SECTION 20, TIER 2 SOIL ANALYSIS FOR PROPOSED CBNG PRODUCED WATER DISCHARGES TO WHITETAIL CREEK, CAMPBELL COUNTY, WYOMING

June 5, 2008

Prepared for:

STORMCAT ENERGY CORPORATION

1125 17th Street, Suite 2310
Denver, Colorado 80202

Prepared by:

BISON ENVIRONMENTAL, INC.
211 S. Cedar St., Suite A
Buffalo, Wyoming 82834

With contributions from:

ARCADIS
Infrastructure, environment, facilities
Buffalo, Wyoming, 82834

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Introduction

This Section 20, Tier 2 soils analysis was conducted on Whitetail Creek, tributary to the Little Powder River, tributary to the Powder River in Campbell County, Wyoming. As per Wyoming Department of Environmental Quality (WDEQ) guidelines, an investigation and analysis is required in drainages with irrigation uses that receive discharge from coal bed natural gas co-produced water. Irrigation within these drainages can be either artificial or natural. This Section 20, Tier 2 soils analysis satisfies this requirement as outlined in Wyoming's Agricultural Use Protection Policy (Chapter 1, Section 20, Water Quality Rules and Regulations).

Background

The project area investigated on Whitetail Creek is located in Township 55 North, and Ranges 71, 72, and 73 West. The location map in Appendix A shows the project area, land ownership, soil sampling locations, harvested bottomland and wetland areas. Arial photo maps are also included in Appendix A.

Irrigated bottomlands along Whitetail Creek and the focus of this soils investigation are located in Section 1, Township 55 North, Range 73 West, and Sections 5, 6, 8, and 9, Township 55 North, Range 72 West. A harvested parcel of land located in Section 5, Township 55 North, Range 72 West was not included in this soils investigation due to its unlikelihood of being affected by Whitetail Creek. The soil sampling site names and surveyed locations are listed Appendix B.

An enhanced vegetated area was investigated in Sections 16 and 17, Township 55 North, Range 71 West. This area was found to be a naturally occurring wetland with no agricultural beneficial use. Soil samples were not collected. Photos of this site are attached in Appendix D.

There is no USGS data available for Whitetail Creek. The closest USGS station is number 06324950 located on the Little Powder River below Elk Creek near Weston, Wyoming. This sampling station is located approximately four stream miles downstream of Whitetail Creek's confluence with the Little Powder River. Monthly samples have been collected at this location since July 2004. A summary table and graphical presentations of the sampling results are attached in Appendix C.

Site Investigation

Soil samples were collected at two harvested bottomland areas along Whitetail Creek. The Harris project area, with seven sampling locations in Sections 8 and 9, Township 55 North, Range 72 West, was sampled on May 18, 2007. There was also a water sample taken from Whitetail Creek on this date. The Upper Whitetail project area has seven sampling locations in Section 1, Township 55 North, Range 72 West. This area was sampled on April 18, 2008. Sample site location information is attached in Appendix B. Appendix C contains laboratory reports and Appendix D contains photos taken during field visits.

Observed vegetation species were noted during field visits. At the Harris project area, the vegetation observed included downy brome, smooth brome, basin wildrye, annual mustard, alfalfa, timothy crested wheatgrass, dandelions, western wheatgrass, and mush thistle. At the Upper Whitetail project area, vegetation included crested wheatgrass, smooth brome, Kentucky bluegrass, alfalfa, and downy brome. The vegetation observed in the hay meadows was at stubble length. Therefore, the identification was based on residual plants from the previous growing season. Alfalfa ranged from 0-30% at each soil sampling site.

Soil was collected and analyzed in twelve inch increments from ground surface (0”) to a depth of four to six feet, depending on the depth to groundwater. Both physical and chemical properties of the soil were analyzed. Physical properties include optimum moisture content, percent saturation, and soil texture. The chemical parameters analyzed include pH, specific conductivity (EC), sodium, calcium, magnesium, sodium adsorption ratio (SAR), cation exchange capacity (CEC), and exchangeable sodium percentage (ESP).

Results and Analyses

Soils

Soil content varied at each location and depth. Overall, the soils analyzed are primarily silty-clays or loams. In the Upper Whitetail sampling area, the silt content was an average of 55%, with an average clay content of 25% and average sand content of 15%. In the Harris sampling region, the average silt content was 45%, while clay averaged around 25% and sand 35%.

Graphs illustrating the soil chemistry are attached in Appendix B. Parameters include specific conductivity (EC), pH, sodium adsorption ratio (SAR), cation exchange capacity (CEC), and exchangeable sodium percentage (ESP). Soil parameters are graphed using bar charts to show the variance in concentration at each soil depth interval. Also included are bar charts illustrating the average concentration of each parameter by site. Two

additional graphs were assembled for EC and SAR results which averages the soil parameter of all sites at a specific depth interval.

EC and SAR were evaluated to determine the salinity and sodicity of the soil samples collected. The Salinity Laboratory Classification (1954) guidelines were used to determine the soil salinity and sodicity. Average EC values were calculated for each depth interval collected in the Harris and Upper Whitetail sampling areas. Soils in the 0”-12” range have an average EC of 2,304 µmhos/cm. The average EC for soil intervals greater than 12” range from 4,220 to 5,793 µmhos/cm. Soils with EC values greater than 4,000 µmhos/cm are classified as saline soils. Average SAR values were also calculated at varying depths to determine sodicity. Average soil SAR values for each depth interval range from 2.6 to 5.1. Soils with SAR values less than 13 are classified as non-sodic.

The parameter of interest for determining Wyoming Pollution Discharge Elimination System (WYPDES) permit irrigation protection limits is EC saturated paste (µmhos/cm). The calculation table used by the WDEQ to determine EC and SAR limits is attached in Appendix B. This calculation table averages the EC results to determine an “observed average”. The data set collected for the Whitetail Creek project area yields an observed average of 4,578 µmhos/cm. The average deviation for this data set is 3,338 µmhos/cm. Using this average deviation and a 95% confidence interval yields a confidence value of 965 µmhos/cm. Subtracting this confidence value from the observed average yields an adjusted average EC equal to 3,613 µmhos/cm. Wyoming’s Agricultural Use Protection Policy defines the relationship between soil EC and water EC as:

$$EC_{soil} = 1.5 \times EC_{water}$$

Given this relationship, the average EC value for water used to irrigate the soils sampled along Whitetail Creek can be calculated using the following:

$$EC_{water} = \frac{EC_{soil}}{1.5}$$

Given the relationship derived above and the adjusted average soil EC (3,613 µmhos/cm), EC_{water} equals 2,409 µmhos/cm.

Maximum allowable SAR is determined by the “Hanson etal. (1999) Chart” as stipulated in the Agricultural Use Protection Policy. This chart establishes allowable SAR based upon the conductivity (EC) of the water. The numerical representation of the maximum SAR in “no reduction in rate of infiltration” zone is:

$$SAR < (0.0071 \times EC) - 2.48$$

Using this formula, the allowable SAR at the maximum EC value of 2,409 µmhos/cm is 14.6.

Water

Water data available at the USGS station 06324950 located on the Little Powder River below Elk Creek near Weston, Wyoming, was analyzed for seasonal trends and general water quality. Data was collected at this station from July 2004 through April 2008 and

is attached in Appendix C. Also in Appendix C are graphs showing the data plotted over time and by monthly average over the period of record. As expected, during periods of peak flow, typically during spring months, specific conductivity (EC) and total dissolved solids (TDS) values decrease. EC ranges from 588 to 4,300 µmhos/cm. On average, EC values are around 3,000 µmhos/cm. TDS ranges from 404 to 3,860 mg/L with an average value of 2,300 mg/L. The sodium adsorption ratio (SAR) also tends to be slightly higher during periods of reduced flow and lower during periods of increased flow. SAR values range from 1.7 to 11 with an average of 6.2.

Summary and Conclusions

This Section 20, Tier 2 soils analysis presents the soil conditions found in the Whitetail Creek drainage and assists the WDEQ in developing WYPDES permit water limits for coal bed natural gas co-produced water discharges to this same drainage. This study was prepared in accordance with Agricultural Use Protection Policy, Chapter 1, Section 20.

The soils found in the Whitetail Creek project area are silty-clay and loam deposits which are moderately saline and non-sodic. Established statistical analysis was used for developing surface water EC and SAR irrigation protection limits. According to this analysis, the proposed WYPDES permit EC limit is 2,409 µmhos/cm, which corresponds to a maximum allowable SAR of 14.6. However, actual SAR limits will be based on EC values of the discharged water and the “Hanson Chart” relationship defined above.

Appendix A

Maps

Appendix B

Soils Data

Laboratory Reports
Site Sampling Locations
EC and SAR Limits Calculation Spreadsheet
Graphs

ENERGY LABORATORIES, INC. • 400 West Boxelder Road • Gillette, WY 82718
307-686-7175 • 866-686-7175 • 307-682-4625 fax • gillette@energylab.com

LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_1_4_5 Composite
Location: 12" to 24" 3 of 6 included
Samp FRQ/Type:
Lab ID: G07050683-002

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	1.51	meq/100g		0.04		SW6010B	05/29/07 12:22 / eli-h
Cation Exchange Capacity	35.5	meq/100g		0.09		SW6010B	05/31/07 09:16 / eli-h
Exchangeable Sodium Percentage	3.0	%		0.1		USDA20a	05/29/07 14:19 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	28	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	47	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	25	%		1		ASA15-5	05/29/07 14:19 / eli-h
Texture	L	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	58.3	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.20	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT							
Conductivity, sat. paste	2.97	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	17.3	meq/L		0.05		SW6010B	06/01/07 08:40 / eli-h
Magnesium, sat. paste	10.6	meq/L		0.08		SW6010B	06/01/07 08:40 / eli-h
Sodium, sat. paste	7.68	meq/L		0.04		SW6010B	06/01/07 08:40 / eli-h
Sodium Adsorption Ratio (SAR)	2.1	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

Michelle Bucholz

Michelle Bucholz
Project Manager

Report Definitions: RL - Analyte reporting limit. QCL - Quality control limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_1_4_5 Composite
Location: 24" to 36"
Samp FRQ/Type:
Lab ID: G07050683-003

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	3.22	meq/100g		0.04		SW6010B	05/29/07 12:30 / eli-h
Cation Exchange Capacity	22.0	meq/100g		0.09		SW6010B	05/31/07 09:19 / eli-h
Exchangeable Sodium Percentage	5.7	%		0.1		USDA20a	05/29/07 14:19 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	30	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	44	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	26	%		1		ASA15-5	05/29/07 14:19 / eli-h
Texture	L	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	53.1	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.60	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT							
Conductivity, sat. paste	8.04	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	22.3	meq/L		0.05		SW6010B	06/01/07 08:43 / eli-h
Magnesium, sat. paste	53.1	meq/L		0.08		SW6010B	06/01/07 08:43 / eli-h
Sodium, sat. paste	37.1	meq/L		0.04		SW6010B	06/01/07 08:43 / eli-h
Sodium Adsorption Ratio (SAR)	6.0	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

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LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_1_4_5 Composite
Location: 36" to 48"
Samp FRQ/Type:
Lab ID: G07050683-004

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	3.61	meq/100g		0.04		SW6010B	05/29/07 12:32 / eli-h
Cation Exchange Capacity	21.6	meq/100g		0.09		SW6010B	05/31/07 09:21 / eli-h
Exchangeable Sodium Percentage	7.8	%		0.1		USDA20a	05/29/07 14:19 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	27	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	48	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	25	%		1		ASA15-5	05/29/07 14:19 / eli-h
Texture	L	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	55.2	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.80	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT							
Conductivity, sat. paste	7.94	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	18.8	meq/L		0.05		SW6010B	06/01/07 08:46 / eli-h
Magnesium, sat. paste	51.3	meq/L		0.08		SW6010B	06/01/07 08:46 / eli-h
Sodium, sat. paste	34.9	meq/L		0.04		SW6010B	06/01/07 08:46 / eli-h
Sodium Adsorption Ratio (SAR)	5.9	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

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LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_1_4_5 Composite
Location: 48" to 60"
Samp FRQ/Type:
Lab ID: G07050683-005

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	2.67	meq/100g		0.04		SW6010B	05/29/07 12:35 / eli-h
Cation Exchange Capacity	19.7	meq/100g		0.09		SW6010B	05/31/07 09:24 / eli-h
Exchangeable Sodium Percentage	7.0	%		0.1		USDA20a	05/29/07 14:19 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	36	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	42	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	22	%		1		ASA15-5	05/29/07 14:19 / eli-h
Texture	L	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	48.6	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.70	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT							
Conductivity, sat. paste	6.33	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	24.2	meq/L		0.05		SW6010B	06/01/07 08:48 / eli-h
Magnesium, sat. paste	34.9	meq/L		0.08		SW6010B	06/01/07 08:48 / eli-h
Sodium, sat. paste	26.6	meq/L		0.04		SW6010B	06/01/07 08:48 / eli-h
Sodium Adsorption Ratio (SAR)	4.9	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

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LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_1_4_5 Composite
Location: 60" to 72"
Samp FRQ/Type:
Lab ID: G07050683-006

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	2.43	meq/100g		0.04		SW6010B	05/29/07 12:38 / eli-h
Cation Exchange Capacity	15.9	meq/100g		0.09		SW6010B	05/31/07 09:27 / eli-h
Exchangeable Sodium Percentage	8.9	%		0.1		USDA20a	05/29/07 14:19 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	42	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	39	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	19	%		1		ASA15-5	05/29/07 14:19 / eli-h
Texture	L	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	43.7	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.60	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT							
Conductivity, sat. paste	5.93	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	23.1	meq/L		0.05		SW6010B	06/01/07 08:51 / eli-h
Magnesium, sat. paste	30.4	meq/L		0.08		SW6010B	06/01/07 08:51 / eli-h
Sodium, sat. paste	23.4	meq/L		0.04		SW6010B	06/01/07 08:51 / eli-h
Sodium Adsorption Ratio (SAR)	4.5	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

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LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_2
Location: 0" to 12"
Samp FRQ/Type:
Lab ID: G07050683-007

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	3.52	meq/100g		0.04		SW6010B	05/29/07 12:40 / eli-h
Cation Exchange Capacity	23.4	meq/100g		0.09		SW6010B	05/31/07 09:29 / eli-h
Exchangeable Sodium Percentage	6.7	%		0.1		USDA20a	05/29/07 14:19 / eli-h
Organic Matter	2.46	%		0.02		ASA29-3	05/29/07 12:06 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	33	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	48	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	19	%		1		ASA15-5	05/29/07 14:19 / eli-h
20 Texture	L	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	55.0	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.60	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT	7370 µmhos/cm						
Conductivity, sat. paste	7.87	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	21.3	meq/L		0.05		SW6010B	06/01/07 08:54 / eli-h
Magnesium, sat. paste	41.8	meq/L		0.08		SW6010B	06/01/07 08:54 / eli-h
Sodium, sat. paste	35.5	meq/L		0.04		SW6010B	06/01/07 08:54 / eli-h
Sodium Adsorption Ratio (SAR)	6.3	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

Michelle Bucholz

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LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_2
Location: 12" to 24"
Samp FRQ/Type:
Lab ID: G07050683-008

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	3.25	meq/100g		0.04		SW6010B	05/29/07 12:43 / eli-h
Cation Exchange Capacity	16.5	meq/100g		0.09		SW6010B	05/31/07 09:32 / eli-h
Exchangeable Sodium Percentage	9.1	%		0.1		USDA20a	05/29/07 14:19 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	46	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	37	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	17	%		1		ASA15-5	05/29/07 14:19 / eli-h
Texture	L	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	46.6	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.70	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT							
Conductivity, sat. paste	7.93	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	22.3	meq/L		0.05		SW6010B	06/01/07 08:56 / eli-h
Magnesium, sat. paste	33.8	meq/L		0.08		SW6010B	06/01/07 08:56 / eli-h
Sodium, sat. paste	37.5	meq/L		0.04		SW6010B	06/01/07 08:56 / eli-h
Sodium Adsorption Ratio (SAR)	7.1	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

Michelle Bucholz

Michelle Bucholz
Project Manager

Report Definitions: RL - Analyte reporting limit. QCL - Quality control limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_2
Location: 24" to 36"
Samp FRQ/Type:
Lab ID: G07050683-009

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	3.82	meq/100g		0.04		SW6010B	05/29/07 12:46 / eli-h
Cation Exchange Capacity	17.8	meq/100g		0.09		SW6010B	05/31/07 09:40 / eli-h
Exchangeable Sodium Percentage	9.9	%		0.1		USDA20a	05/29/07 14:19 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	42	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	39	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	19	%		1		ASA15-5	05/29/07 14:19 / eli-h
Texture	L	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	49.4	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.70	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT							
Conductivity, sat. paste	8.50	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	21.6	meq/L		0.05		SW6010B	06/01/07 08:59 / eli-h
Magnesium, sat. paste	40.1	meq/L		0.08		SW6010B	06/01/07 08:59 / eli-h
Sodium, sat. paste	41.8	meq/L		0.04		SW6010B	06/01/07 08:59 / eli-h
Sodium Adsorption Ratio (SAR)	7.5	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

Michelle Bucholz

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Project Manager

Report Definitions: RL - Analyte reporting limit. QCL - Quality control limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_7
Location: 0" to 12"
Samp FRQ/Type:
Lab ID: G07050683-010

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	0.40	meq/100g		0.04		SW6010B	05/29/07 12:48 / eli-h
Cation Exchange Capacity	24.1	meq/100g		0.09		SW6010B	05/31/07 09:43 / eli-h
Exchangeable Sodium Percentage	1.5	%		0.1		USDA20a	05/29/07 14:19 / eli-h
Organic Matter	2.53	%		0.02		ASA29-3	05/29/07 12:06 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	35	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	42	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	23	%		1		ASA15-5	05/29/07 14:19 / eli-h
Texture	L	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	53.4	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.30	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT							
Conductivity, sat. paste	0.60	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	4.08	meq/L		0.05		SW6010B	06/01/07 09:07 / eli-h
Magnesium, sat. paste	1.17	meq/L		0.08		SW6010B	06/01/07 09:07 / eli-h
Sodium, sat. paste	0.79	meq/L		0.04		SW6010B	06/01/07 09:07 / eli-h
Sodium Adsorption Ratio (SAR)	0.49	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

Michelle Bucholz

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Project Manager

Report Definitions: RL - Analyte reporting limit. QCL - Quality control limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_7
Location: 12" to 24"
Samp FRQ/Type:
Lab ID: G07050683-011

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	0.43	meq/100g		0.04		SW6010B	05/29/07 12:54 / eli-h
Cation Exchange Capacity	17.5	meq/100g		0.09		SW6010B	05/31/07 09:48 / eli-h
Exchangeable Sodium Percentage	2.2	%		0.1		USDA20a	05/29/07 14:19 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	49	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	33	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	18	%		1		ASA15-5	05/29/07 14:19 / eli-h
Texture	L	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	43.4	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.50	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT							
Conductivity, sat. paste	0.43	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	2.79	meq/L		0.05		SW6010B	06/01/07 09:12 / eli-h
Magnesium, sat. paste	1.01	meq/L		0.08		SW6010B	06/01/07 09:12 / eli-h
Sodium, sat. paste	0.92	meq/L		0.04		SW6010B	06/01/07 09:12 / eli-h
Sodium Adsorption Ratio (SAR)	0.67	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

Michelle Bucholz

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Project Manager

Report Definitions: RL - Analyte reporting limit. QCL - Quality control limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_7
Location: 24" to 36"
Samp FRQ/Type:
Lab ID: G07050683-012

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	0.50	meq/100g		0.04		SW6010B	05/29/07 13:02 / eli-h
Cation Exchange Capacity	19.3	meq/100g		0.09		SW6010B	05/31/07 09:51 / eli-h
Exchangeable Sodium Percentage	2.3	%		0.1		USDA20a	05/29/07 14:19 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	41	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	40	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	19	%		1		ASA15-5	05/29/07 14:19 / eli-h
Texture	L	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	46.0	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.50	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT							
Conductivity, sat. paste	0.56	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	3.67	meq/L		0.05		SW6010B	06/01/07 09:15 / eli-h
Magnesium, sat. paste	1.47	meq/L		0.08		SW6010B	06/01/07 09:15 / eli-h
Sodium, sat. paste	1.23	meq/L		0.04		SW6010B	06/01/07 09:15 / eli-h
Sodium Adsorption Ratio (SAR)	0.77	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

Michelle Bucholz

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Project Manager

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LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_7
Location: 36" to 48"
Samp FRQ/Type:
Lab ID: G07050683-013

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	0.53	meq/100g		0.04		SW6010B	05/29/07 13:04 / eli-h
Cation Exchange Capacity	24.6	meq/100g		0.09		SW6010B	05/31/07 09:53 / eli-h
Exchangeable Sodium Percentage	1.8	%		0.1		USDA20a	05/29/07 14:19 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	26	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	47	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	27	%		1		ASA15-5	05/29/07 14:19 / eli-h
Texture	CL	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	47.5	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.50	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT							
Conductivity, sat. paste	1.15	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	6.07	meq/L		0.05		SW6010B	06/01/07 09:18 / eli-h
Magnesium, sat. paste	4.41	meq/L		0.08		SW6010B	06/01/07 09:18 / eli-h
Sodium, sat. paste	1.69	meq/L		0.04		SW6010B	06/01/07 09:18 / eli-h
Sodium Adsorption Ratio (SAR)	0.74	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

Michelle Bucholz

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Project Manager

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LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_7
Location: 48" to 60"
Samp FRQ/Type:
Lab ID: G07050683-014

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	0.67	meq/100g		0.04		SW6010B	05/29/07 13:07 / eli-h
Cation Exchange Capacity	27.7	meq/100g		0.09		SW6010B	05/31/07 09:56 / eli-h
Exchangeable Sodium Percentage	2.0	%		0.1		USDA20a	05/29/07 14:19 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	26	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	41	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	33	%		1		ASA15-5	05/29/07 14:19 / eli-h
Texture	CL	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	54.4	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.50	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT							
Conductivity, sat. paste	1.12	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	5.78	meq/L		0.05		SW6010B	06/01/07 09:20 / eli-h
Magnesium, sat. paste	4.93	meq/L		0.08		SW6010B	06/01/07 09:20 / eli-h
Sodium, sat. paste	2.20	meq/L		0.04		SW6010B	06/01/07 09:20 / eli-h
Sodium Adsorption Ratio (SAR)	0.95	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

Michelle Bucholz

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Project Manager

Report Definitions: RL - Analyte reporting limit. QCL - Quality control limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Harris_7
Location: 60" to 72"
Samp FRQ/Type:
Lab ID: G07050683-015

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Soil
Sampled By: Dave Huber

Analyses	Result	Units	Qualifier	RL	MCL/ QCL	Method	Analysis Date / By
CHEMICAL CHARACTERISTICS							
Sodium, Extractable	2.03	meq/100g		0.04		SW6010B	05/29/07 13:10 / eli-h
Cation Exchange Capacity	21.4	meq/100g		0.09		SW6010B	05/31/07 09:59 / eli-h
Exchangeable Sodium Percentage	4.7	%		0.1		USDA20a	05/29/07 14:19 / eli-h
PHYSICAL CHARACTERISTICS							
Sand	36	%		1		ASA15-5	05/29/07 14:19 / eli-h
Silt	38	%		1		ASA15-5	05/29/07 14:19 / eli-h
Clay	26	%		1		ASA15-5	05/29/07 14:19 / eli-h
Texture	L	unitless				ASA15-5	05/29/07 14:19 / eli-h
SATURATED PASTE							
Saturation	50.0	%		0.1		USDA27a	05/29/07 14:19 / eli-h
pH, sat. paste	7.60	s.u.		0.01		ASAM10-3.2	05/29/07 14:19 / eli-h
SOIL:WATER-PASTE EXTRACT							
Conductivity, sat. paste	5.47	mmhos/cm		0.01		ASAM10-3	05/29/07 14:19 / eli-h
Calcium, sat. paste	29.5	meq/L		0.05		SW6010B	06/01/07 09:23 / eli-h
Magnesium, sat. paste	37.6	meq/L		0.08		SW6010B	06/01/07 09:23 / eli-h
Sodium, sat. paste	20.4	meq/L		0.04		SW6010B	06/01/07 09:23 / eli-h
Sodium Adsorption Ratio (SAR)	3.5	unitless		0.01		Calculation	05/29/07 14:19 / eli-h

Michelle Bucholz

Michelle Bucholz
Project Manager

Report Definitions: RL - Analyte reporting limit. QCL - Quality control limit. MCL - Maximum contaminant level. ND - Not detected at the reporting limit.

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LABORATORY ANALYTICAL REPORT

Client: Storm Cat Energy USA Corp
Project: Upper Whitetail Cr
Workorder: G08041123

Report Date: 05/20/08
Date Received: 04/29/08

		Analysis	OM	Sand	Silt	Clay	Texture	SAT	pH-sat paste	EC-sat paste	Ca-sat paste	Mg-sat paste	Na-sat paste	SAR-sat paste	Na-NH4OAC
		Units	%	%	%	%		%	s_u_	mmhos/cm	meq/L	meq/L	meq/L	unitless	meq/100g
Sample ID	**Client Sample ID**	**Depth**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
G08041123-001	Upper W.T. #1	0-12	3.53	12	63	25	SiL	53.5	7.8	1.41	2.8	1.6	10.3	6.9	1.72
G08041123-002	Upper W.T. #1	12-24		6	65	29	SiCL	57.4	7.8	6.34	22.7	22.7	41.5	8.7	3.71
G08041123-003	Upper W.T. #1	24-36		10	59	31	SiCL	55.1	7.9	8.35	31.3	38.9	55.7	9.4	4.51
G08041123-004	Upper W.T. #1	36-48		14	57	29	SiCL	51.7	7.9	8.72	32.7	44.0	58.4	9.4	4.27
G08041123-005	Upper W.T. #2	0-12	4.98	9	62	29	SiCL	60.9	7.2	4.36	22.3	17.3	13.9	3.1	1.51
G08041123-006	Upper W.T. #2	12-24		6	65	29	SiCL	57.5	8.0	12.7	30.3	96.3	100	12.6	8.27
G08041123-007	Upper W.T. #2	24-36		6	61	33	SiCL	56.6	8.1	12.3	30.8	88.3	97.1	12.6	7.52
G08041123-008	Upper W.T. #2	36-48		4	63	33	SiCL	57.1	8.1	10.7	31.5	66.5	86.2	12.3	6.45
G08041123-009	Upper W.T. #3	0-12	3.10	< 1	51	49	SiC	67.1	7.1	1.32	3.7	3.7	7.3	3.8	1.47
G08041123-010	Upper W.T. #3	12-24		10	51	39	SiCL	54.0	7.5	3.34	10.4	8.1	16.8	5.5	1.94
G08041123-011	Upper W.T. #3	24-36		8	57	35	SiCL	52.8	7.4	6.32	29.6	18.4	27.0	5.5	2.32
G08041123-012	Upper W.T. #3	36-48		8	61	31	SiCL	52.9	7.3	9.24	49.7	30.7	39.7	6.3	2.89
G08041123-013	Upper W.T. #3	48-60		2	61	37	SiCL	57.0	7.7	8.73	32.8	33.5	56.2	9.8	4.96
G08041123-014	Upper W.T. #3	60-72		4	59	37	SiCL	57.2	8.2	10.1	24.9	61.9	77.2	11.7	5.97
G08041123-015	Upper W.T. #4	0-12	3.24	12	59	29	SiCL	55.2	7.6	0.80	4.6	1.7	2.9	1.6	0.422
G08041123-016	Upper W.T. #4	12-24		18	57	25	SiL	44.6	7.8	0.78	4.4	2.0	1.8	1.0	0.234
G08041123-017	Upper W.T. #4	24-36		18	57	25	SiL	43.5	7.9	0.76	4.0	2.6	1.5	0.9	0.179
G08041123-018	Upper W.T. #4	36-48		20	55	25	SiL	44.9	7.9	0.88	4.5	2.8	1.5	0.8	0.173
G08041123-019	Upper W.T. #4	48-60		28	47	25	L	43.9	7.1	2.94	31.3	8.2	2.0	0.5	0.152
G08041123-020	Upper W.T. #4	60-72		24	47	29	CL	46.6	7.6	2.93	31.9	8.6	1.8	0.4	0.129
G08041123-021	Upper W.T. #5	0-12	2.53	28	46	26	L	53.5	7.7	1.41	8.2	5.8	2.0	0.7	0.214
G08041123-022	Upper W.T. #5	12-24		29	46	25	L	45.6	7.7	2.93	19.1	15.2	5.0	1.2	0.486
G08041123-023	Upper W.T. #5	24-36		24	49	27	CL	47.4	7.8	3.58	21.7	18.1	10.4	2.3	0.823
G08041123-024	Upper W.T. #5	36-48		22	51	27	CL	51.3	7.9	1.96	9.4	7.4	6.7	2.3	0.726
G08041123-025	Upper W.T. #5	48-60		28	43	29	CL	50.3	7.8	1.76	9.2	6.8	5.4	1.9	0.619
G08041123-026	Upper W.T. #5	60-72		30	44	26	L	47.2	7.7	1.34	6.3	4.8	4.0	1.7	0.479
G08041123-027	Upper W.T. #7	0-12	2.97	< 1	63	37	SiCL	63.5	7.5	0.66	4.6	1.9	0.5	0.3	0.0457
G08041123-028	Upper W.T. #7	12-24		< 1	69	31	SiCL	50.2	7.8	0.56	3.6	1.7	0.4	0.2	0.0664
G08041123-029	Upper W.T. #7	24-36		16	57	27	SiCL	47.9	7.9	0.69	3.6	2.6	0.8	0.5	0.0850
G08041123-030	Upper W.T. #7	36-48		42	37	21	L	38.8	7.9	1.00	3.8	3.8	2.4	1.2	0.288
G08041123-031	Upper W.T. #7	48-60		13	57	30	SiCL	53.0	8.0	7.83	20.7	88.8	36.4	4.9	3.01
G08041123-032	Upper W.T. #7	60-72		2	57	41	SiC	64.3	8.0	8.99	24.7	119	46.1	5.4	3.66

ENERGY LABORATORIES, INC. * 400 W Boxelder Rd * Gillette, WY 82718-5315
Toll Free 866.686.7175 * 307.686.7175 * FAX 307.682.4625 * gillette@energylab.com

LABORATORY ANALYTICAL REPORT

Client: Storm Cat Energy USA Corp
Project: Upper Whitetail Cr
Workorder: G08041123

Report Date: 05/20/08
Date Received: 04/29/08

		Analysis	CEC	ESP
		Units	meq/100g	%
Sample ID	**Client Sample ID**	**Depth**	**Results**	**Results**
G08041123-001	Upper W.T. #1	0-12	29.9	3.90
G08041123-002	Upper W.T. #1	12-24	26.4	5.05
G08041123-003	Upper W.T. #1	24-36	25.6	5.64
G08041123-004	Upper W.T. #1	36-48	25.3	4.94
G08041123-005	Upper W.T. #2	0-12	37.6	1.75
G08041123-006	Upper W.T. #2	12-24	31.9	7.81
G08041123-007	Upper W.T. #2	24-36	28.4	7.15
G08041123-008	Upper W.T. #2	36-48	26.3	5.82
G08041123-009	Upper W.T. #3	0-12	36.2	2.70
G08041123-010	Upper W.T. #3	12-24	28.0	3.71
G08041123-011	Upper W.T. #3	24-36	29.3	3.06
G08041123-012	Upper W.T. #3	36-48	33.2	2.38
G08041123-013	Upper W.T. #3	48-60	30.8	5.70
G08041123-014	Upper W.T. #3	60-72	27.4	5.66
G08041123-015	Upper W.T. #4	0-12	30.2	0.87
G08041123-016	Upper W.T. #4	12-24	23.3	0.66
G08041123-017	Upper W.T. #4	24-36	22.6	0.49
G08041123-018	Upper W.T. #4	36-48	22.1	0.48
G08041123-019	Upper W.T. #4	48-60	21.2	0.29
G08041123-020	Upper W.T. #4	60-72	23.9	0.19
G08041123-021	Upper W.T. #5	0-12	26.8	0.40
G08041123-022	Upper W.T. #5	12-24	24.2	1.06
G08041123-023	Upper W.T. #5	24-36	23.0	1.44
G08041123-024	Upper W.T. #5	36-48	22.2	1.72
G08041123-025	Upper W.T. #5	48-60	25.0	1.39
G08041123-026	Upper W.T. #5	60-72	21.9	1.33
G08041123-027	Upper W.T. #7	0-12	35.7	0.03
G08041123-028	Upper W.T. #7	12-24	26.5	0.17
G08041123-029	Upper W.T. #7	24-36	22.7	0.20
G08041123-030	Upper W.T. #7	36-48	21.7	0.90
G08041123-031	Upper W.T. #7	48-60	29.2	3.70
G08041123-032	Upper W.T. #7	60-72	32.4	2.14

Whitetail Creek Soil Sampling (Harris) Section 8, T55N-R72W & Section 9, T55N-R72W (5/18/2007)			
Sample Point	**UTM N**	**UTM E**	**Sample Depth**
1	4957544	457514	72"
2	4957429	457486	72"
3	4957310	457373	72"
4	4957301	457963	72"
5	4957151	457971	72"
6	4957001	457906	72"
7	4957145	457576	72"
Water Sample (Whitetail Creek dutring spring runoff)	4957010	458069	N/A

Whitetail Creek Soil Sampling (Upper W.T.) Section 1, T55N-R73W & Section 6, T55N-R72W (4/18/2008)			
Sample Point	**UTM N**	**UTM E**	**Sample Depth**
1	4958424	455234	48"
2	4958316	454635	44"
3	4958470	454730	72"
4	4959064	454340	72"
5	4958811	454536	72"
6	4958562	455057	60"
7	4958296	455684	72"

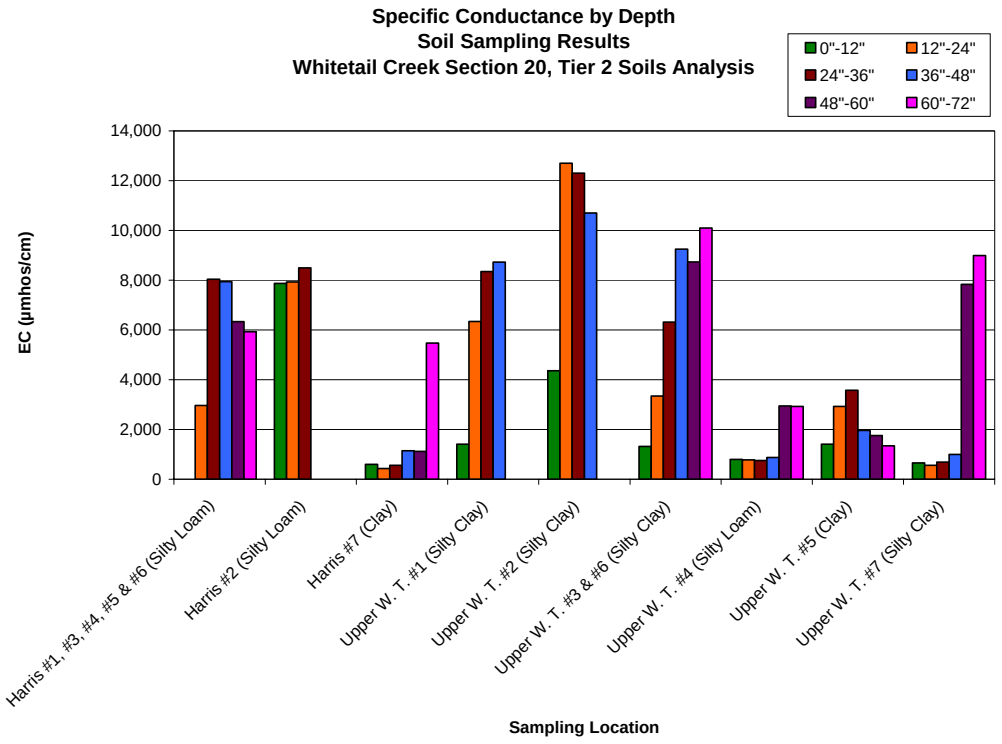
Soil Data: Whitetail Creek (WDEQ Spreadsheet)

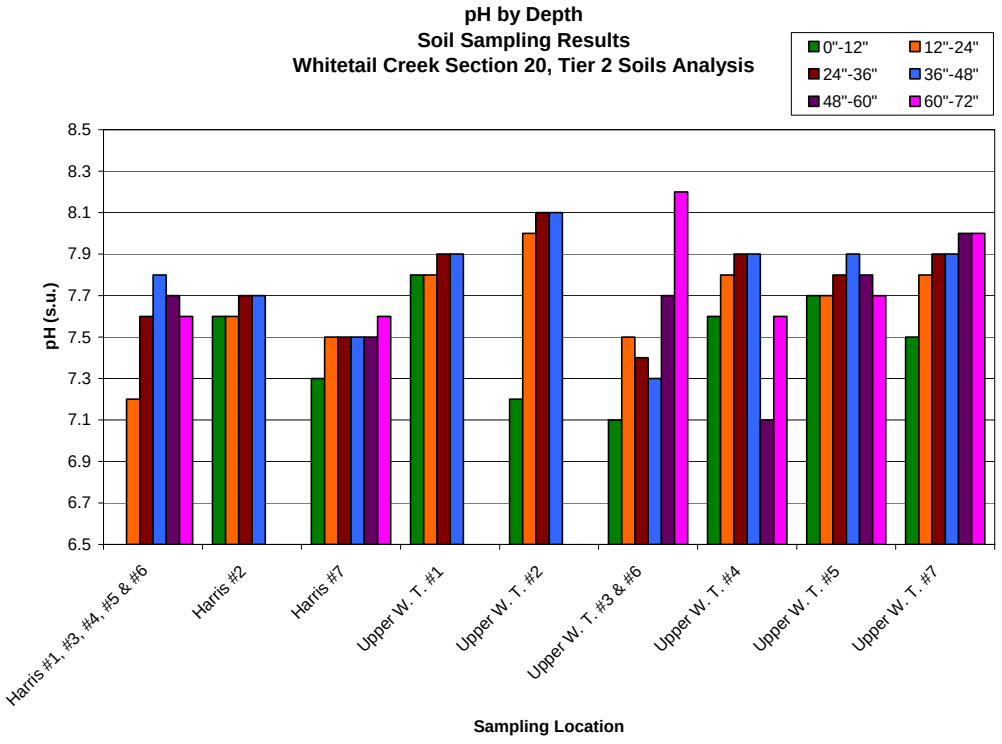
	Soil Depth (inches)			
Sample Location	**Upper**	**Lower**	**EC (dS/m)**	**EC (µmhos/cm)**
Harris 1, 3, 4, 5 & 6 Composite	0	12		
	12	24	2.97	2,970
	24	36	8.04	8,040
	36	48	7.94	7,940
	48	60	6.33	6,330
	60	72	5.93	5,930
Harris 2	0	12	7.87	7,870
	12	24	7.93	7,930
	24	36	8.50	8,500
	36	48		
	48	60		
	60	72		
Harris 7	0	12	0.60	600
	12	24	0.43	430
	24	36	0.56	560
	36	48	1.15	1,150
	48	60	1.12	1,120
	60	72	5.47	5,470
Upper W. T. #1	0	12	1.41	1,410
	12	24	6.34	6,340
	24	36	8.35	8,350
	36	48	8.72	8,720
	48	60		
	60	72		
Upper W. T. #2	0	12	4.36	4,360
	12	24	12.70	12,700
	24	36	12.30	12,300
	36	48	10.70	10,700
Upper W. T. #3 & #6	0	12	1.32	1,320
	12	24	3.34	3,340
	24	36	6.32	6,320
	36	48	9.24	9,240
	48	60	8.73	8,730
	60	72	10.1	10,100
Upper W. T. #4	0	12	0.80	800
	12	24	0.78	780
	24	36	0.76	760
	36	48	0.88	880
	48	60	2.94	2,940
	60	72	2.93	2,930

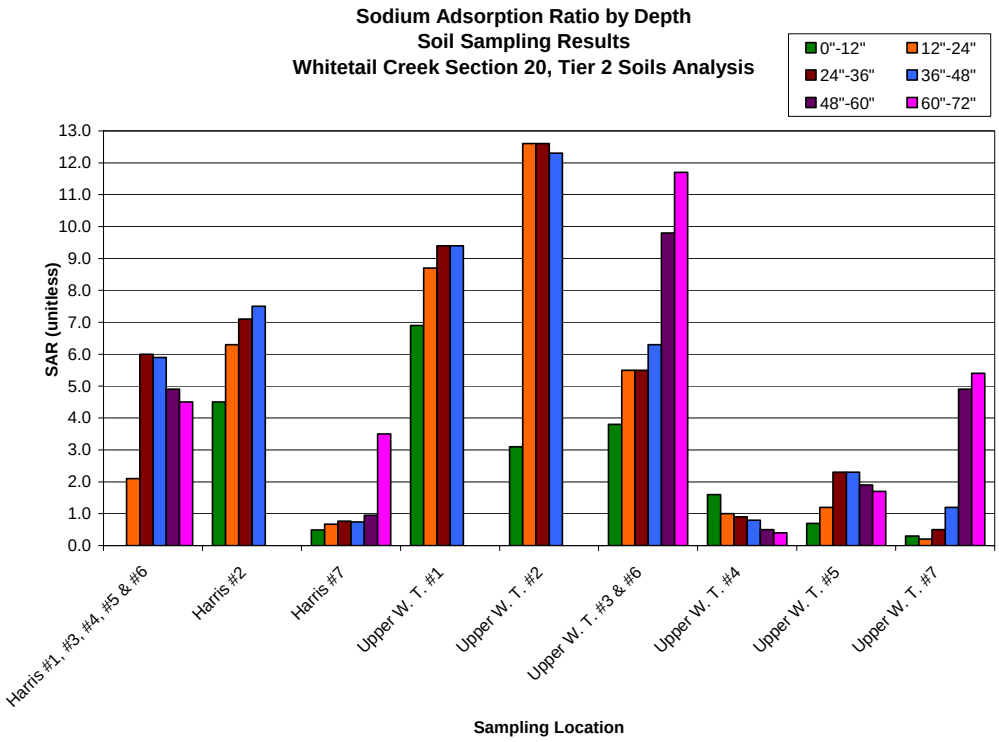
	Soil Depth (inches)			
Sample Location	**Upper**	**Lower**	**EC (dS/m)**	**EC (µmhos/cm)**
Upper W. T. #5	0	12	1.41	1,410
	12	24	2.93	2,930
	24	36	3.58	3,580
	36	48	1.96	1,960
	48	60	1.76	1,760
	60	72	1.34	1,340
Upper W. T. #7	0	12	0.66	660
	12	24	0.56	560
	24	36	0.69	690
	36	48	1.00	1,000
	48	60	7.83	7,830
	60	72	8.99	8,990

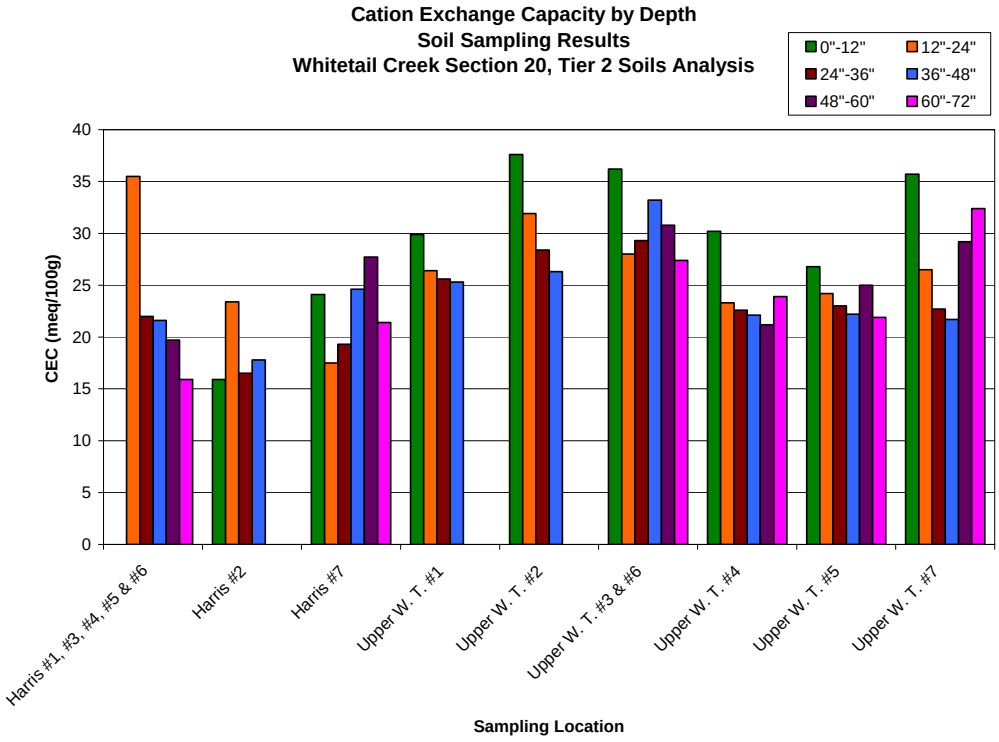
Observed Average		**4,578**
	AVEDEV	**3,338**

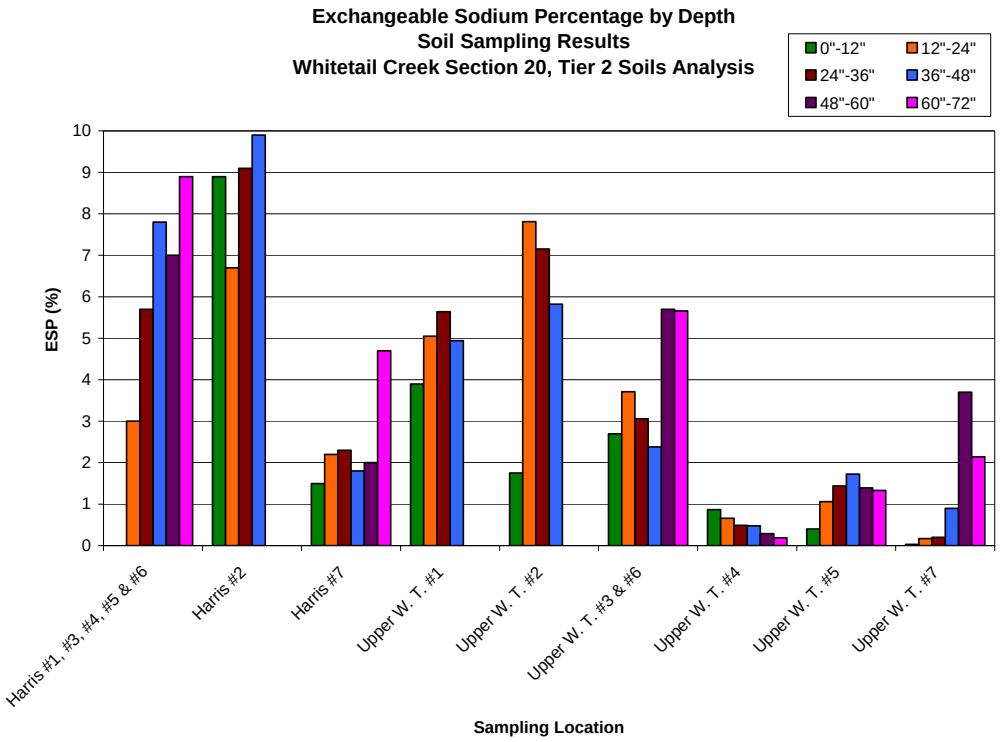
	Effluent Limit Calcs
0.05	1 - 0.95
3338	AveDev
46	Sample Pop (n)
965	Conf Int
3613	Observed Average minus conf interval
2409	Calculated EC Limit: (Adjusted average / 1.5)
	14.6 Allowable SAR

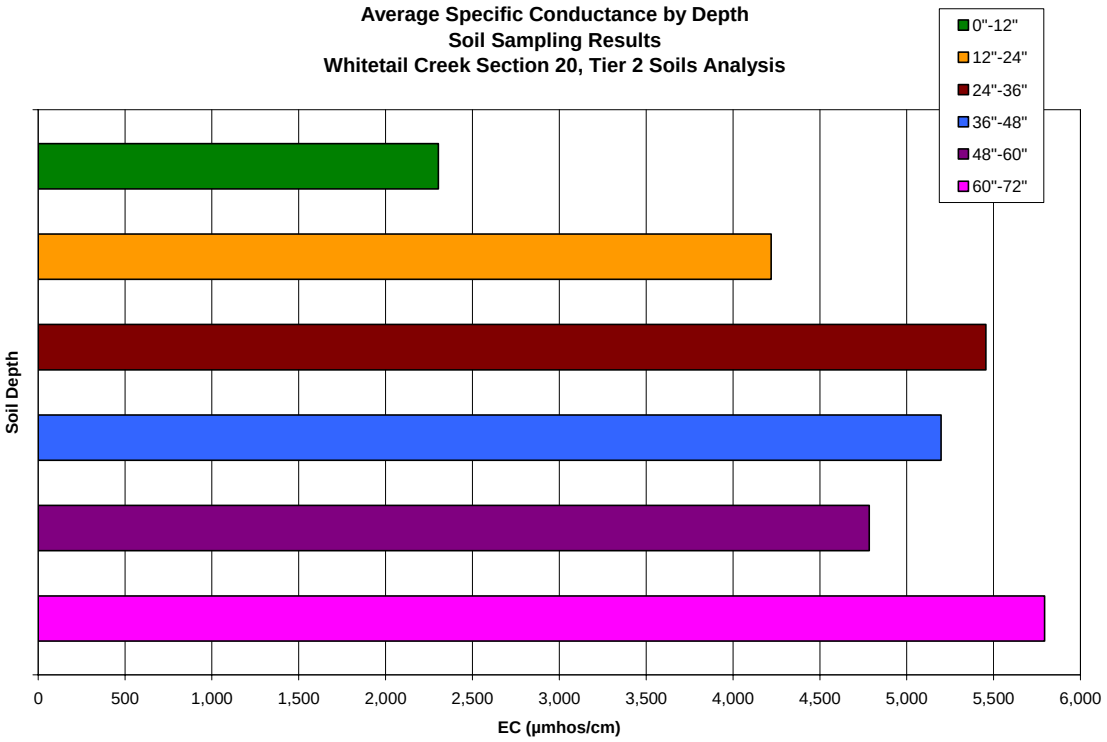

Specific Conductance by Depth
Soil Sampling Results
Whitetail Creek Section 20, Tier 2 Soils Analysis
0"-12"
12"-24"
24"-36"
36"-48"
48"-60"
60"-72"
EC (µmhos/cm)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Harris #1, #3, #4, #5 & #6 (Silty Loam)
Harris #2 (Silty Loam)
Harris #7 (Clay)
Upper W. T. #1 (Silty Clay)
Upper W. T. #2 (Silty Clay)
Upper W. T. #3 & #6 (Silty Clay)
Upper W. T. #4 (Silty Loam)
Upper W. T. #5 (Clay)
Upper W. T. #7 (Silty Clay)
Sampling Location

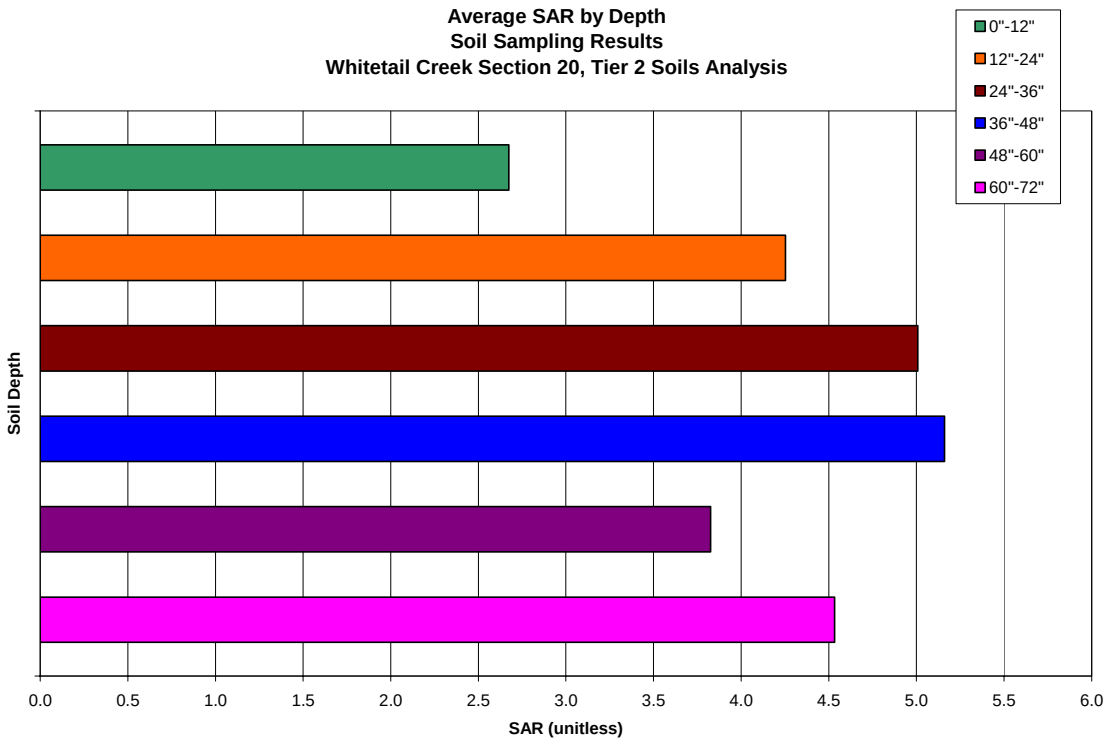

pH by Depth
Soil Sampling Results
Whitetail Creek Section 20, Tier 2 Soils Analysis
0"-12"
12"-24"
24"-36"
36"-48"
48"-60"
60"-72"
pH (s.u.)
8.5
8.3
8.1
7.9
7.7
7.5
7.3
7.1
6.9
6.7
6.5
Harris #1, #3, #4, #5 & #6
Harris #2
Harris #7
Upper W. T. #1
Upper W. T. #2
Upper W. T. #3 & #6
Upper W. T. #4
Upper W. T. #5
Upper W. T. #7
Sampling Location

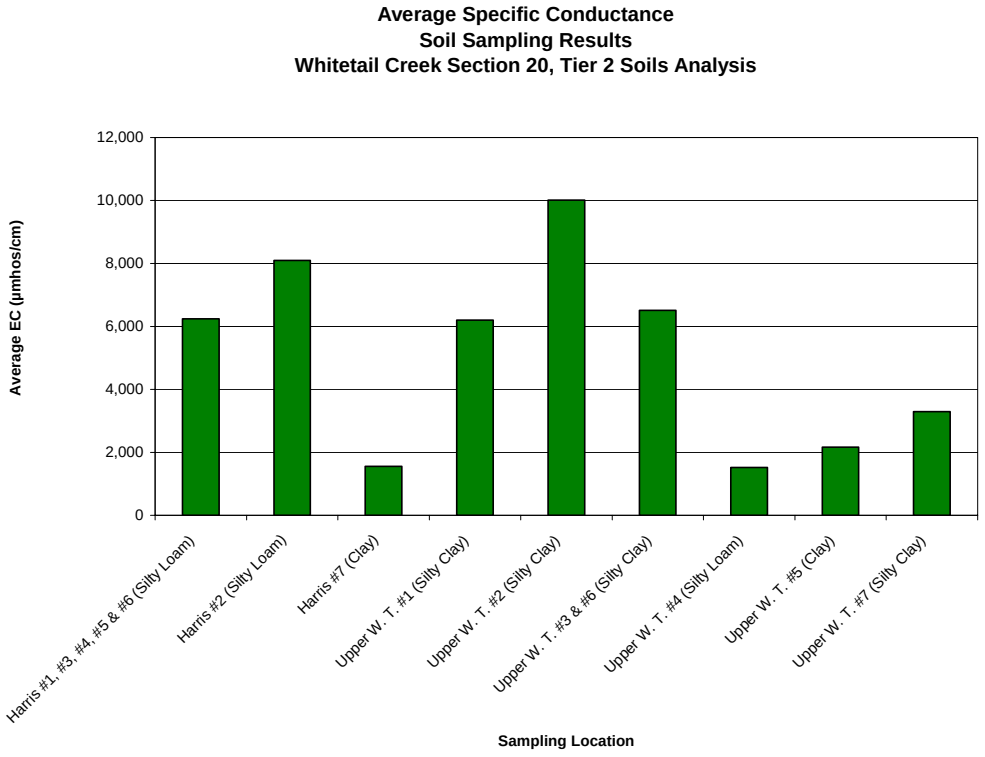

Sodium Adsorption Ratio by Depth
Soil Sampling Results
Whitetail Creek Section 20, Tier 2 Soils Analysis
0"-12"
12"-24"
24"-36"
36"-48"
48"-60"
60"-72"
SAR (unitless)
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Harris #1, #3, #4, #5 & #6
Harris #2
Harris #7
Upper W. T. #1
Upper W. T. #2
Upper W. T. #3 & #6
Upper W. T. #4
Upper W. T. #5
Upper W. T. #7
Sampling Location


Cation Exchange Capacity by Depth
Soil Sampling Results
Whitetail Creek Section 20, Tier 2 Soils Analysis
0"-12"
12"-24"
24"-36"
36"-48"
48"-60"
60"-72"
CEC (meq/100g)
40
35
30
25
20
15
10
5
0
Harris #1, #3, #4, #5 & #6
Harris #2
Harris #7
Upper W. T. #1
Upper W. T. #2
Upper W. T. #3 & #6
Upper W. T. #4
Upper W. T. #5
Upper W. T. #7
Sampling Location

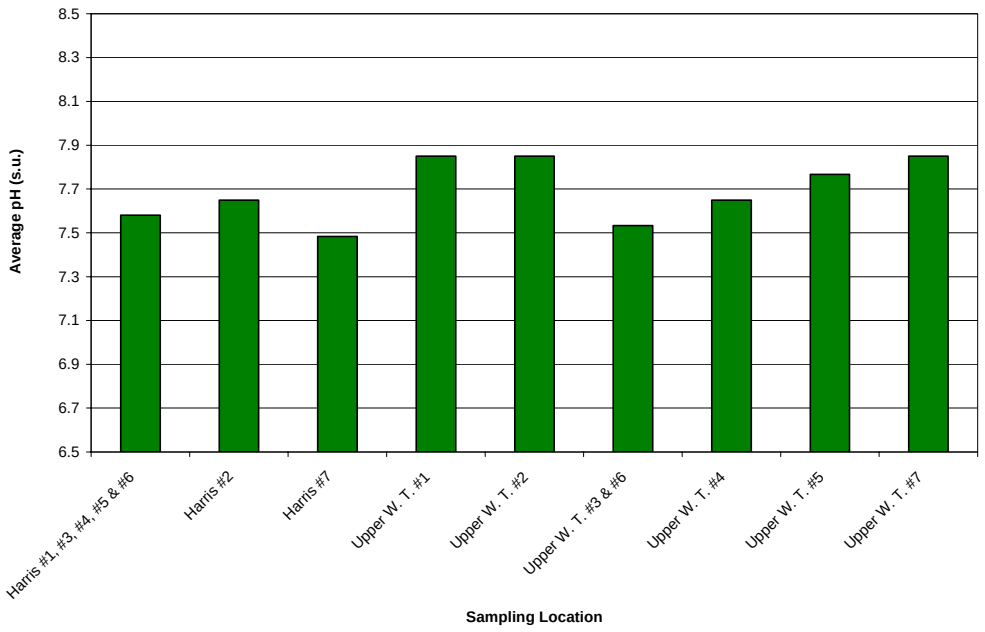

Exchangeable Sodium Percentage by Depth
Soil Sampling Results
Whitetail Creek Section 20, Tier 2 Soils Analysis
0"-12"
12"-24"
24"-36"
36"-48"
48"-60"
60"-72"
ESP (%)
0
1
2
3
4
5
6
7
8
9
10
Harris #1, #3, #4, #5 & #6
Harris #2
Harris #7
Upper W. T. #1
Upper W. T. #2
Upper W. T. #3 & #6
Upper W. T. #4
Upper W. T. #5
Upper W. T. #7
Sampling Location


Average Specific Conductance by Depth
Soil Sampling Results
Whitetail Creek Section 20, Tier 2 Soils Analysis
0"-12"
12"-24"
24"-36"
36"-48"
48"-60"
60"-72"
Soil Depth
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
5,500
6,000
EC (µmhos/cm)

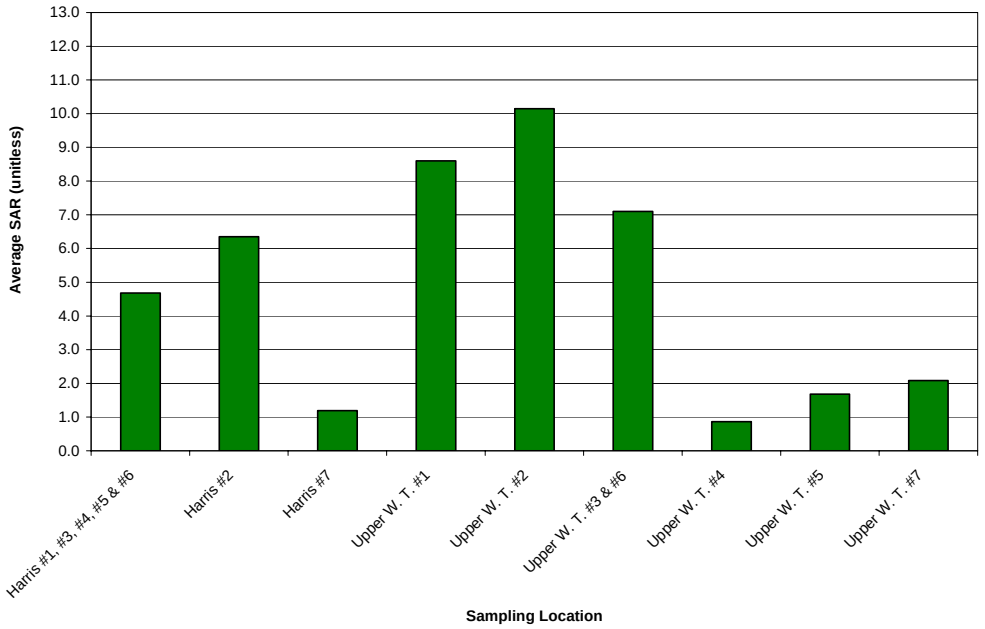

Average SAR by Depth
Soil Sampling Results
Whitetail Creek Section 20, Tier 2 Soils Analysis
0"-12"
12"-24"
24"-36"
36"-48"
48"-60"
60"-72"
Soil Depth
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
SAR (unitless)


Average Specific Conductance
Soil Sampling Results
Whitetail Creek Section 20, Tier 2 Soils Analysis
Average EC (µmhos/cm)
12,000
10,000
8,000
6,000
4,000
2,000
0
Harris #1, #3, #4, #5 & #6 (Silty Loam)
Harris #2 (Silty Loam)
Harris #7 (Clay)
Upper W. T. #1 (Silty Clay)
Upper W. T. #2 (Silty Clay)
Upper W. T. #3 & #6 (Silty Clay)
Upper W. T. #4 (Silty Loam)
Upper W. T. #5 (Clay)
Upper W. T. #7 (Silty Clay)
Sampling Location

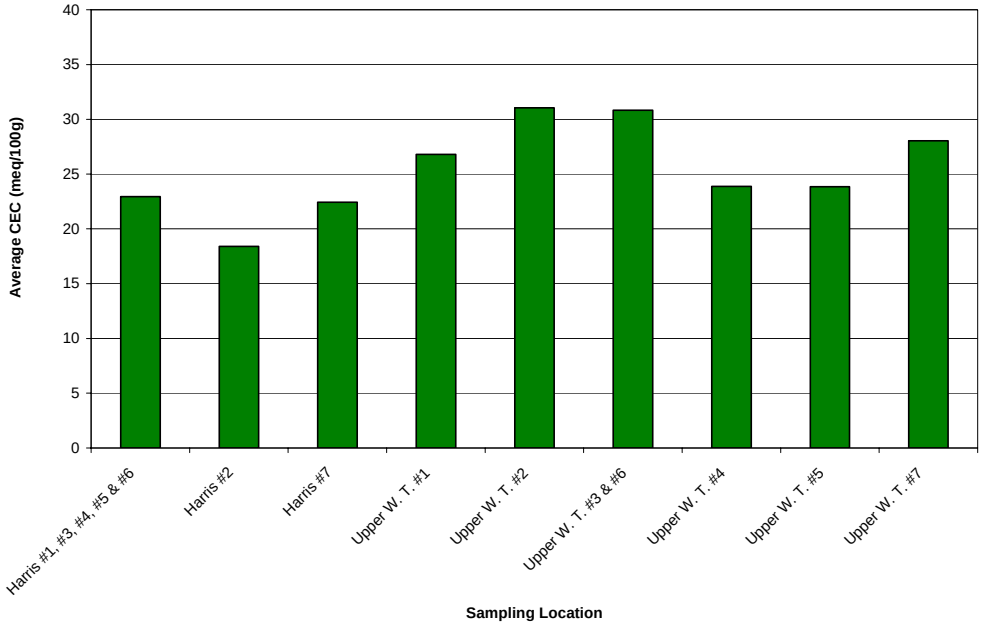
Average pH
Soil Sampling Results
Whitetail Creek Section 20, Tier 2 Soils Analysis



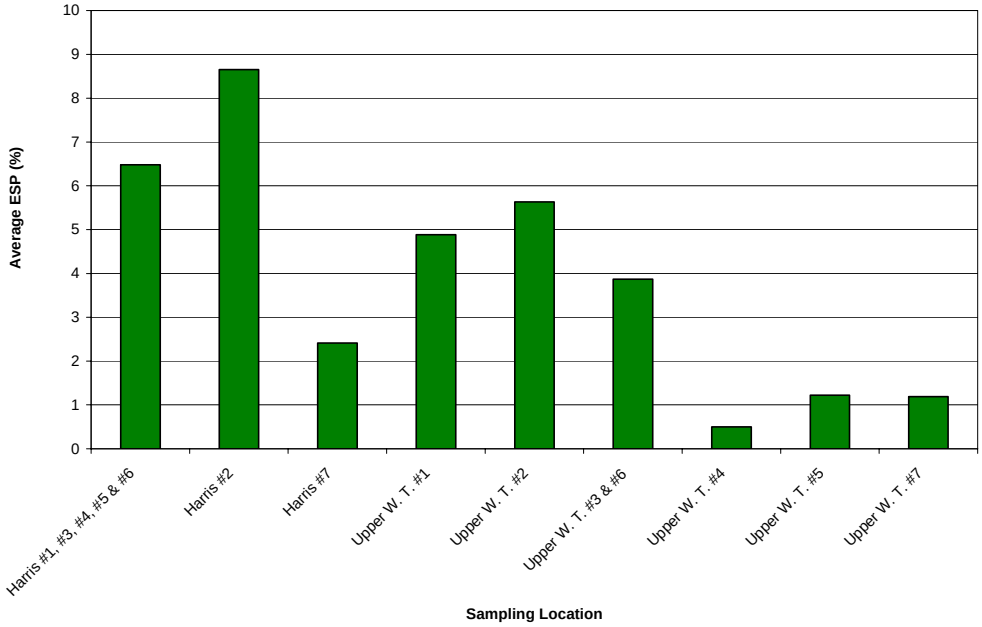
Average Sodium Adsorption Ratio
Soil Sampling Results
Whitetail Creek Section 20, Tier 2 Soils Analysis



Average Cation Exchange Capacity
Soil Sampling Results
Whitetail Creek Section 20, Tier 2 Soils Analysis



Exchangeable Sodium Percentage
Soil Sampling Results
Whitetail Creek Section 20, Tier 2 Soils Analysis



Appendix C

Water Data

Water Sample from Whitetail Creek - Lab Report

USGS Water Quality Data and Graphs

ENERGY LABORATORIES, INC. • 400 West Boxelder Road • Gillette, WY 82718
307-686-7175 • 866-686-7175 • 307-682-4625 fax • gillette@energylab.com

LABORATORY ANALYTICAL REPORT

Client: Arcadis US Inc
Project: Harris POD Whitetail Cr Soil
Client Sample ID: Whitetail Cr 1 of 1
Location: SW NW 5.9 T55-R72
Samp FRQ/Type: STORM WATER- RUNOFF IN WHITETAIL CREEK.
Lab ID: G07050683-016

Report Date: 06/06/07
Collection Date: 05/18/07
DateReceived: 05/18/07
Matrix: Aqueous
Sampled By: Dave Huber

Analyses	Result	Units	Result	Units	Qualifier	Method	Analysis Date / By
MAJOR IONS, DISSOLVED							
Bicarbonate as HCO3	393	mg/L	6.44	meq/L		A2320 B	05/21/07 12:08 / mli
Chloride	1010	mg/L	28.6	meq/L		E300.0	05/22/07 20:50 / mli
Fluoride	0.9	mg/L	0.05	meq/L		E300.0	05/22/07 20:50 / mli
Sulfate	1390	mg/L	28.9	meq/L		E300.0	05/22/07 20:50 / mli
Calcium	383	mg/L	19.1	meq/L		E200.7	05/24/07 14:15 / eli-b
Magnesium	216	mg/L	17.8	meq/L		E200.7	05/24/07 14:15 / eli-b
Potassium	39	mg/L	0.99	meq/L		E200.7	05/26/07 01:58 / eli-b
Sodium	724	mg/L	31.5	meq/L		E200.7	05/24/07 14:15 / eli-b
NON-METALS							
Alkalinity, Total as CaCO3	322	mg/L				A2320 B	05/21/07 12:08 / mli
Conductivity @ 25 C	5660	umhos/cm				A2510 B	05/18/07 16:10 / mtb
Sodium Adsorption Ratio (SAR)	7.3	unitless				Calculation	05/30/07 08:22 / tlc
DATA QUALITY							
A/C Balance	4.13	%				A1030 E	05/30/07 08:17 / tlc
Anions	63.9	meq/L				A1030 E	05/30/07 08:17 / tlc
Cations	69.4	meq/L				A1030 E	05/30/07 08:17 / tlc

Michelle Bucholz

Michelle Bucholz
Project Manager

Report Definitions:
RL - Analyte reporting limit.
QCL - Quality control limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.

USGS 06324950 LITTLE POWDER RIVER BELOW ELK CREEK, NR WESTON, WY

Campbell County, Wyoming

Hydrologic Unit Code 10090208

Latitude 44°48'33.1", Longitude 105°21'58.5" NAD83

Date	Flow (cfs)	EC, field (µmhos/cm)	pH, field (s.u.)	Hardness as CaCO3 (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	SAR	TDS (mg/L)
7/9/2004	3.9	3500	8.1	580	106	76.2	621	11	2510
8/25/2004	0.06	2550	8	1000	225	110	236	3.2	2090
9/9/2004	0.11	3070	7.7	1100	234	128	308	4	2710
10/25/2004	6.8	2380	8.4	420	83.2	52.5	388	8.2	1720
11/17/2004	0.9	1910	8.1	540	116	60.6	230	4.3	1410
12/16/2004	0.88	3590	8.2	920	188	109	592	8.5	2930
1/26/2005	2.9	1050	8	210	44.8	23.4	141	4.2	722
2/24/2005	1.3	2960	8.3	720	149	84.4	442	7.2	2200
3/28/2005	44	1470	8	310	64.7	37	217	5.3	1040
4/11/2005	1.6	2410	8.4	630	130	73.8	352	6.1	1810
5/26/2005	7.2	2610	8.4	810	132	117	372	5.7	2070
6/14/2005	3.5	3050	8.3	860	162	111	447	6.6	2300
7/8/2005	1.5	2510	8.1	550	111	65.8	396	7.4	1840
8/11/2005	0.27	1410	8.1	430	96.4	46.3	166	3.5	1030
9/28/2005	0.03	3100	8.3	1100	221	131	309	4.1	2710
10/25/2005	0.73	1630	8.1	460	96.8	52.7	189	3.8	1200
11/16/2005	0.9	2830	8.3	750	156	86.6	429	6.8	2270
12/13/2005	1.1	3920	8.2	930	191	110	534	7.6	3070
1/25/2006	1.2	3390	8.1	850	179	97.1	490	7.3	2510
2/22/2006	1.2	4060	7.9	970	200	114	571	8	3180
3/28/2006	1.5	3130	8.2	690	138	83.7	455	7.6	2460
4/26/2006	3.5	3030	8.3	630	124	78.2	466	8.1	2330
5/24/2006	117	760	7.8	130	26.2	15	118	4.5	578
6/28/2006	2.2	3340	8.3	750	137	97.9	526	8.4	2640
7/26/2006	0.01	4080	8.2	950	153	138	539	7.6	3360
8/30/2006	2.1	2150	8.2	520	114	57.5	276	5.3	1760
9/26/2006	10	620	7.7	100	23.4	10.8	72.8	3.1	404
10/24/2006	3.9	3220	8.4	660	138	77.9	516	8.7	2550
11/29/2006	0.22	3040	8	710	152	78.8	434	7.1	2390
12/18/2006	1.4	3920	8.1	950	197	111	604	8.5	3190
1/23/2007	0.77	4050	7.8	1200	248	133	593	7.5	3430
2/28/2007	72	588	7.8	170	35	19.1	49.6	1.7	446
3/15/2007	18	1400	8.3	400	82.2	47	161	3.5	1040
4/16/2007	6.9	2620	8.4	820	159	102	286	4.4	2260
5/16/2007	39	3000	8.2	910	155	126	355	5.1	2430
6/14/2007	70	2160	8	660	118	90.1	249	4.2	1720
7/17/2007	4.8	4060	8	1100	200	136	606	8.1	3310
8/16/2007	2.6	4300	7.8	960	175	126	672	9.5	3530
9/11/2007	2.4	4100	8.2	880	164	115	589	8.6	3370
10/18/2007	2.5	3960	8.3	850	154	114	655	9.8	3180
11/15/2007	5.3	3510	8.2	1100	236	134	438	5.6	3080

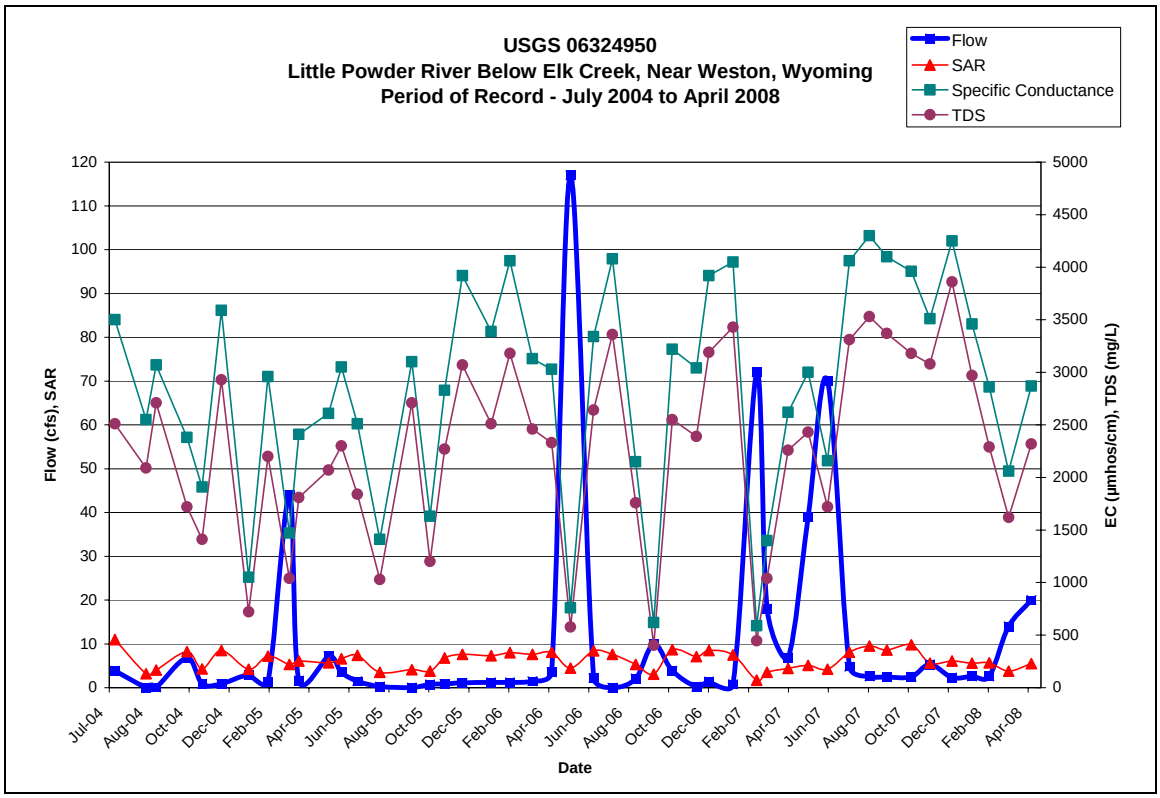
USGS 06324950 LITTLE POWDER RIVER BELOW ELK CREEK, NR WESTON, WY

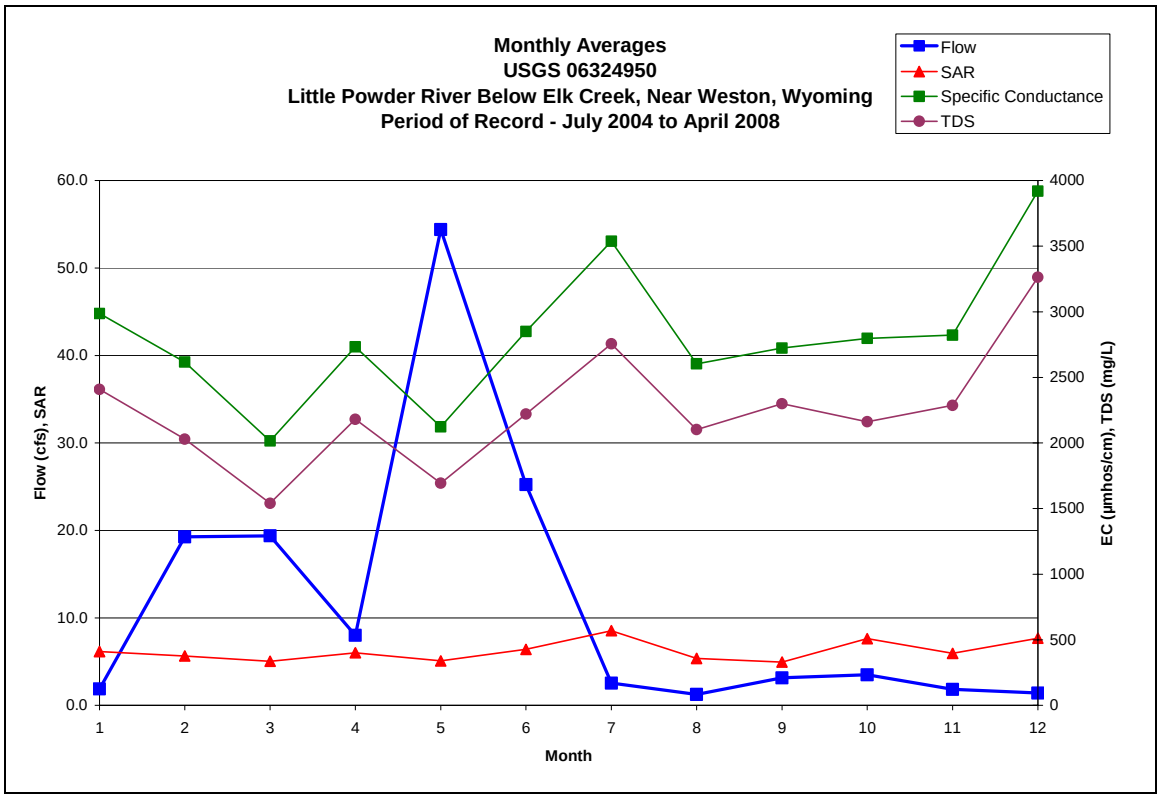
Campbell County, Wyoming

Hydrologic Unit Code 10090208

Latitude 44°48'33.1", Longitude 105°21'58.5" NAD83

Date	Flow (cfs)	EC, field (µmhos/cm)	pH, field (s.u.)	Hardness as CaCO3 (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	SAR	TDS (mg/L)
12/18/2007	2.3	4250	8.1	1500	313	167	541	6.1	3860
1/17/2008	2.6	3460	8.1	1200	252	127	436	5.6	2970
2/12/2008	2.6	2860	8	820	178	91.2	375	5.7	2290
3/12/2008	14	2060	8.2	640	120	82.3	219	3.8	1620
4/15/2008	20	2870	8.3	830	136	118	366	5.5	2320




Monthly Averages
USGS 06324950
Little Powder River Below Elk Creek, Near Weston, Wyoming
Period of Record - July 2004 to April 2008
Flow
SAR
Specific Conductance
TDS
Flow (cfs), SAR
EC (µmhos/cm), TDS (mg/L)
Month
60.0
50.0
40.0
30.0
20.0
10.0
0.0
4000
3500
3000
2500
2000
1500
1000
500
0
1
2
3
4
5
6
7
8
9
10
11
12

Appendix D

Photographs

Harris - Sampling point #1, view north.

Harris – Sample area, view northwest.

Harris – Sample area, view west from county road.

Upper W.T. - General view sample area NWSE Sec 6, Twn 55N, Rng 72W.

Upper W.T. - General view sample area NESE Sec 6, Twn 55N, Rng 72W.

Wetlands – SENE Sec 17, Twn 55N, Rng 71W, close-up vegetation.

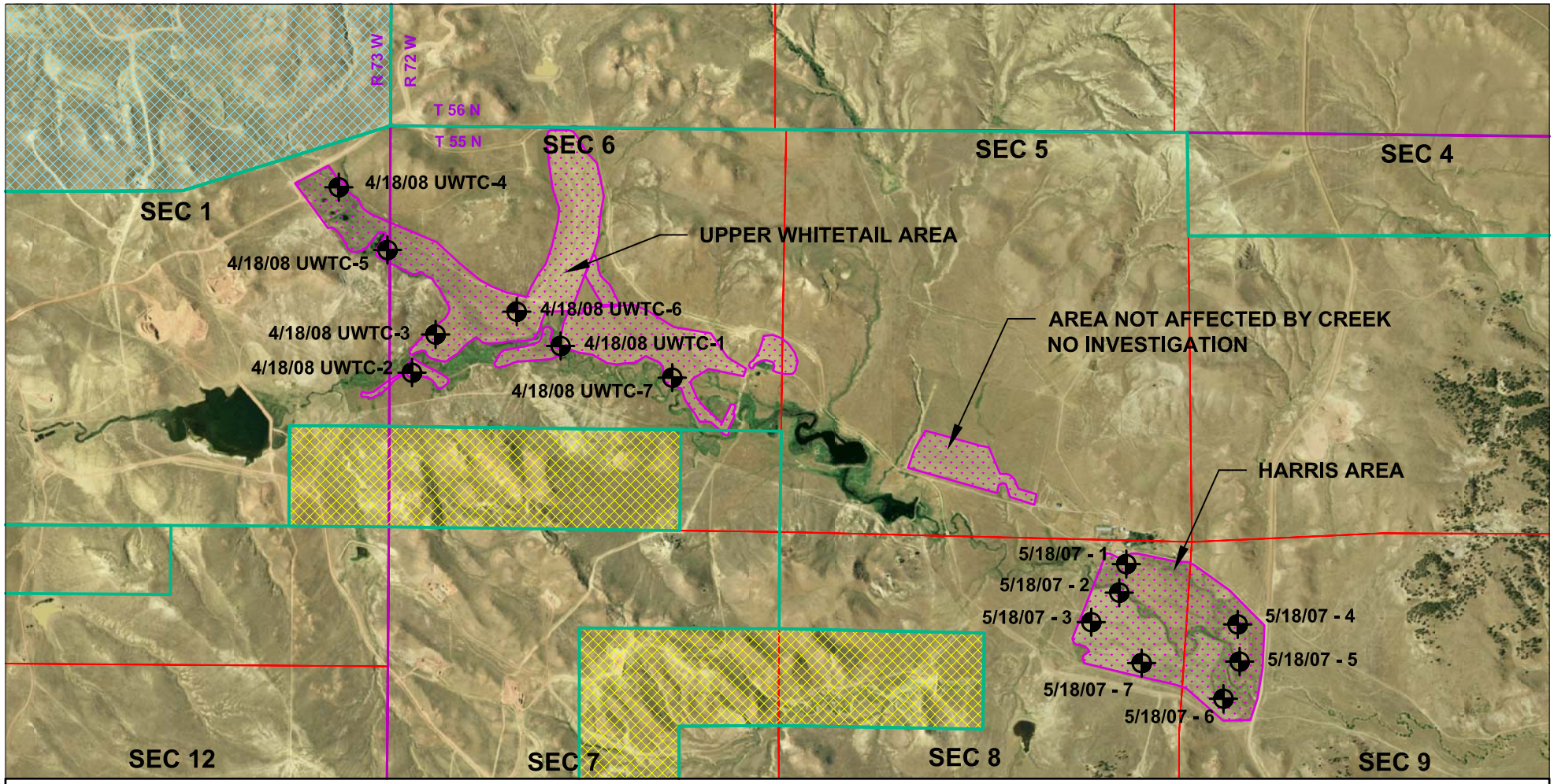
Wetlands – SENE Sec 17, Twn 55N, Rng 71W, view south.

Wetlands – SENE Sec 17, Twn 55N, Rng 71W, view west.

Wetlands – Close-up wetlands vegetation.

Wetlands – W.T.C. NWNE Sec 17, Twn 55N, Rng 71W.

Wetlands – W.T.C. NWNE Sec 17, Twn 55N, Rng 71W, view west.



COLLUMS PROJECT
WHITETAIL CREEK SECTION 20, TIER 2
COMPLIANCE ANALYSIS

STORMCAT
ENERGY CORPORATION

June 11, 2008

LEGEND

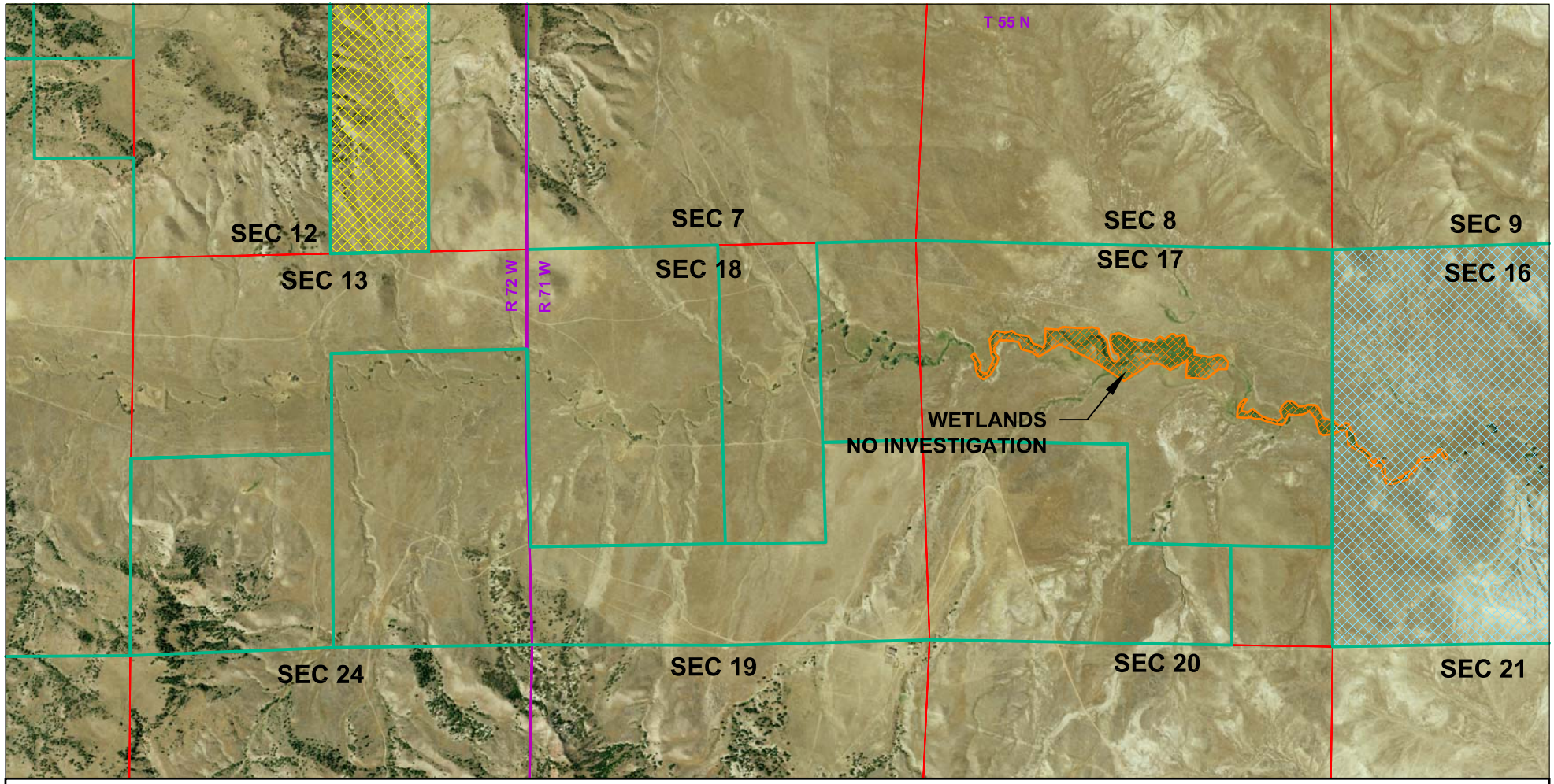
- Private Surface Landowner as Shown
- BLM - Federal Surface
- State Surface
- Soil Samples
- Harvested Bottomlands
- Wetlands

N

0 0.25 0.5 1.0
MILES

SCALE 1:24,000
NAD 83, UTM Zone 13N
Campbell County, WY
T55N R72W, T55N R73W

BISON ENVIRONMENTAL, INC.



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N

0 0.25 0.5 1.0
MILES

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NAD 83, UTM Zone 13N
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T55N R72W, T55N R73W

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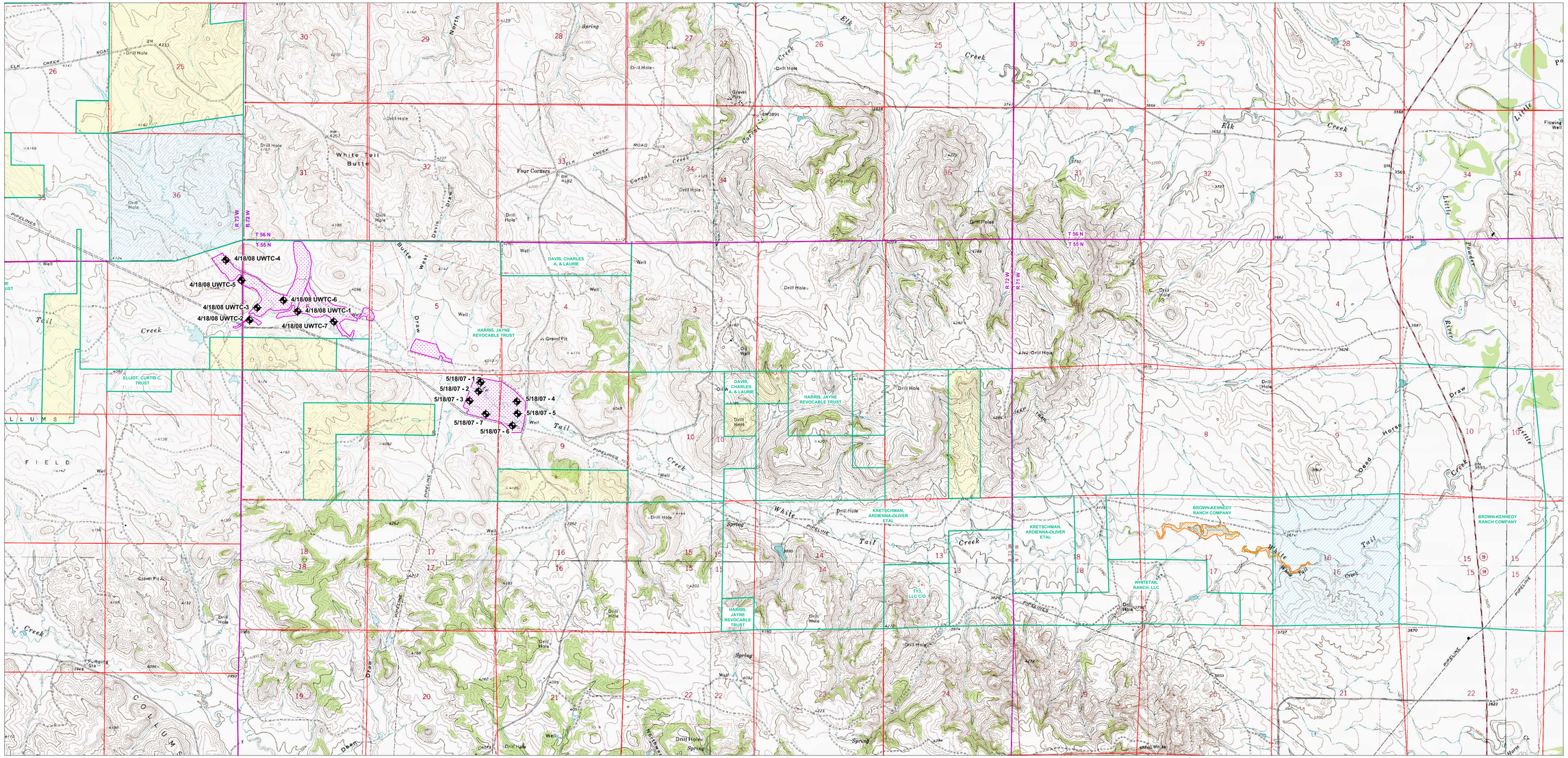

COLLUMS PROJECT
WHITETAIL CREEK SECTION 20
COMPLIANCE ANALYSIS

June 11, 2008

LEGEND

- Private Surface Landowner as Shown
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N

0 0.25 0.5 1.0
MILES

SCALE 1:24,000
NAD 83, UTM Zone 13N
Campbell County, WY
T55N R71W, T55N R72W, T55N R73W

STORMCAT ENERGY CORPORATION

BISON ENVIRONMENTAL, INC.