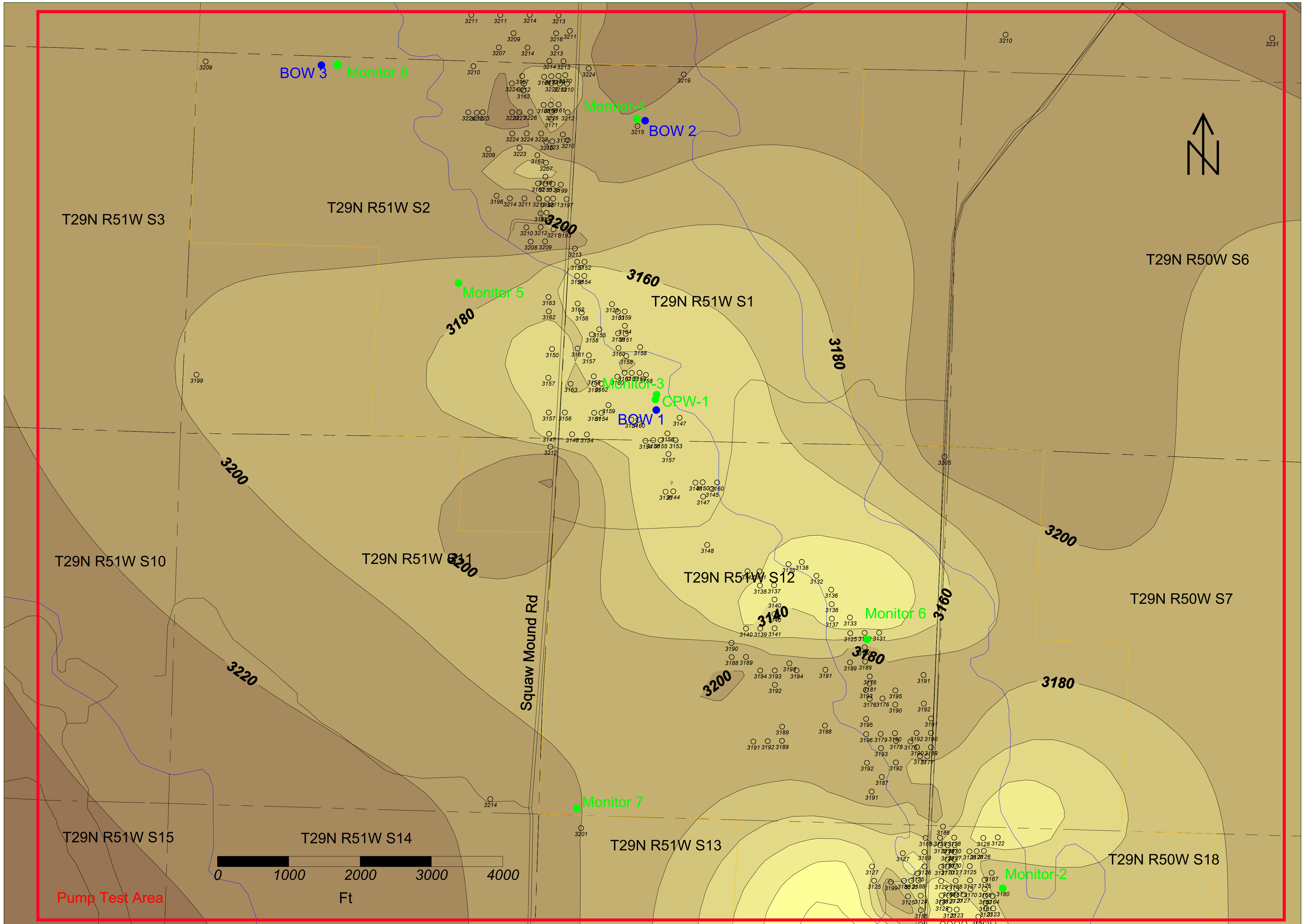
Figure 10



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Structure Contour Map
Top of the Pierre Shale (ft-MSL)

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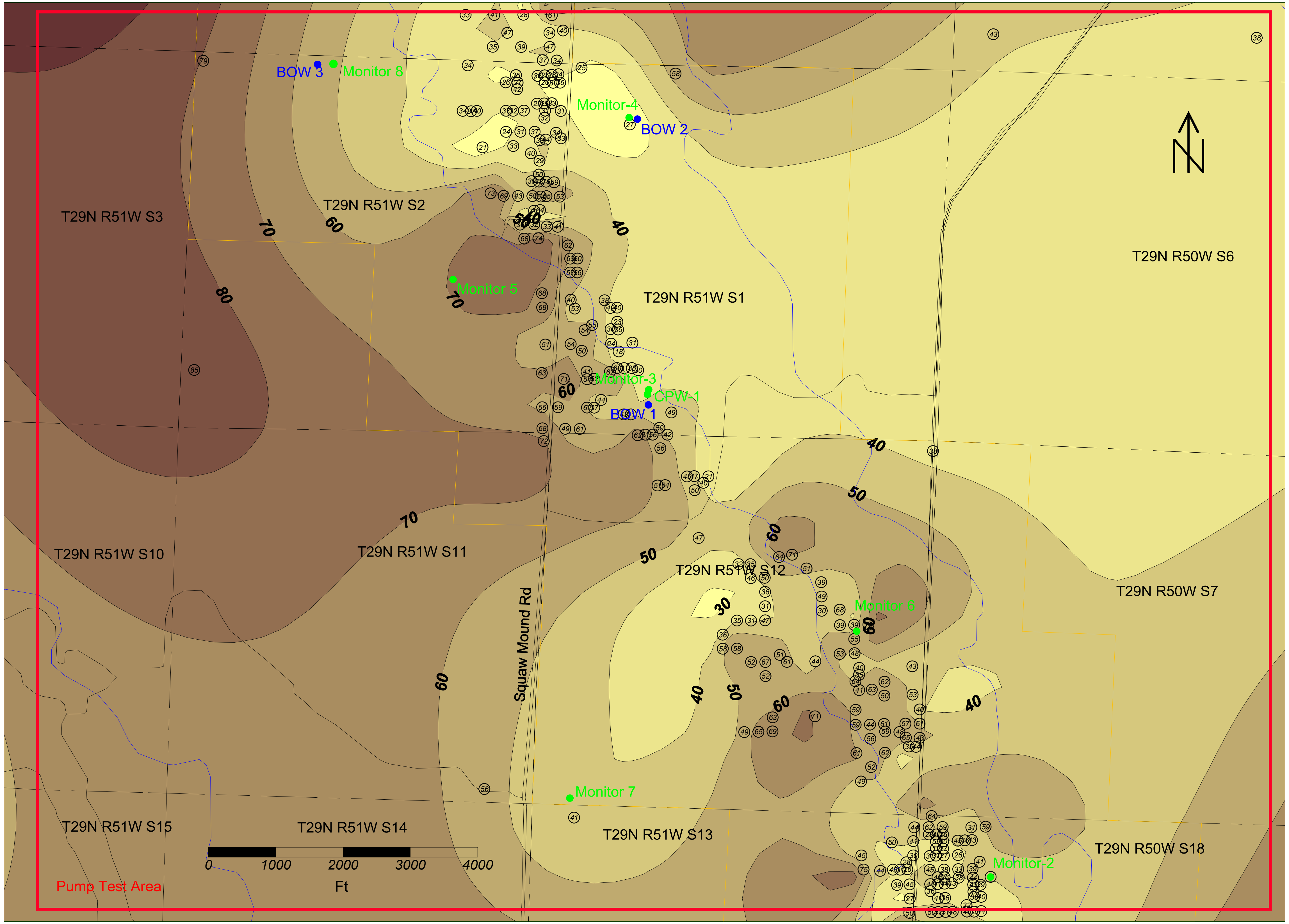
Figure 11



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Isopach (Thickness) Map
Basal Chadron Sandstone (ft-MSL)

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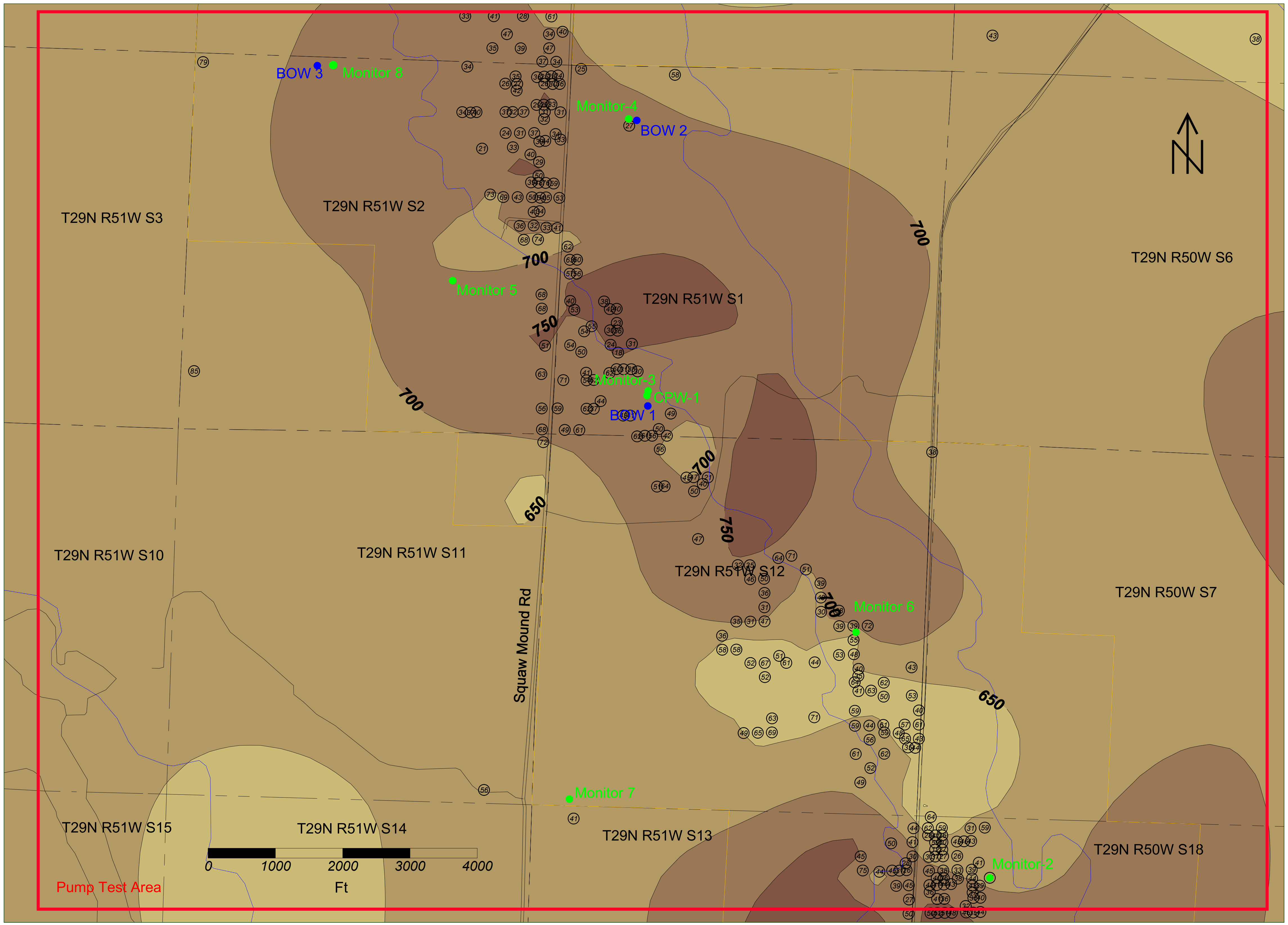
Figure 12



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Isopach (Thickness) Map
Upper/Middle Chadron Confining Unit (ft-MSL)

Date: 9/2010

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Figure 13