SECTION 20 COMPLIANCE ANALYSIS FOR CBNG PRODUCED WATER DISCHARGES BY THE TERMO COMPANY TO BITTER CREEK, CAMPBELL COUNTY, WYOMING

KC HARVEY
Soil & Water Resource Consulting

AN ENERCREST COMPANY

SECTION 20 COMPLIANCE ANALYSIS FOR CBNG PRODUCED WATER DISCHARGES BY THE TERMO COMPANY TO BITTER CREEK, CAMPBELL COUNTY, WYOMING

Prepared For:

THE TERMO COMPANY

P.O. BOX 7297

GILLETTE, WYOMING 82717

Prepared By:

KC Harvey, Inc.

233 Edelweiss Drive, Suite 11
Bozeman, Montana 59718

T 406-585-7402
F 406-585-7428
www.kcharvey.com

Table of Contents

List of Tables

List of Figures:

Appendices:

1.0 INTRODUCTION

This report presents an assessment of potential impacts to agricultural practices along Bitter Creek and defines proposed effluent limits for the discharge of coalbed natural gas (CBNG) produced water to Bitter Creek. The discharge of produced water will be from The Termo Company's (Termo) Homestead Draw II project to Bitter Creek. Bitter Creek, located in Campbell County, Wyoming, is an ephemeral stream that flows north-northwest and drains into the Powder River. An ephemeral drainage is defined as a drainage that only contains water during and immediately after some precipitation or snowmelt events (Ward and Trimble, 2004) therefore the channel is periodically dry.

This assessment incorporates a Tier 2 – Background Water Quality Analysis approach to demonstrate compliance with Chapter 1, Section 20 of the Wyoming Water Quality Rules and Regulations, which state:

> *"All Wyoming surface waters which have the natural water quality potential for use as an agricultural water supply shall be maintained at a quality which allows continued use of such waters for agricultural purposes. Degradation of such waters shall not be of such an extent to cause a measurable decrease in crop or livestock production. Unless otherwise demonstrated, all Wyoming surface waters have the natural water quality potential for use as an agricultural water supply."*

The Tier 2 – Background Water Quality Analysis approach proposes effluent limits as equal to or less than that of background water quality conditions. To obtain estimates of background water quality on ephemeral stream channels such as Bitter Creek, soil sampling and analysis is conducted to obtain the soil electrical conductivity (EC) of fields historically irrigated, naturally or artificially, along the subject stream. In this analysis, water quality estimates calculated from soil sample analyses are compared to Bitter Creek water samples collected in May of 2007 by SWCA Environmental Consultants. The more conservative Bitter Creek water quality estimate derived from soil EC was applied to the effluent limits proposed in this analysis.

The second part of the Tier 2 analysis provides an interpretation of soil samples within fields that are hydraulically isolated from Bitter Creek but could receive irrigation from Bitter Creek during some runoff events. A streamflow characterization of Bitter Creek, hydraulic assessment of the subject fields, and mixing analysis are presented to demonstrate that the proposed effluent limits will not negatively affect the water quality applied to these fields during significant runoff events.

Prior to this Section 20 compliance analysis submission, data collection from the Bitter Creek Drainage was completed by SWCA Environmental Consultants of Sheridan, Wyoming (SWCA) and BKS Environmental Associates of Gillette, Wyoming (BKS) between June 8 and August 30, 2007 and incrementally submitted to the WDEQ as results became available. Upon gaining landowner permission, additional data has been collected in December of 2007 by KC Harvey, Inc. (KC Harvey) at previously unsampled locations in the Bitter Creek drainage. This report constitutes a resubmission and analysis of all data previously collected at Bitter Creek including data collected by KC Harvey in December of 2007 (Table 1).

To identify representative areas suitable for soil sampling, 10 miles of the Bitter Creek stream channel were investigated for the presence of naturally and/or artificially irrigated areas. Naturally irrigated soils are often located on floodplain landscape positions, usually immediately adjacent to the primary channel. These areas consist of distinct vegetation communities and densities which indicate they receive more water than the surrounding landscape, where precipitation is the only water source. This additional water received by naturally irrigated soils is due to occasional flooding or the existence of a fluctuating high water table, with Bitter Creek being the primary source for both. According to a search of the Wyoming State Engineer's Office water rights database, there are no permitted irrigation diversions on Bitter Creek downstream of the Termo CBNG discharges.

2.0 Chronology of Bitter Creek Soil Sampling Efforts

Limited by site access permissions, the initial soil assessment conducted by SWCA (June 11, 2007) resulted in the identification of suitable soil sampling locations within state owned lands in Township 57N, Range 74 W Section 36. Sampling locations were divided into three zones based on their geomorphic setting, hydrologic regime and elevation relative to the Bitter Creek channel bottom (Figure 1, Table 1; Locations 3 through 5). "Zone 1 was adjacent to the stream channel where relatively flat, dry ground was present that could produce useable grass" (SWCA, 2007a). Of the 12 locations sampled within Section 36 by SWCA, only two sites were identified as characteristic of "Zone 1." "Little of this type of terrain (Zone 1) was found in the study areas because Bitter Creek has a deeply incised channel ... with few flat depositional areas" (SWCA, 2007a). Zones 2 and 3 were described by SWCA as located on the first and second terraces above the stream channel and account for the remaining 10 soil sampling locations. Samples collected from each respective zone were composited by zone to represent differences in soil physicochemistry inherent to their landscape position. Based on photographic and narrative descriptions, and KC Harvey's visual review of Bitter Creek fluvial-geomorphology at the 10 soil sampling locations within Zones 2 and 3, the likelihood that soil samples within Zones 2 and 3 reflect background Bitter Creek water quality is questionable. To reflect uncertainties in the merit of data collected in

Zones 2 and 3, KC Harvey calculated historic water quality of Bitter Creek with these data and discovered that the estimated historic Bitter Creek water quality was actually greater when Zone 2 and 3 data were incorporated. Due to the uncertain nature of this data it was decided to exclude the Zone 2 and 3 data (Figure 1; Table 1; Locations 4 & 5) from the Tier 2 analysis. Data collected from within Zone 1 is considered very applicable to this compliance analysis and were included in all water quality calculations (Figure 1; Table 1; Location 3).

As per WDEQ request, additional soil samples were collected by SWCA on July 25, 2007 to further compliment the previously collected dataset. Again, limited by site access permissions, soils data were collected in Township 57N Range 74W Sections 16 and 22. Four appropriate locations were identified (Figure 1, Table 1; Locations 8 - 10). The second submission of Bitter Creek soils data to the WDEQ (August 10, 2007; SWCA, 2007b) included a soils assessment conducted by BKS in Township 56N Range 74W Section 13 on land owned by Robert Brug (Figure 1, Table 1; Locations 1 and 2). Each of the locations sampled by BKS are described in the August 10, 2007 Section 20 submission as unlikely to receive exposure to waters from Bitter Creek and furthermore were not analyzed for electrical conductivity. This dataset is disclosed in Table 1 but could not be incorporated into calculations for approximating the background water quality of Bitter Creek due to the lack of EC data. Furthermore, this data should not be used to estimate background water quality since it was clearly stated that the areas sampled were unlikely to receive water from Bitter Creek.

After reviewing the second submission, the WDEQ again felt that additional data collection was warranted. On August 30, 2007, SWCA collected a third set of soil samples along functioning spreader dikes in Township 57N Range 74W Section 8 (Figure 1, Table 1; Locations 11a through 11l). Due to the presence of alfalfa on location, samples were collected to a depth of 72 inches at 12 locations within areas assumed to be irrigated by the spreader dikes. The soil samples were collected as discrete locations and not composited across the field, therefore these small areas contain a total of 12 samples.

Subsequent surveying and hydrologic assessments of locations 11a through 11l performed in December of 2007 (Figure 2) by Lowham Engineering, LLC (Gillette, WY), as well as interpretations of soil EC data from locations 11a through 11l suggests that conditions resulting in the initiation of irrigation at these artificially irrigated areas are distinct from those initiating irrigation at upstream naturally irrigated areas. The analysis furthermore suggests the initiation of irrigation at these artificially irrigated spreader dike areas and the resulting soil physicochemistry are dependent on 1) low reoccurrence interval Bitter Creek flow regimes 2) hydraulic isolation from Bitter Creek under normal flow regimes, 3) the influence of run-on from the surrounding landscape not associated with Bitter Creek (Figure 3), and 4) a suite of discharge chemistries distinct from those influencing naturally irrigated fields upstream at soil sampling Locations 1 through 10.

The section "Characterization of the Hydraulically Isolated Fields" below is devoted to describing the bodies of evidence which substantiate these hypotheses. A mixing analysis is presented to estimate the water quality of Bitter Creek under runoff events that could initiate irrigation to these flood irrigation areas in the presence of CBNG waters.

In December of 2007, landowner permission was secured to sample private land within Township 57N Range 74W Sections 23 and 26. Of the eight potential spreader dikes identified by aerial photography, on-site inspection by KC Harvey indicated five spreaders were breached and one physically incapable of diverting water over-bank. Due to the presence of alfalfa, flood irrigated areas associated with the remaining two intact spreader dike areas were sampled to a depth of 72 inches and combined into a single sample, composited by depth (Figure 1, Table 1; Location 6). Based on vegetation and hydrologic indicators, an additional area was identified as receiving natural irrigation from Bitter Creek (Figure 1, Table 1; Location 7). The presumption of natural irrigation at this location was confirmed during sampling by subsurface saturated soil conditions within six feet of the soil surface.

The analysis presented herein will demonstrate whether produced water discharged by Termo into Bitter Creek will result in degradation of background water quality leading to a measurable decrease in crop and/or livestock production. As mentioned previously, water quality data collected from Bitter Creek in May of 2007 by SWCA Environmental Consultants was also incorporated into this analysis.

3.0 Delineation of Hydraulically Isolated Fields

As a result of a field visit by KC Harvey and Lowham Engineering to the Oedekoven flood irrigation areas on December 6th 2007, it was determined that the ability to correctly interpret soils data collected by SWCA at sampling locations 11a-l was impeded by a lack of understanding of the path that water takes through the spreader system. In the absence of this understanding, it was difficult to determine with certainty which soil sampling locations had historically received Bitter Creek flood irrigation waters within the Oedekoven spreader dike system and which had not.

3.1 Description of Irrigation System

During December 2007, Lowham Engineering, LLC (Lowham) surveyed the Oedekoven fields and produced a one-foot topographical map with irrigation inundation boundaries (Figure 2). The topographic map was then used to estimate the hydraulic attributes of the identified artificial irrigation areas located in Township 57N Range 74W Section 8. During the initial field visit by KC Harvey and Lowham on December 6th, two distinct features were identified for surveying, these included an on-channel spreader dike with a

headgate structure and associated reservoir basin, and three potential irrigated areas with spreader dikes (Figure 2).

The on-channel spreader dike and headgate are used to prohibit Bitter Creek flow from passing through a culvert and backs Bitter Creek water up into the reservoir basin. The backed up water then fills the reservoir basin until reaching a 12 inch culvert which conveys water onto the flood irrigation areas (Culvert 1, Figure 2). The survey completed by Lowham Engineering indicates that the water level would have to be raised by approximately eight feet before irrigation could be initiated through Culvert 1. Based on the reservoir topography, approximately 41.42 acre-feet of water must be stored in the reservoir basin before irrigation could occur (Table 2) (Lowham Engineering, 2008). Lowham Engineering's surveying of the Oedekoven fields indicates that these fields are hydraulically isolated from Bitter Creek and cannot be artificially irrigated without the headgate structure being closed.

Once irrigation is initiated, the irrigation water will flow into Area 1 and could potentially irrigate up to approximately 4.7 acres (green hashed lines, Figure 2). The area irrigated could be decreased to approximately 2.5 acres (blue hashed lines, Figure 2) if Culvert 3 is unobstructed. Area 1 has a spillway at the northwestern edge of the spreader dike that allows water to flow into Area 2 once the water ponds to a sufficient elevation (approximately 3,646 feet) (Figure 2). Water could also be released into Area 2 if Culvert 3 (elevation 3,642.9 feet) was not obstructed (Figure 2). It should be noted that Culvert 2 can not allow water to pass from Area 1 to Area 3 since the bottom culvert 2 is 1.6 feet higher (3,647.6 feet) than the Area 1 spillway elevation (3,646 feet) (Figure 2). Therefore, it is not possible for water to be diverted through Culvert 2 into area 3 under any circumstances. Since water flow through Culvert 2 into Area 3 is not possible it is assumed that Area 3 is not irrigated artificially by the headgate system.

Area 2 can be irrigated by water from Bitter Creek after the water has passed through Area 1 as described above. Irrigation in Area 2 can be performed on approximately 12.7 acres if both Culvert 4 and Culvert 5 are obstructed. Water would then be released over a spillway and migrate to a small settling basin before returning to Bitter Creek through a six inch steel pipe (Figure 2). If Culvert 4 and Culvert 5 are left unobstructed then approximately 2.2 acres could be irrigated.

As mentioned above, irrigation at the Oedekoven fields can only be initiated when the headgate is closed and greater than 41.42 acre-feet of water has flowed into the reservoir basin. To determine the frequency at which to expect at least 41.42 acre-feet of water to reach the Oedekoven headgate, Lowham Engineering (2008) estimated the streamflow characteristics for the Bitter Creek watershed above the point of diversion (headgate) (Table 3). The streamflow characteristics were calculated using methods published by Miller (2003) and Craig and Rankl (1978). Based on streamflow characteristics calculated by Lowham Engineering (2008) and the fact that Bitter Creek

is an ephemeral stream, irrigation will only be initiated during a significant storm event or series of storm events (Table 3). In other words, in the absence of rainfall or snowmelt events there is not enough flow in Bitter Creek to produce the 41.42 acre-feet of water to initiate irrigation. To fill the reservoir basin with enough water to initiate irrigation a 10 year storm event or a series of smaller (i.e. 5 year events) would be required (Table 3).

3.2 Description of Soils

As previously introduced, soil samples were collected by SWCA on August 30, 2007 within the Oedekoven fields to assist in estimating background water quality of Bitter Creek (Table 1). The sample locations are shown on Figure 2, labeled 11a through 11l. Of the twelve samples collected by SWCA, seven sample points were located outside the areas that could be irrigated with water that flows from Bitter Creek through Culvert 1 (Figure 2). Sample 11f is located in Area 3 and is less than five feet above the elevation of the Bitter Creek stream bottom. Due to its proximity to Bitter Creek and low relative elevation above Bitter Creek, the soil chemistry of sample 11f is influenced by natural irrigation. Surface soil salinity is expected to be impacted by groundwater quality if the groundwater is less than five feet from the soil surface (Hanson et al., 1999). Therefore data from soil sampling location 11f have been included the Tier 2 calculations of background Bitter Creek water quality.

Samples 11b, 11c, 11h, 11i, and 11j are in close proximity to Area 1 but are at least eight feet higher in elevation than Bitter Creek and greater than 300 feet from the channel periphery (Figure 2). Bitter Creek is an ephemeral drainage (i.e. losing stream) which indicates that the water table likely increases in depth as the distance from the stream channel increases. Although groundwater elevation information is not available from the Oedekoven area it is estimated that the groundwater table is at least eight feet below the ground surface at locations 11b, 11c, 11h, 11i and 11j. Surface soil salinity is not expected to be impacted by groundwater quality if the groundwater is greater than five feet from the soil surface (Hanson et al., 1999). Therefore, the EC of soil samples 11b, 11c, 11h, 11i and 11j are not influenced by Bitter Creek water, precluding their ability to estimate historic, background Bitter Creek water quality.

Based on the survey conducted by Lowham (2008), soil sample 11l is near Area 2 and is at least seven feet above and two tenths of a mile from Bitter Creek (Figure 2). For reasons identical to those pertinent at locations 11b, 11c, 11h, 11i, and 11j, soil sample 11l cannot be influenced by Bitter Creek water. Locations 11b, 11c, 11h, 11i, 11j and 11l are considered to operate under dry land conditions.

The soil samples located within the "green hashed" boundaries on Figure 2 are seasonally influenced by Bitter Creek water that flows through Culvert 1 (including sample locations 11a, 11d, 11e, 11g and 11k) and are considered to be artificially

irrigated. To determine whether these samples should be used in the Tier 2 analysis, the EC of the Oedekoven artificially irrigated soil sample locations were statistically compared to the EC of the Oedekoven dry land soil sample locations and also to the soil sample EC data collected from the naturally irrigated areas (locations 3-10 and 11f).

It was determined that the EC of the artificially irrigated soil sample locations was not statistically different from the EC of the dry land soil sampling locations at an alpha of 0.05. In other words, the mean EC inside the Oedekoven artificially irrigated areas (11a, 11d, 11e, 11g and 11k) was statistically equivalent to the mean EC outside of the artificially irrigated areas (11b, 11c, 11h, 11i, 11j and 11l). However, when the EC of the artificially irrigated soil sample locations (11a, 11d, 11e, 11g and 11k) were compared to the naturally irrigated soil sample locations (locations 3-10 and 11f), the mean EC values were significantly different at an alpha of 0.05.

Based on the available soils data, this indicates that the population of soil EC's within the Oedekoven artificially irrigated areas are equivalent to those receiving no irrigation whatsoever, but distinct from the population of soil EC's within Bitter Creek's naturally irrigated soils. This statistical distinction indicates that the EC of the artificially irrigated soils has not been influenced by Bitter Creek water under the same circumstances as the naturally irrigated areas. As a result, data from the artificially irrigated soil sample locations (11a, 11d, 11e, 11g and 11k) were excluded from calculations to determine the historic background water quality of Bitter Creek. This conclusion is supported by review of the 2002 color infrared aerial photographs of the area (Figure 4) and anecdotal evidence from the landowner's employee (Bruce Amende) who communicated he had only observed artificial irrigation at the spreader dikes twice since 1980 (SWCA 2007c).

If WDEQ truly thinks that these data can be used for estimating Bitter Creek water quality, the data from artificially irrigated soil sampling locations 11a, 11d, 11e, 11g and 11k (within the green area on Figure 2) should be averaged by irrigation area and the average value should be used as part of the Tier 2 analysis. If the data are not averaged, these areas would be considered "oversampled" compared to the rest of the Bitter Creek drainage and would bias the resulting analysis.

The majority of soil sample locations in irrigation areas 1 and 2 collected in association with the Oedekoven fields fall within the Moorhead series boundary. The Moorhead soil series is described as very deep well drained soils formed in alluvium derived from shales (National Cooperative Soil Survey, 2005). In the official soil series description of the Moorhead soils it is noted that the electrical conductivity ranges from 0 to 4 dS/m (Appendix A). For Moorhead soils occurring in northern Campbell County, Wyoming, NRCS chemical soil property data lists soil salinity ranging from 0.0 to 2.0 dS/m for this series (Appendix A). The low salinities associated with the dominant soil series, in conjunction with the low salinities observed in the sample data indicate that soils in

Areas 1 and 2 are most likely in their native state and should not be used to estimate Bitter Creek water quality.

Other soil series associated with artificially irrigated areas 1 and 2 are also characterized by low salinity, as indicated by NRCS chemical soil property data for Northern Campbell County (Appendix A). The Fairburn, Samsil, Badland, Muleherder, and Ironbutte series possess low soil salinities, ranging from 0.0 to 2.0 dS/m. These reported low electrical conductivities are similar to the actual electrical conductivities measured in the soil samples obtained by SWCA, again indicating that soil chemistries in areas 1 and 2 remain in a relatively natural state.

3.3 Potential Impacts to Hydraulically Isolated Fields

To ensure that the proposed end-of pipe EC limits are protective of the Oedekoven hydraulically isolated areas, a mixing analysis was conducted to estimate Bitter Creek water quality during periods that could initiate irrigation at the Oedekoven flood irrigation areas. The mixing analysis was performed using PHREEQC (USGS, 2005) on multiple assumed water qualities so that a range of conditions could be evaluated.

By examining the magnitude of precipitation events associated with different storm reoccurrence intervals in the Bitter Creek watershed it is evident that a wide range of runoff volumes can be expected (Table 3). Lowham (2008) predicts that storm events in the Bitter Creek watershed can produce between 10.8 acre-feet and 137.8 acre-ft of runoff depending on the reoccurrence interval. As stated previously, storm events or a series of storm events producing greater than 41.42 acre-feet of runoff are required to initiate irrigation at the Oedekoven spreader dikes (Lowham Engineering, 2008). The minimum single storm event capable of producing 41.4 acre feet of runoff is a 10 year event (Table 3). As a result, characteristics of the Bitter Creek 10 year precipitation-runoff event were used in this mixing analysis.

Using GIS, it was determined that approximately seven percent of the Bitter Creek watershed acreage can contribute runoff waters to upstream Termo tributary CBNG reservoirs (Figure 5). Under the most conservative scenario, runoff waters contributing to CBNG reservoirs will evacuate the entire volume of each tributary reservoir assumed to be at its CBNG storage capacity. This situation would result in a discharge of CBNG water to Bitter Creek equivalent to the volume received by runoff. This is anticipated to contribute approximately seven percent of the storm runoff waters produced in the Bitter Creek watershed. Therefore it was assumed that during runoff events a mixing ratio of 93:7 (93 percent rainfall runoff and seven percent CBNG produced water) is appropriate. In other words 93 percent of the water volume available as storage behind the headgate would reflect the water chemistry associated with natural Bitter Creek runoff, unaffected by CBNG water, and seven percent of the runoff would have characteristics associated with CBNG produced water chemistry.

Although natural runoff water quality is unknown, a few "opportunity" samples were collected from Bitter Creek during May of 2007 (Appendix B). These data were evaluated in the mixing analysis. To provide a degree of sensitivity, a theoretical runoff water of high quality was also incorporated into the mixing analysis. The theoretical water chemistry was developed by using the opportunity water samples and systematically lowering the concentrations of dissolved constituents. This resulted in a water chemistry with an ECw of 1.3 dS/m (note that according to soil salinity-crop yield data, runoff irrigation waters with an ECw of 1.3 dS/m would have no impact to alfalfa yields). It is assumed that any addition of CBNG produced water exhibiting an ECw greater than 1.3 dS/m would result in an increase to the EC of this theoretical water quality.

Three separate scenarios were modeled using PHREEQC to determine if CBNG produced water released during storm events would negatively impact runoff water quality used to irrigate Oedekoven flood irrigation areas. The first scenario mixed Bitter Creek water chemistry measured in May of 2007 (Bitter Creek Water 1) with the estimated CBNG produced water chemistry (Produced Water 1) (Table 4). The model indicated that the addition of seven percent CBNG produced water to measured Bitter Creek chemistries would slightly improve the ECw of runoff waters available to irrigate Oedekoven spreader dike areas (Column 9, Table 4). Under Scenario 1, the irrigation waters would be improved, resulting in no negative impacts on crops grown in the hydraulically isolated fields.

The second modeled scenario combined 93 percent of the theoretical, high quality Bitter Creek water with an ECw of 1.3 dS/m (Bitter Creek Water 2) with seven percent of the estimated CBNG produced water (Produced Water 1). The model indicated a very slight increase in ECw (< 0.04 dS/m), which resulted in a mixed water ECw of 1.3 dS/m when rounded to the tenths (Column 11, Table 4). This scenario indicates that any natural runoff water plus CBNG produced water applied to the hydraulically isolated fields would have no negative impact on crop production with respect to salinity.

The last scenario blended theoretical Bitter Creek water with an ECw of 1.3 dS/m (Bitter Creek Water 2) and a simulated CBNG produced water with an ECw equal to the end of pipe effluent limit proposed later, in Section 6 of this report (Produced Water 2) (Column 13, Table 4). The results of this mixing model demonstrate that the mixed water ECw will increase approximately 0.2 dS/m from 1.3 dS/m to 1.5 dS/m (Table 4). The following equation is a frequently cited relationship that relates irrigation water quality to the soil ECe:

$$ECe = 1.5 \times ECw.$$

Where ECe is the average EC of the soil (measured in a saturated paste extract), and ECw is the long-term average EC of the applied water (Ayers and Westcot, 1985). Scenario 3 produces Bitter Creek runoff waters with an ECw of 1.5 dS/m, suggesting that soils in equilibrium with this water chemistry would have a resulting root zone ECe of 1.5 * 1.5, or 2.25 dS/m. Using alfalfa salinity thresholds published in Hanson et al. (1999), an ECe of 2.25 is greater than the maximum root zone salinity at which 100 % yield occurs, a value placed at ECe = 2.0 dS/m. To calculate the relative yield of alfalfa at an ECe of 2.25 dS/m, the following equation is used (Hanson et al. 1999):

$$Y = 100 - B(ECe-A)$$

Where Y = the relative yield or yield potential (%), A = the maximum root zone salinity at which 100 % yield occurs in dS/m (2.0 dS/m for alfalfa) and B = the slope of the yield reduction line (% reduction in relative yield per increase in soil salinity, dS/m), which equates to 7.3 for alfalfa (Hanson et al. 1999). By substituting alfalfa specific values for A, B and the ECe determined in Scenario 3, we see that under Scenario 3, alfalfa will grow at 98 % of its relative yield potential with a mixed water quality ECw of 1.5 dS/m.

$$Y = 100 - 7.3(2.25 \text{ dS/m} - 2 \text{ dS/m})$$
$$Y = 98.2 \%$$

This scenario indicates that any natural runoff water plus CBNG produced water applied to the hydraulically isolated fields would have minimal negative impacts to alfalfa production with respect to salinity.

4.0 Baseline Conditions of Bitter Creek

4.1 Soils

4.1.1 NRCS Soil Mapping Units

The Natural Resource Conservation Service (NRCS) Campbell County soil survey contains soil maps for the entire Bitter Creek drainage (Figures 6 and 7). Several different soil map units are present within soil sample locations associated with the Tier 2 analysis, Locations 1 through 10 and 11f, most notably the Rockypoint-Boruff Complex. The official NRCS descriptions for the Rockypoint and Boruff soil series are included in Appendix A.

Rockypoint soils consist of very deep, well drained soils formed in recent alluvium derived from mixed sedimentary sources. Rockypoint soils are generally found on flood plains and low terraces with slopes of 0 to 6 percent. Clay percentages usually range between 15 to 35 percent, mean annual precipitation is about 15 inches. Rockypoint

soils are moderately permeable. These soils are utilized primarily as rangeland and wildlife habitat. The native vegetation is mainly green needlegrass, bearded wheatgrass, slender wheatgrass, western wheatgrass, and cottonwoods (National Cooperative Soil Survey, 2005).

Boruff soils consist of very deep, poorly and somewhat poorly drained soils formed in alluvium on flood plains and low stream terraces with slopes of 0 to 3 percent. Clay percentages typically range from 35 to 60 percent. Boruff soils receive approximately 14 inches of precipitation annually and are characterized as having slow permeability. These soils are utilized primarily as rangeland and wildlife habitat. The native vegetation is mainly green needlegrass, bearded wheatgrass, slender wheatgrass, western wheatgrass and cottonwoods (National Cooperative Soil Survey, 2005).

4.1.2 Soil Sampling and Analysis Methods

The extent of literature available to KC Harvey concerning the soil sampling methodologies used by SWCA and BKS to collect data in the Bitter Creek drainage are limited to the contents of previously submitted Section 20 documents to the WDEQ dated June 28, August 10 and September 12, 2007 (SWCA, 2007a; SWCA, 2007b; SWCA, 2007c). The sampling methodologies for these sampling events have already been presented to the WDEQ (SWCA, 2007a; SWCA, 2007b; SWCA 2007c).

On December 6, 2007, KC Harvey soil scientists collected soil samples from three previously unsampled fields within the Bitter Creek drainage. Two of the areas were likely irrigated due to unpermitted spreader dikes while the third identified location was naturally irrigated directly from Bitter Creek. The previously unsampled areas were located on property owned by the Crockett Cattle Company. These locations had not been sampled previously due to landowner access issues.

Due to the small aerial extent of spreader dike fields and their relatively close proximity, they were grouped into one field. Six locations were sampled in the spreader dike fields and composited by depth. Six samples were also collected within an unswathed swale subject to natural irrigation. A handheld global positioning system (GPS) marked each sampling location. At each sample location, soil samples were collected from six depth increments; 0 to 12, 12 to 24, 24 to 36, 36 to 48, and 48 to 60 and 60 to 72 inches using a truck-mounted Giddings Probe (Giddings Machine Company, Windsor, Colorado). Samples were then composited by depth across all sampling locations for a total of six samples representative of the spreader dike fields and six representative of the naturally irrigated swale. Subsequent analysis at Energy Laboratories, Inc. (Helena, Montana) included measurements of the following soil parameters:

- pH,
- electrical conductivity (EC),
- dissolved calcium,
- dissolved magnesium,
- dissolved sodium,
- sodium adsorption ratio (SAR),
- saturation percentage,
- extractable sodium
- exchangeable sodium,
- exchangeable sodium percentage (ESP),
- cation exchange capacity (CEC),
- texture (percent sand, silt, and clay),
- percent lime,
- percent organic matter, bicarbonate, and
- sulfate

Soil data quality were assessed in accordance with PARCC procedures (EPA, 1998). The PARCC parameters; Precision, Accuracy, Repeatability, Completeness, and Comparability are all indicators of data quality. Data collection and validation methods that address these parameters ensure that data are of known and acceptable quality and are representative of the system sampled. Table 1 summarizes the entire soil data set for the Bitter Creek drainage collected by BKS, SWCA, and KC Harvey. Table 5 summarizes the data that meets the PARCC procedures and is suitable for estimating historic, background Bitter Creek water quality. The original laboratory results for the soil data set collected by KC Harvey is provided in Appendix C. As described in Section 2.0 soil sample data collected by BKS was not incorporated into the Tier 2 analysis due to the lack of EC data and that it was clearly stated that the sampling location were likely outside of areas that would be influenced by Bitter Creek water quality. Soil samples collected in Zones 2 and 3 were excluded from the Tier 2 analysis because Zones 2 and 3 were likely not influenced by Bitter Creek water quality (Section 2.0). Some of the data (sample locations 11b, 11c, 11h, 11i, 11j and 11l) from the Oedekoven fields were excluded from the Tier 2 analysis because they were outside the area of artificial irrigation and they were likely not influenced from by natural irrigation (Section 3.2). Sample locations located within the artificially irrigated areas (Figure 2) were excluded due to their lack of comparability to the known naturally irrigated areas (Section 3.2). Soil sample location 11f was used in the Tier 2 analysis because it is likely naturally irrigated with Bitter Creek water and was comparable to the other naturally irrigated datasets in terms of salinity.

4.1.3 Soil Physical Conditions

Soil physical properties affect aeration rates, water infiltration, water storage, and movement of water through the soil profile. Soil textures at Locations 3, 6 through 10 and 11f associated with the Tier 2 analysis are predominately silty clay loam, clay loam and silty clay. Clay content in samples from Locations 3, 6 through 10 and 11f range from 12 to 50 % across all depths, averaging 33 % (Table 5). Percent organic matter in the surface soil samples (0-12 inch) ranges from 2.2 to 7.3 percent (Table 5), which is typical of these soil types in the Powder River Basin.

Soil textures at locations 11a, 11d, 11e, 11g and 11k (within the maximum predicted extent of artificial irrigation) are predominately loam, sandy loam, clay loam, and silty clay loam. Clay content ranges from 10 to 47 percent across all depths (Table 1). Percent organic matter in the surface soil samples (0 to 12 inch) ranges from 2.6 to 3.5 percent (Table 1), which is typical of these soil types in the Powder River Basin.

4.1.4 Soil Chemical Conditions

Soil salinity is the amount of soluble salts in a soil often measured by using the electrical conductivity (ECe) of the saturated paste extract. Salinity is important because high salt levels make it difficult for plants to obtain water (Bohn et al., 1985). Soils with ECe values greater than 4.0 dS/m are classified as saline. However, lower ECe values (< 2.0 dS/m) can affect sensitive plants while salt tolerant plants are productive at ECe levels greater than 8 dS/m.

Soil EC ranged from 0.39 to 14.0 dS/m in the 0 to 48 and 0 to 72 inch depth increment samples at Locations 3, 6 through 10 and 11f applied to the Tier 2 analysis (no soil EC data for soil sampling locations 1 and 2 / locations 4 and 5 represent Zones 1 & 2 and were excluded) (Table 5). EC values of 10 dS/m or greater were measured in samples at Locations 6 and 8 (Table 5). The highest EC values were encountered at inconsistent depth increments throughout Locations 3, 6 through 10 and 11f. These values are comparable to those reported by the NRCS for the Rockypoint and Boruff soil series.

Due to the observed presence of alfalfa at soil sampling Locations 6, 7 and 11f average soil EC was calculated to a depth of 72 inches to assist in determination of background water quality. At the time of sampling, no alfalfa was observed at locations 3, 8, 9 and 10, and average soil EC was calculated to a depth of 48 inches. The average soil profile EC at Locations 3, 6 through 10 and 11f ranged from 2.6 to 10.4 dS/m along Bitter Creek (Table 5). With the exception of Location 9, all sampling locations have average soil EC values greater than 4.0 dS/m which classifies these soils as saline (Table 5). Only plants that are tolerant or moderately tolerant of soil salinity are well suited for growth on these fields.

Soil EC at sampling locations 11a, 11d, 11e, 11g and 11k (artificially irrigated locations) from 0 to 72 inches range from 0.32 to 3.81 dS/m compared to a range of 0.39 to 14.0 dS/m in the 0 to 72 inch depth increment samples collected from naturally irrigated locations (Locations 3, 6 through 10 and 11f). At artificially irrigated locations the highest EC values were usually encountered at depth increments between 24 and 48 inches.

Sodic soils are "nonsaline soils containing sufficient exchangeable sodium to adversely affect crop production and soil structure" (Soil Science Society of America, 2001). High levels of adsorbed sodium tend to disperse clay particles thereby sealing the soil. The result can produce clogged soil pores, hard surface crusts, reduced infiltration, reduced

permeability, and reduced oxygen diffusion rates, all of which interfere with or prevent plant growth.

By definition, sodic soils are those that have an exchangeable sodium percentage (ESP) greater than 15 (Levy et al. 1998; Abrol et al., 1988; Evangelou, 1998; McNeal and Coleman, 1966; Sparks, 1995; Sumner et al., 1998; Shainberg et al., 1971; Soil Improvement Committee, California Plant Health Association, 2002). ESP is the amount of adsorbed sodium on soil exchange sites expressed as a percent of the cation exchange capacity (CEC) in milliequivalents per 100 grams of soil (meq/100 g):

$$ESP = \left(\frac{Exchangeable\ Sodium}{CEC} \right) \cdot 100$$

Soil ESP values at naturally irrigated locations 6, 7 and 11f range from 0.1 to 25 percent to a depth of 72 inches. ESP values at naturally irrigated locations 1, 2, 3, 8, 9 and 10 range from 0.1 to 20 percent to a depth of 48 inches (Table 5). The average soil profile ESP ranges from 1.0 to 16.8 percent across Locations 1 through 3, 6 through 10 and 11f. Soils with mean profile ESP values greater than 15 percent exist naturally at Locations 6 and 8. When combined with the measured salinity, Locations 6 and 8 are considered saline-sodic (Table 5). Therefore, locations 6 and 8 are naturally limited for crop production because of the enriched salinity and sodicity.

Soil samples from artificially irrigated locations 11a, 11d, 11e, 11g and 11k are both non-saline and non-sodic in each depth increment measured, as indicated by low soluble salt content (EC less than 4 dS/m) and low exchangeable sodium content (mean profile ESP less than 15).

4.2 Vegetation

A vegetation assessment of the naturally and artificially irrigated areas was not conducted as part of this Tier 2 analysis. However based on reports completed by SWCA it appears that alfalfa is present in some of the irrigated fields sampled. KC Harvey also noted the presence of alfalfa in the fields that they sampled in December, 2007. KC Harvey was not able to complete a vegetation assessment due to the season of field work. Therefore for this analysis it is assumed that alfalfa is the most limiting crop grown in the drainage with respect to soil salinity.

4.3 Surface Water

Water quality monitoring is conducted monthly at the WQMS TRIB1 near the Wyoming-Montana border located in Township 58N Range 75W Section 23 on Bitter Creek by

SWCA Environmental Consultants (Appendix B). From July 30, 2003 until May 14, 2007 no flow was recorded in Bitter Creek at this station. On May 14, 2007 a flow of 1.32 cfs was measured at this station and a water quality sample was collected. The WQMS water quality sample exhibited an ECw of 3.43 dS/m. The WQMS sample was analyzed for a limited set of parameters and could not be used by PHREEQC in the mixing analysis presented above. An additional Bitter Creek water quality sample was collected on May 18, 2007 on land owned by the Fred and Mary Ann Oedekoven Family Trust. The water sample collected on May 18, 2007 exhibited an ECw of 8.17 dS/m (Appendix B).

5.0 CHARACTERIZATION OF CBNG DISCHARGES

The water management strategy for the Termo Homestead Draw II CBNG Project calls for water storage in on-channel reservoirs, located within tributaries to Bitter Creek. Releases to Bitter Creek will only occur when natural storm flows cause the on-channel tributary reservoirs to overflow or when the landowner requests the water. Termo has submitted complete documentation and specific locations of all reservoirs and outfalls as per WYDEQ permit application requirements. Appendix B provides the water quality from one of two existing outfalls within the Homestead II POD. As measured on September 28, 2007, the EC and SAR of the discharged produced water was 1.62 dS/m and 20.5, respectively.

6.0 PROPOSED EFFLUENT LIMITS AND IMP STANDARDS

The "Tier 2 – Background Water Quality" approach included in the current draft Section 20 Agricultural Use Protection Policy (WYDEQ, 2006) is used herein to estimate the long-term average runoff water EC in Bitter Creek and, in comparison to measured Bitter Creek water quality, derive a proposed effluent limit for EC using sample Locations 3, 6, 7, 8, 9, 10 and 11f. Thus, in this Tier 2 evaluation, the background water EC is estimated from the EC of soil samples collected from areas downstream of the proposed discharges receiving natural and artificial irrigation from Bitter Creek under low flow conditions. This derivation technique assumes that soil chemical conditions along Bitter Creek are in equilibrium with the low flow runoff water chemistry supplied by Bitter Creek over the long term. Therefore, soil chemistry, particularly soil EC, is a function of the long-term average water quality received by the soil. The following equation is a frequently cited relationship that relates irrigation water quality to the soil ECe:

$$ECe = 1.5 \times ECw.$$

Where ECe is the average EC of the soil (measured in a saturated paste extract), and ECw is the long-term average EC of the applied water (Ayers and Westcot, 1985). The equation can be solved for the long-term average EC of the applied water such that:

$$ECw = ECe \div 1.5$$

The resultant equation, which is referenced in the current Section 20 Agricultural Use Protection Policy (WYDEQ, 2006), allows for the estimation of long-term average ECw of the applied water, given that soil data have been collected at a specific site. As discussed above, soil ECe data collected from Zones 2 and 3 in T 57N, R 74 W Section 36 (locations 4 and 5) are inappropriate for use in calculating long-term average runoff water ECw in Bitter Creek; therefore, calculations were applied to data from sample Locations 3, 6, 7, 8, 9, 10 and 11f which resulted in a mean ECe of 6.6 dS/m (Table 6). The estimated long-term water quality of Bitter Creek is approximately 4.4 dS/m (6.6 divided by 1.5).

Based on previous permits issued in the Powder River Basin of Wyoming, the WDEQ has provided a level of conservatism to effluent limits using statistical methods. While not specifically stipulated by the Section 20 Agricultural Use Protection Policy, the statistical methods used by the WDEQ include an outlier test, mean ECe, and 95% confidence intervals. To perform these tests one primary assumption must be made and that is that the collected data is normally distributed. Therefore, before any statistical analysis was performed, the data were analyzed using the SPSS software package (SPSS, 2001) to determine if the data were normally distributed. Based on this analysis, it was determined that soil EC data from Locations 3, 6, 7, 8, 9, 10 and 11f are normally distributed (Table 6). Since the data are normally distributed it is appropriate to use basic T based statistics for the analysis.

An outlier test was performed on the data from soil sample Locations 3, 6, 7, 8, 9, 10 and 11f using the SPSS software. The outlier test indicates that all of the data are acceptable for use. Since all of the data were acceptable, based on the outlier test, a mean ECe, standard deviation, and 95% confidence interval were calculated from the Tier 2 data (Table 5) using SPSS (SPSS, 2001). The average deviation, 95 percent confidence intervals of the data was calculated to be 3.0 and 5.5 dS/m, respectively (Table 6). Dividing the 95 percent lower bound soil ECe by 1.5 estimates the Bitter Creek water quality to be approximately 3.7 dS/m. Therefore, using the current WDEQ procedure, the proposed end-of-pipe effluent limit for ECw would be 3.7 dS/m (Table 6).

In addition to the end-of-pipe EC limit, it is proposed that any resultant WYPDES permit for CBNG discharge in this drainage include monitoring for compliance with an EC standard and the chemical relationship between EC and SAR at designated irrigation monitoring points (IMPs). The proposed EC standard at the IMP would be equivalent to the calculated average soil EC in the irrigated fields (6.6 dS/m) divided by 1.5 to

estimate the allowable salinity in the stream water. The proposed EC standard would not be a compliance limit; instead it would represent the target water quality value that should be achieved at the IMP to protect irrigated fields.

With respect to the IMP standard for SAR, it is proposed that the WDEQ establish an appropriate monitoring program to determine whether or not effluent from the discharge facilities conforms to the following equation for SAR:

$$SAR < (7.10 \times EC) - 2.48$$

This equation applies the soil-water chemical relationship between EC and SAR and is used to evaluate whether or not the long-term use of an irrigation water source would result in potential soil structural impacts and reductions in the infiltration rate of applied water. For any measured water EC value, the equation is used to calculate a corresponding maximum SAR value that would remain within the "no reduction in rate of infiltration" zone on Figure 1 of Hanson et al. (1999). For the Bitter Creek drainage, the maximum SAR standard in a water sample from the IMP would be based on the measured EC in the same sample. For example, if the EC in a water sample collected at an IMP was measured to be 3.0 dS/m, then, based on the equation above, the measured SAR in the same sample would need to be less than 18.8. In this example, the EC standard would be achieved since an EC of 3.0 dS/m is less than the proposed standards. The ongoing monitoring of EC and SAR at the IMP in this fashion would be used to evaluate the actual water quality that may be applied to downstream fields.

In summary, based on the analyses described herein, the discharge of CBNG produced water to the Bitter Creek watershed in accordance with the proposed effluent limits and IMP standards described above is not expected to result in a measurable decrease in crop or livestock production, and would therefore be compliant with Chapter 1, Section 20 of the Wyoming Water Quality Rules and Regulations.

7.0 REFERENCES CITED

Abrol, I.P., Yadav, J.S.P. and Massoud, F.I. 1988. Salt-affected soils and their management. FAO Land and Water Management Division, Soils Bulletin 39.

Ayers, R.S. and Wescot, D.W. 1985. Water quality for agriculture. FAO Irrigation and Drainage Paper, 29 (rev. 1).

Bohn, H.L., B.L. McNeal, and G.A. O'Connor. 1985. Soil Chemistry. John Wiley and Sons, New York.

Craig, G.S., Jr., and Rankl, J.G., 1978, Analysis of runoff from small drainage basins in Wyoming: U.S. Geological Survey Water-Supply Paper 2056

EPA. 1998. EPA Guidance for Quality Assurance Project Plans. United State Department of Environmental Protection, Wasington D.C.

Evangelou, V.P. 1998. Environmental soil and water chemistry principles and applications. John Wiley and Sons (Pub), New York, NY.

Hanson, B., Grattan, S.R. and Fulton, A.F. 1999. Agricultural salinity and drainage. Division of Agriculture and Natural Resources Publication 3375. University of California Irrigation Program. University of California, Davis, CA.

Levy, G.J., Shainberg, I. and Miller, W.P. 1998. Physical Properties of Sodic Soils. In: Sumner, M.E. and Naidu, R. 1998. Sodic soils: Distribution, properties, management and environmental consequences. Oxford University Press, Inc. New York, NY.

Loham Engineering, LLC. 2008. Revised materials for the Bitter Creek spreader system. Received 1/31/08.

McNeal, B.L and Coleman, N.T. 1966. Effect of solution composition on hydraulic conductivity. Soil Sci. Soc. Am. Proc., 30, 308-312.

Miller. K.A. 2003. Peak Flow Characteristics of Wyoming Streams Water-Resources Investigations Report 03-4107. United State Geological Society. Cheyenne, Wyoming.

National Cooperative Soil Survey, USDA_NRCS. 2005. Official Soil Series Descriptions: http://soils.usda.gov/technical/classification/osd/index.html (Accessed 1/6/2008).

Shainberg, I., Bresler, E., and Klausner, Y. 1971. Studies on Na/Ca montmorillonite systems, I: The swelling pressure. Soil Sci. 111:214-219.

SPSS, 2001. SPPS version 11. SPSS Inc. 233 South Wacker Dr, 11th Floor, Chicago, IL 60606.

Soil Improvement Committee, California Plant Health Association. 2002. Western Fertilizer Handbook, ninth edition. Interstate Publishers, Inc. Danville, Illinois.

Soil Science Society of America. 2001. Glossary of Soil Science Terms. Madison, WI.

Sparks, D.L. 1995. Environmental Soil Chemistry. Academic Press, San Diego, Ca.

Sumner, M.E., Rengasamy, P. and Naiud, R. 1998. Sodic soils: A reappraisal. In: Sumner, M.E and Naidu, R. 1998. Sodic soils: Distribution, properties, management and environmental consequences. Oxford University Press, Inc. New York, NY.

SWCA. 2007a. The Termo company's Homestead draw II project, WYPDES permit WY0055158, Section 20 analysis (Submitted to WDEQ June 28, 2007).

SWCA. 2007b. The Termo Company's Homestead Draw II Project, WYPDES Permit WY0055158 Section 20 Analysis (Submitted to WDEQ August 10, 2007).

SWCA, 2007c. The Termo Company's Homestead Draw II Project, WYPDES Permit WY0055158, Section 20 Analysis (Submitted to WDEQ September 12, 2007).

USGS. 2005. PHREEQC (Version 2.11) A Computer Program for Speciation, Batch-Reaction, One-Dimensional Transport, and Inverse Geochemical Calculations http://wwwbrr.cr.usgs.gov/projects/GWC_coupled/phreeqc/ (Acessed 1/27/08)

Ward, A.D. and S.W. Trimble, 2004. Environmental Hydrology – Second Edition. CRC Press, LLC, Boca Raton, FL.

Wyoming Department of Environmental Quality (WYDEQ). December, 2006. Wyoming Water Quality Rules and Regulations, Chapter 1. Wyoming Surface Water Quality Standards. Proposed Rules. EQC Draft.

Table 1. Complete soil physicochemical dataset collected in association with the Bitter Creek Section 20 Compliance Analysis.

Dataset #	Original Name	TRS	Sampled By[1]	Collection Date	Sample Depth	pH	EC	Percent Sat	SAR	ESP	Ca	Mg	Na	Sand	Silt	Clay	Texture	OM	CEC	Na-Ext	Exch Na
					Inches	S. U.	dS/M	%	Unitless	%	meq/L				%		Unitless	%	meq/100g		
1	Brug 1, 4, 5 Comp	56N73WS13	BKS	6/8/2007	0-12	7.0		56.9	0.09	0.10	8.2	3.2	0.2	37	32	31	Clay Loam	4.2			
	Brug 1, 4, 5 Comp	56N73WS13	BKS	6/8/2007	12-24	7.8		43.8	0.73	0.49	3.9	2.1	1.3	39	32	29	Clay Loam				
	Brug 1, 4, 5 Comp	56N73WS13	BKS	6/8/2007	24-36	7.9		48.5	7.74	1.80	27.0	26.0	40.0	52	24	24	Sandy Clay Loam				
	Brug 1, 4, 5 Comp	56N73WS13	BKS	6/8/2007	36-48	8.1		51.9	8.53	1.70	26.0	24.0	43.0	44	27	29	Clay Loam				
2	Brug 2, 3 Comp	56N73WS13	BKS	6/8/2007	0-12	7.1		65.0	0.10	0.13	7.0	2.6	0.2	27	39	34	Clay Loam	3.7			
	Brug 2, 3 Comp	56N73WS13	BKS	6/8/2007	12-24	7.6		62.0	0.59	0.45	4.4	1.6	1.0	14	44	42	Silty Clay				
	Brug 2, 3 Comp	56N73WS13	BKS	6/8/2007	24-36	8.3		68.2	11.90	8.40	23.0	44.0	69.0	18	47	35	Silty Clay Loam				
	Brug 2, 3 Comp	56N73WS13	BKS	6/8/2007	36-48	8.5		67.2	10.30	9.80	23.0	46.0	60.0	17	48	35	Silty Clay Loam				
3	1A	57N73WS36	SWCA	6/11/2007	0-12	7.0	3.05	72.8	0.73	1.70	23.3	15.2	3.2	14	52	34	Silty Clay Loam	7.3	34.9	0.8	0.6
	1B	57N73WS36	SWCA	6/11/2007	12-24	7.5	5.63	49.4	4.10	5.40	27.4	30.1	21.9	38	34	28	Clay Loam		23.6	2.4	1.3
	1C	57N73WS36	SWCA	6/11/2007	24-36	7.5	4.78	50.6	3.50	5.90	25.8	23.4	17.5	30	42	28	Clay Loam		22.6	2.2	1.3
	1D	57N73WS36	SWCA	6/11/2007	36-48	7.4	5.30	37.8	3.80	7.00	27.9	27.2	20.2	49	29	22	Loam		20.1	2.2	1.4
4	2A	57N73WS36	SWCA	6/11/2007	0-12	7.3	0.69	52.5	0.83	1.70	3.4	1.8	1.3	21	47	32	Clay Loam	3.7	28.2	0.6	0.5
	2B	57N73WS36	SWCA	6/11/2007	12-24	7.6	4.72	47.3	5.10	6.20	20.1	19.5	22.8	27	43	30	Clay Loam		21.4	2.4	1.3
	2C	57N73WS36	SWCA	6/11/2007	24-36	7.9	8.46	52.4	9.30	14.00	18.3	48.1	53.3	22	44	34	Clay Loam		23.1	6.1	3.3
	2D	57N73WS36	SWCA	6/11/2007	36-48	7.9	8.51	47.0	8.60	13.00	21.6	44.5	49.2	26	42	32	Clay Loam		21.8	5.1	2.7
	2E	57N73WS36	SWCA	6/11/2007	48-60	8.0	8.60	43.7	13.00	20.00	17.1	33.9	65.2	40	35	25	Loam		18.9	6.5	3.7
	2F	57N73WS36	SWCA	6/11/2007	60-72	7.9	8.32	41.5	9.60	10.00	20.1	42.2	53.5	50	28	22	Loam		19.2	4.2	2.0
5	3A	57N73WS36	SWCA	6/11/2007	0-12	7.3	0.66	58.1	0.59	2.00	3.2	2.0	1.0	8	54	38	Silty Clay Loam	3.6	29.6	0.7	0.6
	3B	57N73WS36	SWCA	6/11/2007	12-24	7.7	3.45	60.4	3.10	6.50	15.3	16.6	12.5	<1	57	43	Silty Clay		21.6	2.2	1.4
	3C	57N73WS36	SWCA	6/11/2007	24-36	8.1	13.10	64.8	14.00	25.00	19.8	83.2	97.0	2	55	43	Silty Clay		16.8	10.5	4.2
	3D	57N73WS36	SWCA	6/11/2007	36-48	8.1	14.00	69.9	15.00	22.00	20.3	94.2	113.0	1	55	44	Silty Clay		22.3	12.9	5.0
	3E	57N73WS36	SWCA	6/11/2007	48-60	8.0	12.20	52.3	16.00	20.00	20.5	60.8	100.0	14	48	38	Silty Clay Loam		22.8	9.7	4.5
	3F	57N73WS36	SWCA	6/11/2007	60-72	8.0	11.00	55.4	14.00	20.00	18.5	55.3	83.3	18	42	40	Silty Clay		21.9	9.1	4.5
6	Crockett Field Sub 2	57N74WS26	KCH	12/6/2007	0-12	7.9	7.54	65.7	12.00	13.00	18.9	30.0	57.3	6	57	37	Silty Clay Loam	2.2	30.7	7.8	4.0
	Crockett Field Sub 2	57N74WS26	KCH	12/6/2007	12-24	8.2	11.80	63.0	17.00	18.00	18.2	40.9	94.6	8	60	32	Silty Clay Loam	1.1	25.8	10.6	4.7
	Crockett Field Sub 2	57N74WS26	KCH	12/6/2007	24-36	8.2	10.70	60.7	16.00	18.00	18.7	43.1	88.4	12	58	30	Silty Clay Loam	1.2	26.5	10.1	4.8
	Crockett Field Sub 2	57N74WS26	KCH	12/6/2007	36-48	8.0	7.60	63.0	12.00	14.00	18.5	31.3	58.6	12	56	32	Silty Clay Loam	1.3	25.0	7.2	3.6
	Crockett Field Sub 2	57N74WS26	KCH	12/6/2007	48-60	8.0	8.30	59.5	12.00	13.00	19.0	30.8	60.9	22	49	29	Clay Loam	1.2	25.2	6.9	3.3
	Crockett Field Sub 2	57N74WS26	KCH	12/6/2007	60-72	8.0	6.11	58.8	10.00	16.00	15.8	24.5	45.4	13	53	34	Silty Clay Loam	0.9	20.8	6.0	3.3
7	Crockett Field 4 & 5	57N74WS26	KCH	12/6/2007	0-12	7.4	1.35	65.0	1.80	2.90	4.6	4.3	3.8	10	52	38	Silty Clay Loam	3.6	29.1	1.1	0.8
	Crockett Field 4 & 5	57N74WS26	KCH	12/6/2007	12-24	7.8	6.38	55.8	9.00	14.00	18.6	26.0	42.5	12	56	32	Silty Clay Loam	1.9	22.1	5.4	3.0
	Crockett Field 4 & 5	57N74WS26	KCH	12/6/2007	24-36	8.3	8.92	59.3	16.00	18.00	15.1	39.0	82.7	18	54	28	Silty Clay Loam	1.3	27.8	10.0	5.0
	Crockett Field 4 & 5	57N74WS26	KCH	12/6/2007	36-48	8.3	8.87	61.0	16.00	21.00	15.1	34.0	77.0	16	56	28	Silty Clay Loam	1.4	22.8	9.6	4.9
	Crockett Field 4 & 5	57N74WS26	KCH	12/6/2007	48-60	8.1	7.82	54.3	13.00	15.00	17.7	32.4	65.4	22	52	26	Silt Loam	1.2	22.4	6.9	3.4
	Crockett Field 4 & 5	57N74WS26	KCH	12/6/2007	60-72	8.1	7.51	52.8	13.00	12.00	18.6	31.4	63.9	26	49	25	Loam	1.1	23.7	6.3	2.9
8	3A (Site4)	57N74WS22	SWCA	7/25/2007	0-12	8.0	11.60	73.7	14.00	13.00	21.1	46.7	83.3	11	52	37	Silty Clay Loam	4.7	39.0	11.3	5.1
	3B (Site4)	57N74WS22	SWCA	7/25/2007	12-24	7.9	10.50	90.5	14.00	20.00	19.7	43.7	78.7	6	54	40	Silty Clay		31.5	13.6	6.5
	3C (Site4)	57N74WS22	SWCA	7/25/2007	24-36	7.8	11.00	90.0	14.00	16.00	22.9	48.5	84.1	6	48	46	Silty Clay		27.4	12.0	4.4
	3D (Site4)	57N74WS22	SWCA	7/25/2007	36-48	7.8	8.66	85.2	9.70	18.00	20.6	32.2	49.6	6	48	46	Silty Clay		22.8	8.2	4.0
9	2A (Site3)	57N74WS22	SWCA	7/25/2007	0-12	8.1	2.73	68.4	13.00	12.00	3.3	3.7	23.7	4	57	39	Silty Clay Loam	3.9	35.5	5.9	4.3
	2B (Site3)	57N74WS22	SWCA	7/25/2007	12-24	8.0	3.39	43.5	5.40	9.10	14.8	8.9	18.7	34	46	20	Loam		22.5	2.9	2.0
	2C (Site3)	57N74WS22	SWCA	7/25/2007	24-36	8.2	2.00	46.7	7.00	7.70	4.7	3.4	13.9	27	51	22	Silty Loam		25.3	2.6	2.0
	2D (Site3)	57N74WS22	SWCA	7/25/2007	36-48	8.1	2.38	62.3	6.30	8.60	7.1	5.3	15.6	10	57	33	Silty Clay Loam		24.8	3.1	2.1
10	1A (Sites 1&2)	57N74WS22	SWCA	7/25/2007	0-12	7.8	7.45	64.7	8.10	8.20	22.9	29.9	41.8	11	51	38	Silty Clay Loam	3.2	32.9	5.4	2.7
	1B (Sites 1&2)	57N74WS22	SWCA	7/25/2007	12-24	7.8	5.74	75.0	8.20	8.00	13.2	17.6	32.2	16	45	39	Silty Clay Loam		40.9	5.7	3.3
	1C (Sites 1&2)	57N74WS22	SWCA	7/25/2007	24-36	7.9	7.16	81.2	7.40	13.00	20.8	31.2	37.8	6	44	50	Silty Clay		25.5	6.4	3.3
	1D (Sites 1&2)	57N74WS22	SWCA	7/25/2007	36-48	7.8	8.01	77.0	7.70	10.00	20.6	35.6	40.8	13	45	42	Silty Clay		28.0	6.1	2.9

Notes:

1. Soil samples were colected by BKS Environmental Associates, Inc. (BKS), SWCA Environmental Consultants (SWCA) and KC Harvey, Inc (KCH).

Abbreviations: TRS = Township, Range, Section; S.U. = Standard units; dS/m = deciseimens per meter; % = percent; SAR = Sodium adsorption ratio; ESP = Exchangeable sodium percentage; Ca = Calcium; Mg = Magnesium; Na = Sodium; CEC = Cation exchange capacity; EC = Electrical conductivity; OM = Organic matter; Na-Ext = Extractable sodium; Exch Na = Exchangeable sodium; meq/L = milliequivalents per liter; meq/100g = milliequivalents per 100 grams of soil.

Table 1. Continued.

Dataset #	Original Name	TRS	Sampled By[1]	Collection Date	Sample Depth	pH	EC	Percent Sat	SAR	ESP	Ca	Mg	Na	Sand	Silt	Clay	Texture	OM	CEC	Na-Ext	Exch Na
					Inches	S.U.	dS/m	%	Unitless	%	meq/l			%			Unitless	%	meq/100g		
11a	Oedek 1	57N74WS8	SWCA	8/30/2007	0-12	7.5	0.53	39.1	0.11	0.96	2.4	1.9	0.2	58	25	17	Sandy Loam	3.2	18.0	0.2	0.2
	Oedek 1	57N74WS8	SWCA	8/30/2007	12-24	7.9	0.47	40.4	1.96	2.56	1.4	1.1	2.2	30	45	25	Loam		20.5	0.6	0.5
	Oedek 1	57N74WS8	SWCA	8/30/2007	24-36	7.9	1.66	40.1	2.97	2.93	6.2	4.7	6.9	32	44	24	Loam		20.6	0.9	0.6
	Oedek 1	57N74WS8	SWCA	8/30/2007	36-48	7.9	1.09	29.9	2.09	2.05	4.2	2.8	3.9	65	20	15	Sandy Loam		12.6	0.4	0.3
	Oedek 1	57N74WS8	SWCA	8/30/2007	48-60	7.8	0.97	28.8	1.82	2.45	3.8	2.5	3.2	69	18	13	Sandy Loam		11.3	0.4	0.3
	Oedek 1	57N74WS8	SWCA	8/30/2007	60-72	7.9	1.06	28.4	1.90	2.62	4.0	3.1	3.6	85	5	10	Loamy Sand		8.7	0.3	0.2
11b	Oedek 2	57N74WS8	SWCA	8/30/2007	0-12	7.1	0.46	48.6	0.57	0.07	2.2	1.5	0.8	19	49	32	Silty Clay Loam	3.9	28.8	0.1	0.0
	Oedek 2	57N74WS8	SWCA	8/30/2007	12-24	7.7	0.43	50.3	1.56	1.92	1.6	0.9	1.7	7	57	36	Silty Clay Loam		27.9	0.6	0.5
	Oedek 2	57N74WS8	SWCA	8/30/2007	24-36	7.7	0.86	44.3	1.48	1.47	3.4	2.7	2.6	19	49	32	Silty Clay Loam		23.8	0.5	0.4
	Oedek 2	57N74WS8	SWCA	8/30/2007	36-48	8.0	1.00	54.2	1.34	1.59	3.5	4.4	2.7	5	49	46	Silty Clay		28.9	0.8	0.5
	Oedek 2	57N74WS8	SWCA	8/30/2007	48-60	7.9	1.33	44.9	1.45	1.81	4.8	6.2	3.4	15	51	34	Silty Clay Loam	-	19.8	0.5	0.4
	Oedek 2	57N74WS8	SWCA	8/30/2007	60-72	7.9	1.68	43.1	1.51	1.72	7.2	9.0	4.3	25	46	29	Clay Loam		19.0	0.5	0.3
11c	Oedek 3	57N74WS8	SWCA	8/30/2007	0-12	7.6	0.47	55.2	0.26	0.20	2.4	1.6	0.4	5	39	56	Silty Clay	2.4	37.2	0.1	0.1
	Oedek 3	57N74WS8	SWCA	8/30/2007	12-24	7.9	0.60	61.1	1.65	1.62	1.7	1.8	2.2	1	40	59	Clay		32.1	0.7	0.5
	Oedek 3	57N74WS8	SWCA	8/30/2007	24-36	7.6	3.31	62.4	1.77	1.67	20.6	14.8	7.5	<0.1	42	58	Clay		32.7	1.0	0.6
	Oedek 3	57N74WS8	SWCA	8/30/2007	36-48	7.6	2.12	58.9	4.06	3.49	7.3	5.4	10.2	6	43	51	Silty Clay		34.5	1.8	1.2
	Oedek 3	57N74WS8	SWCA	8/30/2007	48-60	7.6	1.87	62.0	5.72	5.26	4.4	3.3	11.2	1	47	52	Silty Clay		33.9	2.5	1.8
	Oedek 3	57N74WS8	SWCA	8/30/2007	60-72	7.7	2.43	62.2	6.50	6.39	5.6	5.0	14.9	1	49	50	Silty Clay		33.8	3.1	2.2
11d	Oedek 4	57N74WS8	SWCA	8/30/2007	0-12	7.8	0.47	46.1	0.39	0.14	2.1	1.9	0.5	22	47	31	Clay Loam	3.5	24.0	0.1	0.0
	Oedek 4	57N74WS8	SWCA	8/30/2007	12-24	7.7	1.34	44.1	2.87	3.25	4.4	3.7	5.8	25	43	32	Clay Loam		24.5	1.1	0.8
	Oedek 4	57N74WS8	SWCA	8/30/2007	24-36	7.7	3.41	42.0	2.98	3.13	16.1	13.3	11.8	35	39	26	Loam		19.7	1.1	0.6
	Oedek 4	57N74WS8	SWCA	8/30/2007	36-48	7.7	1.47	35.7	1.41	1.49	7.4	4.9	3.5	59	22	19	Sandy Loam		14.6	0.3	0.2
	Oedek 4	57N74WS8	SWCA	8/30/2007	48-60	7.8	1.13	34.4	1.39	1.38	5.1	3.4	2.9	53	29	18	Sandy Loam		15.0	0.3	0.2
	Oedek 4	57N74WS8	SWCA	8/30/2007	60-72	7.8	0.85	29.0	1.33	1.30	3.4	2.3	2.3	71	16	13	Sandy Loam		11.3	0.2	0.2
11e	Oedek 5	57N74WS8	SWCA	8/30/2007	0-12	7.7	0.44	42.6	0.12	0.15	2.1	1.3	0.2	33	45	22	Loam	3.1	19.6	0.0	0.0
	Oedek 5	57N74WS8	SWCA	8/30/2007	12-24	8.0	0.43	38.3	1.35	1.27	1.6	1.2	1.6	35	41	24	Loam		19.2	0.3	0.2
	Oedek 5	57N74WS8	SWCA	8/30/2007	24-36	8.0	1.25	35.2	2.03	2.34	4.1	4.6	4.2	53	28	19	Sandy Loam		13.1	0.5	0.3
	Oedek 5	57N74WS8	SWCA	8/30/2007	36-48	7.9	1.25	43.7	1.74	2.80	4.4	4.8	3.7	<0.1	53	47	Silty Clay		17.5	0.7	0.5
	Oedek 5	57N74WS8	SWCA	8/30/2007	48-60	7.9	1.29	40.4	1.58	1.96	4.5	5.2	3.5	27	45	28	Clay Loam		16.5	0.5	0.3
	Oedek 5	57N74WS8	SWCA	8/30/2007	60-72	7.8	2.11	43.4	1.75	1.91	8.9	9.6	5.3	11	53	36	Silty Clay Loam		18.7	0.6	0.4
11f	Oedek 6	57N74WS8	SWCA	8/30/2007	0-12	7.5	0.39	49.0	0.12	0.12	2.3	1.3	0.2	11	54	35	Silty Clay Loam	3.9	32.2	0.1	0.0
	Oedek 6	57N74WS8	SWCA	8/30/2007	12-24	7.9	3.00	48.5	2.78	2.92	14.5	13.7	10.4	13	52	35	Silty Clay Loam		25.5	1.3	0.7
	Oedek 6	57N74WS8	SWCA	8/30/2007	24-36	8.3	8.01	43.2	8.27	8.27	17.9	47.3	47.2	31	43	26	Loam		19.2	3.6	1.6
	Oedek 6	57N74WS8	SWCA	8/30/2007	36-48	8.1	7.06	32.6	10.10	13.00	15.7	28.0	47.0	82	6	12	Loamy Sand		17.5	3.8	2.3
	Oedek 6	57N74WS8	SWCA	8/30/2007	48-60	8.1	6.09	29.6	7.10	8.30	18.2	29.3	34.6	67	17	16	Sandy Loam		15.2	2.0	1.0
	Oedek 6	57N74WS8	SWCA	8/30/2007	60-72	8.1	6.54	31.2	8.31	8.10	16.6	30.0	40.1	68	17	15	Sandy Loam		20.2	2.9	1.6
11g	Oedek 7	57N74WS8	SWCA	8/30/2007	0-12	7.6	0.55	36.9	0.57	0.37	3.4	2.0	0.9	43	36	21	Loam	2.9	18.8	0.1	0.1
	Oedek 7	57N74WS8	SWCA	8/30/2007	12-24	8.0	0.41	37.8	1.37	2.56	1.7	1.0	1.6	39	40	21	Loam		15.4	0.5	0.4
	Oedek 7	57N74WS8	SWCA	8/30/2007	24-36	8.0	1.57	43.5	2.51	3.29	5.6	6.3	6.1	18	53	29	Silty Clay Loam		25.0	1.1	0.8
	Oedek 7	57N74WS8	SWCA	8/30/2007	36-48	7.9	3.81	44.2	2.29	2.68	19.7	24.0	10.7	18	52	30	Silty Clay Loam		22.9	1.1	0.6
	Oedek 7	57N74WS8	SWCA	8/30/2007	48-60	7.9	2.49	33.2	2.34	2.20	10.7	12.6	8.0	48	34	18	Loam		12.9	0.6	0.3
	Oedek 7	57N74WS8	SWCA	8/30/2007	60-72	8.0	1.54	29.3	2.23	3.09	5.5	6.7	5.5	60	27	13	Sandy Loam		9.6	0.5	0.3
11h	Oedek 8	57N74WS8	SWCA	8/30/2007	0-12	7.1	0.56	46.5	0.33	0.07	2.6	2.5	0.5	29	45	26	Loam	5.1	26.8	0.0	0.0
	Oedek 8	57N74WS8	SWCA	8/30/2007	12-24	7.9	0.54	42.3	2.07	1.81	1.6	1.4	2.5	20	50	30	Clay Loam		23.7	0.5	0.4
	Oedek 8	57N74WS8	SWCA	8/30/2007	24-36	8.0	0.68	37.7	2.75	2.60	2.1	1.4	3.6	44	32	24	Loam		17.7	0.6	0.5
	Oedek 8	57N74WS8	SWCA	8/30/2007	36-48	8.0	1.23	36.8	2.10	2.25	4.5	4.4	4.4	41	34	25	Loam		14.9	0.5	0.3
	Oedek 8	57N74WS8	SWCA	8/30/2007	48-60	8.0	1.43	39.9	2.04	2.30	4.1	6.8	4.8	27	48	25	Loam		17.5	0.6	0.4
	Oedek 8	57N74WS8	SWCA	8/30/2007	60-72	8.1	1.36	38.3	1.94	2.18	3.7	6.6	4.4	<0.1	40	60	Clay		16.5	0.5	0.4
11i	Oedek 9	57N74WS8	SWCA	8/30/2007	0-12	8.3	0.37	46.1	0.32	0.13	1.7	1.4	0.4	11	52	37	Silty Clay Loam	4.7	29.5	0.1	0.0
	Oedek 9	57N74WS8	SWCA	8/30/2007	12-24	7.8	0.42	41.3	1.19	1.20	1.7	1.0	1.4	27	37	36	Clay Loam		32.1	0.4	0.4
	Oedek 9	57N74WS8	SWCA	8/30/2007	24-36	8.0	1.15	44.6	1.52	1.49	4.5	5.0	3.3	14	55	31	Silty Clay Loam		23.0	0.5	0.3
	Oedek 9	57N74WS8	SWCA	8/30/2007	36-48	8.0	1.65	43.7	1.96	2.09	4.4	8.8	5.0	17	51	32	Silty Clay Loam		22.0	0.7	0.5
	Oedek 9	57N74WS8	SWCA	8/30/2007	48-60	8.1	3.11	43.6	3.86	4.66	5.3	19.2	13.5	17	53	30	Silty Clay Loam		21.2	1.6	1.0
	Oedek 9	57N74WS8	SWCA	8/30/2007	60-72	8.1	5.52	56.4	5.73	6.78	7.1	40.4	27.9	3	57	40	Silty Clay		25.1	3.3	1.7
11j	Oedek 10	57N74WS8	SWCA	8/30/2007	0-12	7.3	0.48	46.0	0.38	0.25	2.3	1.8	0.6	25	39	36	Clay Loam	4.0	27.7	0.1	0.1
	Oedek 10	57N74WS8	SWCA	8/30/2007	12-24	7.9	0.48	42.1	0.72	0.46	1.9	1.8	1.0	27	37	36	Clay Loam		26.5	0.2	0.1
	Oedek 10	57N74WS8	SWCA	8/30/2007	24-36	8.1	0.56	54.3	0.97	0.76	1.7	2.4	1.4	11	37	52	Clay		35.8	0.4	0.3
	Oedek 10	57N74WS8	SWCA	8/30/2007	36-48	8.0	1.05	56.7	0.97	0.87	4.0	5.2	2.1	13	38	49	Clay		23.9	0.3	0.2
	Oedek 10	57N74WS8	SWCA	8/30/2007	48-60	7.6	2.45	49.2	0.59	0.87	23.3	10.5	2.4	23	33	44	Clay		24.7	0.3	0.2
	Oedek 10	57N74WS8	SWCA	8/30/2007	60-72	7.6	2.56	46.0	0.54	1.13	21.4	9.6	2.1	26	32	42	Clay		23.7	0.4	0.3
11k	Oedek 11	57N74WS8	SWCA	8/30/2007	0-12	7.9	0.45	40.5	0.20	0.13	2.3	1.4	0.3	28	44	28	Clay Loam	2.6	20.5	0.0	0.0
	Oedek 11	57N74WS8	SWCA	8/30/2007	12-24	8.0	0.32	40.0	0.83	0.72	1.4	0.8	0.9	21	52	27	Clay Loam		27.0	0.2	0.2
	Oedek 11	57N74WS8	SWCA	8/30/2007	24-36	8.3	0.53	45.4	1.39	1.79	1.5	1.7	1.8	11	56	33	Silty Clay Loam		22.4	0.5	0.4
	Oedek 11	57N74WS8	SWCA	8/30/2007	36-48	8.0	1.43	44.2	0.84	1.26	4.6	9.1	2.2	15	57	28	Silty Clay Loam		20.0	0.4	0.3
	Oedek 11	57N74WS8	SWCA	8/30/2007	48-60	7.8	2.89	42.4	0.55	1.01	21.4	15.4	2.4	28	46	26	Loam		16.5	0.3	0.2
	Oedek 11	57N74WS8	SWCA	8/30/2007	60-72	7.8	2.54	33.6	0.46	1.09	20.8	10.9	1.8	61	23	16	Sandy Loam		9.7	0.2	0.1
11l	Oedek 12	57N74WS8	SWCA	8/30/2007	0-12	7.3	0.37	48.6	0.33	0.29	1.8	1.2	0.4	11	45	44	Silty Clay	5.4	35.7	0.1	0.1
	Oedek 12	57N74WS8	SWCA	8/30/2007	12-24	7.7	2.58	48.0	1.10	1.34	18.6	10.1	4.2	19	42	39	Silty Clay Loam		27.6	0.6	0.4
	Oedek 12	57N74WS8	SWCA	8/30/2007	24-36	7.8	1.68	31.1	1.54	1.77	8.7	5.7	4.1	64	19	17	Sandy Loam		13.7	0.4	0.2
	Oedek 12	57N74WS8	SWCA	8/30/2007	36-48	7.9	0.82	31.4	1.35	1.49	3.3	2.3	2.3	63	19	18	Sandy Loam		15.1	0.3	0.2
	Oedek 12	57N74WS8	SWCA	8/30/2007	48-60	7.9	0.64	30.4	1.41	1.71	2.3	1.6	2.0	61	22	17	Sandy Loam		13.8	0.3	0.2
	Oedek 12	57N74WS8	SWCA	8/30/2007	60-72	7.9	0.65	33.7	1.50	1.48	2.5	1.6	2.2	51	28	21	Loam		17.0	0.3	0.3

Notes:
1. Soil samples were collected by BKS Environmental Associates, Inc. (BKS), SWCA Environmental Consultants (SWCA) and KC Harvey, Inc (KCH).
Abbreviations: TRS = Township, Range, Section; S.U. = Standard units; dS/m = deciseimens per meter; % = percent; SAR = Sodium adsorption ratio; ESP = Exchangeable sodium percentage; Ca = Calcium; Mg = Magnesium; Na = Sodium; CEC = Cation exchange capacity; EC = Electrical conductivity; OM = Organic matter; Na-Ext = Extractable sodium; Exch Na = Exchangeable sodium; meq/L = milliequivalents per liter; meq/100g = milliequivalents per 100 grams of soil.

— = Composite to one field ("Oedekoven Flood")

Table 2. Oedekoven headgate capacities associated with different reoccurrence interval precipitation events.[1]

Elevation	Area	Capacity	Description
	ac	ac-ft	
3,639	0	0	
3,640	1.32	0.66	
3,641	2.79	2.71	
3,642	4.35	6.28	
3,643	5.61	11.25	
3,644	7.38	17.75	
3,645	12.25	27.56	
3,646	15.48	41.42	12" cmp
3,647	17.72	58.02	
3,648	20.6	77.18	
3,649	23.14	99.05	Spillway

Notes

1 Headgate capacity calculations performed by Lowham Engineering, LLC.

Table 3. Estimated Bitter Creek discharges associated with different reoccurrence interval precipitation events[1].

Bitter Creek Drainage area = 82.39 sq. mi. Average annual precipitation = 16 inches.		
Streamflow Characteristic	Streamflow cfs	Volume[2] ac-ft
P1.5 [3]	152	10.8
P2	243	16.3
P5	602	36.1
P10	963	54.5
P25	1560	83.4
P50	2110	108.6
P100	2766	137.8
Qa [4]	2.761	

Notes:

1. Hydraulic assessments calculations performed by Lowham Engineering, LLC.
2. Volumes computed from Craig and Rankl (1978), for areas less than 11 mi^2.
3. P = annual peak flow in cubic feet per second. Number designates the reoccurrence interval in years.
4. Qa = annual peak flow in cubic feet per second.

Table 4. Estimated produced and Bitter Creek water qualities and associated mixing sensetivity analysis.

Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Parameter	Produced Water 1[1]		Produced Water 2[2]		Bitter Creek Water 1[3]		Bitter Creek Water 2[4]		BC1 (93%) PW1 (7%)[5]		BC2 (93%) PW1 (7%)[6]		BC2 (93%) PW2 (7%)[7]	
	mg/L	meq/L	mg/L	meq/L	mg/L	meq/L	mg/L	meq/L	mg/L	meq/L	mg/L	meq/L	mg/L	meq/L
HCO3	1060	17.4	2421	39.7	642	10.5	85	1.4	675	11.1	153	2.5	290	4.8
Ca	16	0.8	37	1.9	263	13.2	42	2.1	247	12.3	40	2.0	42	2.1
Cl	26	0.7	59	1.7	39	1.1	1	0.0	38	1.1	3	0.1	6	0.2
K	6	0.2	14	0.4	25	0.6	4	0.1	24	0.6	0.4	0.0	1	0.0
Mg	8	0.7	18	1.5	536	44.7	70	5.8	496	41.3	65	5.4	66	5.5
Na	398	17.3	909	39.5	800	34.8	127	5.5	777	33.8	121	5.3	173	7.5
SO4	3	0.1	7	0.1	3800	79.2	605	12.6	3554	74.0	512	10.7	512	10.7
SAR[8]	--	20.2	--	30.5	--	6.5	--	2.8	--	6.5	--	2.7	--	3.9
EC	1.6	--	3.7	--	8.2	--	1.3	--	7.7	--	1.3	--	1.5	--
Cations	--	18.9	--	43.2	--	93.2	--	13.6	--	88.0	--	12.7	--	15.1
Anions	--	18.2	--	41.5	--	90.8	--	14.0	--	86.2	--	13.3	--	15.6

Notes

1 Produced Water 1 is the expected produced water quality that will be delivered to the proposed reservoirs within HomeStead Draw II POD.

2 Produced Water 2 is simulated water chemistry of produced water that could enter the reservoirs based on the Tier II assessment.

3 Bitter Creek Water 1 is the water chemistry of Bitter Creek water collected by Stormcat Energy on 5/22/07 WQMS data was not used due to the lack analyses performed. To calibrate the geochemical model to an EC of 8.2 dS/m the sulfate concentration had to be reduced by 1000 mg/L and Sodium was reduced by 550 mg/L.

4 Bitter Creek water 2 is simulated water chemistry that would have an EC of 1.3 dS/m.

5 Projected water quality of water that could be irrigated to the Oedekoven fields assuming 93 % Bitter Creek Water 1 and 7% Produced Water 1.

6 Projected water quality of water that could be irrigated to the Oedekoven fields assuming 93 % Bitter Creek Water 2 and 7 % Produced Water 1.

7 Projected water quality of water that could be irrigated to the Oedekoven fields assuming 93 % Bitter Creek Water 2 and 7 % Produced Water 2.

8 SAR values are unitless.

Abbreviations: HCO3 = Bicarbonate; Ca = Calcium; Cl = Chloride; K = Pottasium; Mg = Magnesium; Na= Sodium; SO4 = Sulfate; SAR = Sodium adsorption ratio; EC = Electrical conductivity; mg/L = miligram per liter; meq/L = milliequivalent per liter.

Table 5. Soil physicochemical dataset used to develop Tier 2 historic background water quality of Bitter Creek.

Dataset #	Original Name	TRS	Sampled By[1]	Collection Date	Sample Depth	pH	EC	Percent Sat	SAR	ESP	Ca	Mg	Na	Sand	Silt	Clay	Texture	OM	CEC	Na-Ext	Exch Na
					Inches	S. U.	dS/m	%	Unitless	%	meq/L			%			Unitless	%	meq/100g		
3	1A	57N73WS36	SWCA	6/11/2007	0-12	7.0	3.05	72.8	0.73	1.70	23.3	15.2	3.2	14	52	34	Silty Clay Loam	7.3	34.9	0.8	0.6
	1B	57N73WS36	SWCA	6/11/2007	12-24	7.5	5.63	49.4	4.10	5.40	27.4	30.1	21.9	38	34	28	Clay Loam		23.6	2.4	1.3
	1C	57N73WS36	SWCA	6/11/2007	24-36	7.5	4.78	50.6	3.50	5.90	25.8	23.4	17.5	30	42	28	Clay Loam		22.6	2.2	1.3
	1D	57N73WS36	SWCA	6/11/2007	36-48	7.4	5.30	37.8	3.80	7.00	27.9	27.2	20.2	49	29	22	Loam		20.1	2.2	1.4
6	Crockett Field Sub 2	57N74WS26	KCH	12/6/2007	0-12	7.9	7.54	65.7	12.00	13.00	18.9	30.0	57.3	6	57	37	Silty Clay Loam	2.2	30.7	7.8	4.0
	Crockett Field Sub 2	57N74WS26	KCH	12/6/2007	12-24	8.2	11.80	63.0	17.00	18.00	18.2	40.9	94.6	8	60	32	Silty Clay Loam	1.1	25.8	10.6	4.7
	Crockett Field Sub 2	57N74WS26	KCH	12/6/2007	24-36	8.2	10.70	60.7	16.00	18.00	18.7	43.1	88.4	12	58	30	Silty Clay Loam	1.2	26.5	10.1	4.8
	Crockett Field Sub 2	57N74WS26	KCH	12/6/2007	36-48	8.0	7.60	63.0	12.00	14.00	18.5	31.3	58.6	12	56	32	Silty Clay Loam	1.3	25.0	7.2	3.6
	Crockett Field Sub 2	57N74WS26	KCH	12/6/2007	48-60	8.0	8.30	59.5	12.00	13.00	19.0	30.8	60.9	22	49	29	Clay Loam	1.2	25.2	6.9	3.3
	Crockett Field Sub 2	57N74WS26	KCH	12/6/2007	60-72	8.0	6.11	58.8	10.00	16.00	15.8	24.5	45.4	13	53	34	Silty Clay Loam	0.9	20.8	6.0	3.3
7	Crockett Field 4 & 5	57N74WS26	KCH	12/6/2007	0-12	7.4	1.35	65.0	1.80	2.90	4.6	4.3	3.8	10	52	38	Silty Clay Loam	3.6	29.1	1.1	0.8
	Crockett Field 4 & 5	57N74WS26	KCH	12/6/2007	12-24	7.8	6.38	55.8	9.00	14.00	18.6	26.0	42.5	12	56	32	Silty Clay Loam	1.9	22.1	5.4	3.0
	Crockett Field 4 & 5	57N74WS26	KCH	12/6/2007	24-36	8.3	8.92	59.3	16.00	18.00	15.1	39.0	82.7	18	54	28	Silty Clay Loam	1.3	27.8	10.0	5.0
	Crockett Field 4 & 5	57N74WS26	KCH	12/6/2007	36-48	8.3	8.87	61.0	16.00	21.00	15.1	34.0	77.0	16	56	28	Silty Clay Loam	1.4	22.8	9.6	4.9
	Crockett Field 4 & 5	57N74WS26	KCH	12/6/2007	48-60	8.1	7.82	54.3	13.00	15.00	17.7	32.4	65.4	22	52	26	Silt Loam	1.2	22.4	6.9	3.4
	Crockett Field 4 & 5	57N74WS26	KCH	12/6/2007	60-72	8.1	7.51	52.8	13.00	12.00	18.6	31.4	63.9	26	49	25	Laom	1.1	23.7	6.3	2.9
8	3A (Site4)	57N74WS22	SWCA	7/25/2007	0-12	8.0	11.60	73.7	14.00	13.00	21.1	46.7	83.3	11	52	37	Silty Clay Loam	4.7	39.0	11.3	5.1
	3B (Site4)	57N74WS22	SWCA	7/25/2007	12-24	7.9	10.50	90.5	14.00	20.00	19.7	43.7	78.7	6	54	40	Silty Clay		31.5	13.6	6.5
	3C (Site4)	57N74WS22	SWCA	7/25/2007	24-36	7.8	11.00	90.0	14.00	16.00	22.9	48.5	84.1	6	48	46	Silty Clay		27.4	12.0	4.4
	3D (Site4)	57N74WS22	SWCA	7/25/2007	36-48	7.8	8.66	85.2	9.70	18.00	20.6	32.2	49.6	6	48	46	Silty Clay		22.8	8.2	4.0
9	2A (Site3)	57N74WS22	SWCA	7/25/2007	0-12	8.1	2.73	68.4	13.00	12.00	3.3	3.7	23.7	4	57	39	Silty Clay Loam	3.9	35.5	5.9	4.3
	2B (Site3)	57N74WS22	SWCA	7/25/2007	12-24	8.0	3.39	43.5	5.40	9.10	14.8	8.9	18.7	34	46	20	Loam		22.5	2.9	2.0
	2C (Site3)	57N74WS22	SWCA	7/25/2007	24-36	8.2	2.00	46.7	7.00	7.70	4.7	3.4	13.9	27	51	22	Silty Loam		25.3	2.6	2.0
	2D (Site3)	57N74WS22	SWCA	7/25/2007	36-48	8.1	2.38	62.3	6.30	8.60	7.1	5.3	15.6	10	57	33	Silty Clay Loam		24.8	3.1	2.1
10	1A (Sites 1&2)	57N74WS22	SWCA	7/25/2007	0-12	7.8	7.45	64.7	8.10	8.20	22.9	29.9	41.8	11	51	38	Silty Clay Loam	3.2	32.9	5.4	2.7
	1B (Sites 1&2)	57N74WS22	SWCA	7/25/2007	12-24	7.8	5.74	75.0	8.20	8.00	13.2	17.6	32.2	16	45	39	Silty Clay Loam		40.9	5.7	3.3
	1C (Sites 1&2)	57N74WS22	SWCA	7/25/2007	24-36	7.9	7.16	81.2	7.40	13.00	20.8	31.2	37.8	6	44	50	Silty Clay		25.5	6.4	3.3
	1D (Sites 1&2)	57N74WS22	SWCA	7/25/2007	36-48	7.8	8.01	77.0	7.70	10.00	20.6	35.6	40.8	13	45	42	Silty Clay		28.0	6.1	2.9
11f	Odek 6	57N74WS8	SWCA	8/30/2007	0-12	7.5	0.39	49.0	0.12	0.12	2.3	1.3	0.2	11	54	35	Silty Clay Loam	3.9	32.2	0.1	0.0
	Odek 6	57N74WS8	SWCA	8/30/2007	12-24	7.9	3.00	48.5	2.78	2.92	14.5	13.7	10.4	13	52	35	Silty Clay Loam		25.5	1.3	0.7
	Odek 6	57N74WS8	SWCA	8/30/2007	24-36	8.3	8.01	43.2	8.27	8.27	17.9	47.3	47.2	31	43	26	Loam		19.2	3.6	1.6
	Odek 6	57N74WS8	SWCA	8/30/2007	36-48	8.1	7.06	32.6	10.10	13.00	15.7	28.0	47.0	82	6	12	Loamy Sand		17.5	3.8	2.3
	Odek 6	57N74WS8	SWCA	8/30/2007	48-60	8.1	6.09	29.6	7.10	6.30	18.2	29.3	34.6	67	17	16	Sandy Loam		15.2	2.0	1.0
	Odek 6	57N74WS8	SWCA	8/30/2007	60-72	8.1	6.54	31.2	8.31	8.10	16.6	30.0	40.1	68	17	15	Sandy Loam		20.2	2.9	1.6

Notes

1. Soil samples were colected by BKS Environmental Associates, Inc. (BKS), SWCA Environmental Consultants (SWCA) and KC Harvey, Inc (KCH).

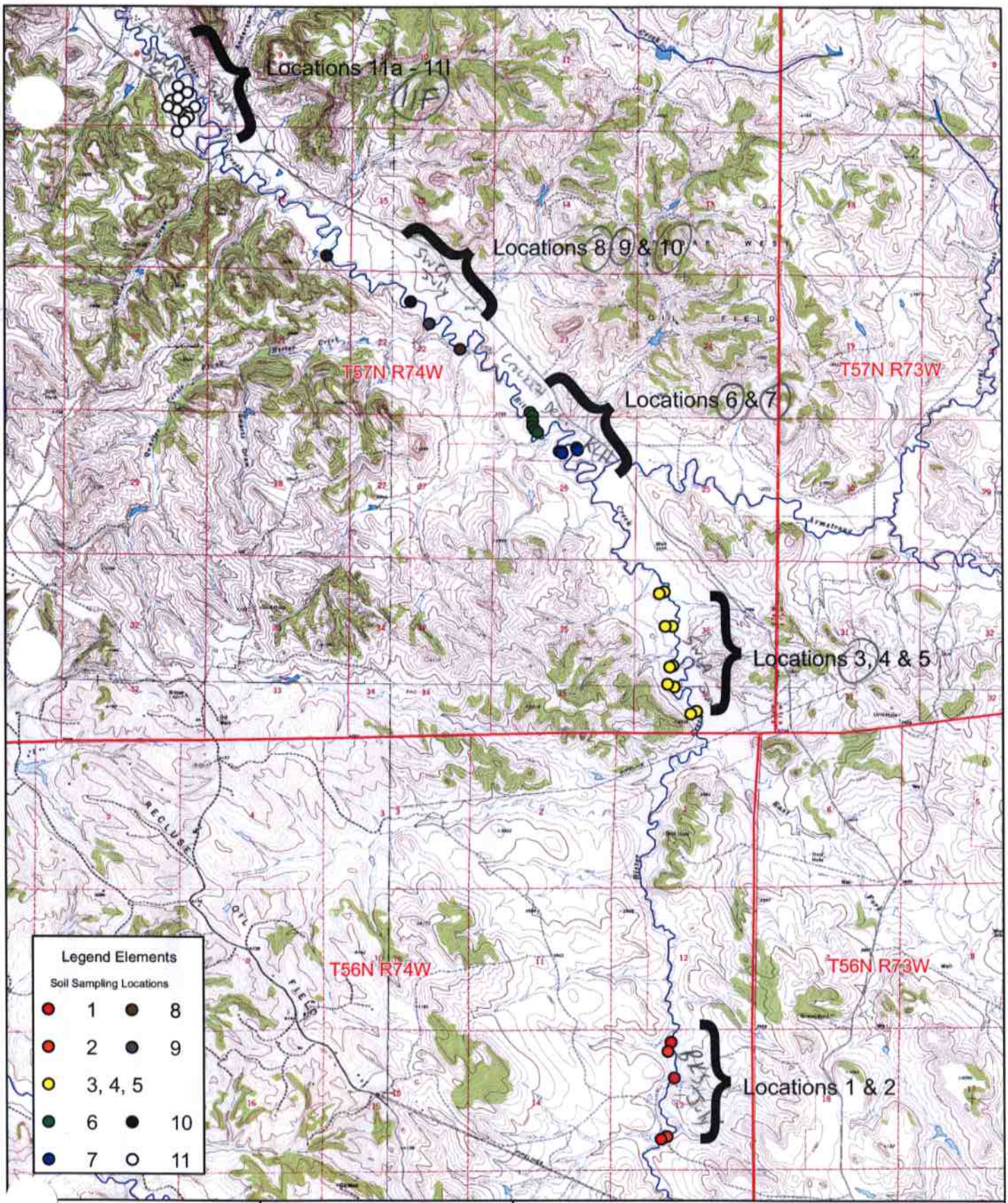
Abbreviations: TRS = Township, Range, Section; S.U. = Standard units; dS/m = deciseimens per meter; % = percent; SAR = Sodium adsorption ratio; ESP = Exchangeable sodium percentage; Ca = Calcium; Mg = Magnesium; Na = Sodium; CEC = Cation exchange capacity; EC = Electrical conductivity; OM = Organic matter; Na-Ext = Extractable sodium; Exch Na = Exchangeable sodium; meq/L = milliequivalents per liter; meq/100g = milliequivalents per 100 grams of soil.

Table 6. Descriptive statistics for soil electrical conductivity data used in the Tier 2 analysis.

Descriptive Statistics[1]	EC for locations 3, 6-10 & 11f (dS/m)
Normally Distributed	Yes
Presence of Outliers	No
Mean	6.6
Standard Deviation	3.0
Standard Error	0.5
Lower Bound 95 % C.I. of Mean	5.5
Median	7.1
Recommended End-of-pipe Effluent Limit = 3.7[2]	

Notes

1. With the exception of the recommended effluent limit, all descriptive statistics derived using SPSS statistical software (2001).
2 Recommended end-of-pipe effluent limit is based on methods used by the WDEQ on other permits within the Powder River Basin.



KC HARVEY
Soil & Water Resource Consulting
233 Edelweiss Drive, Suite 11
Bozeman, MT 59718
406-585-7402
www.kcharvey.com

0 1,200 2,400 4,800 Feet

The Termo Company

Figure 1. Soil sampling locations along the Bitter Creek Drainage.

Project: Bitter Creek Sec. 20	Date: 1/30/08	Revision: Ver. 2

○ = samples included in final data

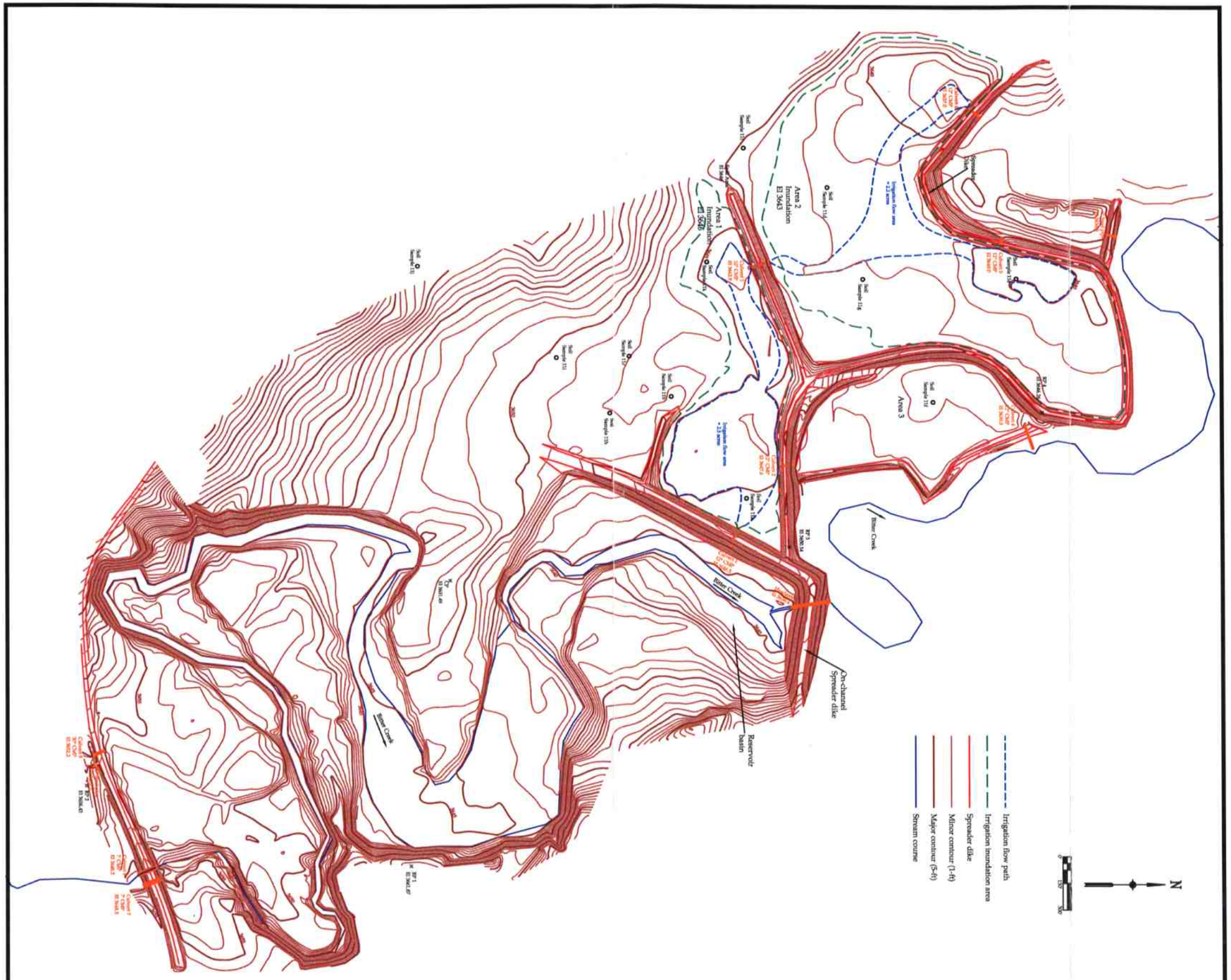


Figure 2. Survey and hydraulic assessment of the Odekoven flood irrigation areas

Termo Company

SEC. 8,9,16,&17, T57N, R74W
CAMPBELL COUNTY, WYOMING

LOWHAM ENGINEERING LLC
HYDROLOGY & WATER RESOURCES

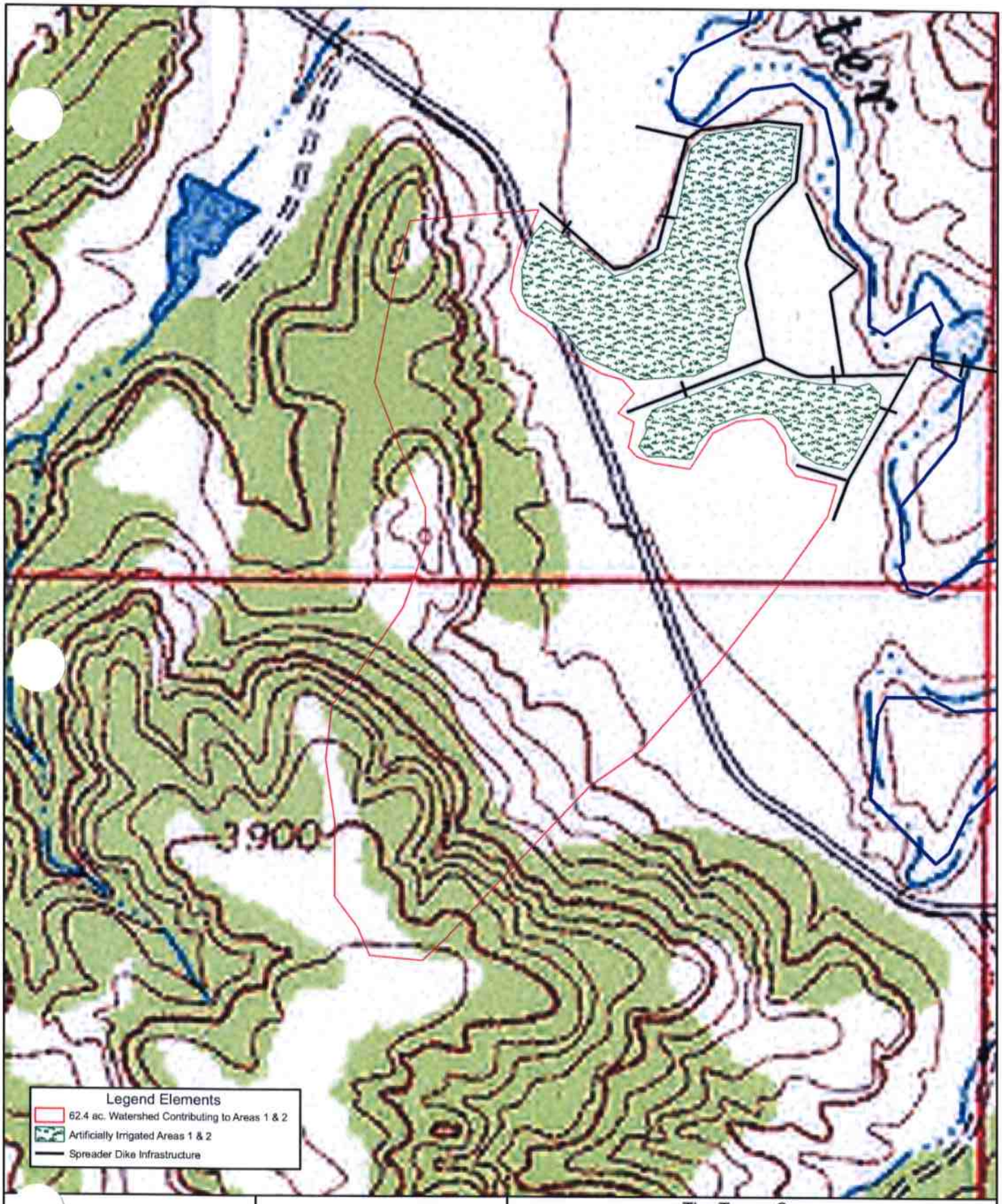
Project:	Bitter Creek
Drawing:	01
Drafted By:	RJP
Date:	12/07/2007
Check By:	RWT
Date:	01/15/2008

REVISED

DATE	BY	REQUESTED BY	CHECK
1-30-08	RWT	KC Harvey	

LOWHAM ENGINEERING LLC
205 South Third St.
Lander, WY 82520
(307) 335-8466

SHEET 1/1



K.C. HARVEY
Soil & Water Resource Consulting
233 Edelweiss Drive, Suite 11
Bozeman, MT 59718
406-585-7402
www.kcharvey.com

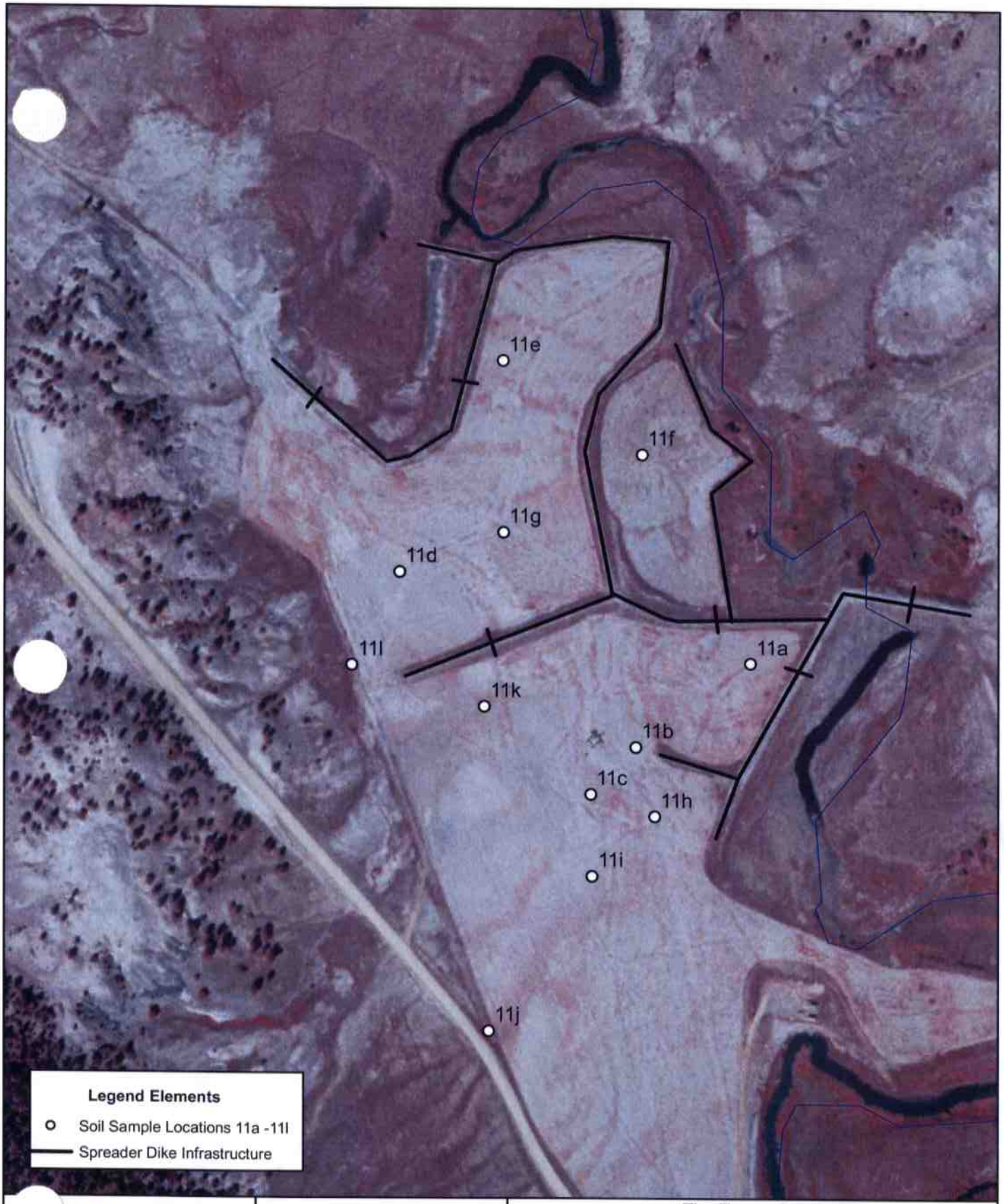
N
W E
S

0 125 250 500 Feet

The Termo Company

Figure 3. Watershed area contributing runoff directly to the Oedekoven flood irrigation areas 1 & 2.

Project: Bitter Creek Sec. 20	Date: 1/30/08	Revision: Ver. 2



KC HARVEY
Soil & Water Resource Consulting
233 Edelweiss Drive, Suite 11
Bozeman, MT 59718
406-585-7402
www.kcharvey.com

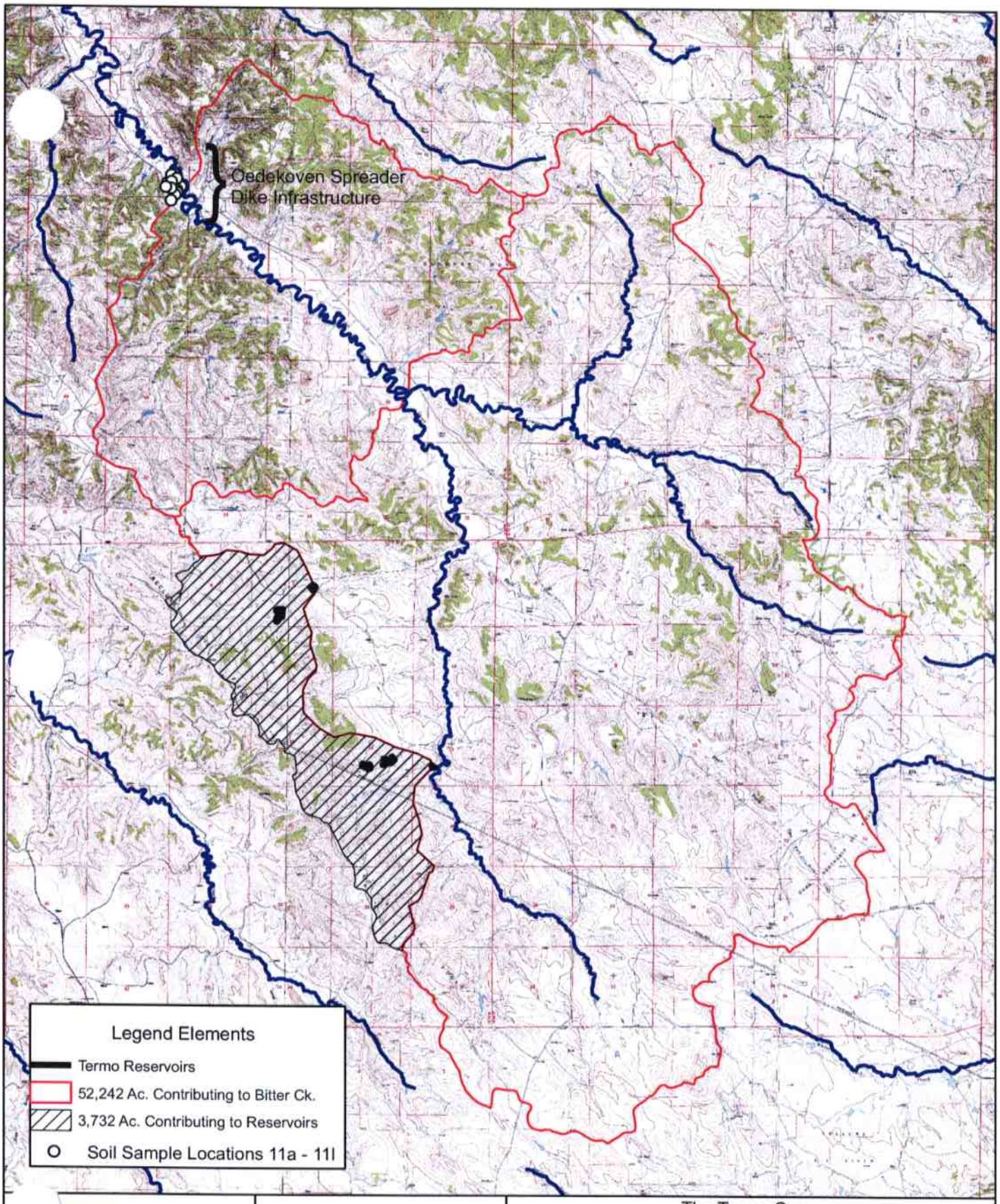
N
W E
S

0 80 160 320 Feet

The Termo Company

Figure 4. 2002 color infrared aerial image of the Oedekoven flood irrigation areas.

Project: Bitter Creek Sec. 20	Date: 1/30/08	Revision: Ver. 2



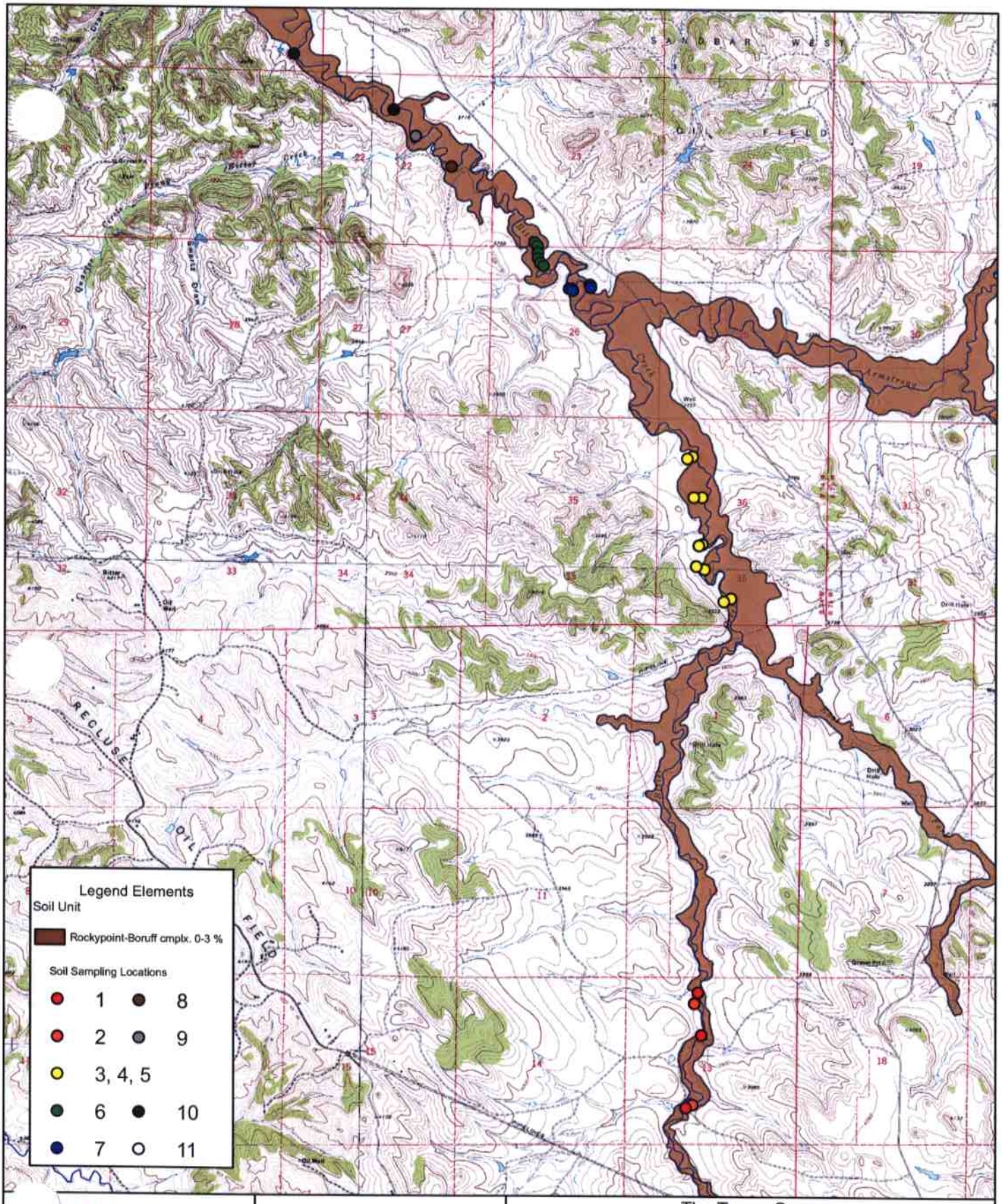
KC HARVEY
Soil & Water Resource Consulting
233 Edelweiss Drive, Suite 11
Bozeman, MT 59718
406-585-7402
www.kcharvey.com

0 2,500 5,000 10,000 Feet

The Termo Company

Figure 5. Watershed of the Bitter Creek drainage above the Oedekoven flood irrigation areas.

Project: Bitter Creek Sec. 20	Date: 1/30/08	Version: Ver. 2



KC HARVEY
Soil & Water Resource Consulting
233 Edelweiss Drive, Suite 11
Bozeman, MT 59718
406-585-7402
www.kcharvey.com

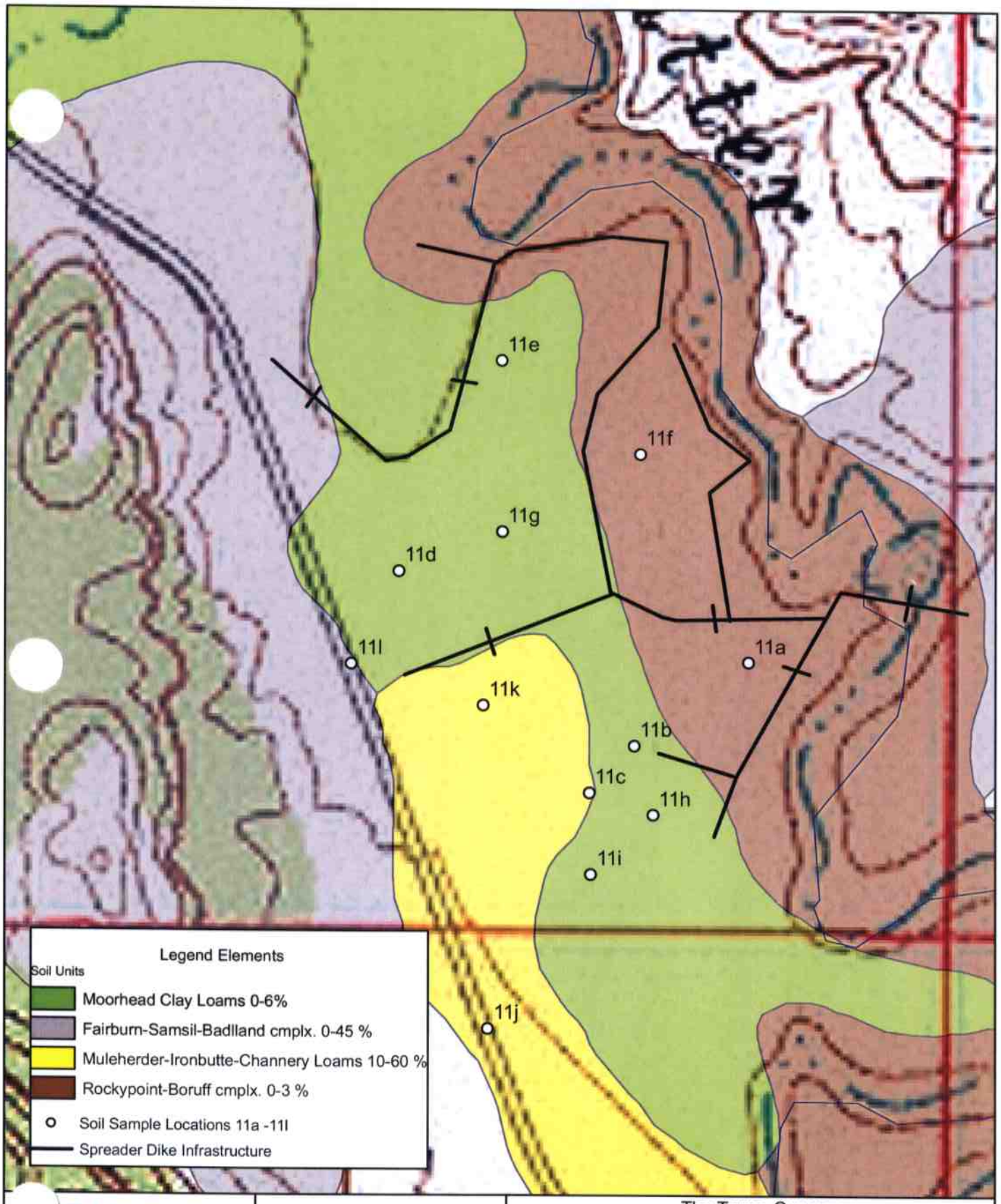
N
W E
S

0 1,050 2,100 4,200 Feet

The Termo Company

Figure 6. NRCS soil mapping units associated with soil sampling locations 1-10.

Project: Bitter Creek Sec. 20	Date: 1/30/08	Revision: Ver. 2



KC HARVEY
Soil & Water Resource Consulting
233 Edelweiss Drive, Suite 11
Bozeman, MT 59718
406-585-7402
www.kcharvey.com

0 80 160 320 Feet

The Termo Company

Figure 7. NRCS soil mapping units associated with the Oedekoven flood irrigation areas.

Project: Bitter Creek Sec. 20	Date: 1/30/08	Revision: Ver. 2

APPENDIX A: OFFICIAL SOIL SERIES DESCRIPTIONS

LOCATION ROCKYPOINT WY

Established Series
CAP/JWW/CJH
06/2002

ROCKYPOINT SERIES

The Rockypoint series consists of very deep, well drained soils formed in recent alluvium derived from mixed sedimentary sources. Rockypoint soils are on flood plains and low terraces. Slopes are 0 to 6 percent. The mean annual precipitation is about 15 inches, and the mean annual air temperature is about 46 degrees F.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, calcareous, mesic Aridic Ustifluvents

TYPICAL PEDON: Rockypoint loam -- on a southwest facing flood plain slope of about 1 percent, utilized as rangeland. (Colors are for dry soil unless otherwise stated)

A--0 to 3 inches; grayish brown (10YR 5/2) loam, brown (10YR 4/3) moist; weak fine platy structure; slightly hard, friable, sticky and slightly plastic; common fine and very fine, few coarse and medium roots; slightly effervescent, calcium carbonate disseminated; slightly alkaline (pH 7.6); clear smooth boundary. (1 to 6 inches thick)

C1--3 to 30 inches; pale brown (10YR 6/3) clay loam, stratified with thin layers of sandy loam, loam, silt loam, and silty clay loam, brown (10YR 5/3) moist; massive; hard, friable, sticky and plastic; common fine and very fine, few coarse and medium roots to about 25 inches, few fine and very fine roots below; slightly effervescent, calcium carbonate disseminated; moderately alkaline (pH 8.0); clear smooth boundary.

C2--30 to 60 inches; pale brown (10YR 6/3) loam, stratified with thin layers of loamy sand, sandy loam, very fine sandy loam, and clay loam, brown (10YR 5/3) moist; massive; hard, friable, slightly sticky and plastic; few fine and very fine roots; slightly effervescent, calcium carbonate disseminated; moderately alkaline (pH 8.2).

TYPE LOCATION: Campbell County, Wyoming; about 1,160 feet west and 2,350 feet south of the northeast corner of section 2, T. 51 N., R. 75 W. 44 degrees 25 minutes 36 seconds north latitude and 105 degrees 50 minutes 13 seconds west longitude.

RANGE IN CHARACTERISTICS: The organic carbon content ranges from 1 to 2 percent in the A horizon and from .5 to 1.5 percent in the C horizon and decreases irregularly with depth. Depth to effervescent horizons is 0 to 10 inches. Exchangeable sodium is typically less than 5 percent but ranges from 0 to 10 percent. The moisture control section is usually moist in some or all parts in March through June. The average annual soil temperature is 47 to 50 degrees F. Rock fragments range from 0 to 10 percent.

The A horizon has hue of 10YR or 2.5Y, value of 4 to 6 dry and 3 to 5 moist, and chroma of 2 to 4. Electrical conductivity ranges from 0 to 4 millimhos per centimeter. It is slightly alkaline or moderately alkaline. Textures are variable. Some pedons have an AC horizon.

The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 dry and 4 to 6 moist, and chroma of 2 to 4. Textures are variable throughout this horizon but average loam or clay loam with 18 to 35 percent clay. It has 1 to 12 percent calcium carbonate equivalent which may vary considerably between strata. Electrical conductivity is commonly 0 to 4 millimhos per centimeter, but may range to 12 millimhos in some pedons. It is slightly alkaline through strongly alkaline.

COMPETING SERIES: These are the Aparejo, Haverson, Hysham and Ramper series. It is assumed the Hickman series is competing pending an update of the classification. Aparejo, Hickman and Ramper soils are usually driest in May and June. Haverson soils are moist in some part in July through September. Hysham soils are very strongly alkaline.

GEOGRAPHIC SETTING: Rockypoint soils are on flood plains and low terraces. They formed in stratified recent alluvium derived from mixed sedimentary sources. Slopes are 0 to 6 percent. Elevations are 3,500 to 5,500 feet. The mean annual precipitation ranges from 15 to 17 inches, half of which falls as rain or snow from March through June. The mean annual air temperature ranges from 44 to 50 degrees F. The frost-free season is about 105 to 130 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Boruff, Deekay, Iwait, Oldwolf, Fairburn and Ucross soils. Boruff soils are poorly and somewhat poorly drained. Deekay and Oldwolf soils have argillic horizons. Iwait soils have a regular decrease in organic matter and have horizons of uniform textures below the A horizon. Fairburn soils are shallow. Ucross soils are moderately deep. The Boruff soils occur in similar positions. The Deekay, Iwait, Oldwolf, Fairburn and Ucross soils occur on uplands.

DRAINAGE AND PERMEABILITY: Well drained; slow runoff; moderate permeability. These soils are subject to rare to frequent flooding for very brief or brief periods during prolonged, high intensity storms in the spring and early summer.

USE AND VEGETATION: These soils are utilized primarily as rangeland and wildlife habitat. The native vegetation is mainly green needlegrass, bearded wheatgrass, slender wheatgrass, western wheatgrass, and cottonwoods.

DISTRIBUTION AND EXTENT: Rockypoint soils occur in the Powder River basin of north-central and northeastern Wyoming. The series is of limited extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Campbell County, Wyoming, Southern Part; 1995.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - 0 to 3 inches (A)

SIR- WY1376

LRR- G

LOCATION BORUFF WY

Established Series
CAP
03/2003

BORUFF SERIES

The Boruff series consists of very deep, poorly and somewhat poorly drained soils formed in alluvium on flood plains and low stream terraces. Slope ranges from 0 to 3 percent. The mean annual precipitation is about 14 inches and the mean annual air temperature is about 48 degrees F.,

TAXONOMIC CLASS: Fine, smectitic, calcareous, mesic Vertic Fluvaquents

TYPICAL PEDON: Boruff silty clay - on a west facing slope of 1 percent in rangeland. (Colors are for dry soil unless otherwise noted)

A--0 to 2 inches; olive brown (2.5Y 4/3) silty clay, dark olive brown (2.5Y 3/3) moist; common fine distinct dark yellowish brown (10YR 4/6) redoximorphic concentrations; moderate fine and medium granular structure; slightly hard, friable, moderately sticky and moderately plastic; many very fine roots throughout and common medium throughout; many fine pores; slightly effervescent; slightly alkaline; EC of 3.5; abrupt smooth boundary. (2 to 10 inches thick)

C1--2 to 6 inches; stratified light yellowish brown (2.5Y 6/3) silty clay, light olive brown (2.5Y 5/3) and olive brown (2.5Y 4/3) moist; common fine distinct gray (N 6/0) redoximorphic depletions and common fine prominent dark yellowish brown (10YR 4/6) redoximorphic concentrations; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, very sticky and very plastic; common very fine roots throughout and common medium throughout; many fine pores; few distinct discontinuous dark brown (10YR 3/3) organic coats in root channels and/or pores; common fine irregular white (10YR 8/1) nests of gypsum throughout; slightly effervescent; moderately alkaline; EC of 5; abrupt wavy boundary.

C2--6 to 46 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist, stratified with thin layers of silty clay loam, clay loam, silt loam and fine sandy loam; many fine distinct gray (N 5/0) redoximorphic depletions and many fine prominent strong brown (7.5YR 4/6) redoximorphic concentrations; massive; hard, friable, slightly sticky and moderately plastic; common very fine roots throughout; many fine pores; few fine rounded white (10YR 8/1) nests of gypsum throughout; slightly effervescent; moderately alkaline; EC of 6; clear wavy boundary.

C3--46 to 60 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist, stratified with thin layers of silty clay loam, clay loam, silt loam and fine sandy loam; many fine and medium distinct gray (N 5/0) redoximorphic depletions, many fine and medium distinct light olive brown (2.5Y 5/6) redoximorphic concentrations, and common fine prominent dark yellowish brown (10YR 4/6) redoximorphic concentrations; massive; hard, friable, moderately sticky and moderately plastic; common very fine roots throughout; many fine pores; few fine rounded white (10YR 8/1) nests of gypsum throughout; slightly effervescent; EC of 5.5; moderately alkaline.

TYPE LOCATION: Campbell County, Wyoming; about 900 feet east and 2300 feet north of the

southwest corner of Sec. 9, T 75 N, R 55 W.; USGS Kline Draw, WY topographic quadrangle; lat. 44 degrees 45 minutes 23 seconds N. and long. 105 degrees 54 minutes 1 seconds W.

RANGE IN CHARACTERISTICS: The organic carbon content ranges from 1 to 3 percent in the A horizon and from 0 to 3 percent in the C horizon and decreases irregularly with depth. Depth to continuous accumulations of carbonates is 0 to 10 inches. The average exchangeable sodium ranges from 0 to 10 percent, but some pedon have subhorizons that are greater than 10 percent. Redoximorphic features are common in the upper 18 inches. The average annual soil temperature is 47 to 50 degrees F.

The A horizon has hue of 5Y, 2.5Y or 10YR, value of 4 to 7 dry and 3 to 5 moist, and chroma of 1 to 3. Texture is clay loam, loam, silt loam, silty clay loam, silty clay or clay. Reaction is neutral to moderately alkaline. The EC is 0 to 4 mmhos/cm and the calcium carbonate equivalent is 0 to 5 percent. Some pedons have an AC horizon.

The C horizon has hue of 5Y, 2.5Y or 10YR, value of 5 to 7 dry and 3 to 5 moist, and chroma of 1 to 4. Texture is silty clay, clay, clay loam or silty clay loam, stratified with very fine sandy loam, fine sandy loam, sandy loam, loam, silt loam or loamy fine sand. In some pedons it has accumulations of carbonates, gypsum or salts. Reaction is slightly alkaline to strongly alkaline. The EC is 2 to 8 mmhos/cm and the calcium carbonate equivalent is 1 to 12 percent.

COMPETING SERIES: These are the Abbott and Apishapa series. The Abbott series have and EC of more than 8 mmhos/cm throughout. In addition, the Abbott soils occur in locations with 11 inches or less of annual precipitation. Apishapa soils average more than 2 percent gypsum in the lower part of the particle-size control section. In addition, Apishapa soils occur in areas that a frost-free season of more than 135 days.

GEOGRAPHIC SETTING: Boruff soils are on flood plains and low stream terraces. They formed in stratified recent alluvium derived from mixed sedimentary sources. Slopes are 0 to 3 percent. Elevations are 3,500 to 5,000 feet. The mean annual precipitation ranges from 10 to 19 inches, half of which falls as rain or snow from March through June. The mean annual air temperature ranges from 44 to 50 degrees F. The frost-free season is about 105 to 130 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Bidman, Clarkelon, Deekay, Draknab, Forkwood, Haverdad, Iwait, Jaywest, Kishona, Moorhead, Rockypoint and Ulm soils. These soils are all on higher lying fans or terraces. They are all better drained than the Boruff soils. In addition, Bidman, Deekay, Forkwood, Jaywest, Moorhead and Ulm soil have argillic horizons; Clarkelon soils are coarse-loamy; Draknab soils are sandy; and Iwait and Kishona soils do not have stratified horizons.

DRAINAGE AND PERMEABILITY: Poorly and somewhat poorly drained; slow runoff; slow permeability. These soils are subject to rare to frequent flooding for very brief or brief periods during prolonged, high intensity storms in the spring and early summer. A seasonal high water table is at a depth of 0.5 to 1.5 feet at some time during the period April through July.

USE AND VEGETATION: These soils are utilized primarily as rangeland and wildlife habitat. The native vegetation is mainly green needlegrass, bearded wheatgrass, slender wheatgrass, western wheatgrass and cottonwoods.
Indian saltgrass, alkali sacaton, sedges and willows.

DISTRIBUTION AND EXTENT: North-eastern Wyoming and possibly south-eastern Montana. These soils are of limited extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota.

SERIES ESTABLISHED: Crook County, Wyoming (Correlation Amendment); 2003.

REMARKS: Diagnostic horizons and features recognized in this pedon are: ochric epipedon - 0 to 2 inches (A horizon); aquic moisture regime - redoximorphic concentrations and chroma of 2 in 40 to 50 cm layer; vertic subgroup criteria - LE of more than 6 in the top meter.

ADDITIONAL DATA: S98WY005-010, type location.

National Cooperative Soil Survey
U.S.A.

LOCATION MOORHEAD WY

Established Series
JWW/CAP/CJH
06/2002

MOORHEAD SERIES

The Moorhead series consists of very deep, well drained soils formed in alluvium derived primarily from shale. Moorhead soils are on fan remnants, alluvial fans, plateaus, terraces, valley fill positions, ridges and hills. Slopes are 0 to 15 percent. The mean annual precipitation is about 15 inches, and the mean annual air temperature is about 46 degrees F.

TAXONOMIC CLASS: Fine, smectitic, mesic Torrertic Haplustalfs

TYPICAL PEDON: Moorhead clay loam -- on an north facing slope of 1 percent, utilized as rangeland. (Colors are for dry soil unless otherwise stated)

A--0 to 4 inches; brown (10YR 5/3) clay loam, brown (10YR 4/3) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable, moderately sticky and moderately plastic; many very fine and fine roots throughout; many fine vescular pores throughout; noneffervescent; neutral (pH 7.3); clear smooth boundary. (1 to 8 inches thick)

Bt--4 to 18 inches; brown (10YR 4/3) clay, dark brown (10YR 3/3) moist; strong medium and coarse prismatic structure parting to moderate fine and medium angular blocky; very hard, firm, very sticky and very plastic; common fine roots and few medium roots throughout; many fine irregular pores throughout; many distinct continuous very dark grayish brown (10YR 3/2) clay films on faces of peds; noneffervescent; slightly alkaline (pH 7.6); clear wavy boundary. (7 to 24 inches thick)

Btk--18 to 24 inches; brown (10YR 5/3) clay, brown (10YR 4/3) moist; strong medium and coarse prismatic structure parting to moderate fine and medium angular blocky; very hard, firm, very sticky and very plastic; common very fine and fine roots throughout; many fine irregular pores throughout; common distinct discontinuous dark brown (10YR 3/3) clay films on faces of peds; common fine irregular light gray (10YR 7/2) carbonate threads throughout; strongly effervescent; moderately alkaline (pH 8.0); gradual wavy boundary. (6 to 13 inches thick)

Bk1--24 to 32 inches; light olive brown (2.5Y 5/3) clay, olive brown (2.5Y 4/3) moist; strong medium and coarse prismatic structure parting to moderate fine and medium angular blocky; hard, firm, very sticky and very plastic; common very fine and fine roots throughout; common fine irregular pores throughout; common fine irregular light gray (10YR 7/2) carbonate threads throughout; violently effervescent; moderately alkaline (pH 8.2); gradual wavy boundary.

Bk2--32 to 60 inches; light yellowish brown (2.5Y 6/3) clay loam, olive brown (2.5Y 4/3) moist; moderate fine and medium angular blocky; hard, friable, moderately sticky and moderately plastic; common fine irregular pores throughout; common fine irregular light gray (10YR 7/2) carbonate threads throughout; strongly effervescent; moderately alkaline (pH 8.4).

TYPE LOCATION: Campbell County, Wyoming; about 2450 feet east and 1450 feet north of the

southwest corner of Sec. 36, T 55 N, R 69 W.; USGS Brislawn School, WY topographic quadrangle; lat. 44 degrees 42 minutes 13 seconds N. and long. 105 degrees 5 minutes 44 seconds W.

RANGE IN CHARACTERISTICS: Depth to the base of the argillic horizon is 21 to 35 inches. Depth to accumulations of calcium carbonate is typically 13 to 20 inches, but ranges to 34 inches in some pedons. It has 0 to 10 percent rock fragments throughout. Electrical conductivity is 0 to 4 millimhos per centimeter. The moisture control section is usually moist in some or all parts in March through June. The average annual soil temperature is 47 to 50 degrees F.

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 dry and 3 to 5 moist, and chroma of 2 or 3. It is clay loam, silty clay loam, loam or silt loam. It is neutral or slightly alkaline. Some pedons have an AB horizon up to 5 inches thick.

The Bt horizon has hue of 7,5YR, 10YR or 2.5Y, value of 5 or 6 dry and 3 to 5 moist, and chroma of 2 to 4. Texture is clay loam, silty clay or clay. It has 35 to 50 percent clay and 10 to 30 percent fine and coarser sand. It is neutral or slightly alkaline.

The Btk horizon has hue of 10YR or 2.5Y, value of 5 to 7 dry and 4 or 5 moist, and chroma of 2 to 4. Texture is clay loam, silty clay or clay with 35 to 50 percent clay. It has 4 to 12 percent calcium carbonate equivalent. It is moderately alkaline or strongly alkaline.

The Bk horizon has hue of 10YR or 2.5Y, value of 5 to 7 dry and 4 or 5 moist, and chroma of 2 to 4. Texture is clay loam, clay, silty clay loam or loam. It has 4 to 15 percent calcium carbonate equivalent. Exchangeable sodium is typically less than 5 percent but ranges from 0 to 10 percent. It is moderately alkaline or strongly alkaline.

COMPETING SERIES: These are the Demar, Horselake, Teeque and Thurlow series. Demar soils are more acid and have a Bz horizon. Horselake soils are moderately deep. Teeque soils are dry during the period of April through June. Thurlow soils do not have a Btk horizon and are cooler.

GEOGRAPHIC SETTING: Moorhead soils are on fan remnants, alluvial fans, plateaus, terraces, valley fill positions, hills and ridges. They formed in alluvium derived primarily from shale. Slopes are 0 to 15 percent. Elevations are 3,500 to 5,000 feet. The mean annual precipitation ranges from 15 to 17 inches, half of which falls as rain or snow from March through June. The mean annual air temperature ranges from 44 to 50 degrees F. The frost-free season is about 105 to 130 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Cromack, Deekay, Echeta, Jaywest, Leiter, Oldwolf and Spottedhorse soils. Deekay and Oldwolf soils are fine-loamy. Echeta and Cromack soils have cambic horizons and are calcareous throughout. Jaywest and Spottedhorse soils have an absolute increase of more than 15 percent clay within a vertical distance of one inch at the upper boundary of the Bt horizon. Lieter soils are moderately deep. Deekay, Echeta, and Jaywest soils are on similar positions. Lieter, Oldwolf, Cromack, and Spottedhorse soils are on shoulders and summits on hills and ridges.

DRAINAGE AND PERMEABILITY: Well drained; medium to very high runoff, depending on slope; slow permeability.

USE AND VEGETATION: These soils are utilized as rangeland, hayland and pasture, irrigated and nonirrigated cropland, and wildlife habitat. The native vegetation is mainly western wheatgrass, green needlegrass, blue grama and big sagebrush. Winter wheat, oats, barley and alfalfa are the principle

cultivated crops.

DISTRIBUTION AND EXTENT: Moorhead soils occur in the Powder River basin of north-central and northeastern Wyoming. The series is of limited extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Campbell County, Wyoming, Southern Part; 1995.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - 0 to 4 inches (A horizon)

Argillic horizon - 4 to 24 inches (Bt, Btk)

SIR- WY1378

LRR- G

National Cooperative Soil Survey
U.S.A.

LOCATION FAIRBURN SD+NE

Established Series
KEC-CJH
04/2002

FAIRBURN SERIES

The Fairburn series consists of shallow, somewhat excessively drained and well drained soils on gently sloping to very steep upland hills and ridges. They formed in residuum weathered from mudstone, very fine-grained sandstone, siltstone or shale. Permeability is moderate or moderately slow. Slopes range from 3 to 60 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 47 degrees F.

TAXONOMIC CLASS: Loamy, mixed, superactive, calcareous, mesic, shallow Aridic Ustorthents

TYPICAL PEDON: Fairburn clay loam - on a convex, southeast-facing slope of 22 percent in range. When described the soil was dry throughout. (Colors are for dry soil unless otherwise stated)

A--0 to 4 inches; brown (10YR 5/3) clay loam, dark grayish brown (10YR 4/2) moist; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; slight effervescence; moderately alkaline; clear smooth boundary. (3 to 5 inches)

AC--4 to 10 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; clear wavy boundary. (0 to 8 inches)

C--10 to 15 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; 10 percent very fine grain sandstone fragments by volume; strong effervescence; strongly alkaline; clear wavy boundary.

Cr--15 to 60 inches; light gray (2.5Y 7/2) weathered very fine-grained sandstone, light brownish gray (2.5Y 6/2) moist; strong effervescence.

TYPE LOCATION: Pennington County, South Dakota; about 7 miles southeast of Scenic; 2300 feet north and 900 feet east of the southwest corner of section 5, T. 4 S., R. 14 E.

RANGE IN CHARACTERISTICS: The control section contains 18 to 35 percent clay. The depth to bedrock ranges from 10 to 20 inches. The depth to carbonates ranges from 0 to 4 inches. The EC ranges from 0 to 2 mmhos/cm throughout.

The A horizon has hue of 10YR or 2.5Y, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It is silty clay loam, clay loam, loam, or silt loam. Reaction is neutral to moderately alkaline. Some pedons have up to 30 percent by volume of rock fragments.

The AC horizon has hue of 10YR, 2.5Y or 5Y, value of 4 to 7 and 3 to 6 moist, and chroma of 2 to 4. It is silty clay loam, clay loam, loam or silt loam. Reaction is slightly alkaline or moderately alkaline.

Some pedons have Bw horizons less than 6 inches thick with properties similar to the AC horizon.

The C horizon has hue of 10YR, 2.5Y or 5Y, value of 4 to 8 and 3 to 7 moist, and chroma of 2 to 4. It is silty clay loam, clay loam, loam or silt loam. Fragments of siltstone or mudstone ranges from 0 to 15 percent by volume. Reaction ranges from slightly alkaline to strongly alkaline.

The Cr horizon has hue of 10YR, 2.5Y, or 5Y. Reaction is moderately alkaline or strongly alkaline. It is very fine-grained sandstone, siltstone, shale or mudstone.

COMPETING SERIES: These are the Dolcan, Menefee, Mittenbutte (T), Sipapu, Spearfish series. Dolcan soils occur at elevations above 6,200 feet and have precipitation that is distributed evenly throughout the year. Menefee soils have Bw horizons more than 6 inches thick. Mittenbutte soils contain less than 18 percent clay in the particle-size control section. Sipapu and Spearfish soils have hues of 7.5YR or redder below the A horizon. In addition, Sipapu soils have more than 15 percent pararock fragments in the particle-size control section.

GEOGRAPHIC SETTING: Fairburn soils are on gently sloping to very steep upland hills and ridges. Slopes generally are convex and range from 3 to 60 percent. The soil formed in residuum weathered from siltstone, very fine-grained sandstone, shale or mudstone. Mean annual air temperature ranges from 43 to 50 degrees F. Mean annual precipitation ranges from 12 to 18 inches, most of which occurs in the spring and early summer. Elevation ranges from 2,600 to 5,800 feet. Frost-free period ranges from 105 to 150 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Blackpipe, Metre, Norrest, Orella and Wortman soils. The Blackpipe, Metre, Norrest and Wortman soils have mudstone or shale at a depth below 20 inches and their particle-size control section contain more than 35 percent clay. In addition, the Blackpipe, Metre and Wortman soils have a mollic epipedon. They are on less sloping parts of the landscape below the Fairburn soils. Orella soils are on similar parts of the landscape as the Fairburn soils. Orella soils have a fine textured control section.

DRAINAGE AND PERMEABILITY: Well drained. Runoff is medium or high depending on slope. Permeability is moderate or moderately slow.

USE AND VEGETATION: Used primarily as rangeland. Native vegetation includes threadleaf sedge, needleleaf sedge, sideoats grama, blue grama, western wheatgrass, green needlegrass, yucca, and pricklypear.

DISTRIBUTION AND EXTENT: Southwestern South Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Pennington County, South Dakota, 1985.

REMARKS: Diagnostic horizons and features recognized in this pedon are: ochric epipedon - the zone from the surface of the soil to a depth of about 4 inches (A horizon).

LOCATION SAMSIL SD+CO NE WY

Established Series
KEC-CJH
06/2002

SAMSIL SERIES

The Samsil series consists of shallow, well drained soils formed in alluvium or residuum weathered from shale. Permeability is slow. Slope ranges from 2 to 60 percent. Mean annual precipitation is about 15 inches, and mean annual air temperature is about 47 degrees F.

TAXONOMIC CLASS: Clayey, smectitic, calcareous, mesic, shallow Aridic Ustorthents

TYPICAL PEDON: Samsil clay - on a convex, southwest-facing slope of 15 percent in native grass. When described the soil was moist to 12 inches, dry from 12 to 21 inches, and moist below 21 inches. (Colors are for dry soil unless otherwise stated)

A--0 to 2 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate fine granular structure; slightly hard, friable, sticky and plastic; common fine roots; few very fine fragments of shale; slight effervescence; slightly alkaline; clear wavy boundary. (2 to 4 inches thick)

AC--2 to 7 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure parting to weak medium granular; hard, friable, sticky and plastic; common fine roots; common fine fragments of soft shale; slight effervescence; slightly alkaline; clear wavy boundary. (0 to 6 inches)

C1--7 to 11 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) crushing to grayish brown (2.5Y 5/2) moist; massive; hard, friable, sticky and plastic; common fine roots; 30 percent by volume of fine and medium fragments of soft shale; few fine distinct olive yellow (2.5Y 6/6) stains on fragments of shale; slight effervescence; slightly alkaline; gradual wavy boundary.

C2--11 to 17 inches; light olive gray (5Y 6/2) clay, olive gray (5Y 5/2) moist; massive; hard, friable, sticky and plastic; common fine roots; about 50 percent by volume of fragments of soft shale; common distinct olive yellow (2.5Y 6/6) stains on faces of shale fragments; few fine and medium accumulations of carbonate; slight effervescence; moderately alkaline; gradual wavy boundary. (Combined C horizons 2 to 12 inches thick)

Cr--17 to 60 inches; light gray (5Y 7/2) shale; olive gray (5Y 5/2) moist; soft when moist but hard and brittle when dry; few fine roots in upper part; few iron and manganese stains in upper part.

TYPE LOCATION: Pennington County, South Dakota; about 3 miles east of Wasta; 1,515 feet east and 1,120 feet south of the northwest corner of sec. 12, T. 1 N., R. 14 E.; 24 feet south of C & GS BM J381 (1962) on west side of Jensen Road.

RANGE IN CHARACTERISTICS: The control section is clay and contains 50 to 65 percent clay. The depth to bedded shale ranges from 6 to 20 inches. Horizons above the shale range from loose to hard when dry, and friable or firm when moist. These horizons contain free carbonates. Effervescence

ranges from slight to strong and reaction is slightly alkaline or moderately alkaline. The C1 and C2 horizons and upper part of the Cr horizons commonly have accumulations of carbonate, gypsum, and other salts. Colors throughout, including mottles and stains, are inherited from the shale.

The A horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 2 to 4. It is clay, silty clay, silty clay loam or clay loam and commonly contains few to common fragments of shale ranging from 2 to 25 mm in diameter. It has fine or medium subangular blocky or fine or very fine granular structure. The upper 1/4 to 1/2 inch commonly is a fragile crust or mulch or very fine granules when dry.

The AC horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It contains up to 35 percent fragments of shales by volume that range from less than 2 mm to 30 mm in diameter.

The C horizon has hue of 5Y, 2.5Y or 10YR, value of 4 to 7 and 3 to 6 moist, and chroma of 1 to 4. It is clay. The C horizon contains from 35 to more than 50 percent fragments of shale by volume that range from less than 2 mm to 35 mm in diameter.

The Cr horizon has the same range in color as the overlying C horizons. It ranges from medium acid to moderately alkaline.

COMPETING SERIES: These are the Epsie and Zigsag soils. Epsie soils have E and Bky horizons. Zigzag soils do not have carbonates, gypsum or salts.

GEOGRAPHIC SETTING: Samsil soils are on gently sloping to very steep hills, ridges and breaks of dissected shale plains. Surfaces mainly are convex, and slope gradients range from 2 to 60 percent or more. The soil formed in alluvium or residuum weathered from shale. Mean annual air temperature ranges from 45 to 48 degrees F, and mean annual precipitation ranges from 14 to 19 inches.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Cromack, Fairburn, Kyle, Nunn, Pierre, Satanta and Swanboy soils. Cromack and Pierre soils have bedrock between depths of 20 and 40 inches. In addition, Cromack soils have cambic horizons. Fairburn soils have a loamy particle-size control section. Kyle soils have bedrock at depths greater than 40 inches. Nunn soils have a fine textured argillic horizon. Satanta soils have a fine-loamy particle-size control section. Swanboy soils have visible salts within 10 inches of the surface. Kyle and Pierre soils are on smoother parts of nearby landscapes. Nunn and Satanta soils are on flats above the Samsil soils. Swanboy soils are on toeslopes and flats below the Samsil soils.

DRAINAGE AND PERMEABILITY: Well drained. Surface runoff ranges from medium to very high depending on slope. Permeability is slow.

USE AND VEGETATION: Rangeland. Native vegetation is mainly little bluestem, western wheatgrass, sideoats grama, blue grama, green needlegrass, sedges, and forbs.

DISTRIBUTION AND EXTENT: Southwestern South Dakota and parts of Nebraska and Wyoming. The soil is extensive.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota

SERIES ESTABLISHED: Stanley County, South Dakota, 1967.

REMARKS: Diagnostic horizons and features recognized in the pedon are: ochric epipedon - the zone from the surface to a depth of 2 inches (A horizon).

National Cooperative Soil Survey
U.S.A.

LOCATION MULEHERDER WY

Established Series
CAP/CJH
06/2002

MULEHERDER SERIES

The Muleherder series consists of very deep, well drained soils formed in alluvium derived from porcelanite. Muleherder soils are on hills, knolls and ridges. Slopes range from 0 to 75 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 47 degrees F.

TAXONOMIC CLASS: Loamy-skeletal over fragmental, mixed, superactive, mesic Aridic Haplustepts

TYPICAL PEDON: Muleherder channery loam - utilized as range land. (Colors are for dry soils unless otherwise stated)

A--0 to 2 inches; reddish brown (5YR 4/3) channery loam, dark reddish brown (5YR 3/3) moist; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; 15 percent angular porcelanite channers; neutral; clear smooth boundary. (2 to 6 inches thick)

Bw1--2 to 12 inches; reddish brown (5YR 4/4) channery loam, dark reddish brown (5YR 3/4) moist; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; 15 percent angular porcelanite channers; neutral; clear smooth boundary.

Bw2--12 to 16 inches; red (2.5YR 5/6) channery loam, red (2.5YR 4/6) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; 20 percent angular porcelanite channers; neutral; clear wavy boundary. (Combined Bw horizons 6 to 20 inches thick)

BCk1--16 to 28 inches; light reddish brown (5YR 6/4) very channery fine sandy loam, reddish brown (5YR 5/4) moist; massive; loose, loose, nonsticky and nonplastic; few distinct discontinuous light gray (10YR 7/2) carbonate coats on rock fragments; strongly effervescent; 40 percent angular porcelanite channers; moderately alkaline; clear wavy boundary.

BCk2--28 to 33 inches; red (2.5YR 5/6) extremely channery fine sandy loam, red (2.5YR 4/6) moist; massive; loose, loose, nonsticky and nonplastic; few distinct discontinuous light gray (10YR 7/2) carbonate coats on rock fragments; strongly effervescent; 65 percent angular porcelanite channers; moderately alkaline; clear wavy boundary. (Combined BCk horizons 0 to 20 inches thick)

2C--33 to 80 inches; fractured porcelanite.

TYPE LOCATION: Campbell County, Wyoming; about 200 feet west and 900 feet south of the northeast corner of Sec. 7, T 57 N, R 73 W.; USGS Corral Creek, WY topographic quadrangle; lat. 44 degrees 56 minutes 36 seconds N. and long. 105 degrees 40 minutes 31 seconds W.

RANGE IN CHARACTERISTICS: Depth to the fragmental substratum ranges from 20 to 40 inches. Depth to carbonates ranges from 0 to 24 inches. The fragmental materials in some pedons are inconsistently calcareous. The weighted average organic carbon content of the surface 15 inches or that

portion of the profile above the fragmental beds ranges from approximately 0.4 to 1.0 percent. Electrical conductivity is typically less than 2 mmhos/cm and exchangeable sodium percentage is normally less than 3 percent. The fragmental material contains interstices ranging from 2 mm. to over 2 cm. in diameter. These are devoid of any fine earth material.

The A horizon has hue of 5YR, 7.5YR or 10YR, value of 4 to 7 dry, 3 to 6 moist, and chroma of 2 to 6. When the value of the A horizon is as dark as 5 dry and 3 moist, the horizon is too thin or contains too little organic matter to be a mollic epipedon. Texture is channery loam, very channery loam, loam, channery fine sandy loam, very channery fine sandy loam or fine sandy loam. Reaction is neutral or slightly alkaline. Rock fragments range from 0 to 40 percent, with 0 to 5 percent flagstones and stones. Some pedons have an AC horizon.

The Bw and BCK horizons have hue of 2.5YR, 5YR, 7.5YR or 10YR, value of 4 to 7 dry, 3 to 6 moist, and chroma of 3 to 6. Texture is channery to extremely channery, loam, sandy clay loam, silt loam, clay loam or fine sandy loam. Reaction is neutral to moderately alkaline. Rock fragments range from 15 to 90 percent, with 0 to 5 percent stones and 0 to 15 percent flagstones. Some pedons have a C horizon above the Cr horizon.

The 2C horizon consists of fractured or collapsed porcelanite beds. Fine earth material is uncommon but when present is less than 5 percent. Colors of the rock are quite variable but commonly have 10R or 2.5YR hue. Hues of 5YR have been recorded in some areas. Flagstones make up from 15 to 45 percent and channers 50 to 85 percent of this horizon.

COMPETING SERIES: There are no competing series in the same family.

GEOGRAPHIC SETTING: The Muleherder series occurs on hills, knolls, and the crests and shoulders of ridges. Slopes range from 0 to 75 percent. The soil formed in moderately deep, medium to moderately fine textured, channery materials weathered principally from beds of porcelanite. The average annual precipitation ranges from 15 to 17 inches with peak periods of precipitation occurring in April, May, and June. The mean annual air temperature ranges from 44 to 50 degrees F., and the mean summer temperature is 65 degrees F. Elevation is 3,500 to 5,800 feet. The frost-free season is 105 to 130 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Deekay, Fairburn, Ironbutte (T), Mittenbutte and Moorhead soils. Deekay and Moorhead soils occur on uplands and footslopes. Fairburn, Ironbutte and Mittenbutte occur on similar positions as Muleherder soils. Deekay, Fairburn, Mittenbutte and Moorhead soils lack fragmental discontinuities. In addition, Deekay and Moorhead soils have argillic horizons. Ironbutte soils are shallow to fractured porcelanite.

DRAINAGE AND PERMEABILITY: Well drained; runoff is negligible to high depending on slope; permeability is moderate over very rapid.

USE AND VEGETATION: They are used as native rangeland. Native vegetation includes sage, prairie junegrass, Sandberg bluegrass and needleandthread.

DISTRIBUTION AND EXTENT: Northeastern Wyoming and possibly southeastern Montana, and western South Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota.

SERIES ESTABLISHED: Campbell County, Southern Part, Wyoming, 2001.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - 0 to 2 inches (A horizon)

Cambic horizon - 2 to 16 inches (Bw1 and Bw2 horizons)

Fragmental discontinuity - 33 inches (top of 2C horizon)

National Cooperative Soil Survey
U.S.A.

LOCATION IRONBUTTE WY

Established Series
CAP
05/2002

IRONBUTTE SERIES

The Ironbutte series consists of very deep, somewhat excessively drained soils formed in material derived from porcelanite. Ironbutte soils are on hills, knolls and ridges. Slopes range from 0 to 75 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 47 degrees F.

TAXONOMIC CLASS: Loamy-skeletal over fragmental, mixed, superactive, nonacid, mesic Aridic Ustorthents

TYPICAL PEDON: Ironbutte channery loam - on a 15 percent southwest facing slope utilized as range land. (Colors are for dry soils unless otherwise stated)

A--0 to 4 inches; light reddish brown (5YR 6/3) channery loam, reddish brown (5YR 4/3) moist; moderate very fine granular structure; soft, very friable; 20 percent channers; slightly alkaline (pH 7.4); clear smooth boundary. (3 to 6 inches thick)

C--4 to 12 inches; light reddish brown (5YR 6/4) very channery loam, reddish brown (5YR 4/4) moist; massive; soft, very friable; 55 percent channers 1/2 to 5 inches in length; slightly alkaline (pH 7.4); clear wavy boundary. (4 to 17 inches thick)

2C--12 to 60 inches; fractured porcelanite. Intricacies between coarse fragments are void of fines.

TYPE LOCATION: Campbell County, Wyoming; about 660 feet north and 250 feet west of the southeast corner of Sec. 19, T 50 N, R 71 W.; USGS Gillette East, WY topographic quadrangle; lat. 44 degrees 17 minutes 33 seconds N. and long. 105 degrees 25 minutes 47 seconds W.

RANGE IN CHARACTERISTICS: Depth to the fragmental material ranges from 7 to 20 inches. These soils are typically noncalcareous throughout the loamy-skeletal part of the control section but some pedons have carbonates within 6 inches. The fragmental materials in some pedons are inconsistently calcareous. The weighted average organic carbon content of the material above the fragmental beds ranges from approximately 0.4 to 1.0 percent. Conductivity is typically less than 2 mmhos/cm and exchangeable sodium percentage is normally less than 3 percent. The mean annual soil temperature ranges from 47 to 53 degrees F. The soil temperature at 20 inches is 41 degrees F. or higher for 175 to 210 days. The fragmental material contains interstices ranging from 2 mm to over 2 cm in diameter. These are devoid of any fine earth material.

The A horizon has hue of 5YR, 7.5YR or 10YR, value of 5 to 7, 3 to 6 moist, and chroma of 2 to 6. When the A horizon has a value of 5 dry and 3 moist, it is too thin or contains too little organic matter to be a mollic epipedon. Texture is channery loam, very channery loam, loam, channery fine sandy loam, very channery fine sandy loam or fine sandy loam. Rock fragments range from 5 to 40 percent, with 0 to 5 percent flagstone. Reaction is neutral or slightly alkaline. Some pedons have an AC horizon.

The C horizon has hue of 2.5YR, 5YR, 7.5YR or 10YR, value of 4 to 7, 3 to 6 moist, and chroma of 2 to 8. Where the horizon has color value of 5 or less dry and 3 moist the organic matter is too low to be mollic. The high chromas in the horizon are related to colors inherent to the parent material and are not related to soil development characteristic of a cambic horizon. Texture is very channery loam, extremely channery loam, very channery fine sandy loam or extremely channery fine sandy loam. Rock fragments range from 35 to 90 percent, with 0 to 15 percent flagstones and 0 to 5 percent stones. Reaction is neutral to slightly alkaline. Moderately alkaline reactions may occur where the horizon is derived from sodic porcelanite.

The 2C horizon consists of fractured and/or collapsed porcelanite beds. A fine-earth matrix is uncommon, but when present is less than 5 percent. Colors of the rock are quite variable but commonly have 10R or 2.5YR hue. Hues of 5YR have been recorded in some areas.

COMPETING SERIES: This is the Muleherder series. Muleherder soils are moderately deep to fragmental, porcelanite beds.

GEOGRAPHIC SETTING: The Ironbutte series occurs on hills, knolls and the crests and shoulders of ridges. Slopes range from 0 to 75 percent. The soil is developing in thin mantels of medium to moderately fine textured, noncalcareous, channery materials weathered principally from porcelanite beds. The average annual precipitation ranges from 15 to 17 inches with peak periods of precipitation occurring in April, May, and June. The mean annual air temperature ranges from 44 to 50 degrees F., and the mean summer temperature is 65 degrees F. Elevation is 3,500 to 5,800 feet. The frost-free season is 105 to 130 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Deekay, Fairburn, Mittenbutte (T), Muleherder (T) and Ucross soils. The Deekay soils have argillic horizons and lack fragmental discontinuities. Fairburn, Mittenbutte and Ucross soils lack fragmental discontinuities. Muleherder soils are moderately deep to fractured porcelanite. Deekay occur on flats and footslopes. Fairburn, Mittenbutte, Muleherder and Ucross soils occur on similar positions as Ironbutte soils.

DRAINAGE AND PERMEABILITY: Somewhat excessively drained; runoff is negligible to high depending on slope; permeability is moderate over very rapid.

USE AND VEGETATION: They are used as native rangeland. Native vegetation includes sage, prairie junegrass, Sandberg bluegrass, and needleandthread. Some pedons have ponderosa pine and juniper.

DISTRIBUTION AND EXTENT: Northeastern Wyoming and possibly adjacent areas of Montana and South Dakota. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Bismarck, North Dakota.

SERIES ESTABLISHED: Campbell County, Southern Part, Wyoming; 2001.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - 0 to 3 inches (A horizon)

Fragmental discontinuity - 16 inches (top of 2C horizon)

National Cooperative Soil Survey
U.S.A.

APPENDIX B: WATER QUALITY MONITORING DATA

Produced Water Quality (Homestead Draw II)

Bitter Creek Water Quality (WQMS TRIB 1)

Bitter Creek Water Quality (Non-WQMS SW_BitterCK)

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: The Termo Co Gillette
Project: Homestead Draw II
Client Sample ID: 3CK-14-5674
Location:
Samp FRQ/Type:
Lab ID: G07090870-001

Report Date: 10/16/07
Collection Date: 09/28/07 12:00
DateReceived: 09/28/07
Matrix: Aqueous
Sampled By: Ralph Combs

Analyses	Result	Units	Result	Units	Qualifier	Method	Analysis Date / By
MAJOR IONS, DISSOLVED							
Bicarbonate as HCO3	1060	mg/L	17.4	meq/L		A2320 B	10/01/07 11:21 / mli
Chloride	26	mg/L	0.73	meq/L		E300.0	10/01/07 19:48 / mjh
Fluoride	0.8	mg/L	0.04	meq/L		E300.0	10/01/07 19:48 / mjh
Sulfate	3	mg/L	0.07	meq/L		E300.0	10/01/07 19:48 / mjh
Calcium	16	mg/L	0.78	meq/L		E200.7	10/02/07 22:20 / eli-b
Magnesium	8	mg/L	0.64	meq/L		E200.7	10/02/07 22:20 / eli-b
Potassium	6	mg/L	0.16	meq/L		E200.7	10/02/07 22:20 / eli-b
Sodium	398	mg/L	17.3	meq/L		E200.7	10/02/07 22:20 / eli-b
METALS, DISSOLVED							
Boron	<100	ug/L				E200.7	10/02/07 22:20 / eli-b
Cadmium	<0.1	ug/L				E200.8	10/11/07 04:28 / eli-b
Chromium	<1	ug/L				E200.8	10/11/07 04:28 / eli-b
Copper	1	ug/L				E200.8	10/11/07 04:28 / eli-b
Iron	265	ug/L				E200.7	10/02/07 22:20 / eli-b
Lead	<2	ug/L				E200.8	10/11/07 04:28 / eli-b
Manganese	32	ug/L				E200.7	10/02/07 22:20 / eli-b
Mercury	<0.06	ug/L				E200.8	10/11/07 04:28 / eli-b
Nickel	<10	ug/L				E200.7	10/02/07 22:20 / eli-b
Silver	<3	ug/L				E200.8	10/11/07 04:28 / eli-b
Zinc	21	ug/L				E200.8	10/11/07 04:28 / eli-b
METALS, TOTAL RECOVERABLE							
Aluminum	<50	ug/L				E200.8	10/11/07 04:36 / eli-b
Antimony	<5	ug/L				E200.8	10/11/07 04:36 / eli-b
Arsenic	<0.5	ug/L				E200.8	10/11/07 04:36 / eli-b
Barium	350	ug/L				E200.8	10/11/07 04:36 / eli-b
Beryllium	<0.03	ug/L				E200.8	10/11/07 04:36 / eli-b
Selenium	<5	ug/L				E200.8	10/11/07 04:36 / eli-b
Thallium	<1	ug/L				E200.8	10/11/07 04:36 / eli-b
NON-METALS							
Alkalinity, Total as CaCO3	872	mg/L				A2320 B	10/01/07 11:21 / mli
Conductivity @ 25 C	1620	umhos/cm				A2510 B	09/28/07 17:14 / mtb
Cyanide, Total	<5	ug/L				Kelada mod	10/03/07 10:13 / eli-b
Hardness as CaCO3	71	mg/L				A2340 B	10/11/07 11:07 / tlc
pH	7.66	s.u.				A4500-H B	09/28/07 17:15 / mtb
Phenolics, Total Recoverable	<10	ug/L				E420.2	10/02/07 11:53 / eli-b
Sodium Adsorption Ratio (SAR)	20.5	unitless				Calculation	10/11/07 11:07 / tlc
Solids, Total Dissolved TDS @ 180 C	995	mg/L				A2540 C	10/01/07 09:08 / mli
Total Petroleum Hydrocarbons	<1.0	mg/L				E1664A	10/05/07 12:51 / wet

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

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: The Termo Co Gillette
Project: Homestead Draw II
Client Sample ID: 3CK-14-5674
Location:
Samp FRQ/Type:
Lab ID: G07090870-001

Report Date: 10/16/07
Collection Date: 09/28/07 12:00
DateReceived: 09/28/07
Matrix: Aqueous
Sampled By: Ralph Combs

Analyses	Result	Units	Result	Units	Qualifier	Method	Analysis Date / By
RADIONUCLIDES - TOTAL							
Radium 226	27	pCi/L				E903.0M	10/08/07 15:56 / eli-c
Radium 226 precision (±)	1.0	pCi/L				E903.0M	10/08/07 15:56 / eli-c
DATA QUALITY							
A/C Balance	-1.31	%				A1030 E	10/11/07 11:06 / tlc
Anions	19.4	meq/L				A1030 E	10/11/07 11:06 / tlc
Cations	18.9	meq/L				A1030 E	10/11/07 11:06 / tlc
BACTERIA							
Bacteria, Sulfate Reducing	1000	col/ml				INDICATOR	09/28/07 14:30 / wet

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.

ENERGY LABORATORIES, INC. * 1105 West First Street. * Gillette, WY 82716
Toll Free 866.686.7175 * 307.686.7175 * Fax 307.682.4625 * gillette@energylab.com

LABORATORY ANALYTICAL REPORT

Client: JM Huber Corporation
Site Name: S_Joe_Creek
Project: WYPDES_WQMS
Client Sample ID: DP_BitterCk_WY0052523_Trib1
Location: SENW_23_58N_75W
Samp FRQ/Type: M
Lab ID: G07050556-001

Report Date: 05/23/07
Collection Date: 05/14/07 11:00
DateReceived: 05/16/07
Sampled By: Todd Adams
Matrix: AQUEOUS
Tracking Number: 102949

Analyses	Result	Units	Result	Units	Qualifier	Method	Analysis Date / By
FIELD PARAMETERS							
Flow	0.851	mgd				FIELD	05/14/07 11:00 / ***
pH, field	8.30	s.u.				FIELD	05/14/07 11:00 / ***
Temperature °C, field	17.2	Deg C				FIELD	05/14/07 11:00 / ***
Temperature °F, field	63.0	Deg F				FIELD	05/14/07 11:00 / ***
*** Performed by Sampler							
MAJOR IONS, DISSOLVED							
Calcium	169	mg/L	8.44	meq/L		E200.7	05/22/07 05:34 / eli-b
Magnesium	177	mg/L	14.5	meq/L		E200.7	05/22/07 05:34 / eli-b
Sodium	420	mg/L	18.3	meq/L		E200.7	05/22/07 05:34 / eli-b
NON-METALS							
Conductivity @ 25 C	3430	umhos/cm				A2510 B	05/16/07 11:53 / mtb
Sodium Adsorption Ratio (SAR)	5.4	unitless				Calculation	05/23/07 08:53 / tlc

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

ENERGY LABORATORIES, INC. * 1105 W First St * Gillette, WY 82716
Toll Free 866.686.7175 * 307.686.7175 * FAX 307.682.4625 * gillette@energylab.com

LABORATORY ANALYTICAL REPORT

Client: Storm Cat Energy USA Corp
Site Name: SW_BitterCk
Project: Surface_Water
Client Sample ID: SW_BitterCk
Location: NESE_22_57N_74W
Samp FRQ/Type: SP
Lab ID: G07050760-001

Report Date: 05/31/07
Collection Date: 05/18/07 10:00
DateReceived: 05/22/07
Sampled By: Manoj Patil
Matrix: Aqueous
Tracking Number: 100391

Analyses	Result	Units	Result	Units	Qualifier	Method	Analysis Date / By
MAJOR IONS, DISSOLVED							
Bicarbonate as HCO3	642	mg/L	10.5	meq/L		A2320 B	05/23/07 18:52 / mli
Chloride	39	mg/L	1.09	meq/L		E300.0	05/29/07 13:05 / mli
Fluoride	0.4	mg/L	0.02	meq/L		E300.0	05/29/07 13:05 / mli
Sulfate	4800	mg/L	99.9	meq/L		E300.0	05/24/07 14:31 / mli
Calcium	263	mg/L	13.1	meq/L		E200.7	05/25/07 23:36 / eli-t
Magnesium	536	mg/L	44.1	meq/L		E200.7	05/25/07 23:36 / eli-t
Potassium	25	mg/L	0.64	meq/L		E200.7	05/25/07 23:36 / eli-t
Sodium	1350	mg/L	58.6	meq/L		E200.7	05/25/07 23:36 / eli-t
NON-METALS							
Alkalinity, Total as CaCO3	526	mg/L				A2320 B	05/23/07 18:52 / mli
Conductivity @ 25 C	8170	umhos/cm				A2510 B	05/22/07 15:38 / jjb
Sodium Adsorption Ratio (SAR)	11.0	unitless				Calculation	05/30/07 12:48 / tlc
DATA QUALITY							
A/C Balance	2.16	%				A1030 E	05/30/07 12:47 / tlc
Anions	112	meq/L				A1030 E	05/30/07 12:47 / tlc
Cations	116	meq/L				A1030 E	05/30/07 12:47 / tlc

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

APPENDIX C: ORIGINAL LABORATORY SOILS REPORTS FROM LATEST SAMPLING (KC HARVEY, INC., DECEMBER, 2007)

ENERGY LABORATORIES, INC. • P.O. Box 3658 • 3161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

LABORATORY ANALYTICAL REPORT

Client: Termo Co
Project: Bitter Creek Sec 20
Workorder: H07120123

Report Date: 01/03/08
Date Received: 12/12/07

		Analysis		pH-SatPst	COND	Percent Sat	SAR	HCO3 SatPst	Ca-SatPst	Mg-SatPst	Na-SatPst	Sand	Silt	Clay
		Units		s_u_	mmhos/cm	%	unitless	meq/L	meq/l	meq/l	meq/l	%	%	%
Sample ID	**Client Sample ID**	**Up**	**Low**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
H07120123-001	Crockett Field 4 & 5 0-12"	0	0	7.4	1.35	65.0	1.8	5.31	4.55	4.30	3.75	10	52	38
H07120123-002	Crockett Field 4 & 5 12-24"	12	24	7.8	6.38	55.8	9.0	3.94	18.6	26.0	42.5	12	56	32
H07120123-003	Crockett Field 4 & 5 24-36"	24	36	8.3	8.92	59.3	16	1.48	15.1	39.0	82.7	18	54	28
H07120123-004	Crockett Field 4 & 5 36-48"	36	48	8.3	8.87	61.0	16	1.67	15.1	34.0	77.0	16	56	28
H07120123-005	Crockett Field 4 & 5 48-60"	48	60	8.1	7.82	54.3	13	1.57	17.7	32.4	65.4	22	52	26
H07120123-006	Crockett Field 4 & 5 60-72"	60	72	8.1	7.51	52.8	13	2.16	18.6	31.4	63.9	26	49	25

ENERGY LABORATORIES, INC. • P.O. Box 3658 • 3161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

LABORATORY ANALYTICAL REPORT

Client: Tenno Co
Project: Bitter Creek Sec 20
Workorder: H07120123

Report Date: 01/03/08
Date Received: 12/12/07

		Analysis		Texture	OM-WB	CEC	Lime	Na-Ext	Exch Na	ESP
		Units		unitless	%	meq/100g	%	meq/100g	meq/100g	%
Sample ID	Client Sample ID	Up	Low	Results	Results	Results	Results	Results	Results	Results
H07120123-001	Crockett Field 4 & 5 0-12"	0	0	SiCL	3.56	29.1	4.4	1.09	0.8	2.9
H07120123-002	Crockett Field 4 & 5 12-24"	12	24	SiCL	1.87	22.1	5.3	5.39	3.0	14
H07120123-003	Crockett Field 4 & 5 24-36"	24	36	SiCL	1.34	27.8	5.4	9.96	5.0	18
H07120123-004	Crockett Field 4 & 5 36-48"	36	48	SiCL	1.40	22.8	5.5	9.59	4.9	21
H07120123-005	Crockett Field 4 & 5 48-60"	48	60	SiL	1.15	22.4	5.2	6.93	3.4	15
H07120123-006	Crockett Field 4 & 5 60-72"	60	72	L	1.09	23.7	5.0	6.28	2.9	12

ENERGY LABORATORIES 877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

LABORATORY ANALYTICAL REPORT

Client: Termo Co
Project: Bitter Creek Sec 20
Workorder: H07120122

Report Date: 01/03/08
Date Received: 12/12/07

		Analysis		pH-SatPst	COND	Percent Sat	SAR	HCO3 SatPst	Ca-SatPst	Mg-SatPst	Na-SatPst	SO4-SatPst	Sand	Silt
		Units		s_u_	mmhos/cm	%	unitless	meq/L	meq/l	meq/l	meq/l	meq/l	%	%
Sample ID	Client Sample ID	Up	Low	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results
H07120122-001	Crockett Field Sub 2 0-12"	0	12	7.9	7.54	65.7	12	3.74	18.9	30.0	57.3	103	6	57
H07120122-002	Crockett Field Sub 2 12-24"	12	24	8.2	11.8	63.0	17	1.97	18.2	40.9	94.6	151	8	60
H07120122-003	Crockett Field Sub 2 24-36"	24	36	8.2	10.7	60.7	16	2.16	18.7	43.1	88.4	147	12	58
H07120122-004	Crockett Field Sub 2 36-48"	36	48	8.0	7.60	63.0	12	1.57	18.5	31.3	58.6	107	12	56
H07120122-005	Crockett Field Sub 2 48-60"	48	60	8.0	8.30	59.5	12	1.77	19.0	30.8	60.9	107	22	49
H07120122-006	Crockett Field Sub 2 60-72"	60	72	8.0	6.11	58.8	10	1.87	15.8	24.5	45.4	82.8	13	53

ENERGY LABORATORIES 877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

LABORATORY ANALYTICAL REPORT

Client: Termo Co
Project: Bitter Creek Sec 20
Workorder: H07120122

Report Date: 01/03/08
Date Received: 12/12/07

		Analysis		Clay	Texture	OM-WB	CEC	Lime	Na-Ext	Exch Na	ESP
		Units		%	unitless	%	meq/100g	%	meq/100g	meq/100g	%
Sample ID	Client Sample ID	Up	Low	Results	Results	Results	Results	Results	Results	Results	Results
H07120122-001	Crockett Field Sub 2 0-12"	0	12	37	SiCL	2.15	30.7	5.7	7.76	4.0	13
H07120122-002	Crockett Field Sub 2 12-24"	12	24	32	SiCL	1.09	25.8	5.7	10.6	4.7	18
H07120122-003	Crockett Field Sub 2 24-36"	24	36	30	SiCL	1.19	26.5	5.3	10.1	4.8	18
H07120122-004	Crockett Field Sub 2 36-48"	36	48	32	SiCL	1.28	25.0	4.5	7.24	3.6	14
H07120122-005	Crockett Field Sub 2 48-60"	48	60	29	CL	1.22	25.2	4.9	6.89	3.3	13
H07120122-006	Crockett Field Sub 2 60-72"	60	72	34	SiCL	0.94	20.8	5.0	6.01	3.3	16

From: Jason Thomas
To: Sobotka, Brent
Date: 9/13/2007 2:26 PM
Subject: Re: Termo Section 20
Attachments: Bitter Creek Soils.xls

CC: Combs, Ralph; DiRienzo, Bill; Knauss, Georgia; Martin, Jamie; Throne...

Brent-

The Bitter Creek soils report arrived today. Looks good. From what I can tell in the photos, and in your description of the irrigation activities, it appears that this round of soil samples is from an area representative of an actual protected agricultural use, as outlined in WDEQ's ag policy. Attached is WDEQ's analysis of the Bitter Creek irrigated soils data. The first table in the spreadsheet is an outlier test (we identified 5 outliers in the submitted data set). The second table calculates effluent limits from the soils data. Since the calculated tier 2 EC limit (747 micromhos/cm) is lower than the default EC limit (1330 micromhos/cm), we would just revert to the default limit in this case (1330 micromhos/cm). This allows some degradation of existing soil conditions, while still protecting the ag use (alfalfa production). If you have any questions, please let us know.

-jason

>>> "Brent Sobotka" <bsobotka@swca.com> 9/13/2007 9:30 AM >>>
Hi Jason,

I wanted to let you know that I sent you the additional information that you requested for Termo's Bitter Creek Section 20. It went out by FedEx yesterday, so it should be in your office today. If you have any questions, don't hesitate to call me. If you have any initial thoughts or concerns, Ralph or I would like to hear them as soon as possible so that we can start planning accordingly.

Thanks much,

Brent Sobotka
SWCA Environmental Consultants
1043 Coffeen Ave, Suite D
Sheridan, WY 82801
Office (307)673-4303
Cell (307)217-2430
Fax (307)673-4303
Home (307) 684-2230

Soil Data: Bitter Creek
Derived From: SWCA; Sept 2007

	Soil Depth (inches)		
Sample Location	Upper	Lower	EC (μmhos/cm)
Odekoven 1	0	12	530
	12	24	470
	24	36	1660
	36	48	1090
	48	60	970
	60	72	1060
Odekoven 2	0	12	460
	12	24	430
	24	36	860
	36	48	1000
	48	60	1330
	60	72	1680
Odekoven 3	0	12	470
	12	24	600
	24	36	3310
	36	48	2120
	48	60	1870
	60	72	2430
Odekoven 4	0	12	470
	12	24	1340
	24	36	3410
	36	48	1470
	48	60	1130
	60	72	850
Odekoven 5	0	12	440
	12	24	430
	24	36	1250
	36	48	1250
	48	60	1290
	60	72	2110
Odekoven 6	0	12	390
	12	24	3000
	24	36	8010
	36	48	7060
	48	60	6090
	60	72	6540
Odekoven 7	0	12	550
	12	24	410
	24	36	1570
	36	48	3810
	48	60	2490
	60	72	1540

Odekoven 8	0	12	560
	12	24	540
	24	36	680
	36	48	1230
	48	60	1430
	60	72	1360
Odekoven 9	0	12	370
	12	24	420
	24	36	1150
	36	48	1650
	48	60	3110
	60	72	5520
Odekoven 10	0	12	480
	12	24	480
	24	36	560
	36	48	1050
	48	60	2450
	60	72	2560
Odekoven 11	0	12	450
	12	24	320
	24	36	530
	36	48	1430
	48	60	2890
	60	72	2540
Odekoven 12	0	12	370
	12	24	2580
	24	36	1680
	36	48	820
	48	60	640
	60	72	650

Outlier Test:	
25th percentile	**538**
75th percentile	**2113**
Inter-Quartile Range	**1575**
1.5 x IQR =	**2363**
Upper Bound	***4475***
Lower Bound	***-1825***
Five Outliers (>4475)	

Soil Data: Bitter Creek
Derived From: SWCA; Sept 2007

	Soil Depth (inches)			
Sample Location	Upper	Lower	EC (μmhos/cm)	Outliers (Removed from data set)
Odekoven 1	0	12	530	
	12	24	470	
	24	36	1660	
	36	48	1090	
	48	60	970	
	60	72	1060	
Odekoven 2	0	12	460	
	12	24	430	
	24	36	860	
	36	48	1000	
	48	60	1330	
	60	72	1680	
Odekoven 3	0	12	470	
	12	24	600	
	24	36	3310	
	36	48	2120	
	48	60	1870	
	60	72	2430	
Odekoven 4	0	12	470	
	12	24	1340	
	24	36	3410	
	36	48	1470	
	48	60	1130	
	60	72	850	
Odekoven 5	0	12	440	
	12	24	430	
	24	36	1250	
	36	48	1250	
	48	60	1290	
	60	72	2110	
Odekoven 6	0	12	390	
	12	24	3000	
	24	36		8010
	36	48		7060
	48	60		6090
	60	72		6540
Odekoven 7	0	12	550	
	12	24	410	
	24	36	1570	
	36	48	3810	
	48	60	2490	
	60	72	1540	

Odekoven 8	0	12	560	
	12	24	540	
	24	36	680	
	36	48	1230	
	48	60	1430	
	60	72	1360	
Odekoven 9	0	12	370	
	12	24	420	
	24	36	1150	
	36	48	1650	
	48	60	3110	
	60	72		5520
Odekoven 10	0	12	480	
	12	24	480	
	24	36	560	
	36	48	1050	
	48	60	2450	
	60	72	2560	
Odekoven 11	0	12	450	
	12	24	320	
	24	36	530	
	36	48	1430	
	48	60	2890	
	60	72	2540	
Odekoven 12	0	12	370	
	12	24	2580	
	24	36	1680	
	36	48	820	
	48	60	640	
	60	72	650	

Observed Average **1291**
AVEDEV **715**

Effluent Limit Calcs

0.05	1 - 0.95
715	AveDev
67	Sample Pop (n)
171	Conf Int

1120 Observed Average minus conf interval

747 Calculated EC Limit: (Adjusted average / 1.5)

2.8 Allowable SAR

From: Jason Thomas
To: adejoia@kcharvey.com
Date: 2/21/2008 5:33 PM
Subject: Bitter Creek Section 20 Study
Attachments: Bitter Creek Soils.xls

CC: Combs, Ralph; Ferguson, Carrie; Zygmunt, Jennifer

Aaron-

Attached is a spreadsheet with our calculation of an EC effluent limit for Bitter Creek. The resulting limit for EC is 2,920 micromhos/cm. We composited and added in the data for the Odekoven flood-irrigated areas (within the surveyed green zone). We also removed the data from areas 8,9,10 for the same reason that areas 1 and 2 are not included. The samplers noted an absence of irrigation or influence from the creek in those areas, in their report. The Odekoven sub-irrigated area (11f) was kept, and also zone 1 of area 3, plus areas 6 & 7.

If you have any questions, please let me know.

Jason Thomas
WDEQ Water Quality Div.
(307) 777-5504

SWCA
ENVIRONMENTAL CONSULTANTS

Sheridan Office
1043 Coffeen Ave. Suite D
Sheridan, WY 82801
Tel 307.673.4303 Fax 307.673.4505
www.swca.com

SUPPLEMENTAL

September 12, 2007

Mr. Jason Thomas
Wyoming Department of Environmental Quality
Water Quality Division
Herschler Building, 4W
122 West 25th Street
Cheyenne, WY 82002

SUPPLEMENTAL

RECEIVED
SEP 13 2007

RE: The Termo Company's Homestead Draw II Project, WYPDES Permit WY0055158, Section 20 Analysis

Dear Mr. Thomas:

On June 28, 2007 The Termo Company (Termo) submitted to the Wyoming Department of Environmental Quality (WDEQ) a request for a review of the Agricultural Use Protection Policy (Chapter 1, Section 20) for Bitter Creek in Northern Campbell County, Wyoming in respect to Termo's WYPDES permit WY0055158. WDEQ felt that the data submitted with that request was insufficient to ascertain the historic irrigation water quality in Bitter Creek, and asked that Termo collect additional data. On August 10, 2007 Termo submitted additional data to WDEQ in hopes that this would sufficiently meet WDEQ's needs. After reviewing this additional data, WDEQ again felt that they needed more data. More specifically, WDEQ wanted soils data from alfalfa fields in Section 8, Township 57 North, Range 74 West. This letter and its attachments are being submitted to WDEQ in hopes that they supply all of the information that WDEQ requires to complete the Section 20 Analysis. This package of information is intended to be treated as an addendum to the information provided in the June 28th and August 10th submittals.

On August 30, 2007, Brent Sobotka and Jamie Martin of SWCA Environmental Consultants conducted a third set of soil sample collections along Bitter Creek in Campbell County, Wyoming. This sampling effort focused around a series of alfalfa fields, owned by Fred Odekoven in Section 8, Township 57 North, Range 74 West.

The Odekovens have constructed a system of dikes that were designed to flood portions of the fields when there is water available in Bitter Creek. As part of these facilities, a dike has been built across Bitter Creek in the SE¼ SE¼ of Section 8. When high flows are occurring in Bitter Creek, a headgate in the dike can be closed so that water backs up in the channel to a point where water will flow onto the fields about 800 feet southwest of the headgate. Numerous other dikes with headgates have been constructed around the fields that allow the Odekovens to direct flood water into various portions of the fields.

The alfalfa fields are not level. They tend to slope upwards to the west and south, and there are areas of uneven elevation throughout the field. Because of these characteristics, there are significant portions of the field that cannot be exposed to irrigation water using the existing facilities. While on site, we met with Bruce Amende, who works for Mr. Odekoven on these lands. Mr. Amende showed us approximately where water flows when the irrigation system is in operation. Using this information and the general topography of the site, a rough boundary was delineated around the possible irrigation area and is provided on the attached map. It should be noted that there are significant portions of the field within the boundary that cannot receive flood

irrigation water because of the uneven topography. The overall area within the boundary is about 28 acres, while the fields themselves total about 55 acres. Mr. Amende also conveyed that he only remembers the irrigation system functioning twice since 1980, he also stated that he thinks that these fields are the only ones in the area that are irrigated from Bitter Creek.

WDEQ requested a minimum of 12 sample locations throughout the fields, and since alfalfa is present at the site, samples were collected on 1-foot increments to a depth of 6-feet. Additionally, at the request of WDEQ, samples from like depths were not composited as has been done in previous sampling efforts. Due to the patchwork pattern of areas that could receive irrigation water, efforts were made to collect samples in low areas that could collect water.

In order to ensure all potential irrigated sites were accounted for along Bitter Creek, the area around the creek was inspected all the way to the Montana state line. No additional irrigated fields were observed.

A total of 72 samples were delivered to Intermountain Laboratories in Sheridan, Wyoming for analysis. The completed analyses are attached to this letter along with a table that compiles the data from all of the soil sampling efforts. Additionally, photographs of the sampling sites and surrounding area are included, as well as maps that show the sampling locations.

SWCA, on behalf of Termo, respectfully requests that WDEQ review these data in combination with the previously submitted data to determine to what extent irrigation protection is needed, and assess the historic water quality of Bitter Creek based on the soils data, and then reassign discharge water quality standards for WYPDES permit WY0055158 accordingly.

If you have any questions, or need additional information, please feel free to contact Brent Sobotka at (307) 673-4303, or e-mail bsobotka@swca.com.

Respectfully,

Brent Sobotka

Brent Sobotka
Hydrologist

Attachments

cc: The Termo Company

Attachments to Termo's Section 20 Review Request

Part 3

Soil Analyses

Sampling Site Photographs and Notes

Sampling Site Maps

Soil Chemistry Table

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report

SWCA Environmental Consultants

1043 Coffeen Avenue
Suite D
Sheridan, WY 82801

Report ID: S0708630001

Project: Termo Section 20
Date Received: 8/31/2007

Date: 9/12/2007
Work Order: S0708630

Lab ID	Sample ID	Depths Inches	pH s.u.	Saturation %	Electrical Conductivity dS/m	Organic Matter %	Calcium meq/L	Magnesium meq/L	Sodium meq/L	SAR
S0708630-001	Odek 1	0-12	7.5	39.1	0.53	3.2	2.38	1.94	0.16	0.11
S0708630-002	Odek 1	13-24	7.9	40.4	0.47		1.40	1.09	2.18	1.96
S0708630-003	Odek 1	25-36	7.9	40.1	1.66		6.21	4.67	6.93	2.97
S0708630-004	Odek 1	37-48	7.9	29.9	1.09		4.15	2.84	3.91	2.09
S0708630-005	Odek 1	49-60	7.8	28.8	0.97		3.77	2.47	3.21	1.82
S0708630-006	Odek 1	60-72	7.9	28.4	1.06		4.03	3.11	3.60	1.90
S0708630-007	Odek 2	0-12	7.1	46.6	0.46	3.9	2.15	1.48	0.77	0.57
S0708630-008	Odek 2	13-24	7.7	50.3	0.43		1.56	0.88	1.73	1.56
S0708630-009	Odek 2	25-36	7.7	44.3	0.86		3.36	2.68	2.57	1.48
S0708630-010	Odek 2	37-48	8.0	54.2	1.00		3.47	4.39	2.66	1.34
S0708630-011	Odek 2	49-60	7.9	44.9	1.33		4.78	6.20	3.41	1.45
S0708630-012	Odek 2	60-72	7.9	43.1	1.68		7.18	9.04	4.31	1.51
S0708630-013	Odek 3	0-12	7.6	55.2	0.47	2.4	2.40	1.63	0.38	0.26
S0708630-014	Odek 3	13-24	7.9	61.1	0.60		1.70	1.83	2.19	1.65
S0708630-015	Odek 3	25-36	7.6	62.4	3.31		20.6	14.8	7.45	1.77
S0708630-016	Odek 3	37-48	7.6	59.9	2.12		7.27	5.40	10.2	4.06
S0708630-017	Odek 3	49-60	7.6	62.0	1.87		4.41	3.30	11.2	5.72
S0708630-018	Odek 3	60-72	7.7	62.2	2.43		5.55	4.96	14.9	6.50
S0708630-019	Odek 4	0-12	7.8	46.1	0.47	3.5	2.09	1.85	0.54	0.39
S0708630-020	Odek 4	13-24	7.7	44.1	1.34		4.35	3.73	5.78	2.87

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
en Secor, Soil Lab Supervisor

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report

SWCA Environmental Consultants

1043 Coffeen Avenue
Suite D
Sheridan, WY 82801

Report ID: S0708630001

Project: Termo Section 20
Date Received: 8/31/2007

Date: 9/12/2007
Work Order: S0708630

Lab ID	Sample ID	Depths	pH	Saturation	Electrical Conductivity	Organic Matter	Calcium	Magnesium	Sodium	SAR
		Inches	s.u.	%	dS/m	%	meq/L	meq/L	meq/L	
S0708630-021	Odek 4	25-36	7.7	42.0	3.41		18.1	13.3	11.8	2.98
S0708630-022	Odek 4	37-48	7.7	35.7	1.47		7.37	4.89	3.49	1.41
S0708630-023	Odek 4	49-60	7.8	34.4	1.13		5.09	3.43	2.87	1.39
S0708630-024	Odek 4	60-72	7.8	29.0	0.85		3.43	2.34	2.25	1.33
S0708630-025	Odek 5	0-12	7.7	42.8	0.44	3.1	2.06	1.25	0.16	0.12
S0708630-026	Odek 5	13-24	8.0	38.3	0.43		1.56	1.19	1.58	1.35
S0708630-027	Odek 5	25-36	8.0	35.2	1.25		4.12	4.60	4.24	2.03
S0708630-028	Odek 5	37-48	7.9	43.7	1.25		4.35	4.77	3.71	1.74
S0708630-029	Odek 5	49-60	7.9	40.4	1.29		4.51	5.22	3.48	1.58
S0708630-030	Odek 5	60-72	7.8	43.4	2.11		8.92	9.57	5.33	1.75
S0708630-031	Odek 6	0-12	7.5	49.0	0.39	3.9	2.26	1.32	0.16	0.12
S0708630-032	Odek 6	13-24	7.9	48.5	3.00		14.5	13.7	10.4	2.78
S0708630-033	Odek 6	25-36	8.3	43.2	8.01		17.9	47.3	47.2	8.27
S0708630-034	Odek 6	37-48	8.1	32.6	7.06		15.7	28.0	47.0	10.1
S0708630-035	Odek 6	49-60	8.1	29.6	6.09		18.2	29.3	34.6	7.10
S0708630-036	Odek 6	60-72	8.1	31.2	6.54		16.6	30.0	40.1	8.31
S0708630-037	Odek 7	0-12	7.6	36.9	0.55	2.9	3.37	2.04	0.94	0.57
S0708630-038	Odek 7	13-24	8.0	37.8	0.41		1.67	1.03	1.60	1.37
S0708630-039	Odek 7	25-36	8.0	43.5	1.57		5.62	6.25	6.12	2.51
S0708630-040	Odek 7	37-48	7.9	44.2	3.81		19.7	24.0	10.7	2.29

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor

en Secor, Soil Lab Supervisor

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report

SWCA Environmental Consultants

1043 Coffeen Avenue
Suite D
Sheridan, WY 82801

Report ID: S0708630001

Project: Termo Section 20
Date Received: 8/31/2007

Date: 9/12/2007
Work Order: S0708630

Lab ID	Sample ID	Depths	pH	Saturation	Electrical Conductivity	Organic Matter	Calcium	Magnesium	Sodium	SAR
		Inches	s.u.	%	dS/m	%	meq/L	meq/L	meq/L	
S0708630-041	Odek 7	49-60	7.9	33.2	2.49		10.7	12.6	7.99	2.34
S0708630-042	Odek 7	60-72	8.0	29.3	1.54		5.47	6.72	5.50	2.23
S0708630-043	Odek 8	0-12	7.1	46.5	0.56	5.1	2.55	2.48	0.53	0.33
S0708630-044	Odek 8	13-24	7.9	42.3	0.54		1.60	1.40	2.54	2.07
S0708630-045	Odek 8	25-36	8.0	37.7	0.68		2.06	1.35	3.60	2.75
S0708630-046	Odek 8	37-48	8.0	36.8	1.23		4.54	4.39	4.44	2.10
S0708630-047	Odek 8	49-60	8.0	39.9	1.43		4.06	6.84	4.77	2.04
S0708630-048	Odek 8	60-72	8.1	38.3	1.36		3.73	6.58	4.39	1.94
S0708630-049	Odek 9	0-12	6.3	46.1	0.37	4.7	1.71	1.40	0.40	0.32
S0708630-050	Odek 9	13-24	7.8	41.3	0.42		1.70	1.04	1.39	1.19
S0708630-051	Odek 9	25-36	8.0	44.6	1.15		4.52	5.01	3.33	1.52
S0708630-052	Odek 9	37-48	8.0	43.7	1.65		4.40	8.78	5.03	1.96
S0708630-053	Odek 9	49-60	8.1	43.6	3.11		5.32	19.2	13.5	3.86
S0708630-054	Odek 9	60-72	8.1	56.4	5.52		7.05	40.4	27.9	5.73
S0708630-055	Odek 10	0-12	7.3	46.0	0.48	4.0	2.32	1.76	0.55	0.38
S0708630-056	Odek 10	13-24	7.9	42.1	0.48		1.86	1.76	0.97	0.72
S0708630-057	Odek 10	25-36	8.1	54.3	0.56		1.74	2.41	1.40	0.97
S0708630-058	Odek 10	37-48	8.0	56.7	1.05		3.95	5.20	2.07	0.97
S0708630-059	Odek 10	49-60	7.6	49.2	2.45		23.3	10.5	2.41	0.59
S0708630-060	Odek 10	60-72	7.6	46.0	2.56		21.4	9.57	2.13	0.54

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor

Karen Secor, Soil Lab Supervisor

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report

SWCA Environmental Consultants

1043 Coffeen Avenue
Suite D
Sheridan, WY 82801

Report ID: S0708630001

Project: Termo Section 20
Date Received: 8/31/2007

Date: 9/12/2007
Work Order: S0708630

Lab ID	Sample ID	Depths Inches	pH s.u.	Saturation %	Electrical Conductivity dS/m	Organic Matter %	Calcium meq/L	Magnesium meq/L	Sodium meq/L	SAR
S0708630-061	Odek 11	0-12	7.9	40.5	0.45	2.6	2.25	1.38	0.27	0.20
S0708630-062	Odek 11	13-24	8.0	40.0	0.32		1.41	0.83	0.88	0.83
S0708630-063	Odek 11	25-36	8.3	45.4	0.53		1.50	1.69	1.75	1.39
S0708630-064	Odek 11	37-48	8.0	44.2	1.43		4.55	9.09	2.18	0.84
S0708630-065	Odek 11	49-60	7.8	42.4	2.89		21.4	15.4	2.38	0.55
S0708630-066	Odek 11	60-72	7.8	33.6	2.54		20.8	10.9	1.82	0.46
S0708630-067	Odek 12	0-12	7.3	48.6	0.37	5.4	1.80	1.17	0.40	0.33
S0708630-068	Odek 12	13-24	7.7	48.0	2.58		18.6	10.1	4.16	1.10
S0708630-069	Odek 12	25-36	7.8	31.1	1.68		8.69	5.72	4.12	1.54
S0708630-070	Odek 12	37-48	7.9	31.4	0.82		3.32	2.31	2.26	1.35
S0708630-071	Odek 12	49-60	7.9	30.4	0.64		2.32	1.60	1.97	1.41
S0708630-072	Odek 12	60-72	7.9	33.7	0.65		2.50	1.60	2.15	1.50

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor

ren Secor, Soil Lab Supervisor

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report

SWCA Environmental Consultants

1043 Coffeen Avenue
Suite D
Sheridan, WY 82801

Report ID: S0708630001

Project: Termo Section 20
Date Received: 8/31/2007

Date: 9/12/2007
Work Order: S0708630

Lab ID	Sample ID	Depths Inches	CEC meq/100g	Available Sodium meq/100g	Exchangeable Sodium meq/100g	ESP %	Sand %	Silt %	Clay %	Texture
S0708630-001	Odek 1	0-12	18.0	0.18	0.17	0.96	58.0	25.0	17.0	Sandy Loam
S0708630-002	Odek 1	13-24	20.5	0.61	0.52	2.56	30.0	45.0	25.0	Loam
S0708630-003	Odek 1	25-36	20.6	0.88	0.61	2.93	32.0	44.0	24.0	Loam
S0708630-004	Odek 1	37-48	12.6	0.38	0.26	2.05	65.0	20.0	15.0	Sandy Loam
S0708630-005	Odek 1	49-60	11.3	0.37	0.28	2.45	69.0	18.0	13.0	Sandy Loam
S0708630-006	Odek 1	60-72	8.71	0.33	0.23	2.62	85.0	5.0	10.0	Loamy Sand
S0708630-007	Odek 2	0-12	28.8	0.06	0.02	0.07	19.0	49.0	32.0	Silty Clay Loam
S0708630-008	Odek 2	13-24	27.9	0.62	0.54	1.92	7.0	57.0	36.0	Silty Clay Loam
S0708630-009	Odek 2	25-36	23.8	0.46	0.35	1.47	19.0	49.0	32.0	Silty Clay Loam
S0708630-010	Odek 2	37-48	28.9	0.60	0.46	1.59	5.0	49.0	46.0	Silty Clay
S0708630-011	Odek 2	49-60	19.8	0.51	0.36	1.81	15.0	51.0	34.0	Silty Clay Loam
S0708630-012	Odek 2	60-72	19.0	0.51	0.33	1.72	25.0	46.0	29.0	Clay Loam
S0708630-013	Odek 3	0-12	37.2	0.10	0.07	0.20	5.0	39.0	56.0	Silty Clay
S0708630-014	Odek 3	13-24	32.1	0.65	0.52	1.62	1.0	40.0	59.0	Clay
S0708630-015	Odek 3	25-36	32.7	1.01	0.55	1.67	<0.1	42.0	58.0	Clay
S0708630-016	Odek 3	37-48	34.5	1.82	1.21	3.49	6.0	43.0	51.0	Silty Clay
S0708630-017	Odek 3	49-60	33.9	2.48	1.78	5.26	1.0	47.0	52.0	Silty Clay
S0708630-018	Odek 3	60-72	33.8	3.09	2.16	6.39	1.0	49.0	50.0	Silty Clay
S0708630-019	Odek 4	0-12	24.0	0.06	0.03	0.14	22.0	47.0	31.0	Clay Loam
S0708630-020	Odek 4	13-24	24.5	1.05	0.80	3.25	25.0	43.0	32.0	Clay Loam

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor

en Secor, Soil Lab Supervisor

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report

SWCA Environmental Consultants

1043 Coffeen Avenue
Suite D
Sheridan, WY 82801

Report ID: S0708630001

Project: Termo Section 20
Date Received: 8/31/2007

Date: 9/12/2007
Work Order: S0708630

Lab ID	Sample ID	Depths Inches	CEC meq/100g	Available Sodium meq/100g	Exchangeable Sodium meq/100g	ESP %	Sand %	Silt %	Clay %	Texture
S0708630-021	Odek 4	25-36	19.7	1.11	0.62	3.13	35.0	39.0	26.0	Loam
S0708630-022	Odek 4	37-48	14.6	0.34	0.22	1.49	59.0	22.0	19.0	Sandy Loam
S0708630-023	Odek 4	49-60	15.0	0.30	0.20	1.36	53.0	29.0	18.0	Sandy Loam
S0708630-024	Odek 4	60-72	11.3	0.21	0.15	1.30	71.0	16.0	13.0	Sandy Loam
S0708630-025	Odek 5	0-12	19.6	0.04	0.03	0.15	33.0	45.0	22.0	Loam
S0708630-026	Odek 5	13-24	19.2	0.30	0.24	1.27	35.0	41.0	24.0	Loam
S0708630-027	Odek 5	25-36	13.1	0.46	0.31	2.34	53.0	28.0	19.0	Sandy Loam
S0708630-028	Odek 5	37-48	17.5	0.65	0.49	2.80	<0.1	53.0	47.0	Silty Clay
S0708630-029	Odek 5	49-60	16.5	0.46	0.32	1.96	27.0	45.0	28.0	Clay Loam
S0708630-030	Odek 5	60-72	18.7	0.59	0.36	1.91	11.0	53.0	36.0	Silty Clay Loam
S0708630-031	Odek 6	0-12	32.2	0.05	0.04	0.12	11.0	54.0	35.0	Silty Clay Loam
S0708630-032	Odek 6	13-24	25.5	1.25	0.74	2.92	13.0	52.0	35.0	Silty Clay Loam
S0708630-033	Odek 6	25-36	19.2	3.62	1.58	8.27	31.0	43.0	26.0	Loam
S0708630-034	Odek 6	37-48	17.5	3.80	2.27	13.0	82.0	6.0	12.0	Loamy Sand
S0708630-035	Odek 6	49-60	15.2	1.98	0.96	6.30	67.0	17.0	16.0	Sandy Loam
S0708630-036	Odek 6	60-72	20.2	2.89	1.64	8.10	68.0	17.0	15.0	Sandy Loam
S0708630-037	Odek 7	0-12	18.8	0.11	0.07	0.37	43.0	36.0	21.0	Loam
S0708630-038	Odek 7	13-24	15.4	0.46	0.40	2.56	39.0	40.0	21.0	Loam
S0708630-039	Odek 7	25-36	25.0	1.09	0.82	3.29	18.0	53.0	29.0	Silty Clay Loam
S0708630-040	Odek 7	37-48	22.9	1.09	0.61	2.68	18.0	52.0	30.0	Silty Clay Loam

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
ren Secor, Soil Lab Supervisor

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report

SWCA Environmental Consultants

1043 Coffeen Avenue
Suite D
Sheridan, WY 82801

Report ID: S0708630001

Project: Termo Section 20
Date Received: 8/31/2007

Date: 9/12/2007
Work Order: S0708630

Lab ID	Sample ID	Depths Inches	CEC meq/100g	Available Sodium meq/100g	Exchangeable Sodium meq/100g	ESP %	Sand %	Silt %	Clay %	Texture
S0708630-041	Odek 7	49-60	12.9	0.55	0.28	2.20	48.0	34.0	18.0	Loam
S0708630-042	Odek 7	60-72	9.63	0.46	0.30	3.09	60.0	27.0	13.0	Sandy Loam
S0708630-043	Odek 8	0-12	26.8	0.04	0.02	0.07	29.0	45.0	26.0	Loam
S0708630-044	Odek 8	13-24	23.7	0.54	0.43	1.81	20.0	50.0	30.0	Clay Loam
S0708630-045	Odek 8	25-36	17.7	0.60	0.46	2.60	44.0	32.0	24.0	Loam
S0708630-046	Odek 8	37-48	14.9	0.50	0.34	2.25	41.0	34.0	25.0	Loam
S0708630-047	Odek 8	49-60	17.5	0.59	0.40	2.30	27.0	48.0	25.0	Loam
S0708630-048	Odek 8	60-72	16.5	0.53	0.36	2.18	<0.1	40.0	60.0	Clay
S0708630-049	Odek 9	0-12	29.5	0.06	0.04	0.13	11.0	52.0	37.0	Silty Clay Loam
S0708630-050	Odek 9	13-24	32.1	0.44	0.39	1.20	27.0	37.0	36.0	Clay Loam
S0708630-051	Odek 9	25-36	23.0	0.49	0.34	1.49	14.0	55.0	31.0	Silty Clay Loam
S0708630-052	Odek 9	37-48	22.0	0.68	0.46	2.09	17.0	51.0	32.0	Silty Clay Loam
S0708630-053	Odek 9	49-60	21.2	1.58	0.99	4.66	17.0	53.0	30.0	Silty Clay Loam
S0708630-054	Odek 9	60-72	25.1	3.27	1.70	6.78	3.0	57.0	40.0	Silty Clay
S0708630-055	Odek 10	0-12	27.7	0.10	0.07	0.25	25.0	39.0	36.0	Clay Loam
S0708630-056	Odek 10	13-24	26.5	0.16	0.12	0.46	27.0	37.0	36.0	Clay Loam
S0708630-057	Odek 10	25-36	35.8	0.35	0.27	0.76	11.0	37.0	52.0	Clay
S0708630-058	Odek 10	37-48	23.9	0.33	0.21	0.87	13.0	38.0	49.0	Clay
S0708630-059	Odek 10	49-60	24.7	0.33	0.22	0.87	23.0	33.0	44.0	Clay
S0708630-060	Odek 10	60-72	23.7	0.37	0.27	1.13	26.0	32.0	42.0	Clay

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
ren Secor, Soil Lab Supervisor

Inter-Mountain Laboratories, Inc.
1673 Terra Avenue, Sheridan, Wyoming 82801
(307) 672-8945

Soil Analysis Report

SWCA Environmental Consultants

1043 Coffeen Avenue
Suite D
Sheridan, WY 82801

Report ID: S0708630001

Project: Termo Section 20
Date Received: 8/31/2007

Date: 9/12/2007
Work Order: S0708630

Lab ID	Sample ID	Depths Inches	CEC meq/100g	Available Sodium meq/100g	Exchangeable Sodium meq/100g	ESP %	Sand %	Silt %	Clay %	Texture
S0708630-061	Odek 11	0-12	20.5	0.04	0.03	0.13	28.0	44.0	28.0	Clay Loam
S0708630-062	Odek 11	13-24	27.0	0.23	0.19	0.72	21.0	52.0	27.0	Clay Loam
S0708630-063	Odek 11	25-36	22.4	0.48	0.40	1.79	11.0	56.0	33.0	Silty Clay Loam
S0708630-064	Odek 11	37-48	20.0	0.35	0.25	1.26	15.0	57.0	28.0	Silty Clay Loam
S0708630-065	Odek 11	49-60	16.5	0.27	0.17	1.01	28.0	46.0	26.0	Loam
S0708630-066	Odek 11	60-72	9.65	0.17	0.11	1.09	61.0	23.0	16.0	Sandy Loam
S0708630-067	Odek 12	0-12	35.7	0.12	0.10	0.29	11.0	45.0	44.0	Silty Clay
S0708630-068	Odek 12	13-24	27.6	0.57	0.37	1.34	19.0	42.0	39.0	Silty Clay Loam
S0708630-069	Odek 12	25-36	13.7	0.37	0.24	1.77	64.0	19.0	17.0	Sandy Loam
S0708630-070	Odek 12	37-48	15.1	0.30	0.23	1.49	63.0	19.0	18.0	Sandy Loam
S0708630-071	Odek 12	49-60	13.8	0.30	0.24	1.71	61.0	22.0	17.0	Sandy Loam
S0708630-072	Odek 12	60-72	17.0	0.33	0.25	1.48	51.0	28.0	21.0	Loam

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor

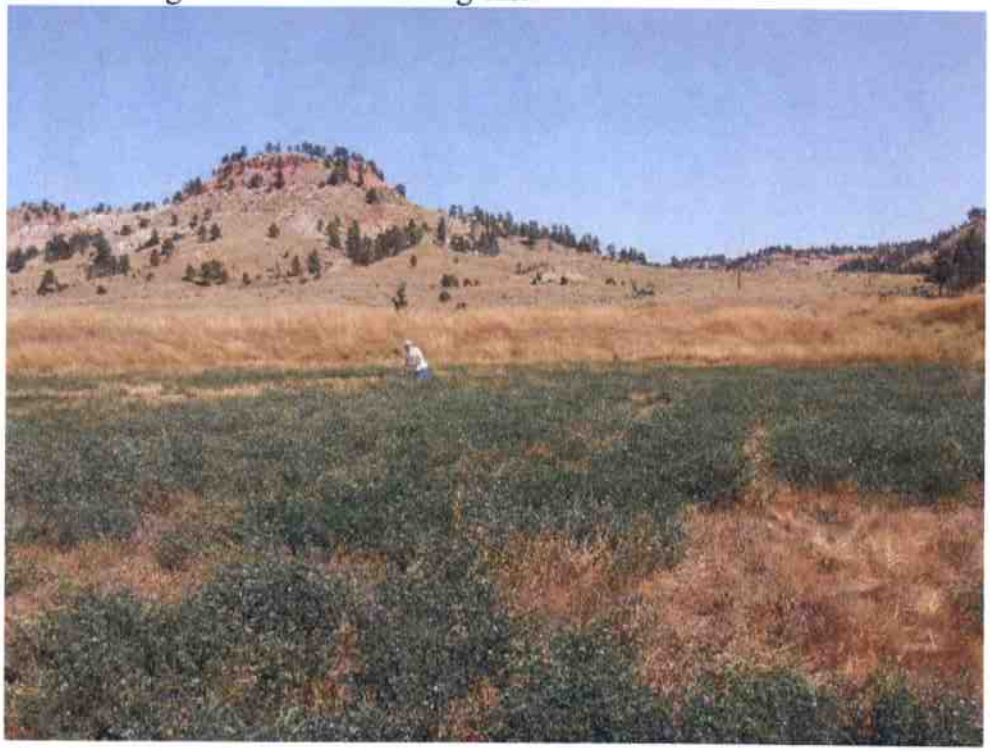
en Secor, Soil Lab Supervisor

Beaver Creek Section 20, Part III: Photographic Document of Study Area in Section 8, Township 57 North, Range 64 West

Sampling Site Photographs and Notes

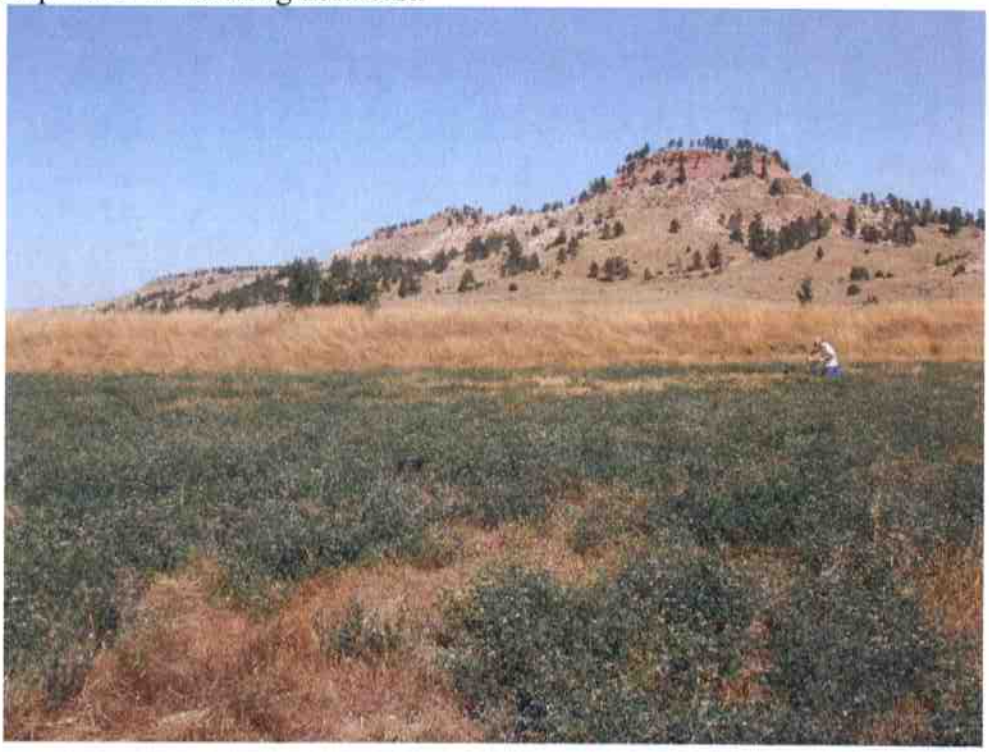
Headgate in spreader dike northwest of Soil Sample Site 1. Looking northwest.

Soil Sample Site 1. Spreader dike in background. Spreader dikes are present on three sides of field. Alfalfa present. Scoria seen in soil column at 61-72 inches. Indiscernible soil moisture throughout column. Looking east.



Beaver Creek Section 20, Part III: Photographic Document of Study Area in Section 8, Township 57 North, Range 64 West

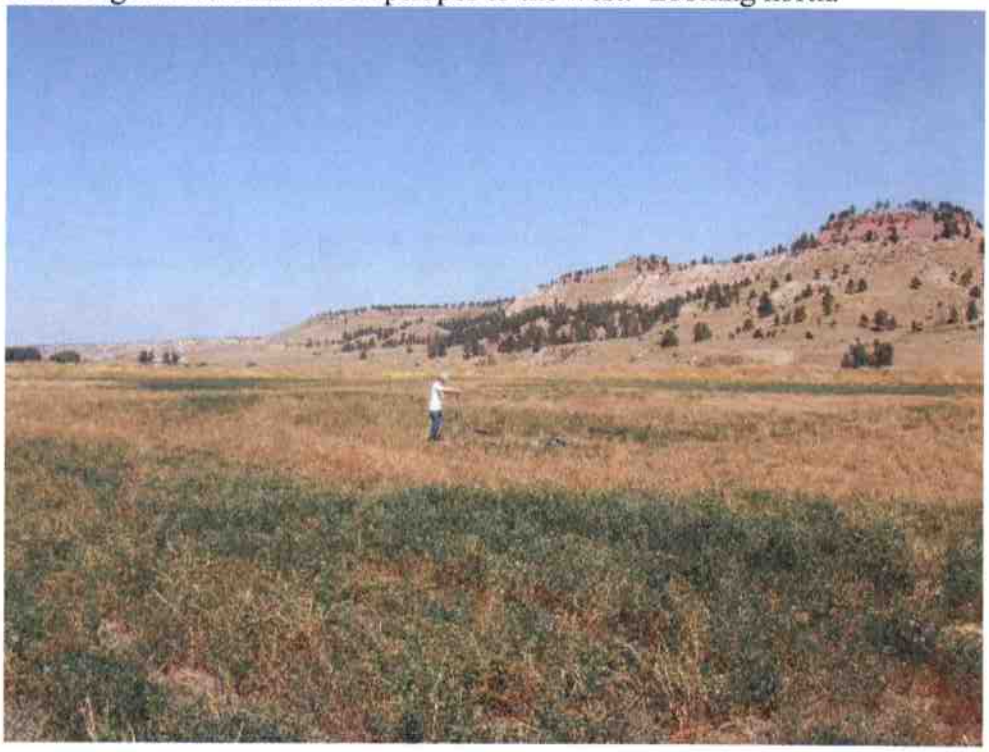
Soil Sample Site 1. Looking northeast.



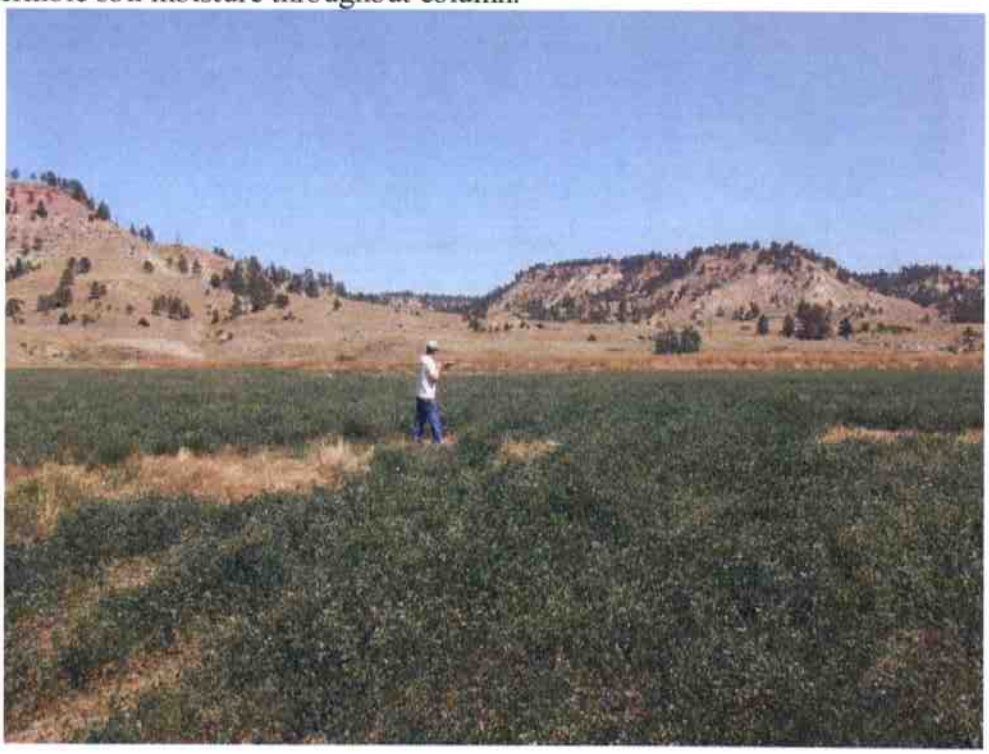
Soil Sample Site 2. Spreader dike in background. Alfalfa present. Indiscernible soil moisture throughout column. Looking east.

Beaver Creek Section 20, Part III: Photographic Document of Study Area in Section 8, Township 57 North, Range 64 West

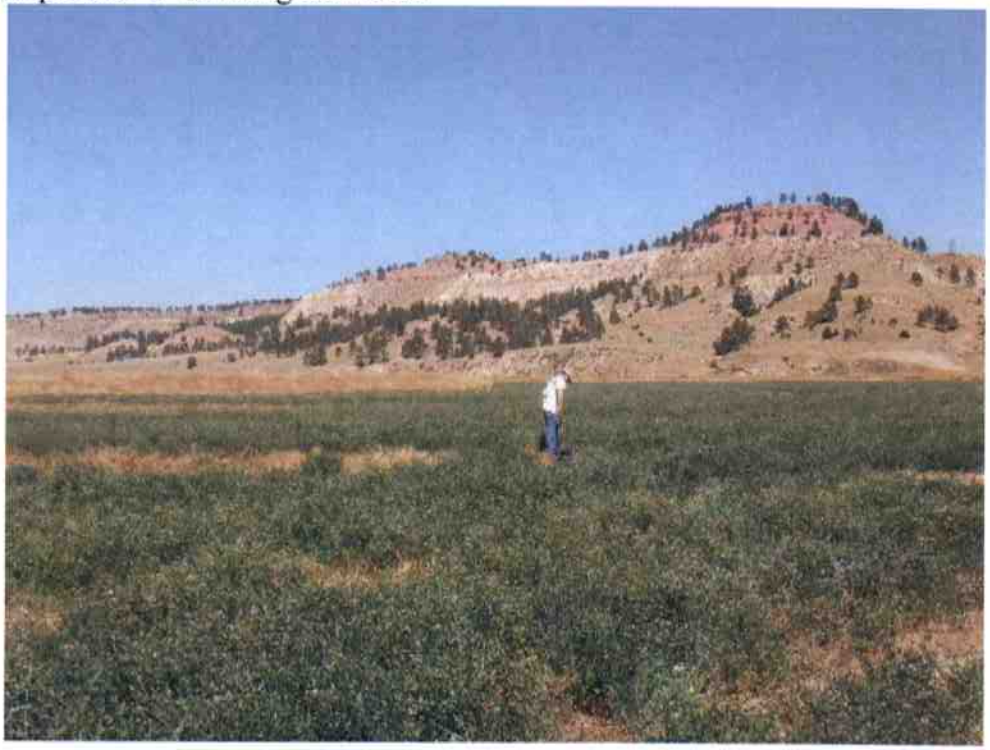
Soil Sample Site 3. Spreader dike in background. Alfalfa present. Indiscernible soil moisture throughout column. Site upslopes to the west. Looking north.



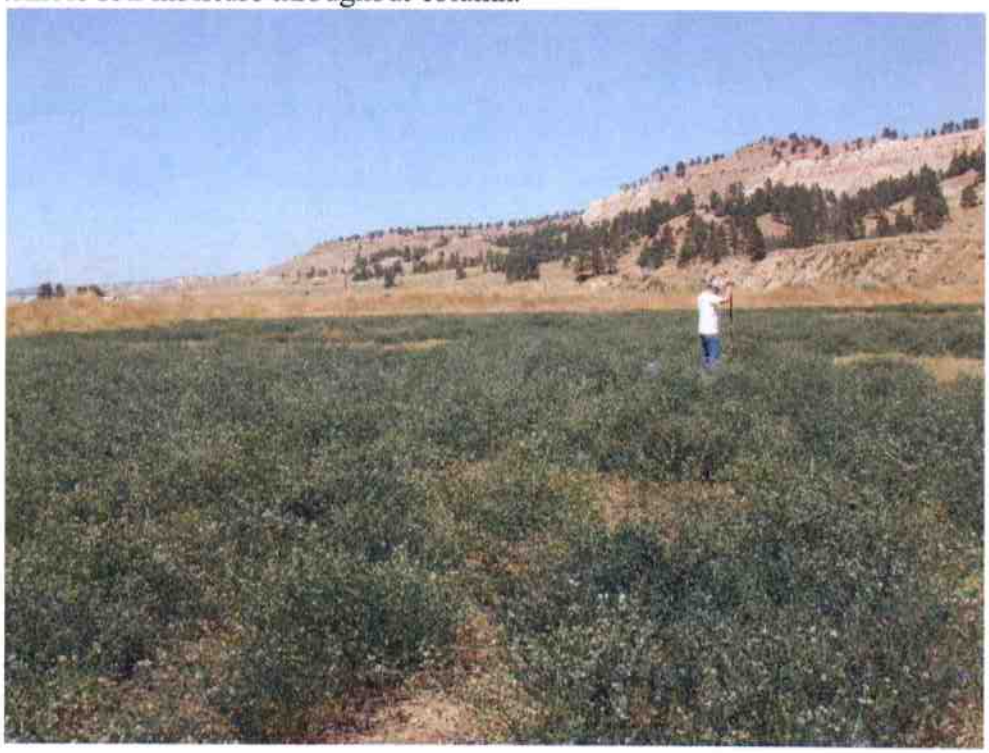
Soil Sample Site 4. Spreader dike in background. Looking east. Alfalfa present. Indiscernible soil moisture throughout column.



Soil Sample Site 4. Looking northeast.



Soil Sample Site 5. Spreader dike in background. Looking northeast. Alfalfa present. Indiscernible soil moisture throughout column.



Beaver Creek Section 20, Part III: Photographic Document of Study Area in Section 8, Township 57 North, Range 64 West

Soil Sample Site 5. Looking east.

Soil Sample Site 6. Spreader dike in background. Looking east. Alfalfa present. Soil moist below 48 inches. Wet alluvium found between 60-72 inches.

Beaver Creek Section 20, Part III: Photographic Document of Study Area in Section 8, Township 57 North, Range 64 West

Soil Sample Site 6. Looking northeast.

Photo Point 1. Bitter Creek looking downstream, taken from top of spreader dike. Looking northeast.

Beaver Creek Section 20, Part III: Photographic Document of Study Area in Section 8, Township 57 North, Range 64 West

Photo Point 1. Bitter Creek looking upstream, taken from top of spreader dike. Looking southeast.

Photo Point 1. Bitter Creek wetland vegetation conditions along channel, taken from top of spreader dike. Looking east.

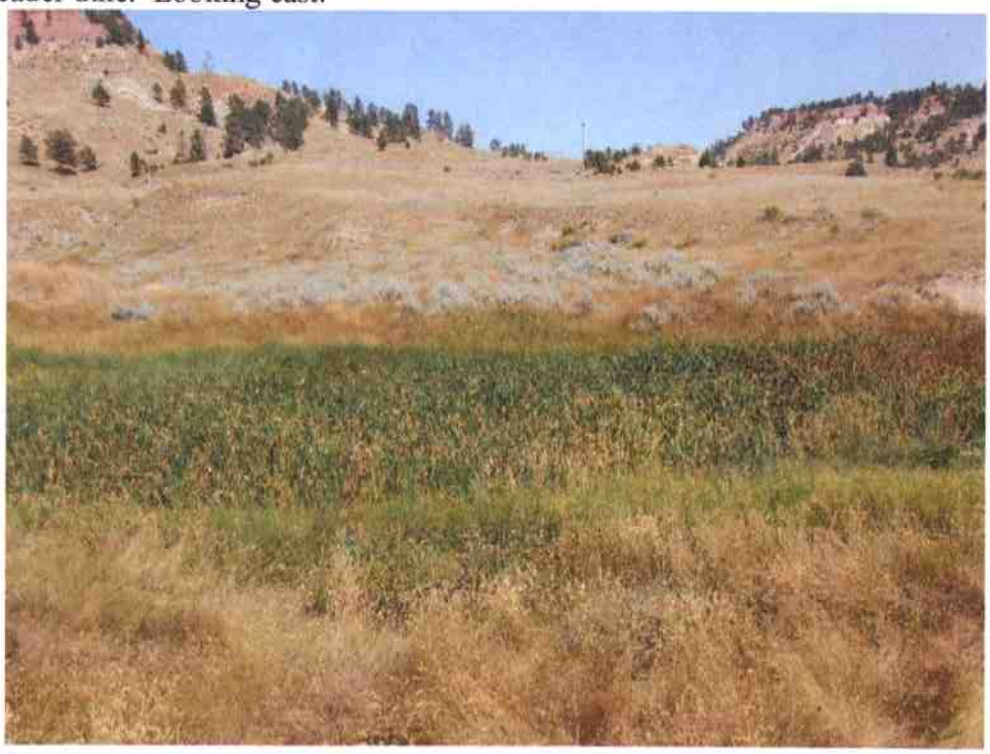


Photo Point 2. Shot 1. Panorama shots of entire irrigated area moving from north (downstream) to south (upstream).

Photo Point 2. Shot 2. Panorama shots of entire irrigated area moving from north (downstream) to south (upstream).

Photo Point 2. Shot 3. Panorama shots of entire irrigated area moving from north (downstream) to south (upstream).

Photo Point 2. Shot 4. Panorama shots of entire irrigated area moving from north (downstream) to south (upstream).

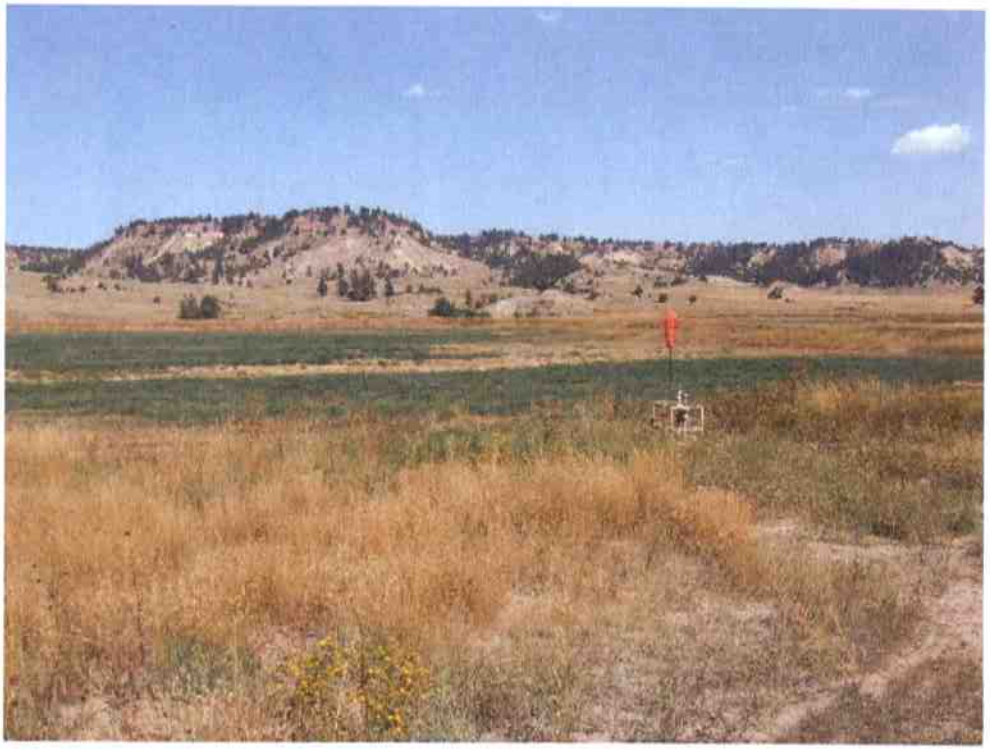


Photo Point 2. Shot 5. Panorama shots of entire irrigated area moving from north (downstream) to south (upstream).

Photo Point 2. Shot 6. Panorama shots of entire irrigated area moving from north (downstream) to south (upstream).

Soil Sample Site 7. Spreader dike in background. Looking northeast. Alfalfa present. Indiscernible soil moisture throughout column.

Soil Sample Site 7. Looking east.

Beaver Creek Section 20, Part III: Photographic Document of Study Area in Section 8, Township 57 North, Range 64 West

Photo Point 3. Shot 1. Non-irrigated field. Looking west. Channel below spreader dike and eroded channel that intercepts water flows. Green area is a headcut.

Photo Point 3. Shot 2. Non-irrigated field. Looking north. Channel below spreader dike and eroded channel that intercepts water flows. Green area is a headcut.

Photo Point 3. Shot 3. Non-irrigated field. Looking north. Channel below spreader dike and eroded channel that intercepts water flows. Green area is an incised channel.

Photo Point 3. Shot 4. Non-irrigated field. Looking northeast. Channel below spreader dike and eroded channel that intercepts water flows. Green area is a headcut.

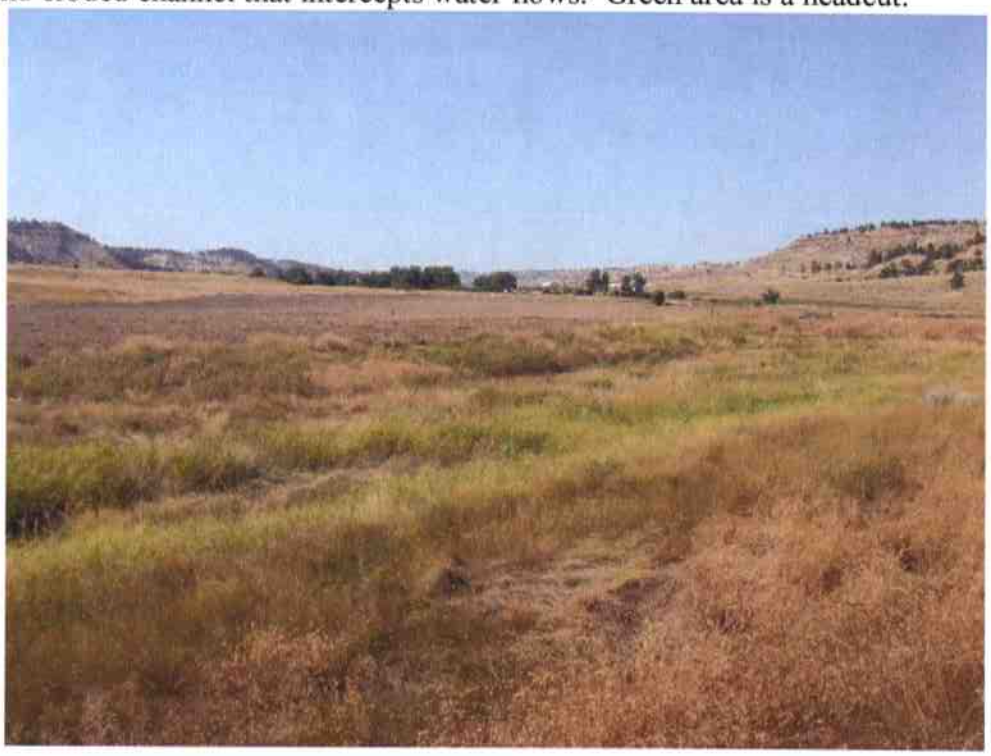
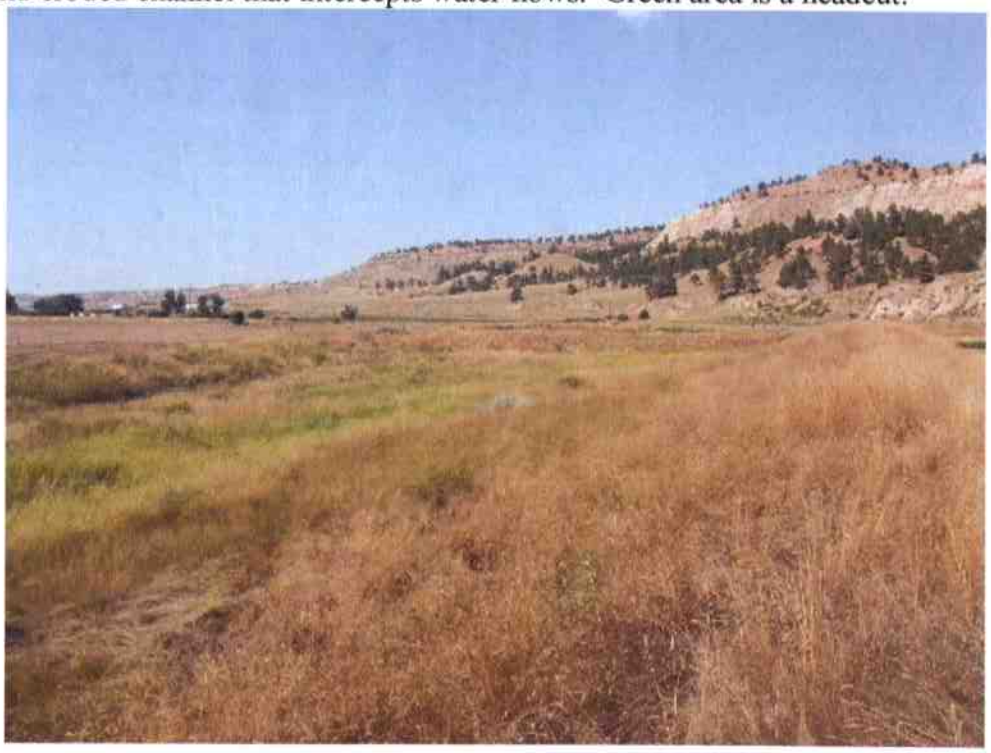


Photo Point 3. Shot 5. Non-irrigated field. Looking northeast. Channel below spreader dike and eroded channel that intercepts water flows. Green area is a headcut.



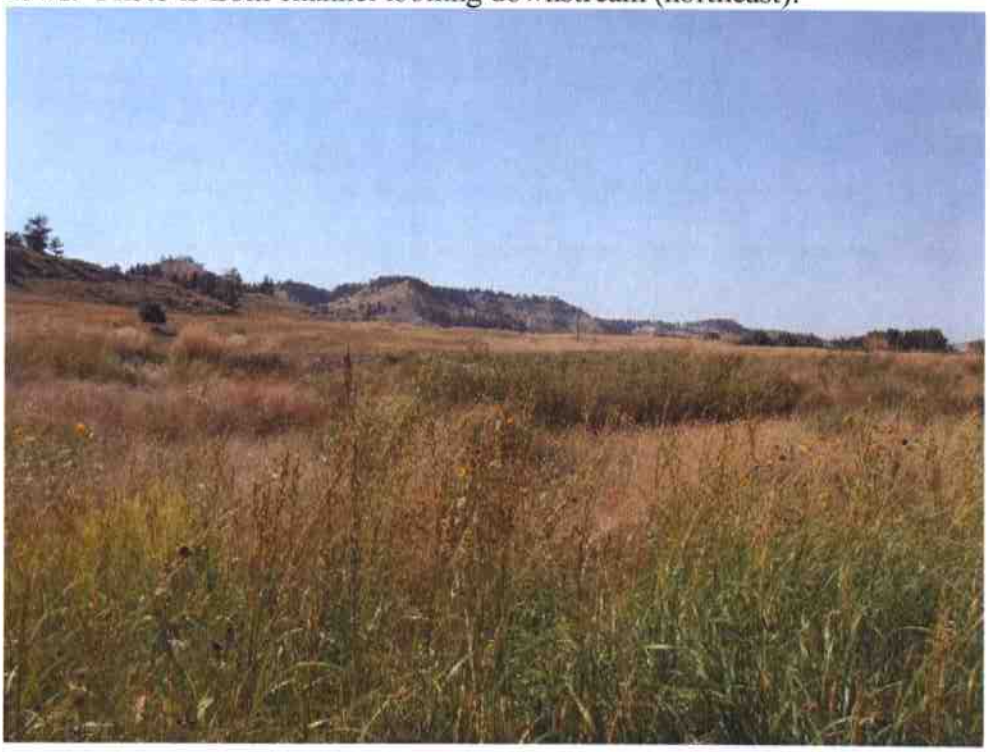
Beaver Creek Section 20, Part III: Photographic Document of Study Area in Section 8, Township 57 North, Range 64 West

Photo Point 4. Shot 1. Channel below spreader dike and eroded channel that intercepts water flows. Photo is from channel looking upstream (southwest).

Photo Point 4. Shot 2. Channel below spreader dike and eroded channel that intercepts water flows. Photo is from channel looking upstream (southwest).

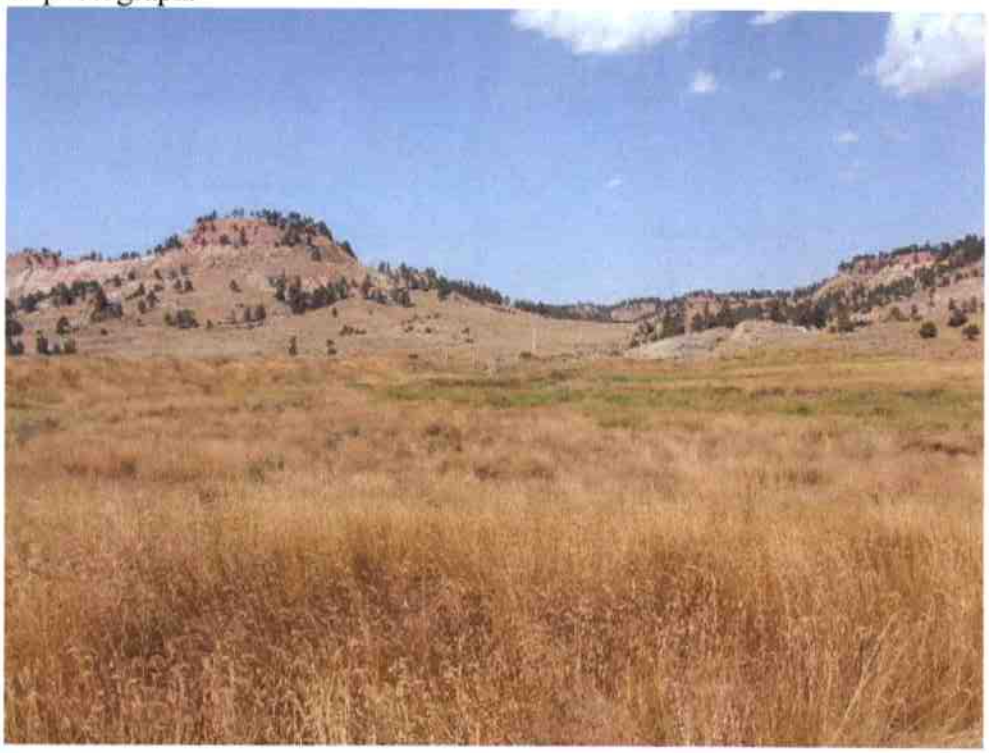
Photo Point 4. Shot 3. Channel below spreader dike and eroded channel that intercepts water flows. Photo is from channel looking upstream (southwest).

Photo Point 4. Shot 4. Channel below spreader dike and eroded channel that intercepts water flows. Photo is from channel looking downstream (northeast).

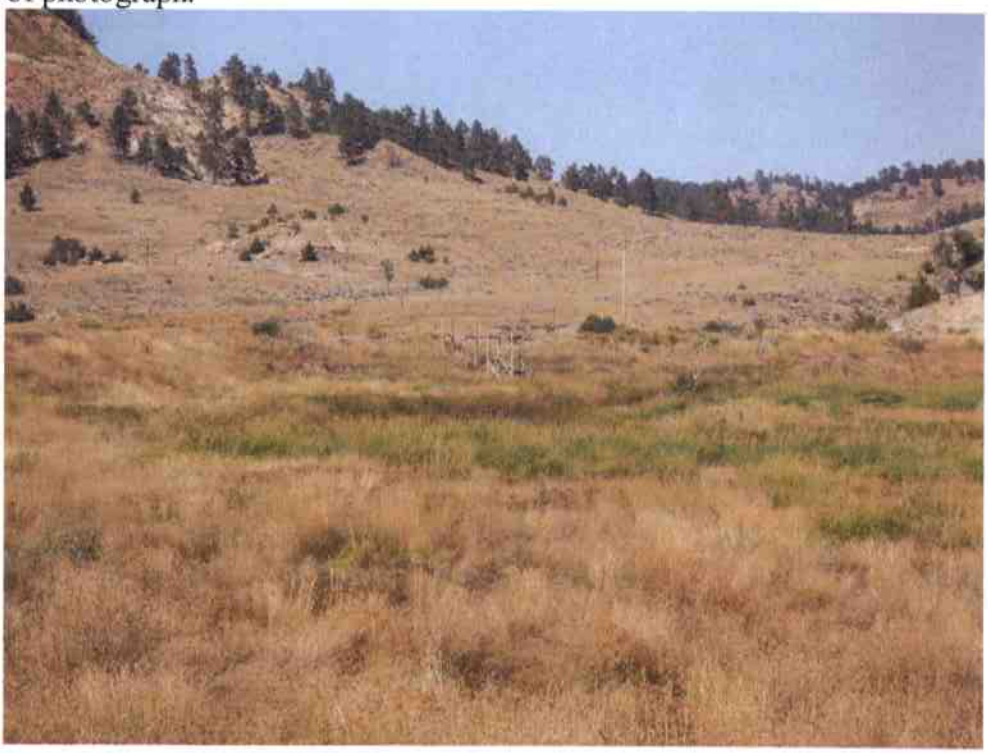


Beaver Creek Section 20, Part III: Photographic Document of Study Area in Section 8, Township 57 North, Range 64 West

Green area is Bitter Creek. Looking northeast. Headgate on Bitter Creek can be seen in center of photograph.



Green area is Bitter Creek. Looking northeast. Headgate on Bitter Creek can be seen in center of photograph.



Beaver Creek Section 20, Part III: Photographic Document of Study Area in Section 8, Township 57 North, Range 64 West

Soil Sample Site 8. Spreader dike in background. Looking east. Alfalfa present. Indiscernible soil moisture throughout column.

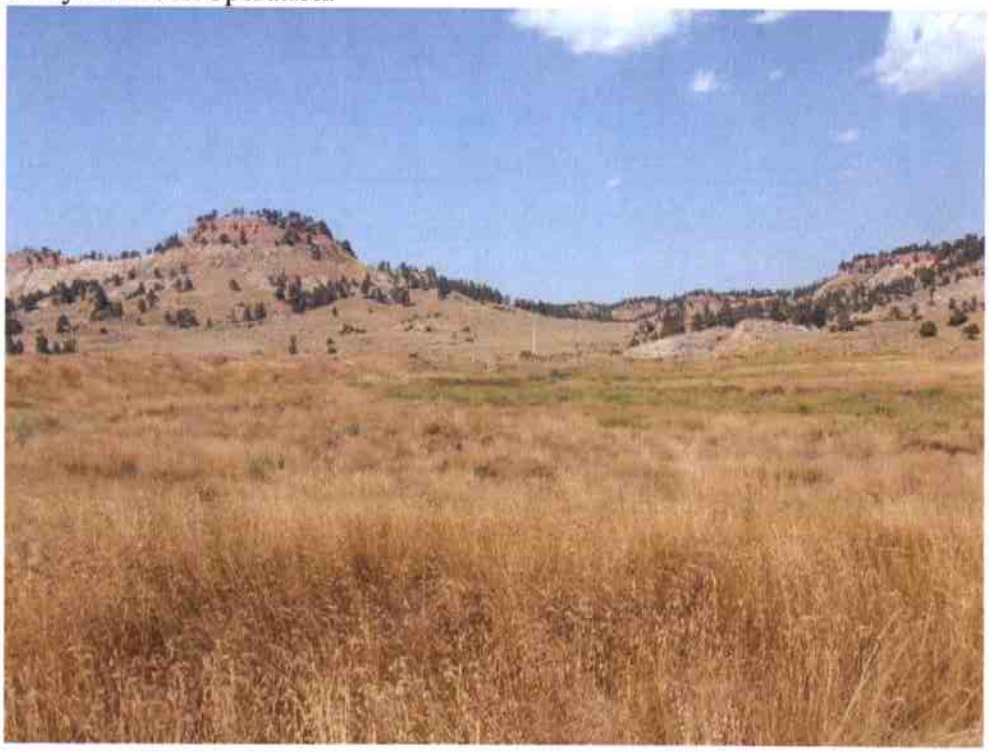
Soil Sample Site 8. Looking southeast.

Soil Sample Site 9. Spreader dike in background. Looking east. Alfalfa present. Indiscernible soil moisture throughout column.

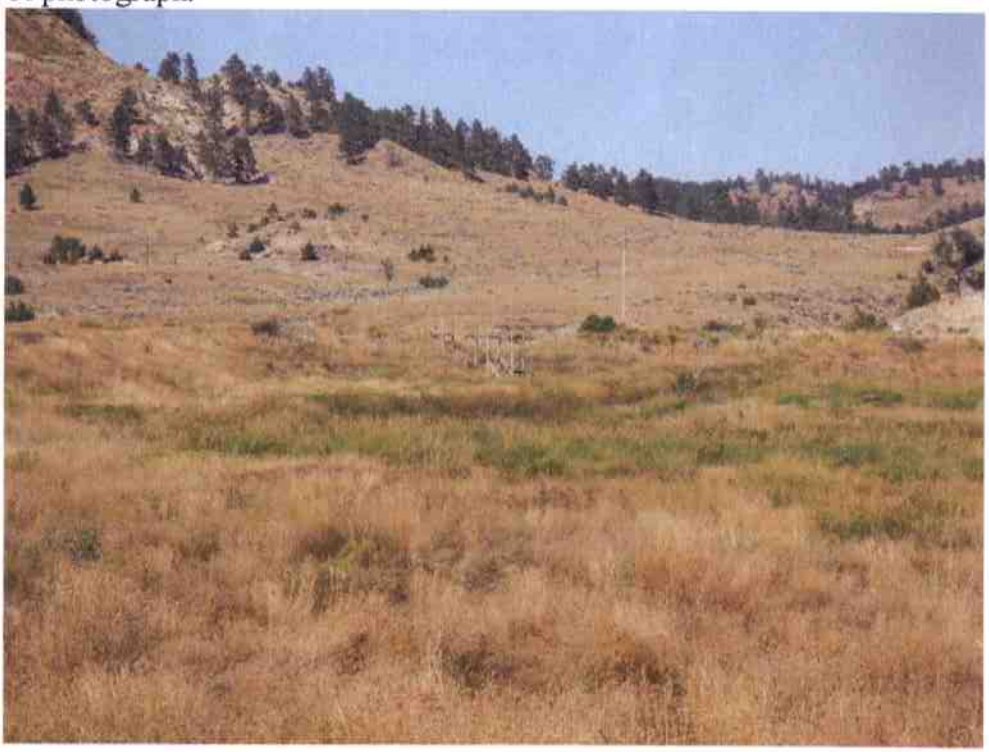
Dogleg spreader dike that crosses Bitter Creek. Looking east. Headgate on Bitter Creek can be seen on the right.

Beaver Creek Section 20, Part III: Photographic Document of Study Area in Section 8, Township 57 North, Range 64 West

Green area is Bitter Creek. Looking northeast. Headgate on Bitter Creek can be seen in center of photograph. Taken from point where backwater would flow onto fields when irrigation system is in operation.



Green area is Bitter Creek. Looking northeast. Headgate on Bitter Creek can be seen in center of photograph.



Beaver Creek Section 20, Part III: Photographic Document of Study Area in Section 8, Township 57 North, Range 64 West

Dogleg spreader dike that crosses Bitter Creek. Looking east. Headgate on Bitter Creek can be seen in the center.

Headgate on Bitter Creek from top of spreader dike, looking upstream (south).

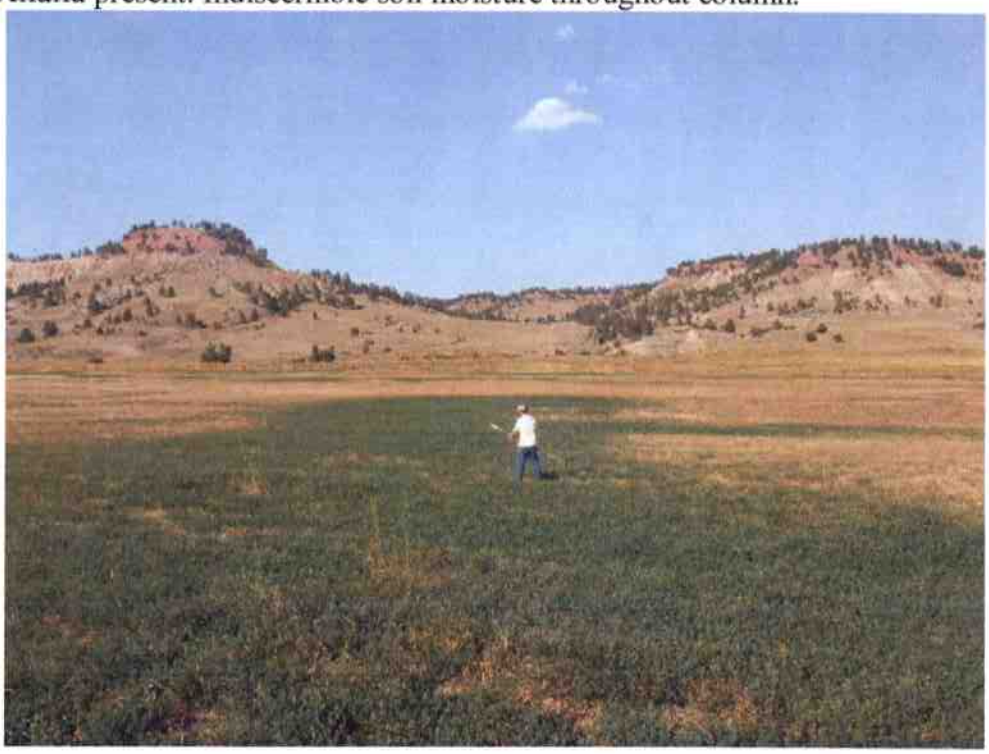
Beaver Creek Section 20, Part III: Photographic Document of Study Area in Section 8, Township 57 North, Range 64 West

Downstream view from spreader dike at location of Bitter Creek headgate. Looking north.

Downstream view from spreader dike at location of Bitter Creek headgate. Looking north. Pool is on the creek.

Downstream view from spreader dike at location of Bitter Creek headgate. Looking northeast.

Soil Sample Site 10. Spreader dike and Bitter Creek are in the far background. Looking east. Alfalfa present. Indiscernible soil moisture throughout column.



Soil Sample Site 11. Spreader dike in background. Looking north. Alfalfa present. Indiscernible soil moisture throughout column.

Soil Sample Site 12. Looking south. Alfalfa present. Indiscernible soil moisture throughout column.

Headgate in spreader dike north of Soil Sample Site 11.

The Termo Company

Soil Sample Data Part 1

Sample ID	Sample Depth	Collection Date	pH	Conductivity	Percent Sat	SAR	Ca	Mg	Na	Sand	Silt	Clay	Texture	Organic Matter	CEC	Na-Ext	Exch Na	ESP
	Inches		S. U.	mmhos/cm	%	Unitless	meq/l	meq/l	meq/l	%	%	%	Unitless	%	meq/100g	meq/100g	meq/100g	%
Brug 1, 4, 5 Comp	0-12	6/8/2007	7.0		56.9	0.09	8.2	3.2	0.23	37	32	31	Clay Loam	4.20				0.10
Brug 1, 4, 5 Comp	13-24	6/8/2007	7.8		43.8	0.73	3.9	2.1	1.3	39	32	29	Clay Loam					0.49
Brug 1, 4, 5 Comp	25-36	6/8/2007	7.9		48.5	7.74	27	26	40	52	24	24	Sandy Clay Loam					1.80
Brug 1, 4, 5 Comp	37-48	6/8/2007	8.1		51.9	8.53	26	24	43	44	27	29	Clay Loam					1.70
Brug 2, 3 Comp	0-12	6/8/2007	7.1		65.0	0.1	7	2.6	0.22	27	39	34	Clay Loam	3.70				0.13
Brug 2, 3 Comp	13-24	6/8/2007	7.6		62.0	0.59	4.4	1.6	1	14	44	42	Silty Clay					0.45
Brug 2, 3 Comp	25-36	6/8/2007	8.3		68.2	11.9	23	44	69	18	47	35	Silty Clay Loam					8.40
Brug 2, 3 Comp	37-48	6/8/2007	8.5		67.2	10.3	23	46	60	17	48	35	Silty Clay Loam					9.80
1A	0-12	6/11/2007	7.0	3.05	72.8	0.73	23.3	15.2	3.22	14	52	34	Silty Clay Loam	7.26	34.9	0.81	0.6	1.70
1B	13-24	6/11/2007	7.5	5.63	49.4	4.1	27.4	30.1	21.9	38	34	28	Clay Loam		23.6	2.35	1.3	5.40
1C	25-36	6/11/2007	7.5	4.78	50.6	3.5	25.8	23.4	17.5	30	42	28	Clay Loam		22.6	2.22	1.3	5.90
1D	37-48	6/11/2007	7.4	5.30	37.8	3.8	27.9	27.2	20.2	49	29	22	Loam		20.1	2.17	1.4	7.00
2A	0-12	6/11/2007	7.3	0.69	52.5	0.83	3.44	1.8	1.34	21	47	32	Clay Loam	3.68	28.2	0.55	0.5	1.70
2B	13-24	6/11/2007	7.6	4.72	47.3	5.1	20.1	19.5	22.8	27	43	30	Clay Loam		21.4	2.41	1.3	6.20
2C	25-36	6/11/2007	7.9	8.46	52.4	9.3	18.3	48.1	53.3	22	44	34	Clay Loam		23.1	6.13	3.3	14.00
2D	37-48	6/11/2007	7.9	8.51	47.0	8.6	21.6	44.5	49.2	26	42	32	Clay Loam		21.8	5.05	2.7	13.00
2E	49-60	6/11/2007	8.0	8.60	43.7	13	17.1	33.9	65.2	40	35	25	Loam		18.9	6.54	3.7	20.00
2F	61-72	6/11/2007	7.9	8.32	41.5	9.6	20.1	42.2	53.5	50	28	22	Loam		19.2	4.21	2.0	10.00
3A	0-12	6/11/2007	7.3	0.66	58.1	0.59	3.18	2.03	0.96	8	54	38	Silty Clay Loam	3.61	29.6	0.66	0.6	2.00
3B	13-24	6/11/2007	7.7	3.45	60.4	3.1	15.3	16.6	12.5	<1	57	43	Silty Clay		21.6	2.16	1.4	6.50
3C	25-36	6/11/2007	8.1	13.10	64.8	14	19.8	83.2	97	2	55	43	Silty Clay		16.8	10.50	4.2	25.00
3D	37-48	6/11/2007	8.1	14.00	69.9	15	20.3	94.2	113	1	55	44	Silty Clay		22.3	12.90	5.0	22.00
3E	49-60	6/11/2007	8.0	12.20	52.3	16	20.5	60.8	100	14	48	38	Silty Clay Loam		22.8	9.71	4.5	20.00
3F	61-72	6/11/2007	8.0	11.00	55.4	14	18.5	55.3	83.3	18	42	40	Silty Clay		21.9	9.12	4.5	20.00

The Termo Company

Soil Sample Data Part 2

Sample ID	Sample Depth	Collection Date	pH	Conductivity	Percent Sat	SAR	Ca	Mg	Na	Sand	Silt	Clay	Texture	Organic Matter	CEC	Na-Ext	Exch Na	ESP
	Inches		S. U.	mmhos/cm	%	Unitless	meq/l	meq/l	meq/l	%	%	%	Unitless	%	meq/100g	meq/100g	meq/100g	%
1A	0-12	7/25/2007	7.8	7.45	64.7	8.1	22.9	29.9	41.8	11	51	38	Silty Clay Loam	3.22	32.9	5.40	2.7	8.20
1B	13-24	7/25/2007	7.8	5.74	75.0	8.2	13.2	17.6	32.2	16	45	39	Silty Clay Loam		40.9	5.69	3.3	8.00
1C	25-36	7/25/2007	7.9	7.16	81.2	7.4	20.8	31.2	37.8	6	44	50	Silty Clay		25.5	6.40	3.3	13.00
1D	37-48	7/25/2007	7.8	8.01	77.0	7.7	20.6	35.6	40.8	13	45	42	Silty Clay		28.0	6.09	2.9	10.00
2A	0-12	7/25/2007	8.1	2.73	68.4	13	3.29	3.73	23.7	4	57	39	Silty Clay Loam	3.90	35.5	5.90	4.3	12.00
2B	13-24	7/25/2007	8.0	3.39	43.5	5.4	14.8	8.89	18.7	34	46	20	Loam		22.5	2.86	2.0	9.10
2C	25-36	7/25/2007	8.2	2.00	46.7	7	4.67	3.36	13.9	27	51	22	Silty Loam		25.3	2.61	2.0	7.70
2D	37-48	7/25/2007	8.1	2.38	62.3	6.3	7.07	5.32	15.6	10	57	33	Silty Clay Loam		24.8	3.10	2.1	8.60
3A	0-12	7/25/2007	8.0	11.60	73.7	14	21.1	46.7	83.3	11	52	37	Silty Clay Loam	4.71	39.0	11.30	5.1	13.00
3B	13-24	7/25/2007	7.9	10.50	90.5	14	19.7	43.7	78.7	6	54	40	Silty Clay		31.5	13.60	6.5	20.00
3C	25-36	7/25/2007	7.8	11.00	90.0	14	22.9	48.5	84.1	6	48	46	Silty Clay		27.4	12.00	4.4	16.00
3D	37-48	7/25/2007	7.8	8.66	85.2	9.7	20.6	32.2	49.6	6	48	46	Silty Clay		22.8	8.21	4.0	18.00

The Termo Company

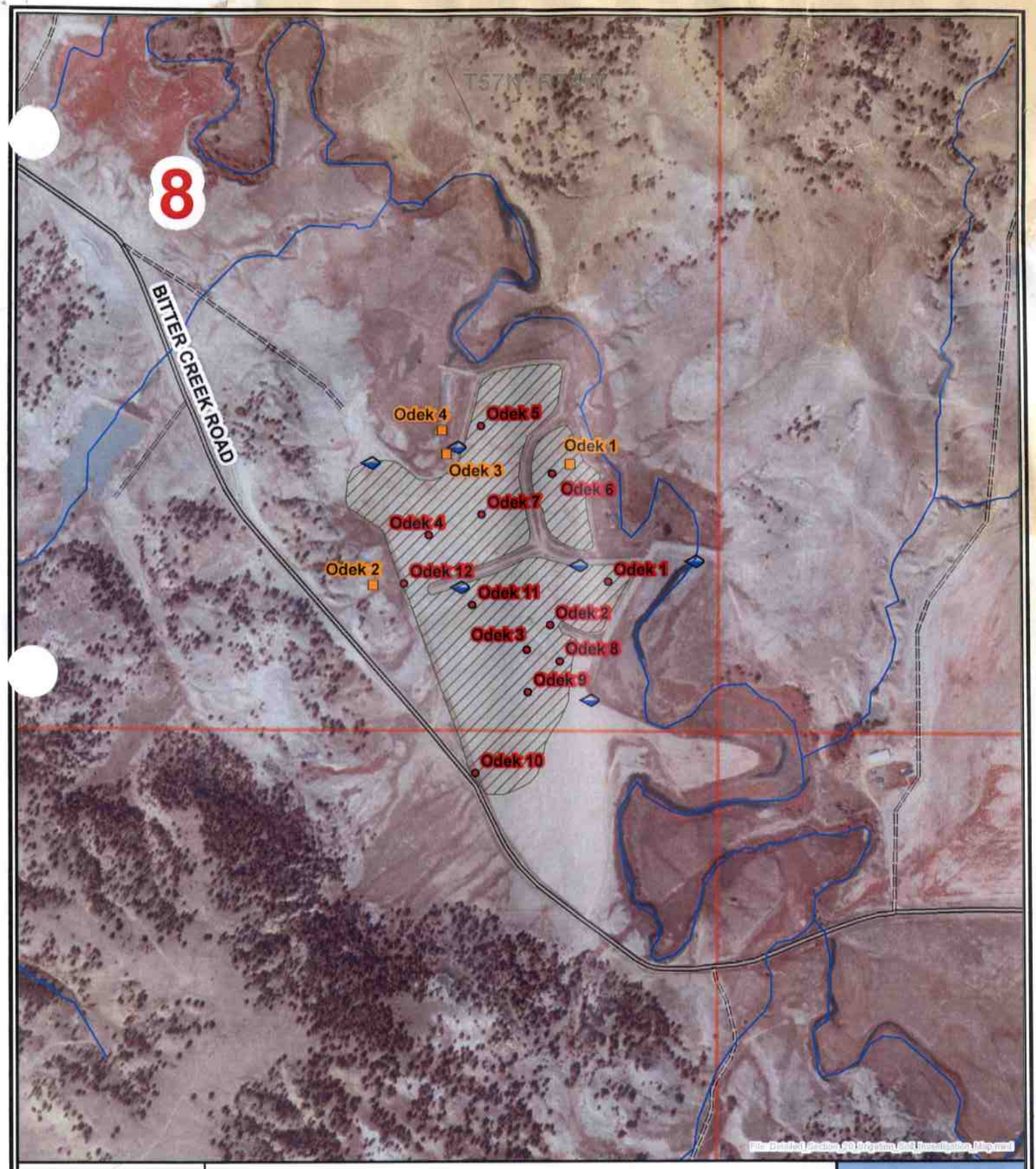
Soil Sample Data Part 3

Sample ID	ample Dep	llection Da	pH	Conductivit	Percent Sa	SAR	Ca	Mg	Na	Sand	Silt	Clay	Texture	rganic Matt	CEC	Na-Ext	Exch Na	ESP
	Inches		S. U.	mmhos/cm	%	Unitless	meq/l	meq/l	meq/l	%	%	%	Unitless	%	meq/100g	meq/100g	meq/100g	%
Odek 1	0-12	8/30/2007	7.5	53	39.1	0.11	2.38	1.94	0.16	58.0	25.0	17.0	Sandy Loam	3.2	18.0	0.18	0.17	0.96
Odek 1	13-24	8/30/2007	7.9	47	40.4	1.96	1.40	1.09	2.18	30.0	45.0	25.0	Loam		20.5	0.61	0.52	2.56
Odek 1	25-36	8/30/2007	7.9	166	40.1	2.97	6.21	4.67	6.93	32.0	44.0	24.0	Loam		20.6	0.88	0.61	2.93
Odek 1	37-48	8/30/2007	7.9	109	29.9	2.09	4.15	2.84	3.91	65.0	20.0	15.0	Sandy Loam		12.6	0.38	0.26	2.05
Odek 1	49-60	8/30/2007	7.8	97	28.8	1.82	3.77	2.47	3.21	69.0	18.0	13.0	Sandy Loam		11.3	0.37	0.28	2.45
Odek 1	61-72	8/30/2007	7.9	106	28.4	1.90	4.03	3.11	3.60	85.0	5.0	10.0	Loamy Sand		8.71	0.33	0.23	2.62
Odek 2	0-12	8/30/2007	7.1	46	46.6	0.57	2.15	1.48	0.77	19.0	49.0	32.0	Silty Clay Loam	3.9	28.8	0.06	0.02	0.07
Odek 2	13-24	8/30/2007	7.7	43	50.3	1.56	1.56	0.88	1.73	7.0	57.0	36.0	Silty Clay Loam		27.9	0.62	0.54	1.92
Odek 2	25-36	8/30/2007	7.7	86	44.3	1.48	3.36	2.68	2.57	19.0	49.0	32.0	Silty Clay Loam		23.8	0.46	0.35	1.47
Odek 2	37-48	8/30/2007	8.0	100	54.2	1.34	3.47	4.39	2.66	5.0	49.0	46.0	Silty Clay		28.9	0.60	0.46	1.59
Odek 2	49-60	8/30/2007	7.9	133	44.9	1.45	4.78	6.20	3.41	15.0	51.0	34.0	Silty Clay Loam		19.8	0.51	0.36	1.81
Odek 2	61-72	8/30/2007	7.9	168	43.1	1.51	7.18	9.04	4.31	25.0	46.0	29.0	Clay Loam		19.0	0.51	0.33	1.72
Odek 3	0-12	8/30/2007	7.6	47	55.2	0.26	2.40	1.63	0.38	5.0	39.0	56.0	Silty Clay	2.4	37.2	0.10	0.07	0.20
Odek 3	13-24	8/30/2007	7.9	60	61.1	1.65	1.70	1.83	2.19	1.0	40.0	59.0	Clay		32.1	0.65	0.52	1.62
Odek 3	25-36	8/30/2007	7.6	331	62.4	1.77	20.6	14.8	7.45	<0.1	42.0	58.0	Clay		32.7	1.01	0.55	1.67
Odek 3	37-48	8/30/2007	7.6	212	59.9	4.06	7.27	5.40	10.2	6.0	43.0	51.0	Silty Clay		34.5	1.82	1.21	3.49
Odek 3	49-60	8/30/2007	7.6	187	62.0	5.72	4.41	3.30	11.2	1.0	47.0	52.0	Silty Clay		33.9	2.48	1.78	5.26
Odek 3	61-72	8/30/2007	7.7	243	62.2	6.50	5.55	4.96	14.9	1.0	49.0	50.0	Silty Clay		33.8	3.09	2.16	6.39
Odek 4	0-12	8/30/2007	7.8	47	46.1	0.39	2.09	1.85	0.54	22.0	47.0	31.0	Clay Loam	3.5	24.0	0.06	0.03	0.14
Odek 4	13-24	8/30/2007	7.7	134	44.1	2.87	4.35	3.73	5.78	25.0	43.0	32.0	Clay Loam		24.5	1.05	0.80	3.25
Odek 4	25-36	8/30/2007	7.7	341	42.0	2.98	18.1	13.3	11.8	35.0	39.0	26.0	Loam		19.7	1.11	0.62	3.13
Odek 4	37-48	8/30/2007	7.7	147	35.7	1.41	7.37	4.89	3.49	59.0	22.0	19.0	Sandy Loam		14.6	0.34	0.22	1.49
Odek 4	49-60	8/30/2007	7.8	113	34.4	1.39	5.09	3.43	2.87	53.0	29.0	18.0	Sandy Loam		15.0	0.30	0.20	1.36
Odek 4	61-72	8/30/2007	7.8	85	29.0	1.33	3.43	2.34	2.25	71.0	16.0	13.0	Sandy Loam		11.3	0.21	0.15	1.30
Odek 5	0-12	8/30/2007	7.7	44	42.8	0.12	2.06	1.25	0.16	33.0	45.0	22.0	Loam	3.1	19.6	0.04	0.03	0.15
Odek 5	13-24	8/30/2007	8.0	43	38.3	1.35	1.56	1.19	1.58	35.0	41.0	24.0	Loam		19.2	0.30	0.24	1.27
Odek 5	25-36	8/30/2007	8.0	125	35.2	2.03	4.12	4.60	4.24	53.0	28.0	19.0	Sandy Loam		13.1	0.46	0.31	2.34
Odek 5	37-48	8/30/2007	7.9	125	43.7	1.74	4.35	4.77	3.71	<0.1	53.0	47.0	Silty Clay		17.5	0.65	0.49	2.80
Odek 5	49-60	8/30/2007	7.9	129	40.4	1.58	4.51	5.22	3.48	27.0	45.0	28.0	Clay Loam		16.5	0.46	0.32	1.96
Odek 5	61-72	8/30/2007	7.8	211	43.4	1.75	8.92	9.57	5.33	11.0	53.0	36.0	Silty Clay Loam		18.7	0.59	0.36	1.91
Odek 6	0-12	8/30/2007	7.5	39	49.0	0.12	2.26	1.32	0.16	11.0	54.0	35.0	Silty Clay Loam	3.9	32.2	0.05	0.04	0.12
Odek 6	13-24	8/30/2007	7.9	300	48.5	2.78	14.5	13.7	10.4	13.0	52.0	35.0	Silty Clay Loam		25.5	1.25	0.74	2.92
Odek 6	25-36	8/30/2007	8.3	801	43.2	8.27	17.9	47.3	47.2	31.0	43.0	26.0	Loam		19.2	3.62	1.58	8.27
Odek 6	37-48	8/30/2007	8.1	706	32.6	10.1	15.7	28.0	47.0	82.0	6.0	12.0	Loamy Sand		17.5	3.80	2.27	13.0
Odek 6	49-60	8/30/2007	8.1	609	29.6	7.10	18.2	29.3	34.6	67.0	17.0	16.0	Sandy Loam		15.2	1.98	0.96	6.30
Odek 6	61-72	8/30/2007	8.1	654	31.2	8.31	16.6	30.0	40.1	68.0	17.0	15.0	Sandy Loam		20.2	2.89	1.64	8.10
Odek 7	0-12	8/30/2007	7.6	55	36.9	0.57	3.37	2.04	0.94	43.0	36.0	21.0	Loam	2.9	18.8	0.11	0.07	0.37
Odek 7	13-24	8/30/2007	8.0	41	37.8	1.37	1.67	1.03	1.60	39.0	40.0	21.0	Loam		15.4	0.46	0.40	2.56
Odek 7	25-36	8/30/2007	8.0	157	43.5	2.51	5.62	6.25	6.12	18.0	53.0	29.0	Silty Clay Loam		25.0	1.09	0.82	3.29
Odek 7	37-48	8/30/2007	7.9	381	44.2	2.29	19.7	24.0	10.7	18.0	52.0	30.0	Silty Clay Loam		22.9	1.09	0.61	2.68
Odek 7	49-60	8/30/2007	7.9	249	33.2	2.34	10.7	12.6	7.99	48.0	34.0	18.0	Loam		12.9	0.55	0.28	2.20
Odek 7	61-72	8/30/2007	8.0	154	29.3	2.23	5.47	6.72	5.50	60.0	27.0	13.0	Sandy Loam		9.63	0.46	0.30	3.09
Odek 8	0-12	8/30/2007	7.1	56	46.5	0.33	2.55	2.48	0.53	29.0	45.0	26.0	Loam	5.1	26.8	0.04	0.02	0.07
Odek 8	13-24	8/30/2007	7.9	54	42.3	2.07	1.60	1.40	2.54	20.0	50.0	30.0	Clay Loam		23.7	0.54	0.43	1.81
Odek 8	25-36	8/30/2007	8.0	68	37.7	2.75	2.06	1.35	3.60	44.0	32.0	24.0	Loam		17.7	0.60	0.46	2.60
Odek 8	37-48	8/30/2007	8.0	123	36.8	2.10	4.54	4.39	4.44	41.0	34.0	25.0	Loam		14.9	0.50	0.34	2.25
Odek 8	49-60	8/30/2007	8.0	143	39.9	2.04	4.06	6.84	4.77	27.0	48.0	25.0	Loam		17.5	0.59	0.40	2.30
Odek 8	61-72	8/30/2007	8.1	136	38.3	1.94	3.73	6.58	4.39	<0.1	40.0	60.0	Clay		16.5	0.53	0.36	2.18

The Termo Company

Soil Sample Data Part 3

Sample ID	ample Dep	llection Da	pH	Conductivit	Percent Sa	SAR	Ca	Mg	Na	Sand	Silt	Clay	Texture	rganic Matt	CEC	Na-Ext	Exch Na	ESP
	Inches		S. U.	mmhos/cm	%	Unitless	meq/l	meq/l	meq/l	%	%	%	Unitless	%	meq/100g	meq/100g	meq/100g	%
Odek 9	0-12	8/30/2007	6.3	37	46.1	0.32	1.71	1.40	0.40	11.0	52.0	37.0	Silty Clay Loam	4.7	29.5	0.06	0.04	0.13
Odek 9	13-24	8/30/2007	7.8	42	41.3	1.19	1.70	1.04	1.39	27.0	37.0	36.0	Clay Loam		32.1	0.44	0.39	1.20
Odek 9	25-36	8/30/2007	8.0	115	44.6	1.52	4.52	5.01	3.33	14.0	55.0	31.0	Silty Clay Loam		23.0	0.49	0.34	1.49
Odek 9	37-48	8/30/2007	8.0	165	43.7	1.96	4.40	8.78	5.03	17.0	51.0	32.0	Silty Clay Loam		22.0	0.68	0.46	2.09
Odek 9	49-60	8/30/2007	8.1	311	43.6	3.86	5.32	19.2	13.5	17.0	53.0	30.0	Silty Clay Loam		21.2	1.58	0.99	4.66
Odek 9	61-72	8/30/2007	8.1	552	56.4	5.73	7.05	40.4	27.9	3.0	57.0	40.0	Silty Clay		25.1	3.27	1.70	6.78
Odek 10	0-12	8/30/2007	7.3	48	46.0	0.38	2.32	1.76	0.55	25.0	39.0	36.0	Clay Loam	4.0	27.7	0.10	0.07	0.25
Odek 10	13-24	8/30/2007	7.9	48	42.1	0.72	1.86	1.76	0.97	27.0	37.0	36.0	Clay Loam		26.5	0.16	0.12	0.46
Odek 10	25-36	8/30/2007	8.1	56	54.3	0.97	1.74	2.41	1.40	11.0	37.0	52.0	Clay		35.8	0.35	0.27	0.76
Odek 10	37-48	8/30/2007	8.0	105	56.7	0.97	3.95	5.20	2.07	13.0	38.0	49.0	Clay		23.9	0.33	0.21	0.87
Odek 10	49-60	8/30/2007	7.6	245	49.2	0.59	23.3	10.5	2.41	23.0	33.0	44.0	Clay		24.7	0.33	0.22	0.87
Odek 10	61-72	8/30/2007	7.6	256	46.0	0.54	21.4	9.57	2.13	26.0	32.0	42.0	Clay		23.7	0.37	0.27	1.13
Odek 11	0-12	8/30/2007	7.9	45	40.5	0.20	2.25	1.38	0.27	28.0	44.0	28.0	Clay Loam	2.6	20.5	0.04	0.03	0.13
Odek 11	13-24	8/30/2007	8.0	32	40.0	0.83	1.41	0.83	0.88	21.0	52.0	27.0	Clay Loam		27.0	0.23	0.19	0.72
Odek 11	25-36	8/30/2007	8.3	53	45.4	1.39	1.50	1.69	1.75	11.0	56.0	33.0	Silty Clay Loam		22.4	0.48	0.40	1.79
Odek 11	37-48	8/30/2007	8.0	143	44.2	0.84	4.55	9.09	2.18	15.0	57.0	28.0	Silty Clay Loam		20.0	0.35	0.25	1.26
Odek 11	49-60	8/30/2007	7.8	289	42.4	0.55	21.4	15.4	2.38	28.0	46.0	26.0	Loam		16.5	0.27	0.17	1.01
Odek 11	61-72	8/30/2007	7.8	254	33.6	0.46	20.8	10.9	1.82	61.0	23.0	16.0	Sandy Loam		9.65	0.17	0.11	1.09
Odek 12	0-12	8/30/2007	7.3	37	48.6	0.33	1.80	1.17	0.40	11.0	45.0	44.0	Silty Clay	5.4	35.7	0.12	0.10	0.29
Odek 12	13-24	8/30/2007	7.7	258	48.0	1.10	18.6	10.1	4.16	19.0	42.0	39.0	Silty Clay Loam		27.6	0.57	0.37	1.34
Odek 12	25-36	8/30/2007	7.8	168	31.1	1.54	8.69	5.72	4.12	64.0	19.0	17.0	Sandy Loam		13.7	0.37	0.24	1.77
Odek 12	37-48	8/30/2007	7.9	82	31.4	1.35	3.32	2.31	2.26	63.0	19.0	18.0	Sandy Loam		15.1	0.30	0.23	1.49
Odek 12	49-60	8/30/2007	7.9	64	30.4	1.41	2.32	1.60	1.97	61.0	22.0	17.0	Sandy Loam		13.8	0.30	0.24	1.71
Odek 12	61-72	8/30/2007	7.9	65	33.7	1.50	2.50	1.60	2.15	51.0	28.0	21.0	Loam		17.0	0.33	0.25	1.48



SWCA
ENVIRONMENTAL CONSULTANTS
1043 Coffeen Avenue, Suite D Sheridan, WY 82801
Office: 307.673.4303 Fax: 307.673.4505
www.swca.com

Projection: NAD_1983_UTM_Zone_13N

Author: Wade L Epperson

Date: 9/12/2007

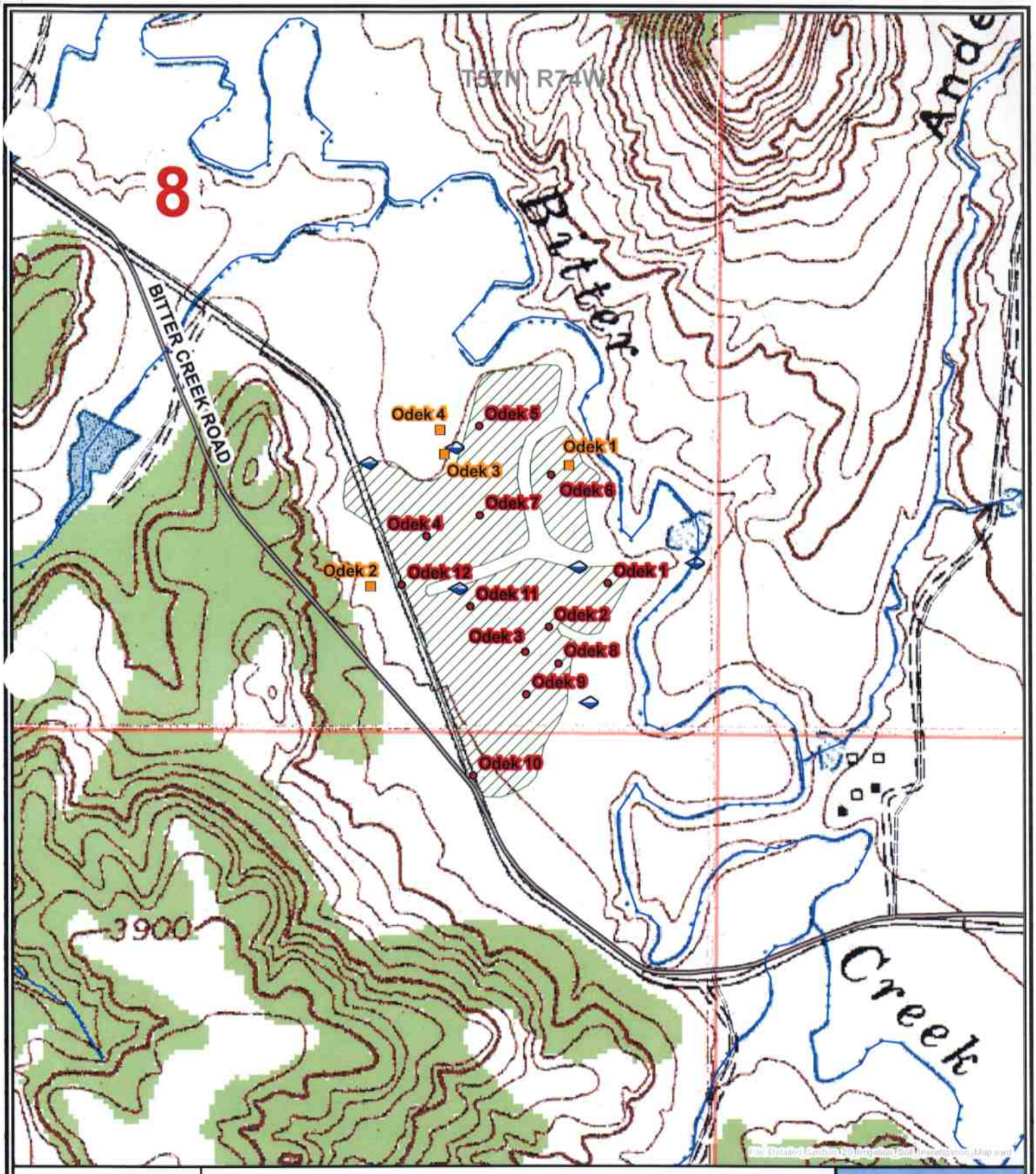
Section 20 Irrigation Soil Investigation Map

- Supplemental Soil Sample Site
- Photo Reference Sites
- Observed Headgate
- Irrigated Area
- USGS NHD Stream Channel
- Existing Unimproved Road
- County Road

N

Scale: 1:7,500

0 100 200 400 Meters



SWCA
ENVIRONMENTAL CONSULTANTS
1043 Coffeen Avenue, Suite D Sheridan, WY 82801
Office: 307.673.4303 Fax: 307.673.4505
www.swca.com

Projection: NAD_1983_UTM_Zone_13N

Author: Wade L Epperson

Date: 9/12/2007

Section 20 Irrigation Soil Investigation Map

- Supplemental Soil Sample Site
- Photo Reference Sites
- Observed Headgate
- Irrigated Area
- USGS NHD Stream Channel
- Existing Unimproved Road
- County Road

N

Scale: 1:7,500

0 100 200 400 Meters

From: Jason Thomas
To: Combs, Ralph
Date: 7/12/2007 10:34 AM
Subject: Bitter Creek Irrigation Protection

CC: DiRienzo, Bill

Hello Ralph-

I have looked through the Section 20 Study for Bitter Creek that you brought in last week. Looks like the consultant did a thorough job and the field notes were particularly helpful. The main issue we have to address is that based on the sampler's observations, Section 36 of T57N - R74W does not appear to have any natural or artificial irrigation going on. The terrain zone defined in the report as Zone 1 would be the closest thing to naturally irrigated lands, but it appears to be very narrow and small in aerial extent. We typically would not consider that to be a protected irrigation use, given its small size. So we have to wonder if Section 36 is representative of other areas along Bitter Creek that may have natural or artificial irrigation going on. Based on the available color infra-red images, these other potential irrigated lands appear to be in Sections 25, 22, 16, 8 and 6 of 57-74; plus maybe Section 1 of 56-74.

The main thing we need to find out is if those other fields actually do receive water from Bitter Creek. If they are all like Section 36 (6-12 ft in elevation above the top of the wetted channel) then we would likely conclude that there is no natural irrigation use occurring with Bitter Creek water, downstream of the project area. We also need to find out what is going on with those spreader dams cited on page 2 of the report. Are they still there? Do they catch water from Bitter Creek? We have seen some areas where there were old spreader dams, but they are no longer used for irrigation because the channel has cut through them and down, making the spreader dams high and non-functional. If that is the case, then we don't worry about them as an artificial irrigation use. Once you get back to us with any details you can gather on the other potentially irrigated areas downstream along Bitter Creek, we can make an assessment of what needs protection and what does not.

If you have any questions, please let us know.

Jason Thomas
WDEQ Water Quality Div.
307-777-5504

>>> "Ralph Combs" <RalphC@termoco.com> 7/11/2007 11:06 AM >>>
Mary-

I just met with Brent from SWCA and we took a look at the GIS photo site that Bill gave me. They are the same photos that SWCA is using to determine ag use, etc. So to answer a question that was asked, Termo's consultants and the DEQ are looking at the same info.

Ralph

Ralph Combs

HSE Specialist

The Termo Company

P.O. Box 7297, Gillette, WY. 82717

1900 W. Warlow, Suite C, Gillette, WY. 82716

M 307.299.0534 / O 307.686.3688 / F 307.686.6004

ralphc@termoco.com <BLOCKED::BLOCKED::mailto:ralphc@termoco.com>

Main Office:

The Termo Company

P.O. Box 2767, Long Beach, CA. 90801

3275 Cherry Avenue, Long Beach, CA 90807

O 888.260.4715 / F 562.426.2730

www.termoco.com <blocked::BLOCKED::http://www.termoco.com>

Section 20 Analysis

Upper Bitter Creek Section 36, T57, R74
Campbell County Wyoming

Prepared By
SWCA Environmental Consultants

For
The Termo Company

Submitted July 2, 2007 to Wyoming Department of Environmental Quality

---

SWCA
ENVIRONMENTAL CONSULTANTS

THE TERMO COMPANY
OIL & GAS EXPLORATION SINCE 1933

SWCA
ENVIRONMENTAL CONSULTANTS

Sheridan Office
1043 Coffeen Ave. Suite D
Sheridan, WY 82801
Tel 307.673.4303 Fax 307.673.4505
www.swca.com

June 28, 2007

Mr. Jason Thomas
Wyoming Department of Environmental Quality
Water Quality Division
Herschler Building, 4W
122 West 25th Street
Cheyenne, WY 82002

RE: The Termo Company's Homestead Draw II Project, WYPDES Permit WY0055158, Section 20 Analysis

Dear Mr. Thomas:

On March 7, 2007 the Wyoming Department of Environmental Quality (WDEQ) issued WYPDES Permit WY055158 to The Termo Company (Termo) for water discharge from their Homestead Draw II coal bed methane project. In this permit, WDEQ established effluent limits based in part on default values that are designed to protect downstream irrigation uses. Based on knowledge of the Bitter Creek drainage, Termo suspects that the default water quality standards may be more restrictive than the natural water quality available in Bitter Creek. Moreover, Termo feels that WDEQ may be attempting to protect irrigation uses that are not occurring on Bitter Creek. Therefore, SWCA Environmental Consultants, on behalf of Termo, and in consultation with WDEQ, have prepared this Tier 2, Section 20 study for Bitter Creek downstream of the Homestead Draw II project, in Section 36, Township 57N, Range 74W. We ask that WDEQ review this study to determine if there are, in fact, irrigation uses downstream of the project area that WDEQ is required to protect, and if there are, if less restrictive effluent limits would be appropriate.

This analysis was developed by following instructions in the Agricultural Use Protection Policy (Chapter 1, Section 20). Termo has had difficulty getting permission to access some of the lands on Bitter Creek downstream of the Homestead Draw II project area. Therefore, we concentrated our efforts on portions of the channel that we had permission to access, which are owned by the State of Wyoming in Section 36, Township 57N, Range 74W. Soil samples were collected in areas that appear to be representative of the conditions of the entire stream channel, as determined by examining aerial photography.

As described in the Section 20 instructions, we have divided the irrigated areas into three zones where soil samples were collected. The first zone (Zone 1) is adjacent to the stream channel where relatively flat, dry ground was present that could produce usable grass. Little of this type of terrain was found in the study area because Bitter Creek often has a deeply incised channel with steep side slopes that end at the wetted channel with few flat, depositional areas. The second zone (Zone 2) is on the first terrace above the

stream channel. These areas include fields that are dry-land farmed for hay crops. The third zone (Zone 3) is the second terrace above the stream channel, and is also dry-land farmed for hay crops. During field reconnaissance, it was discovered that none of the Zone 2 or Zone 3 areas are naturally or artificially irrigated, and only small areas of Zone 1 are present, but are mostly situated such that they are largely non-harvestable. Moreover, in all of our fieldwork in the area, we saw no evidence of any artificial irrigation from the creek, and due to the highly incised condition of the channel, natural flood irrigation is going to be a rare occurrence, only as a result of very large runoff events. There is evidence of some unpermitted spreader dikes on Bitter Creek, downstream of our study area, but due to access limitations, we were unable to ascertain their status or condition. Additionally, there is land permitted for irrigation in Sections 25 and 26, Township 57N, Range 74W with water from Bitter Creek. However, there is no evidence that these lands are being actively irrigated as confirmed by the May 16, 2007 letter from the Wyoming State Engineers Office (attached).

A soil sample was collected at depths of 0 to 12-inches, 13 to 24-inches, 25 to 36-inches, and 37 to 48-inches at each of 12 sampling sites (Site 1-12). Alfalfa was present at Sites 1 and 2, and therefore, according to WDEQ guidance, samples were also collected at 49 to 60-inches, and 61 to 72-inches at those locations. Once all of the samples were collected, samples from like depths from each zone were mixed for a single analysis, (i.e. all 7 samples from Zone 1, depth 0 to 12-inches were combined for a single analysis). The samples were delivered to Energy Laboratories, and analyzed for EC, pH, SAR, soil texture and exchangeable sodium percentage. Percent organic matter was analyzed in the 0-12 inch samples only. The results of those analyses are included here. Photographs and verbal descriptions of each site are also included with this letter.

Although this Tier 2, Section 20 analysis focused on the use of soil chemistry to ascertain the quality of historic irrigation water to protect current irrigation uses, WDEQ should consider whether protecting irrigation uses is appropriate given the lack of current irrigation activity. Additionally, since it is apparent that none of the land adjacent to the creek is being irrigated by Bitter Creek, these lands are only being irrigated by natural precipitation which is almost certainly of better quality than the water in the creek. Given this situation, WDEQ's attempts to qualify historic Bitter Creek water quality from soil data may be misleading.

Therefore, SWCA, on behalf of Termo, respectfully requests that WDEQ review these data to determine to what extent irrigation protection is needed, and assess the historic water quality of Bitter Creek based on the soils data, and then reassign discharge water quality standards for WYPDES permit WY0055158 accordingly.

If you have any questions, or need additional information, please feel free to contact Brent Sobotka at (307) 673-4303, or e-mail bsobotka@swca.com.

Respectfully,

Brent Sobotka

Brent Sobotka
Hydrologist

The Termo Company, Homestead Draw II, Section 20, Tier-2
Soil Sampling Site Summaries and Descriptions

Field work was conducted on June 11, 2007 by Brent Sobotka and Jamie Martin of SWCA Environmental Consultants of Sheridan, WY.

Zone Descriptions:

Zone 1 was adjacent to the stream channel where relatively flat, dry ground was present that could produce usable grass.

Zone 2 was on the first terrace above the stream channel.

Zone 3 was the second terrace above the channel.

Further zone descriptions are available on the cover letter submitted with this document.

Soil sampling Site 1 was located in the NW¼ NW¼ of Section 36, Township 57 North, Range 74 West. This site was located on a Zone 2 terrace about 8-feet from the west edge of the Bitter Creek channel incision. The site is vegetated with hay grasses, cheat grass and 10-20% alfalfa. Soil samples were collected at depths of 0 to 12-inches, 13 to 24-inches, 25 to 36-inches, and 37 to 48-inches. Since alfalfa is present, additional samples were collected at 49 to 60-inches, and 61 to 72-inches. This Zone 2 terrace is approximately 7-feet higher in elevation than the top of the wetted channel. The soils here are largely clayic and were mostly wet at the time of sampling. The soils were wettest within a few inches of the surface as a result of recent precipitation. Soil moisture declined through the first 3-feet and was mostly dry below that. Visual analysis of site topography suggests that overbank flows which provide natural flood irrigation are rare. The 7-foot channel incision at the site and the fact that the soils appear to become dryer with depth, suggests that Bitter Creek may not be supplying much subsurface irrigation water to the site. Additionally, there is no evidence that the area is being artificially irrigated by the grazing lessee.

Figure 1 Site 1, Zone 2, Looking Downstream

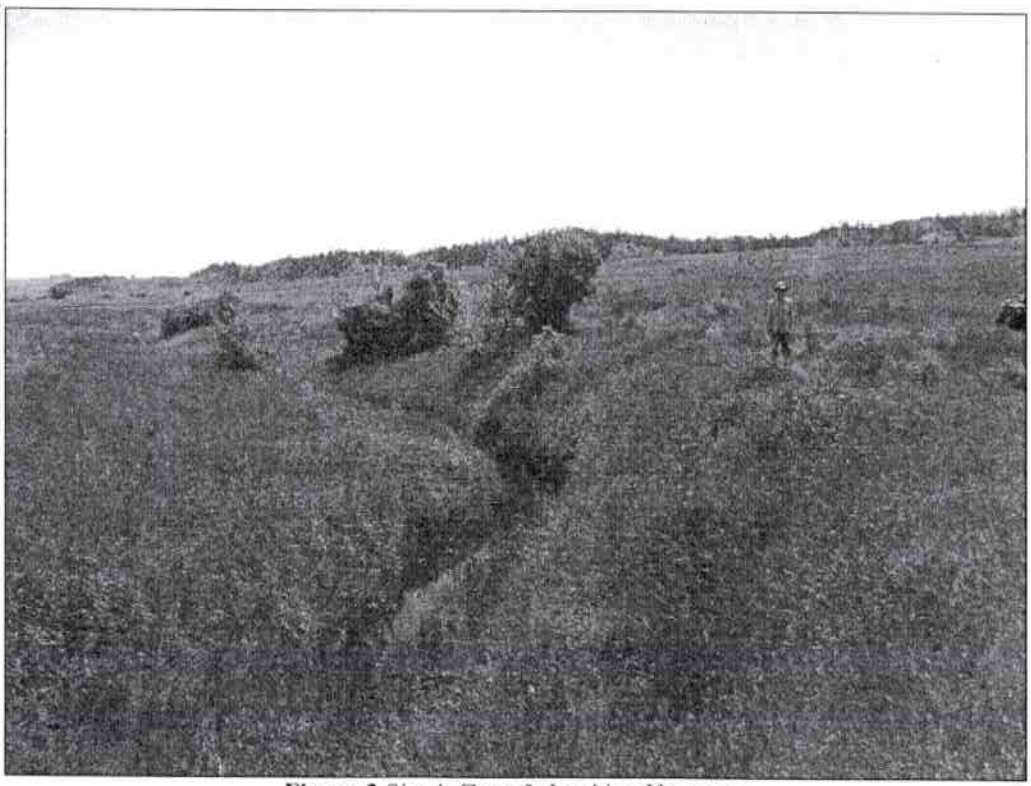


Figure 2 Site 1, Zone 2, Looking Upstream

Soil sampling Site 2 was located in the NW¼ NW¼ of Section 36, Township 57 North, Range 74 West. This site is on a Zone 3 terrace about 170-feet west of Site 1. The site is vegetated with hay grasses, cheat grass, and 10-20% alfalfa. Soil samples were collected at depths of 0 to 12-inches, 13 to 24-inches, 25 to 36-inches, and 37 to 48-inches. Since alfalfa is present, additional samples were collected at 49 to 60-inches, and 61 to 72-inches. The soils here are largely clayic and were mostly wet at the time of sampling. The soils were wettest within a few inches of the surface as a result of recent precipitation. Soil moisture declined through the first 3-feet and the soil was mostly dry below that point. This Zone 3 terrace only had a slight elevation gain over the Zone 2 terrace at site 1. There was no indication of flood flow impacts near the terrace in recent years, and there is no evidence that the area is being artificially irrigated by the grazing lessee.

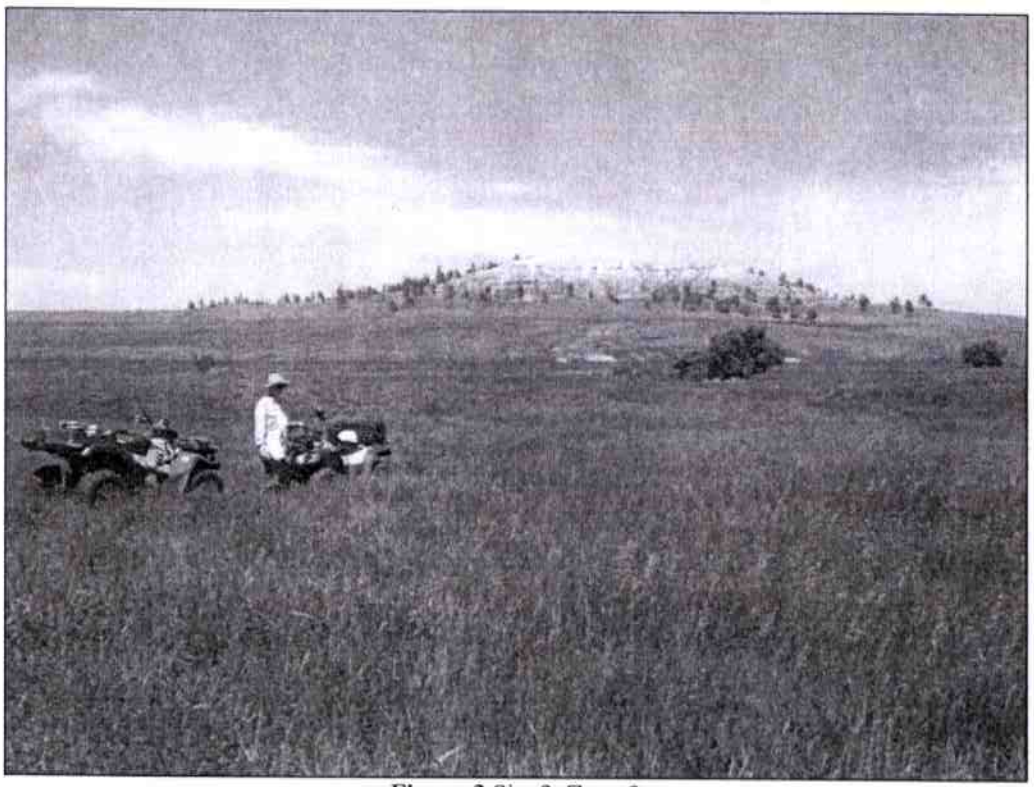


Figure 3 Site 2, Zone 3

Soil sampling Site 3 was located in the SE¼ NW¼ of Section 36, Township 57 North, Range 74 West, about 1390 feet south of Site 1. This site was located on a Zone 2 terrace about 8-feet west of the Bitter Creek channel incision edge,. The site is vegetated with hay grasses and cheat grass, but no alfalfa. Soil samples were collected at depths of 0 to 12-inches, 13 to 24-inches, 25 to 36-inches, and 37 to 48-inches. This Zone 2 terrace is approximately 10-feet higher in elevation than the top of the wetted channel. The soils here are largely clayic and were mostly wet at the time of sample collection. The soils were wettest within a few inches of the surface as a result of recent precipitation. Soil moisture declined through the first 3-feet and below that point the soil was mostly dry. Visual analysis of the site topography suggests that overbank flows which provide natural flood irrigation are rare. The 10-foot channel incision at the site and the fact that the soils appear to become dryer with depth, suggests that Bitter Creek may not be supplying much subsurface irrigation water to the site. Additionally, there is no evidence that the area is being artificially irrigated by the grazing lessee.

Figure 4 Site 3, Zone 2, Looking Downstream

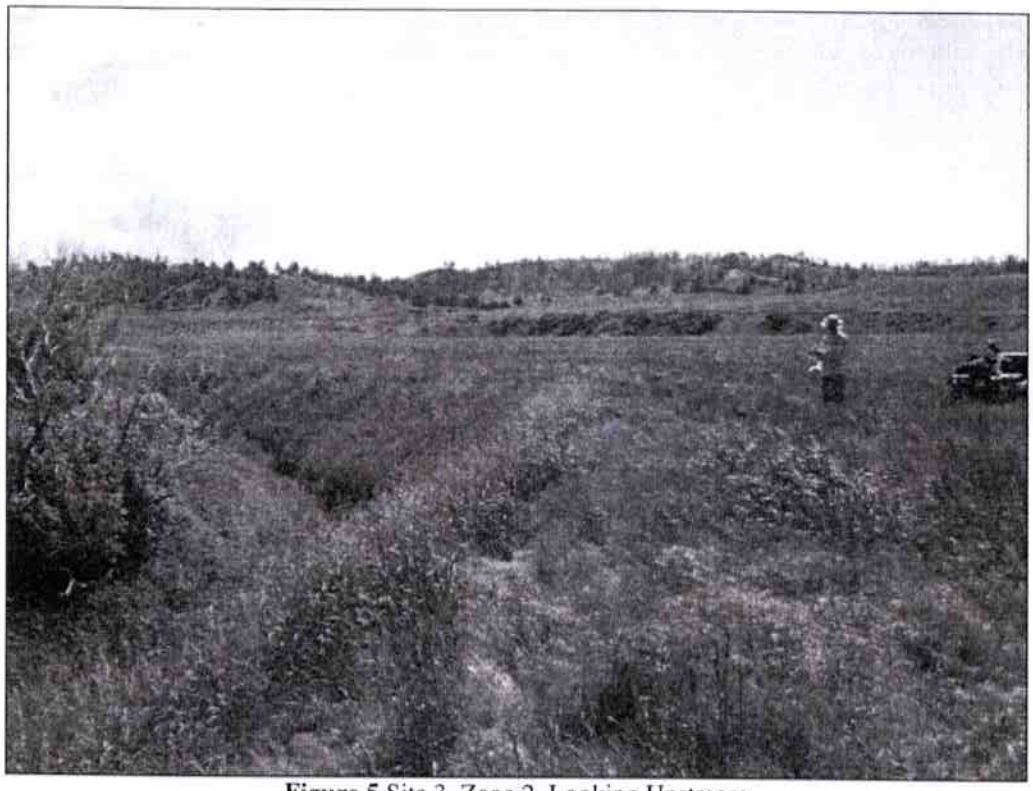


Figure 5 Site 3, Zone 2, Looking Upstream

Soil sampling Site 4 was located in the SW¼ NW¼ of Section 36, Township 57 North, Range 74 West, about 340 feet west of Site 3. The site is vegetated with hay grasses and cheat grass, but no alfalfa. Soil samples were collected at depths of 0 to 12-inches, 13 to 24-inches, 25 to 36-inches, and 37 to 48-inches. The soils here are largely clayic and were mostly wet at the time of sample collection. The soils were wettest within a few inches of the surface as a result of recent precipitation. Soil moisture declined through the first 3-feet and was mostly dry below that. This Zone 3 terrace only had a slight elevation gain over the Zone 2 terrace at site 3. There was no indication of flood flow impacts near the terrace in recent years, and there is no evidence of artificial irrigation by the grazing lessee.

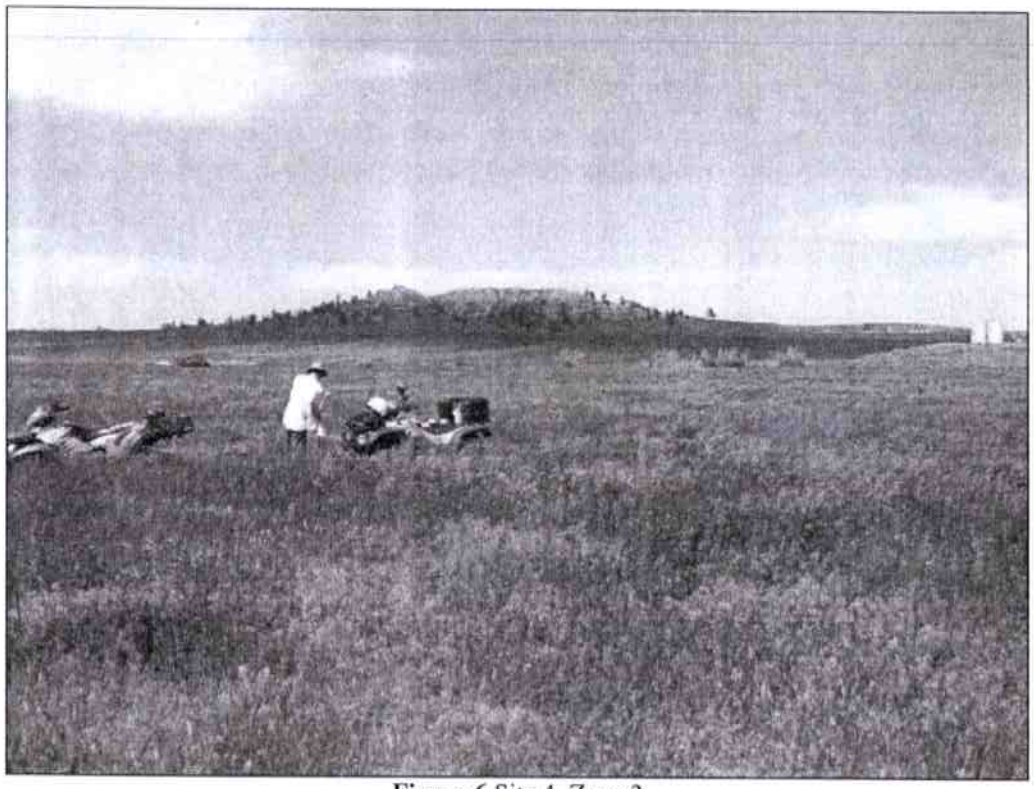


Figure 6 Site 4, Zone 3

Soil sampling Site 5 was located in the NE¼ SW¼ of Section 36, Township 57 North, Range 74 West, about 1350 feet south of Site 3. This site was located on a Zone 2 terrace about 8-feet from the edge of the Bitter Creek channel incision, and on the west side of the creek. The site is vegetated with hay grasses and cheat grass, but no alfalfa. Soil samples were collected at depths of 0 to 12-inches, 13 to 24-inches, 25 to 36-inches, and 37 to 48-inches. This Zone 2 terrace is approximately 12-feet higher in elevation than the top of the wetted channel. The soils here are largely clayic and were mostly wet at the time of sampling. The soils were wettest within a few inches of the surface as a result of recent precipitation. Soil moisture declined through the first 3-feet and was mostly dry below that. Visual analysis of the site topography suggests that overbank flows which provide natural flood irrigation are rare. The 12-foot channel incision at the site and the fact that the soils appear to become dryer with depth, suggests that Bitter Creek may not be supplying much subsurface irrigation water to the site. Additionally, there is no evidence that the area is being artificially irrigated by the grazing lessee.

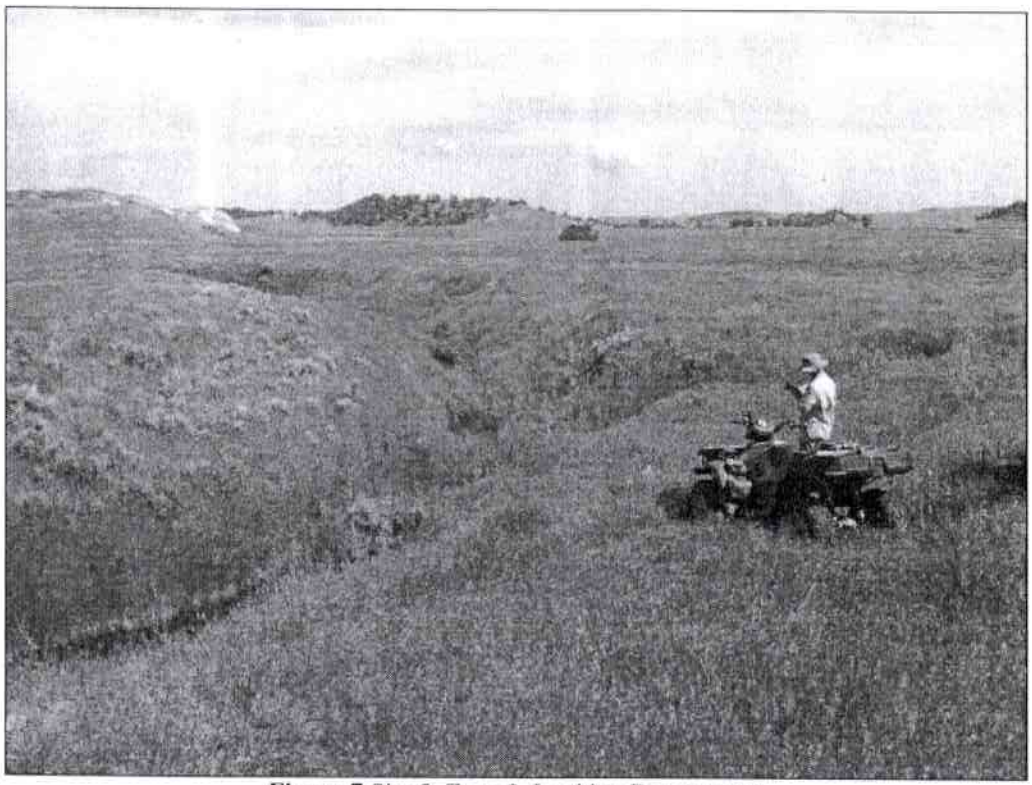


Figure 7 Site 5, Zone 2, Looking Downstream

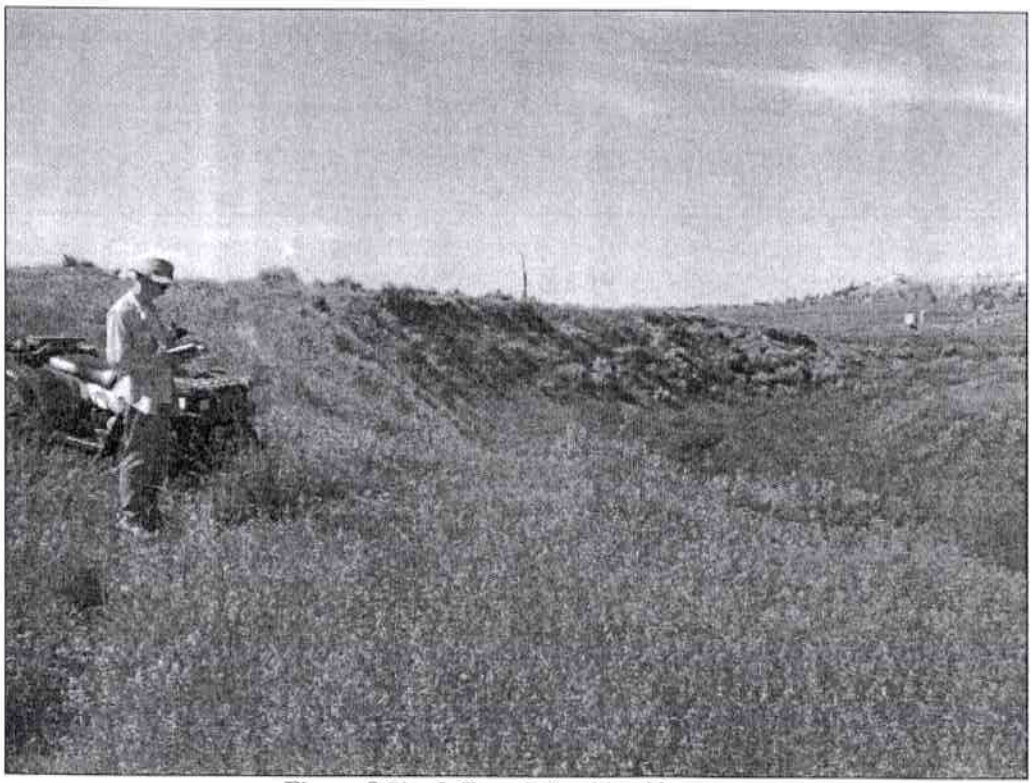


Figure 8 Site 5, Zone 2, Looking Upstream

Soil sampling Site 6 was located in the NW¼ SW¼ of Section 36, Township 57 North, Range 74 West, about 80 feet west of Site 5. The site is vegetated with hay grasses and cheat grass, but no alfalfa. Soil samples were collected at depths of 0 to 12-inches, 13 to 24-inches, 25 to 36-inches, and 37 to 48-inches. The soils here are largely clayic and were mostly wet at the time of sample collection. The soils were wettest within a few inches of the surface as a result of recent precipitation. Soil moisture declined through the first 3-feet and was dryer below that. This Zone 3 terrace had about a 10-foot elevation gain over the Zone 2 terrace at site 5. There was no indication that there has been any flood flow impacts near the terrace in recent years, and there is no evidence that the area is being artificially irrigated by the grazing lessee.

Figure 9 Site 6, Zone 3

Soil sampling Site 7 was located in the NE¼ SW¼ of Section 36, Township 57 North, Range 74 West, about 770 feet south of Site 5. This site was located on a Zone 1 terrace about 5-feet from the wetted edge of the Bitter Creek channel. The sampling site is vegetated with hay grasses and cheat grass, but no alfalfa, and the creek channel is vegetated with cattails. Soil samples were collected at depths of 0 to 12-inches, 13 to 24-inches, 25 to 36-inches, and 37 to 48-inches. The sampling site is approximately 1-foot higher in elevation than the top of the wetted channel. The soils here are largely clayic and were very wet at the time of sample collection. The soils near the surface were gleyed, indicating an anaerobic condition. Visual analysis of the site topography suggests that this area is occasionally exposed to out-of-channel flows that provide natural flood irrigation, however the site is small and situated such that it would be difficult to cut hay on.

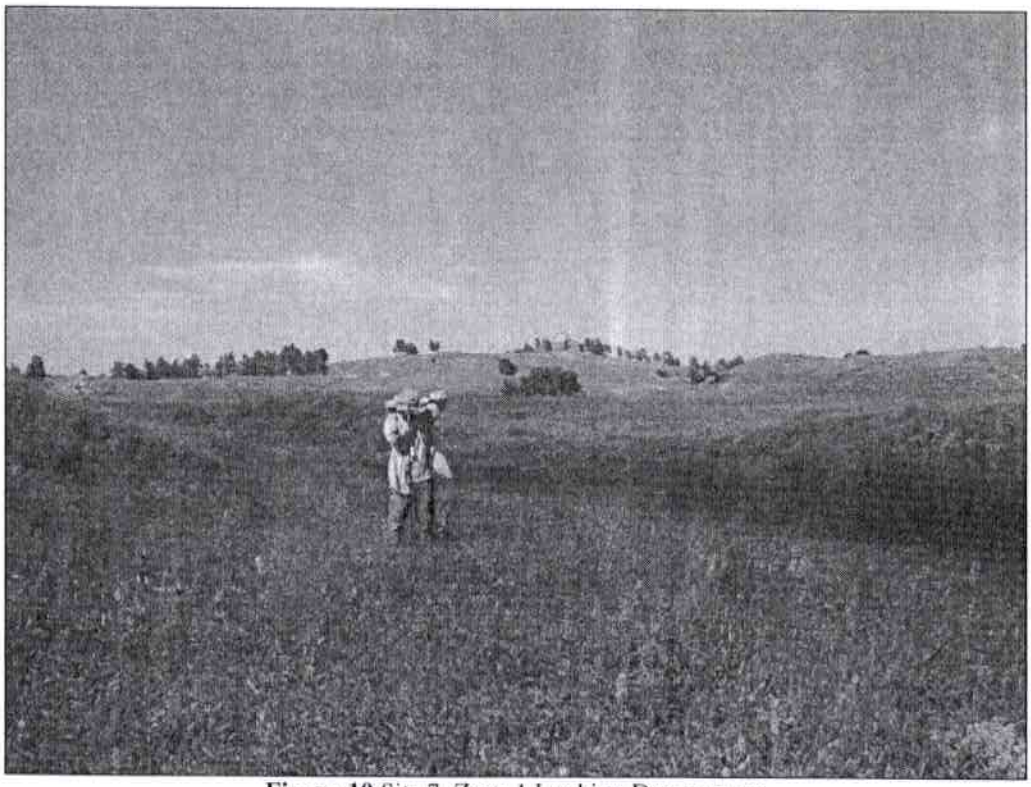


Figure 10 Site 7, Zone 1 Looking Downstream

Figure 11 Site 7, Zone 1 Looking Upstream

Soil sampling Site 8 was located in the NE¼ SW¼ of Section 36, Township 57 North, Range 74 West, about 30 feet north-west of Site 7. This site was located on a Zone 2 terrace about 35-feet from the edge of the Bitter Creek wetted channel, and on the north side of the creek. The site is vegetated with hay grasses and cheat grass, but no alfalfa. Soil samples were collected at depths of 0 to 12-inches, 13 to 24-inches, 25 to 36-inches, and 37 to 48-inches. This Zone 2 terrace is approximately 6-feet higher in elevation than the top of the wetted channel. The soils here are largely clayic and were mostly wet at the time of sample collection. The soils were wettest within a few inches of the surface as a result of recent precipitation. Soil moisture declined slightly the first 3-feet and was moist throughout the entire soil profile. Visual analysis of the site topography suggests that overbank flows that provide natural flood irrigation may occur occasionally, but there is no evidence of recent flooding. Additionally, there is no evidence that the area is being artificially irrigated by the grazing lessee.

Figure 12 Site 8, Zone 2 Looking Downstream

Figure 13 Site 8, Zone 2 Looking Upstream

Soil sampling Site 9 was located in the NE¼ SW¼ of Section 36, Township 57 North, Range 74 West, about 190 feet north-west of Site 8. The site is vegetated with hay grasses and cheat grass, but no alfalfa. Soil samples were collected at depths of 0 to 12-inches, 13 to 24-inches, 25 to 36-inches, and 37 to 48-inches. The soils here are largely clayic and were mostly wet at the time of sample collection. The soils were wettest within a few inches of the surface as a result of recent precipitation. Soil moisture declined through the first 3-feet and was dryer throughout the remainder of the soil profile. This Zone 3 terrace is about 6-feet higher in elevation than the Zone 2 terrace at Site 8. There was no indication that there has been any flood flow impacts near the terrace in recent years, and there is no evidence that the area is being artificially irrigated by the grazing lessee.

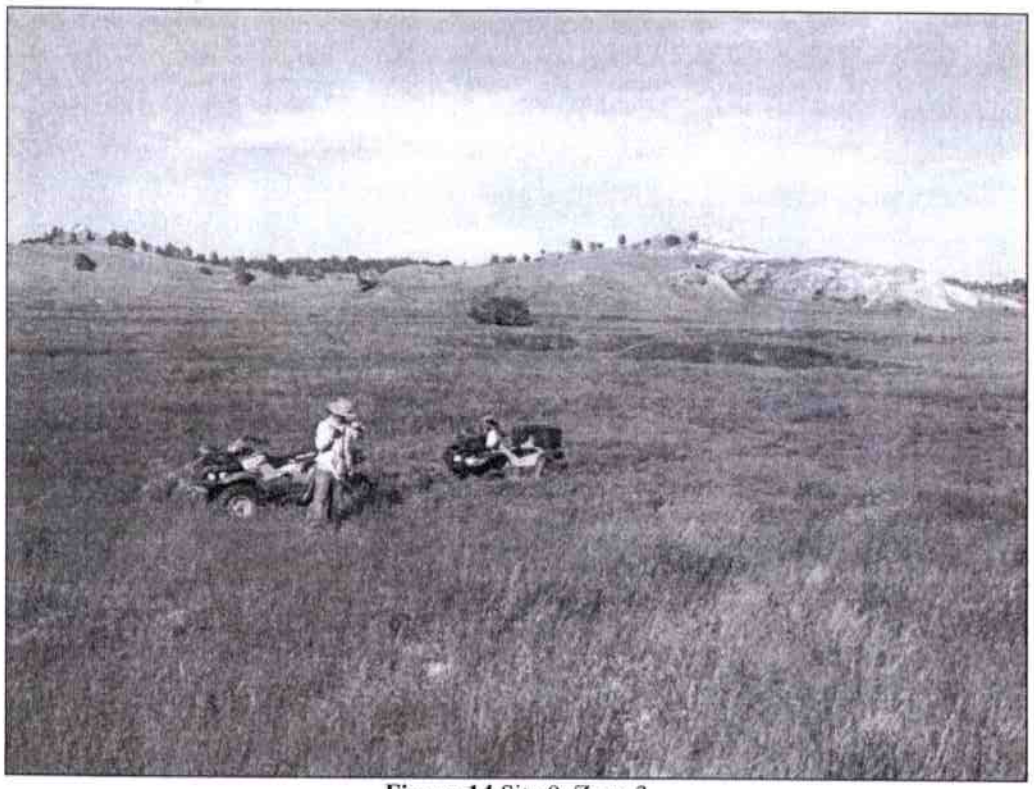


Figure 14 Site 9, Zone 3

Soil sampling Site 10 was located in the SE¼ SW¼ of Section 36, Township 57 North, Range 74 West, about 1180 feet south-east of Site 7. This site was located on a Zone 1 terrace about 8-feet from the wetted edge of the Bitter Creek channel. The sampling site is vegetated with hay grasses and cheat grass, but no alfalfa, and the creek channel is vegetated with cattails. Soil samples were collected at depths of 0 to 12-inches, 13 to 24-inches, 25 to 36-inches, and 37 to 48-inches. The sampling site is approximately 3-foot higher in elevation than the top of the wetted channel. The soils here are largely clayic and were very wet at the time of sample collection. The soils near the surface were gleyed, indicating an anaerobic condition. Visual analysis of the site topography suggests that this area is occasionally naturally irrigated by out-of-channel flows, however the site is small and situated such that it would be difficult to cut hay on.

Figure 15 Site 10, Zone 1 Looking Downstream

Figure 16 Site 10, Zone 1 Looking Downstream

Soil sampling Site 11 was located in the SE¼ SW¼ of Section 36, Township 57 North, Range 74 West, about 30 feet north-west of Site 10. This site was located on a Zone 2 terrace about 40-feet from the edge of the Bitter Creek wetted channel, and on the north side of the creek. The site is vegetated with hay grasses and cheat grass, but no alfalfa. Soil samples were collected at depths of 0 to 12-inches, 13 to 24-inches, 25 to 36-inches, and 37 to 48-inches. This Zone 2 terrace is approximately 8-feet higher in elevation than the top of the wetted channel. The soils here are largely clayic and were mostly wet at the time of sample collection. The soils were wettest within a few inches of the surface as a result of recent precipitation. Soil moisture declined slightly the first 3-feet and was moist throughout the entire soil profile. Visual analysis of the site topography suggests that natural flood irrigation from overbank flows may occur occasionally, but there is no evidence of recent flooding. Additionally, there is no evidence of artificial irrigation by the grazing lessee.

Figure 17 Site 11, Zone 2

Soil sampling Site 12 was located in the SE¼ SW¼ of Section 36, Township 57 North, Range 74 West, about 180 feet south-west of Site 11. The site is vegetated with hay grasses and cheat grass, but no alfalfa. Soil samples were collected at depths of 0 to 12-inches, 13 to 24-inches, 25 to 36-inches, and 37 to 48- inches. The soils here are largely clayic and were mostly wet at the time of sample collection. The soils were wettest within a few inches of the surface as a result of recent precipitation. Soil moisture declined through the first 3-feet and the remainder of the soil profile was mostly dry. This Zone 3 terrace is about 6-feet here in elevation than the Zone 2 terrace at Site 11. There was no indication of flood flow impacts near the terrace in recent years, and there is no evidence of artificial irrigation by the grazing lessee.

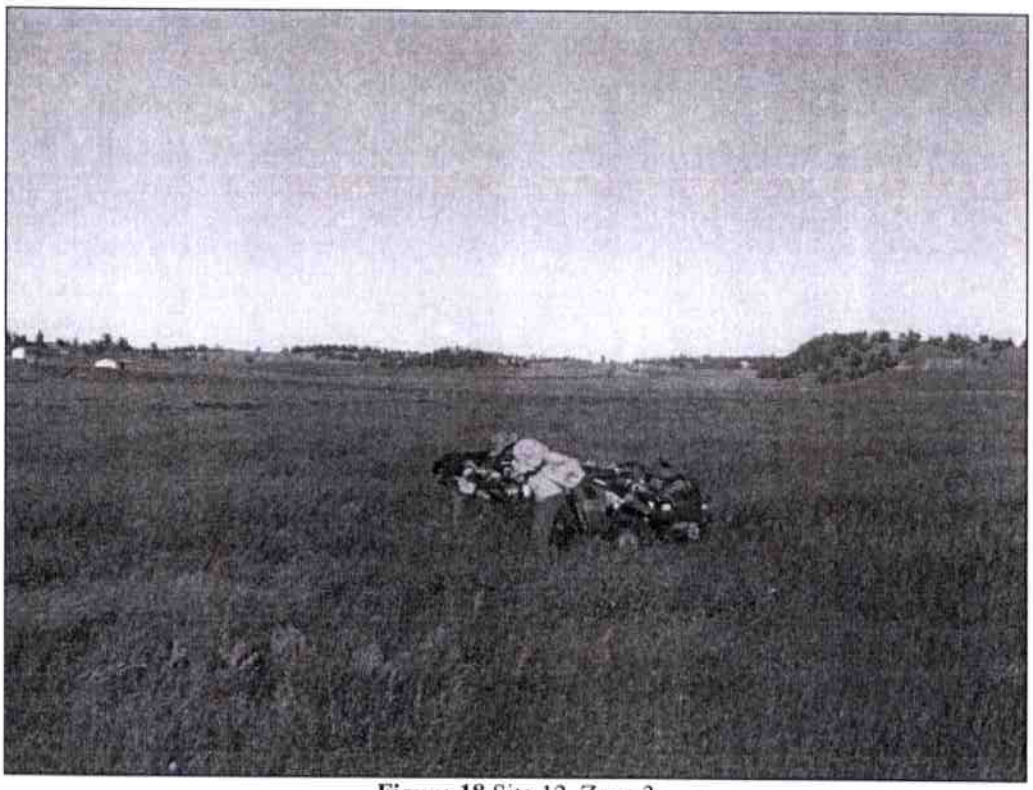


Figure 18 Site 12, Zone 3

ENERGY LABORATORIES, INC. • P.O. Box 3 161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 fa... .ielena@energylab.com

LABORATORY ANALYTICAL REPORT

Client: SWCA Environmental Consultants Inc
Project: Homestead Draw II Section 20 Analysis
Workorder: H07060138

Report Date: 06/20/07
Date Received: 06/14/07

		Analysis		pH-SatPst	COND	Percent Sat	SAR	Ca-SatPst	Mg-SatPst	Na-SatPst	Sand	Silt	Clay	Texture
		Units		s_u_	mmhos/cm	%	unitless	meq/l	meq/l	meq/l	%	%	%	unitless
Sample ID	Client Sample ID	Up	Low	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results	Results
H07060138-001	1A	0	0	7.0	3.05	72.8	0.73	23.3	15.2	3.22	14	52	34	SiCL
H07060138-002	1B	0	0	7.5	5.63	49.4	4.1	27.4	30.1	21.9	38	34	28	CL
H07060138-003	1C	0	0	7.5	4.78	50.6	3.5	25.8	23.4	17.5	30	42	28	CL
H07060138-004	1D	0	0	7.4	5.30	37.8	3.8	27.9	27.2	20.2	49	29	22	L
H07060138-005	2A	0	0	7.3	0.69	52.5	0.83	3.44	1.80	1.34	21	47	32	CL
H07060138-006	2B	0	0	7.6	4.72	47.3	5.1	20.1	19.5	22.8	27	43	30	CL
H07060138-007	2C	0	0	7.9	8.46	52.4	9.3	18.3	46.1	53.3	22	44	34	CL
H07060138-008	2D	0	0	7.9	8.51	47.0	8.6	21.6	44.5	49.2	26	42	32	CL
H07060138-009	2E	0	0	8.0	8.60	43.7	13	17.1	33.9	65.2	40	35	25	L
H07060138-010	2F	0	0	7.9	8.32	41.5	9.6	20.1	42.2	53.5	50	28	22	L
H07060138-011	3A	0	0	7.3	0.66	58.1	0.59	3.18	2.03	0.96	8	54	38	SiCL
H07060138-012	3B	0	0	7.7	3.45	60.4	3.1	15.3	16.6	12.5	< 1	57	43	SiC
H07060138-013	3C	0	0	8.1	13.1	64.8	14	19.8	83.2	97.0	2	55	43	SiC
H07060138-014	3D	0	0	8.1	14.0	69.9	15	20.3	94.2	113	1	55	44	SiC
H07060138-015	3E	0	0	8.0	12.2	52.3	16	20.5	60.8	100	14	48	38	SiCL
H07060138-016	3F	0	0	8.0	11.0	55.4	14	18.5	55.3	83.3	18	42	40	SiC

ENERGY LABORATORIES, INC. • P.O. Box : 161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 f. helena@energylab.com

LABORATORY ANALYTICAL REPORT

Client: SWCA Environmental Consultants Inc
Project: Homestead Draw II Section 20 Analysis
Workorder: H07060138

Report Date: 06/20/07
Date Received: 06/14/07

		Analysis		OM-WB	CEC	Na-Ext	Exch Na	ESP
		Units		%	meq/100g	meq/100g	meq/100g	%
Sample ID	Client Sample ID	Up	Low	Results	Results	Results	Results	Results
H07060138-001	1A	0	0	7.26	34.9	0.81	0.6	1.7
H07060138-002	1B	0	0		23.6	2.35	1.3	5.4
H07060138-003	1C	0	0		22.6	2.22	1.3	5.9
H07060138-004	1D	0	0		20.1	2.17	1.4	7.0
H07060138-005	2A	0	0	3.68	28.2	0.55	0.5	1.7
H07060138-006	2B	0	0		21.4	2.41	1.3	6.2
H07060138-007	2C	0	0		23.1	6.13	3.3	14
H07060138-008	2D	0	0		21.8	5.05	2.7	13
H07060138-009	2E	0	0		18.9	6.54	3.7	20
H07060138-010	2F	0	0		19.2	4.21	2.0	10
H07060138-011	3A	0	0	3.61	29.6	0.66	0.6	2.0
H07060138-012	3B	0	0		21.6	2.16	1.4	6.5
H07060138-013	3C	0	0		16.8	10.5	4.2	25
H07060138-014	3D	0	0		22.3	12.9	5.0	22
H07060138-015	3E	0	0		22.8	9.71	4.5	20
H07060138-016	3F	0	0		21.9	9.12	4.5	20

ENERGY LABORATORIES, INC. • P.O. Box 5688 • 3161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

QA/QC Summary Report

Client: SWCA Environmental Consultants Inc
Project: Homestead Draw II Section 20 Analysis

Report Date: 06/20/07
Work Order: H07060138

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: ASA15-5									Batch: 3412
Sample ID: H07060138-010ADUP	Sample Duplicate				Run: MISC SOILS_070619B				06/15/07 08:16
Sand	50	%	1.0				0.0	30	
Silt	28	%	1.0				0.0	30	
Clay	22	%	1.0				0.0	30	
Method: ASA29-3									Batch: 3410
Sample ID: LCS0706180949	Laboratory Control Sample				Run: MISC SOILS_070618B				06/18/07 09:49
Organic Matter	1.93	%	0.020	101	70	130			
Sample ID: MBLK0706180949	Method Blank				Run: MISC SOILS_070618B				06/18/07 09:49
Organic Matter	ND	%	0.009						
Method: ASAM10-3									Batch: 3405
Sample ID: H07060138-010ADUP	Sample Duplicate				Run: MISC SOILS_070619B				06/15/07 08:16
Conductivity, sat. paste	8.15	mmhos/cm	0.010				2.1	30	
Sample ID: LCS	Laboratory Control Sample				Run: MISC SOILS_070619B				06/15/07 08:16
Conductivity, sat. paste	5.05	mmhos/cm	0.010	107	70	130			
Method: ASAM10-3.2									Batch: 3405
Sample ID: H07060138-010ADUP	Sample Duplicate				Run: MISC SOILS_070619B				06/15/07 08:16
pH, sat. paste	7.91	s.u.	0.10				0.1	30	
Sample ID: LCS	Laboratory Control Sample				Run: MISC SOILS_070619B				06/15/07 08:16
pH, sat. paste	7.15	s.u.	0.10	96	80	120			
Method: Calculation									Batch: R38034
Sample ID: H07060138-010ADUP	Sample Duplicate				Run: MISC SOILS_070619B				06/15/07 08:16
Exchangeable Sodium	2.42	meq/100g	0.10				20	30	
Sample ID: H07060138-010ADUP	Sample Duplicate				Run: MISC SOILS_070619B				06/15/07 08:16
Sodium Adsorption Ratio (SAR)	9.4	unitless	0.010				1.9	30	
Sample ID: LCS	Laboratory Control Sample				Run: MISC SOILS_070619B				06/15/07 08:16
Sodium Adsorption Ratio (SAR)	6.7	unitless	0.010	94	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. • P.O. Box 5688 • 3161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

QA/QC Summary Report

Client: SWCA Environmental Consultants Inc
Project: Homestead Draw II Section 20 Analysis

Report Date: 06/20/07
Work Order: H07060138

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B								Analytical Run: ICP1-HE_070618A	
Sample ID: CCV	Continuing Calibration Verification Standard								06/18/07 15:37
Calcium	232	mg/L	1.0	93	90	110			
Magnesium	228	mg/L	1.0	91	90	110			
Sodium	239	mg/L	1.0	96	90	110			
Calcium, sat. paste	11.6	meq/L	0.050	93	90	110			
Magnesium, sat. paste	18.7	meq/L	0.082	91	90	110			
Sodium, sat. paste	10.4	meq/L	0.044	96	90	110			
Sample ID: CCB	Continuing Calibration Blank								06/18/07 15:40
Calcium	0.00570	mg/L	1.0						
Magnesium	0.186	mg/L	1.0						
Sodium	0.669	mg/L	1.0						
Calcium, sat. paste	0.000284	meq/L	0.050						
Magnesium, sat. paste	0.0153	meq/L	0.082						
Sodium, sat. paste	0.0291	meq/L	0.044						
Sample ID: CCV	Continuing Calibration Verification Standard								06/18/07 16:09
Calcium	229	mg/L	1.0	92	90	110			
Sodium	236	mg/L	1.0	94	90	110			
Calcium, sat. paste	11.4	meq/L	0.050	92	90	110			
Sodium, sat. paste	10.3	meq/L	0.044	94	90	110			
Sample ID: CCB	Continuing Calibration Blank								06/18/07 16:12
Calcium	0.00570	mg/L	1.0						
Magnesium	0.191	mg/L	1.0						
Sodium	0.700	mg/L	1.0						
Calcium, sat. paste	0.000284	meq/L	0.050						
Magnesium, sat. paste	0.0158	meq/L	0.082						
Sodium, sat. paste	0.0304	meq/L	0.044						
Sample ID: CCV	Continuing Calibration Verification Standard								06/18/07 16:29
Calcium	230	mg/L	1.0	92	90	110			
Sodium	237	mg/L	1.0	95	90	110			
Calcium, sat. paste	11.5	meq/L	0.050	92	90	110			
Sodium, sat. paste	10.3	meq/L	0.044	95	90	110			
Sample ID: CCB	Continuing Calibration Blank								06/18/07 16:31
Calcium	0.00570	mg/L	1.0						
Magnesium	0.191	mg/L	1.0						
Sodium	0.674	mg/L	1.0						
Calcium, sat. paste	0.000284	meq/L	0.050						
Magnesium, sat. paste	0.0157	meq/L	0.082						

Qualifiers:

RL - Analyte reporting limit

ND - Not detected at the reporting limit

ENERGY LABORATORIES, INC. • P.O. Box 5688 • 3161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

QA/QC Summary Report

Client: SWCA Environmental Consultants Inc
Project: Homestead Draw II Section 20 Analysis

Report Date: 06/20/07
Work Order: H07060138

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B									Analytical Run: ICP1-HE_070618A
Sample ID: CCB	Continuing Calibration Blank								06/18/07 16:31
Sodium, sat. paste	0.0293	meq/L	0.044						
Method: SW6010B									Batch: 3405
Sample ID: LCS	Laboratory Control Sample				Run: ICP1-HE_070618A				06/18/07 15:16
Calcium	482	mg/L	1.0	98	80	120			
Magnesium	131	mg/L	1.0	88	80	120			
Sodium	641	mg/L	1.0	92	80	120			
Calcium, sat. paste	24.0	meq/L	0.050	98	80	120			
Magnesium, sat. paste	10.7	meq/L	0.082	89	80	120			
Sodium, sat. paste	27.9	meq/L	0.044	92	80	120			
Sample ID: H07060138-010ADUP	Sample Duplicate				Run: ICP1-HE_070618A				06/18/07 15:53
Calcium	372	mg/L	1.0				7.7	30	
Magnesium	487	mg/L	1.0				5.2	30	
Sodium	1170	mg/L	1.0				4.9	30	
Calcium, sat. paste	18.6	meq/L	0.050				7.7	30	
Magnesium, sat. paste	40.1	meq/L	0.082				5.2	30	
Sodium, sat. paste	50.9	meq/L	0.044				4.9	30	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. • P.O. Box 5688 • 3161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

QA/QC Summary Report

Client: SWCA Environmental Consultants Inc
Project: Homestead Draw II Section 20 Analysis

Report Date: 06/20/07
Work Order: H07060138

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B								Analytical Run: ICP1-HE_070618A	
Sample ID: CCV	Continuing Calibration Verification Standard								06/18/07 14:33
Sodium	237	mg/kg	1.0	95	90	110			
Cation Exchange Capacity	20.6	meq/100g	0.087	98	90	110			
Sample ID: CCB	Continuing Calibration Blank								06/18/07 14:36
Sodium	0.970	mg/kg	1.0						
Cation Exchange Capacity	0.0844	meq/100g	0.087						
Sample ID: CCV	Continuing Calibration Verification Standard								06/18/07 15:05
Sodium	234	mg/kg	1.0	93	90	110			
Cation Exchange Capacity	20.3	meq/100g	0.087	97	90	110			
Sample ID: CCB	Continuing Calibration Blank								06/18/07 15:08
Sodium	1.01	mg/kg	1.0						
Cation Exchange Capacity	0.0879	meq/100g	0.087						
Method: SW6010B									Batch: 3406
Sample ID: LCS-3406	Laboratory Control Sample				Run: ICP1-HE_070618A				06/18/07 14:11
Sodium	293	mg/kg	1.0	93	80	120			
Cation Exchange Capacity	25.5	meq/100g	0.087	93	80	120			
Sample ID: H07060138-010ADUP	Sample Duplicate				Run: ICP1-HE_070618A				06/18/07 14:47
Sodium	215	mg/kg	1.0				2.8	30	
Cation Exchange Capacity	18.7	meq/100g	0.087				2.8	30	
Sample ID: H07060138-015AMS	Sample Matrix Spike				Run: ICP1-HE_070618A				06/18/07 15:03
Sodium	349	mg/kg	1.0	88	70	130			
Cation Exchange Capacity	30.4	meq/100g	0.087	88	70	130			
Sample ID: H07060138-015AMSD	Sample Matrix Spike Duplicate				Run: ICP1-HE_070618A				06/18/07 15:11
Sodium	361	mg/kg	1.0	100	70	130	3.4	30	
Cation Exchange Capacity	31.4	meq/100g	0.087	100	70	130	3.4	30	

Qualifiers:

RL - Analyte reporting limit

ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. • P.O. Box 5688 • 3161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

QA/QC Summary Report

Client: SWCA Environmental Consultants Inc
Project: Homestead Draw II Section 20 Analysis

Report Date: 06/20/07
Work Order: H07060138

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW6010B								Analytical Run: ICP1-HE_070618A	
Sample ID: CCV	Continuing Calibration Verification Standard								06/18/07 13:29
Sodium	245	mg/kg	1.0	98	90	110			
Sodium, Extractable	10.6	meq/100g	0.044	98	90	110			
Sample ID: CCB	Continuing Calibration Blank								06/18/07 13:31
Sodium	0.905	mg/kg	1.0						
Sodium, Extractable	0.0394	meq/100g	0.044						
Sample ID: CCV	Continuing Calibration Verification Standard								06/18/07 14:01
Sodium	238	mg/kg	1.0	95	90	110			
Sodium, Extractable	10.4	meq/100g	0.044	95	90	110			
Sample ID: CCB	Continuing Calibration Blank								06/18/07 14:03
Sodium	0.852	mg/kg	1.0						
Sodium, Extractable	0.0371	meq/100g	0.044						
Method: SW6010B									Batch: 3407
Sample ID: MB-3407	Method Blank				Run: ICP1-HE_070618A				06/18/07 13:05
Sodium	7	mg/kg	0.02						
Sodium, Extractable	0.3	meq/100g	0.0009						
Sample ID: LCS-3407	Laboratory Control Sample				Run: ICP1-HE_070618A				06/18/07 13:07
Sodium	75.5	mg/kg	1.0	106	80	120			
Sodium, Extractable	3.28	meq/100g	0.044	106	80	120			
Sample ID: H07060138-010ADUP	Sample Duplicate				Run: ICP1-HE_070618A				06/18/07 13:42
Sodium	102	mg/kg	1.0				5.7	30	
Sodium, Extractable	4.46	meq/100g	0.044				5.7	30	
Sample ID: H07060138-015AMS	Sample Matrix Spike				Run: ICP1-HE_070618A				06/18/07 13:58
Sodium	325	mg/kg	1.0	102	80	120			
Sodium, Extractable	14.2	meq/100g	0.044	102	80	120			
Sample ID: H07060138-015AMSD	Sample Matrix Spike Duplicate				Run: ICP1-HE_070618A				06/18/07 14:06
Sodium	327	mg/kg	1.0	104	80	120	0.4	20	
Sodium, Extractable	14.2	meq/100g	0.044	104	80	120	0.4	20	
Method: USDA20a									Batch: R38034
Sample ID: H07060138-010ADUP	Sample Duplicate				Run: MISC SOILS_070619B				06/15/07 08:16
Exchangeable Sodium Percentage	13	%	0.10				21	30	

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.

ENERGY LABORATORIES, INC. • P.O. Box 5688 • 3161 East Lyndale Ave. • Helena, MT 59604
877-472-0711 • 406-442-0711 • 406-442-0712 fax • helena@energylab.com

QA/QC Summary Report

Client: SWCA Environmental Consultants Inc
Project: Homestead Draw II Section 20 Analysis

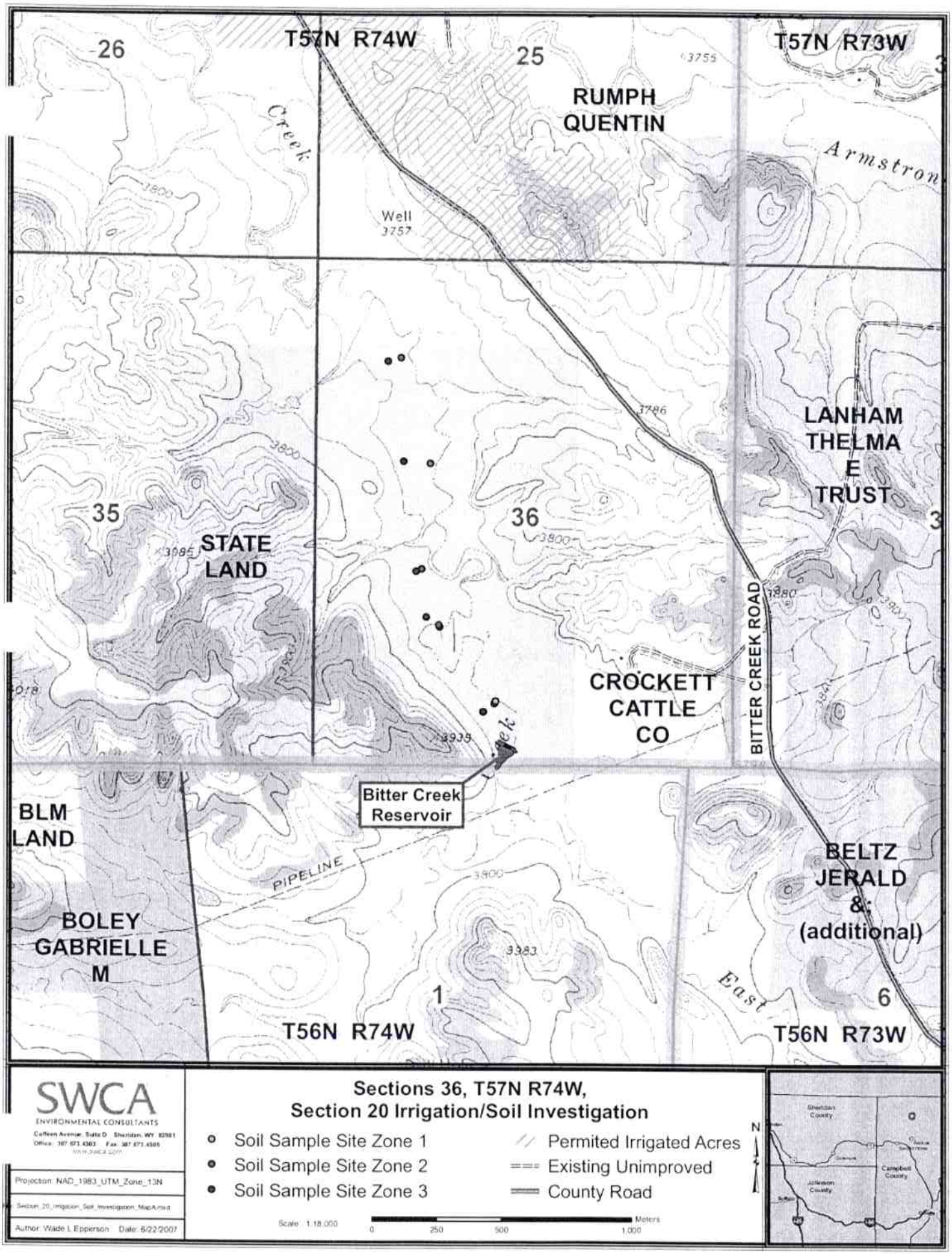
Report Date: 06/20/07
Work Order: H07060138

Analyte	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: USDA27a									Batch: 3405
Sample ID: H07060138-010ADUP	Sample Duplicate				Run: MISC SOILS_070619B				06/15/07 08:16
Saturation	40.2	%	0.10				3.2	30	
Sample ID: LCS	Laboratory Control Sample				Run: MISC SOILS_070619B				06/15/07 08:16
Saturation	51.4	%	0.10	98	80	120			

Qualifiers:

RL - Analyte reporting limit.

ND - Not detected at the reporting limit.



SWCA
ENVIRONMENTAL CONSULTANTS
Colleen Avenue, Suite D Sheridan, WY 82801
Office: 307.673.4303 Fax: 307.673.4505
www.swca.com

Projection: NAD_1983_UTM_Zone_13N
Section_20_Irrigation_Soil_Investigation_MapA.mxd
Author: Wade L Epperson Date: 6/22/2007

Sections 36, T57N R74W, Section 20 Irrigation/Soil Investigation

- Soil Sample Site Zone 1
- Soil Sample Site Zone 2
- Soil Sample Site Zone 3
- Permited Irrigated Acres
- Existing Unimproved
- County Road

Scale 1:18,000
0 250 500 1,000 Meters

N

FAX TRANSMISSION

WYOMING STATE ENGINEER'S OFFICE
HERSCHLER BLDG. #4E
CHEYENNE, WY 82002
307-777-6150
FAX: 307-777-5451

To: Ralph Combs
Fax #: 307-686-6004
From: Harry LaBonde
Subject: Proposed Reservoirs

Date: 5-22-07
Pages: 5, including this cover sheet.

COMMENTS:

As requested

- Cox Law Office letter of 4-19-07 w/o attachments
- State Engineer's Office letter of 5-16-07

If you have questions about the material faxed to you, please contact: Harry LaBonde at phone (307) 777-6150. Our facsimile machine telephone number is listed above; the confirmation number for this machine is (307) 777-7355. Thank you for your prompt delivery of this document.

State Engineer's Office

HERSCHLER BUILDING, 4-E CHEYENNE, WYOMING 82002
(307) 777-7354 FAX (307) 777-5451
seoleg@seo.wyo.gov

DAVE FREUDENTHAL
GOVERNOR

PATRICK TYRRELL
STATE ENGINEER

May 16, 2007

Mr. Randall T. Cox
Cox Law Office
400 South Kendrick Ave., Suite 101
Gillette, WY 82716

Re: Termo Company proposed reservoirs

Dear Mr. Cox,

This letter is in response to your letter of April 19, 2007 which included pages 357 & 358 from the Division II tab book and the Homestead Draw III North POD Water Management Plan. The information has been reviewed and the following comments are offered:

1. Our field personnel did inspect the water rights on Bitter Creek and the Armstrong Prong of Bitter Creek. Based on this inspection we have protected the Armstrong Prong of Bitter Creek.
2. 2006 aerial photos of this area have been reviewed. The point of diversion for Permit No. 10012D on Corral Creek, tributary to Armstrong Prong was found but there appeared to be no evidence of the ditches that irrigated the permitted lands.
3. The aerial photos did not reveal the points of diversion for Permit Nos. 11587D and 11588D diverting from Armstrong Prong. The lands being farmed do not match the lands shown on the permit map.
4. The point of diversion on Bitter Creek for Permit No. 10662D appears on the aerial photo. Some remnants of the ditch appear but the ditch does not extend to the lands to be irrigated under the permit.
5. More lands are being farmed than are shown on the permit maps.
6. No evidence of spreader dike systems could be found on the aerial photographs. The lands appear to be dry land farmed or sub-irrigated from the various creeks. Additionally, we do not have any permits where

spreader dikes are identified as the official points of diversion.

Your client's facilities on the ground do not conform to the records of this office, and in many cases appear inactive. Without up-to-date information on what lands are being irrigated and how the water is delivered to the lands, this office cannot determine if the upstream reservoir should be constructed to allow the natural flow in the drainage to reach the adjudicated lands. Your clients should have the appropriate petitions prepared to correct the records of this office to reflect the on-the-ground conditions. Updated records will allow this office to assess how to have an upstream reservoir constructed to protect natural flows to your client's adjudicated rights.

Please feel free to contact me at 307-777-6168 if you have any questions regarding this matter.

With best regards,

John R. Barnes
Administrator, Surface Water

and

Engineering Division

JRB/ra

Cc: Patrick T. Tyrrell, State Engineer
✓Harry LaBonde, Deputy State Engineer
Mike Whitaker, Superintendent - Water Division No. 2

COX LAW OFFICE
RANDALL T. COX, P.C.
A Professional Corporation

Randall T. Cox*
Clinton D. Beaver

Attorneys and Counselors At Law

Admitted in Wyoming
****Also admitted in Montana***

Kendrick Professional Building
400 South Kendrick Ave., Suite 101
Gillette, Wyoming 82716
Telephone (307) 682-2500
Telecopier (307) 685-0527
e-mail: rt@coxhorning.com
clint@coxhorning.com

April 19, 2007

Patrick Tyrrell
State Engineer
Herschler Building, 4th Floor East
Cheyenne, Wyoming 82002

RE: Termo Company proposed reservoirs

Dear Mr. Tyrrell:

This office represents Scott and Jodean Crockett and the Crockett Cattle Company. They own land in the northern portions of T56N, R73 and 74W, together with other lands. The Termo Company is proposing to build a number of reservoirs for impoundment of CBM produced water in the Bitter Creek watershed upstream of the places of use of the Crocketts' adjudicated water rights. We believe there is a chance that these reservoirs would interfere with natural flows which supply established, permitted spreader dikes in the Bitter Creek drainage.

The Termo Company is proposing that these reservoirs be flow-through reservoirs, such that storm events could be permitted to flow through. However, their information indicates that their produced water has a sodium adsorption ratio (SAR) of 34.6. If the reservoirs are drained this water would run down the channels to the Crocketts' irrigation systems. The Crocketts do not want to try to irrigate their land with water with such an extremely high SAR.

I am enclosing a copy of the water management plan which has been submitted by Termo to the Bureau of Land Management in January of 2007. Included is information regarding locations of discharge points and proposed reservoirs.

I am also enclosing copies of two pages from the Tab Book for Division 2, which lists the irrigation permits and secondary permits held by the Crocketts, all of which are, of course,

adjudicated water rights.

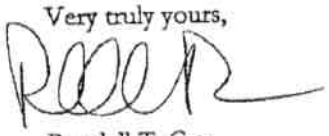
The Termo Water Management Plan reveals that the watersheds above these reservoirs contribute substantial amounts of irrigation water on a mean annual basis. It appears that these watersheds are a significant source of flows for the Crocketts' irrigation systems.

The Crocketts request that you do not approve any of these reservoir permits until it is determined that such reservoirs will not cause any interference with natural flows to the Crocketts' irrigation systems, or, if the permits have been approved, that you require Termo to bypass all natural flows around these reservoirs, which are, of course, junior to the Crocketts' adjudicated rights.

Further, the Crocketts will not consent to the construction of the proposed Crockett 15-42 Reservoir in Section 12, T56N R74W.

Please feel free to contact me if you have any questions.

Very truly yours,



Randall T. Cox

RTC/dw

cc: Termo Company
Mr. and Mrs. Crockett

Enclosures

Bitter Creek
Downstream Irrigation Assessment

To Support Renewal Application
For WYPDES Permit
WY0049131 – Bitter Creek 2

June 28, 2007

Prepared For:

HUBER

A FAMILY OF SOLUTIONS

J. M. Huber Corporation
2266 North Main Street
P.O. Box 6850
Sheridan, WY 82801

Prepared By:

CBM Associates, Inc.

500 W. Lott St.
Buffalo, WY 82834

Table of Contents:

Table of Figures:

List of Appendices:

Appendix A: Irrigation Land Classification
Appendix B: State Engineers Office Permit for Bitter Creek Ditch and Bitter Creek Reservoir
Appendix C : Bitter Creek Irrigation Assessment Map

Overview

This Bitter Creek downstream irrigation assessment was prepared to accompany J. M. Huber Corporation's (J.M. Huber) April 27, 2007, renewal application for WYPDES permit WY0049131, Bitter Creek 2. This renewal application requests to consolidate WYPDES permit WY0050024, Recluse Project (Bitter Creek North #1) into WYPDES permit WY0049131. Irrigated lands on Bitter Creek exist below part of this consolidated coal bed natural gas (CBNG) facility in Section 36, T57N, R74W. However, at the request of Wyoming Department of Environmental Quality – Water Quality Division (WDEQ-WQD), an irrigation assessment was conducted downstream of this known irrigated land in Section 36, T57N, R74W, along Bitter Creek to the Montana state line. This irrigation assessment was completed by reviewing existing publications, current CBNG WYPDES permits located on the Bitter Creek drainage, the Wyoming State Engineers (SEO) database, as well as conducting a field investigation.

Introduction

J.M. Huber has requested to consolidate WYPDES permit WY0050024, Recluse Project (Bitter Creek North #1) into WYPDES permit WY0049131, Bitter Creek 2. There is known irrigation on the Bitter Creek drainage located in Section 36, T57N, R74W; however, at WDEQ-WQD's request, an additional assessment of potential active irrigation on Bitter Creek, downstream of the known irrigation in Section 36, T57N, R74W, was conducted. This report will demonstrate the findings of the potential active downstream irrigation on Bitter Creek below Section 36, T57N, R74W. For simplicity, the Irrigated Lands are listed as numbers sequentially starting with Irrigated Area #1 in Section 36, T57N, R74W, working northwest (downstream) along the Bitter Creek drainage towards the Montana state line to Irrigated Area #10. This progression is detailed on the attached irrigation assessment map.

The "Powder/Tongue River Basin Plan Final Report", Chapter II, Basin Water Use Policy was reviewed to gain a broad knowledge of the Bitter Creek drainage area and its potential active irrigation. The "Powder/Tongue River Basin Plan Final Report" was prepared February 2002 by HKM Engineering Inc., Lord Consulting, and Watts and Associates for the Wyoming Water Development Commission Basin Planning Program. The data that was collected and presented within this report is used by the SEO as defining areas of active irrigation and diversions on Bitter Creek. [1]

The Bitter Creek Irrigation Assessment facility map (see Appendix C) shows the irrigated lands, irrigated diversions, irrigated types, and surface ownership along Bitter Creek. The irrigated lands, irrigated diversions, and irrigated types were determined through the "Powder/Tongue River Basin Plan Final Report".[2] These irrigated lands were broken into two groups of either man-induced irrigation or subirrigation, and were further delineated and divided into several categories or irrigation types, that explain the extent of the irrigation and the acreage it covers via the uses of various diversions, see Appendix A - Irrigation Land Classification table.

To verify potential active irrigation downstream of Section 36, T57N, R74W, a field investigation was conducted on May 27, 2007, and several photos were taken at twenty three (23) different locations along the Bitter Creek county road. These locations are depicted on the enclosed Bitter Creek Irrigation Assessment facility map as Sites A-W. At some of the locations for Sites A-W, several pictures were taken of the area from different angles to best characterize field conditions. The arrows on the map indicate where each photo or set of photos were taken from and the general perspective.

---

[1] Powder/Tongue River Basin Plan Final Report; Prepared for Wyoming Water Development Commission Basin Planning Program 2002; http://waterplan.state.wy.us/basins/powder/powder.html

[2] Powder/Tongue River Basin Plan – 1:24,000-scale Irrigated Lands, in Decimal Degrees – NAD 1927, (Shapefile, metadata), 2002 Final Report; and Powder/Tongue River Basin Plan – 1:24,000-scale Irrigation Points of Diversion (Service Area), in Decimal Degrees – NAD 192, (Shapefile and metadata), 2002 Final Report; http://waterplan.state.wy.us/basins/powder/powder.html

Based on the combined information from the assessment of potential active irrigation downstream of Section 36, T57N, R74W of the Bitter Creek drainage, Irrigated Areas #1 through #10 are described in further detail below.

Irrigated Areas #1 and #2

The Irrigated Areas #1 and #2 have active irrigation that is currently being protected for by WDEQ-WQD within WYPDES permits. Irrigated Area #1 is defined as irrigation type B, partial service irrigation that typically receives a reduced water supply due to limited water availability or the inability to provide complete field coverage, while Irrigated Area #2 is defined as irrigation type S, spreader dikes constructed across ephemeral streams to spread infrequent flows over the land to increase beneficial use.[3] Due to the location and topography between these two irrigation areas and the Bitter Creek county road, pictures were unable to be taken. Figure 1 represents the photo documentation of Site A, an unnamed ephemeral drainage to Bitter Creek prior to its confluence with Bitter Creek in the NWNW of Section 36, T57N, R74W. The black lines were used in the picture to help depict the location of the unnamed ephemeral drainage.

Figure 1. Site A looking west-southwest towards Bitter Creek.

[3] Powder/Tongue River Basin Plan – 1:24,000-scale Irrigated Lands, in Decimal Degrees – NAD 1927, (Shapefile, metadata), 2002 Final Report; and Powder/Tongue River Basin Plan – 1:24,000-scale Irrigation Points of Diversion (Service Area), in Decimal Degrees – NAD 192, (Shapefile and metadata), 2002 Final Report; http://waterplan.state.wy.us/basins/powder/powder.html

Irrigated Area #3

The Irrigated Area #3 is defined as irrigation type H, minor beneficial use of lands that receive some beneficial use on occasion such as lands served by "kick-out" ditches on ephemeral streams. [4] Figure 2 represents the photo documentation of Site B, which shows Bitter Creek as it flows towards the diversion prior to the Irrigated Area #3. A black line was used in the picture to depict the top of the diversion for the Irrigated Area #3 and the location of Bitter Creek as it flow towards the diversion.

Figure 2. Site B looking west-northwest towards Bitter Creek, Irrigated Area #3.

An exiting irrigation ditch, Bitter Creek Ditch (SEO permit number P10662D), begins to divert water in SWSE of Section 36, T57N, R74W, and runs approximately 2 miles in length where the ditch enters back into Bitter Creek in the SENE of Section 26, T57N, R74W. Snow melt and runoff water flowing down Bitter Creek is caught and stored in the Bitter Creek Reservoir (SEO Permit Number 2143 Res.) where it is then diverted via the outlet, the Bitter Creek Ditch. Water diverted via the Bitter Creek Ditch is applied on hay and alfalfa fields located within Sections 25, 26, and 36 of T57N, R74W. Please refer to Appendix B for the SEO Bitter Creek Reservoir Permit and SEO Bitter Creek Ditch Permit.

A review of Pinnacle Gas Resources (Pinnacle) WYPDES permit WY0053759 - "Harris Brug Bitter Creek" application submitted July 27, 2005 to WDEQ-WQD, included Pinnacle's proposed water management strategy, "Harris Brug Bitter Creek WYPDES Water Management Plan". This water management plan presented detailed information about Bitter Creek bottomlands located within Sections 22, 23, 26 and 36 of T57N, R74W. Mr. Scott Crockett of Crockett Cattle Company, landowner, had confirmed the use of the Bitter Creek Ditch located in SWSE Section 36, Township 57 North, Range 74 West. [5] The Bitter Creek Ditch is permitted to divert water from Bitter Creek to irrigate approximately 68 acres of land within

---

[4] Powder/Tongue River Basin Plan Final Report; Prepared for Wyoming Water Development Commission Basin Planning Program 2002; http://waterplan.state.wy.us/basins/powder/powder.html

[5] Pinnacle Gas Resource's WYPDES permit application for WY0053759, Harris Brug Bitter Creek, submitted July 27, 2005.

Sections 25, 26, and 36 of T57N, R74W. Please refer to Appendix B for the SEO Bitter Creek Reservoir Permit and SEO Bitter Creek Ditch Permit.

Figure 3 represents the photo documentation of Site C, which shows Bitter Creek and the Bitter Creek Ditch. A black line was used in the picture to depict the locations of the Bitter Creek Ditch and Bitter Creek to aid in showing the two structures.

Figure 3. Site C looking west towards Bitter Creek, Irrigated Area #3.

Figure 4 represents the photo documentation of Site D, which shows a diversion where the Bitter Creek Ditch ends in approximately the SENE corner of Section 26, T57N, R74W. A black line was used in the picture to depict the top of the diversion structure to help show where the Bitter Creek ditch ends and how water is allowed to pool up behind the diversion.

Figure 4. Site D looking west-northwest towards Bitter Creek, Irrigated Area #3.

Sites E, F, and G

Photos were taken at Sites E, F, and G to help depict what is occurring along Bitter Creek between the identified irrigation areas and diversions from the "Powder/Tongue River Basin Plan Final Report". Figure 5 represents the photo documentation of Site E, which illustrates Bitter Creek meandering down the drainage in the NENW and NWNE of Section 26, T57N, R74W. A black line was used in the picture to depict the course of Bitter Creek. The land surrounding Bitter Creek shown in Figure 5 is owned by Crockett Cattle Company.

Figure 5. Site E looking west-southwest towards Bitter Creek.

Figure 6 represents the photo documentation of Site F, which continues to show the meandering of Bitter Creek in SWSW Section 23 and NWNW Section 26 of T57N, R74W. A black line was used in the picture to depict the meandering course of Bitter Creek.

Figure 6. Site F looking southwest towards Bitter Creek.

Figure 7 represents the photo documentation of Site F. The far right of the picture illustrates Quarter Circle Prong of Bitter Creek prior to its confluence with Bitter Creek. The Quarter Circle Prong of Bitter Creek confluences with Bitter Creek in SWNE of Section 22 of T57N, R74W. From the Site F location, determining exactly where Bitter Creek continues to meander through Section 22 T57N, R74W is difficult. Two black lines were used in the picture to depict the valley of Quarter Circle Prong of Bitter Creek in the eastern portion of Section 22 T57N, R74W.

Figure 7. Site F looking west towards Bitter Creek.

Figures 8 and 9 represent the photo documentation of Site G. These pictures were taken to assist in showing the areas that are located to the west–northwest of Bitter Creek. This area shows active cutting and baling by the landowner, as indicated by the brown coloration within Figures 8 and 9. There was no indication of an active diversion of water from Bitter Creek for irrigation purposes along these areas. A black line was used in the picture to depict the location of Bitter Creek in the upper portion of the picture. Quarter Circle Prong of Bitter Creek is located off to the left of the picture.

Figure 8. Site G looking west-southwest towards Bitter Creek.

In Figure 9 a black line was used in the picture to depict the location of Bitter Creek in the upper portion of the photo. A black polygon shape is used to depict where active cutting and baling is occurring in the foreground of the picture.

Figure 9. Site G looking west-northwest towards Bitter Creek.

Irrigated Areas #4, #5, and #6

The Irrigated Area #4 is defined as irrigation type B, partial service irrigation that typically receives a reduced water supply due to limited water availability or the inability to provide complete field coverage.[6] The diversion for Irrigated Area #4 is located on a tributary drainage to Bitter Creek that runs in a southwesterly direction towards Bitter Creek. The field investigation did not reveal an irrigation diversion, but rather showed a culvert that allows water from the upstream reservoir, located in the NWNW of Section 23, T57N, R74W, to cross under the roadway towards Bitter Creek. Figure 10 represents the photo documentation of Site G, which shows the face of the unknown reservoir location in the NWNW of Section 23, T57N, R74W. No additional information was found on this reservoir during this irrigation assessment.

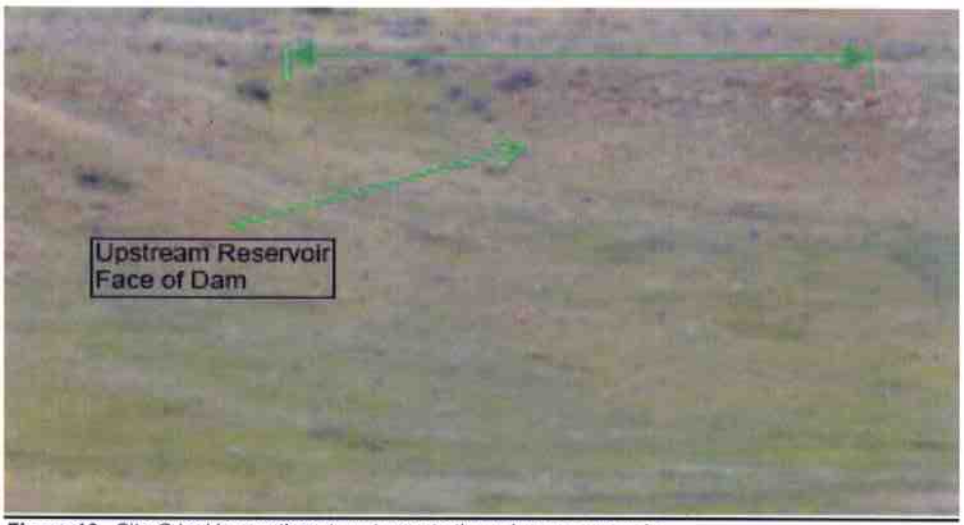


Figure 10. Site G looking northeast upstream to the unknown reservoir.

Figures 11 and 12 represent the photo documentation of Sites H and I, which show the diversion for the Irrigated Area #5, as well as part of the Irrigated Areas #4 and #5. Figure 11 shows the diversion prior to Irrigated Area #5. A black line was used in the picture to depict the top of the diversion for Irrigated Area #5. Another black line is used to depict the boundary of the Irrigated Area #4, as shown by the green vegetation in the foreground.

[6] Powder/Tongue River Basin Plan – 1:24,000-scale Irrigated Lands, in Decimal Degrees – NAD 1927, (Shapefile, metadata), 2002 Final Report; and Powder/Tongue River Basin Plan – 1:24,000-scale Irrigation Points of Diversion (Service Area), in Decimal Degrees – NAD 192, (Shapefile and metadata), 2002 Final Report; http://waterplan.state.wy.us/basins/powder/powder.html

Figure 11. Site I looking west-southwest towards Bitter Creek, Irrigated Area #4

Figure 12 shows the irrigated lands below the diversion for Irrigated Area #5 at the upper portion of the picture. The Irrigated Area #5 is defined as irrigation type S, which are spreader dikes constructed across ephemeral streams to spread infrequent flows over the land to increase beneficial use.[7] The topographic contours along this part of Bitter Creek help define the land areas that will benefit from the use of spreader dikes or kick-out systems along Bitter Creek. A black line was used in the picture to outline the Irrigated Area #4 which is defined by the topography of the land. As shown in the picture below, the land slopes gently in a westerly direction towards Bitter Creek when moving from Irrigated Area #4 to Irrigated Area #5.

Figure 12. Site H looking northwest towards Bitter Creek.

[7]Powder/Tongue River Basin Plan – 1:24,000-scale Irrigated Lands, in Decimal Degrees – NAD 1927, (Shapefile, metadata), 2002 Final Report; and Powder/Tongue River Basin Plan – 1:24,000-scale Irrigation Points of Diversion (Service Area), in Decimal Degrees – NAD 192, (Shapefile and metadata), 2002 Final Report; http://waterplan.state.wy.us/basins/powder/powder.html

Figure 13 represents the photo documentation of Site J, which shows another view of the Irrigated Area #4 and the gently westerly sloping direction of the land when moving from Irrigated Area #4 to Irrigated Area #5, as shown in the photo below. The areas that will most benefit from the use of spreader dikes along Bitter Creek are shown in the upper left part of the picture. A black line was used in the picture to aid in showing the gentle sloping direction and the distinct difference in elevation between Irrigated Area #4 and Irrigated Area #5.

Figure 13. Site J looking southwest towards Irrigation Area #4.

The Irrigated Area #6 is defined as irrigation type H, minor beneficial use of lands that receive some beneficial use on occasion such as lands served by "kick-out" ditches on ephemeral streams.[8] During the field investigation it was difficult to determine the difference between Irrigated Area #4, #5, and #6, as shown in the pictures taken from Site H, I, and J.

A phone conversation with Mr. Fred Oedekoven, Oedekoven Family Trust, on May 30, 2007 confirmed that there is active irrigation on Bitter Creek in Section 8, T57N, R74W. Irrigated Areas #4, #5, and #6 are located on the Oedekoven Family Trust property; please see Appendix C – Bitter Creek Irrigation Assessment map.

Irrigated Area #7

The Irrigated Area #7 is defined as irrigation type H, minor beneficial use of lands that receive some beneficial use on occasion such as lands served by "kick-out" ditches on ephemeral streams. Figure 14 represents the photo documentation of Site K, which shows an unknown diversion located near the Irrigated Area #7. The diversion is located on a tributary to Bitter Creek in the NESE of Section 16, T57N, R74W. This diversion was not defined or identified within the "Powder/Tongue River Basin Plan Final Report", or the shapefile of irrigation points of diversions[9]. This diversion diverts water from the tributary

[8] Powder/Tongue River Basin Plan – 1:24,000-scale Irrigated Lands, in Decimal Degrees – NAD 1927, (Shapefile, metadata), 2002 Final Report; and Powder/Tongue River Basin Plan – 1:24,000-scale Irrigation Points of Diversion (Service Area), in Decimal Degrees – NAD 192, (Shapefile and metadata), 2002 Final Report; http://waterplan.state.wy.us/basins/powder/powder.html

[9] Powder/Tongue River Basin Plan – 1:24,000-scale Irrigated Lands, in Decimal Degrees – NAD 1927, (Shapefile, metadata), 2002 Final Report; and Powder/Tongue River Basin Plan – 1:24,000-scale Irrigation Points of Diversion (Service Area), in Decimal Degrees – NAD 192, (Shapefile and metadata), 2002 Final Report; http://waterplan.state.wy.us/basins/powder/powder.html

drainage into a ditch that runs in a northwesterly direction of the Bitter Creek county road. The overgrowth of vegetation and dead tree limbs within the ditch and the unknown diversion indicates the inactivity of this system.

Figure 14. Site K looking west-southwest towards Bitter Creek.

The diverted water from the tributary drainage of Bitter Creek would be used to irrigate the lands located to the west-southwest of the unknown irrigation ditch as shown below. Figures 15 and 16 represent the photo documentation of Site L, which helps to show the difficulty in determining exactly where Bitter Creek is located. According to the topographic map, Bitter Creek Irrigation Assessment, Bitter Creek is meandering through the Irrigated Area #7 in the photos below. A black line was used in the picture to depict the unknown irrigation ditch.

Figure 15. Site L looking southwest towards an unknown irrigation ditch and Irrigated Area #7.

Figure 16. Site L looking west towards Irrigated Area #7.

Figures 17 and 18 represent the photo documentation of Site M, which shows a recently plowed field that is most likely in the northern part of Irrigated Area #7 due to its proximity to Bitter Creek county road. The amount of water within Bitter Creek at these two sites indicates that Bitter Creek over the years has changed its flow path. In comparing the topographic map of Bitter Creek in Section 16, T57N, R74W, and the pictures taken at Site L location, it is evident that Bitter Creek does not meander through the Irrigated Area #7 as depicted on the topographic map.

Figure 17. Site M looking south at a recently plowed field in the northern part of Irrigated Area #7.

Figure 18. Site M looking northwest at a recently plowed field in the northern part of Irrigated Area #7.

Sites N and O

Figures 19 and 20 are pictures representing Sites N and O, which were taken from Bitter Creek county road. This photo documentation shows where Bitter Creek crosses Bitter Creek county road in the NWNW of Section 16, T57N, R74W. Photos N and O show significantly more water in the stream channel than the upstream photos, this is primarily due to CBNG water augmenting the stream channel from upstream CBNG facilities.

Figure 19. Site N looking south off of Bitter Creek county road.

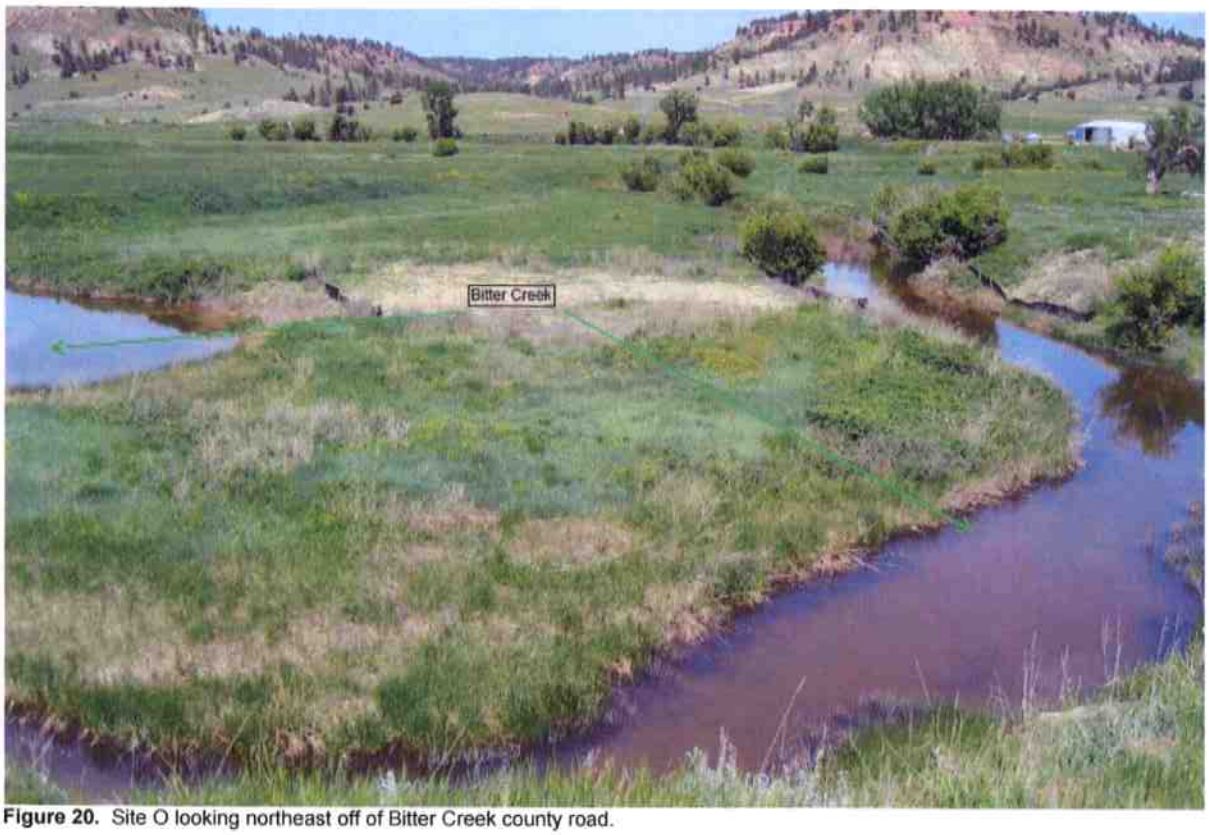


Figure 20. Site O looking northeast off of Bitter Creek county road.

Irrigated Area #8

The Irrigated Area #8 is defined as irrigation type S, which are spreader dikes constructed across ephemeral streams to spread infrequent flows over the land to increase beneficial use.[10] Figures 21, 23, and 24 represents the photo documentation of Site P, which shows a diversion located in the SESE of Section 8, T57N, R74W. Figure 21 shows Bitter Creek prior to it reaching the head gate diversion. The diversion consists of a series of spreader dikes that receive water from Bitter Creek via the head gate. A phone conversation with Mr. Fred Oedekoven, Oedekoven Family Trust, on May 30, 2007 confirmed that the head gate and spreader dike system is actively used. In years when enough runoff or snow melt permits, the head gate is closed to allow water from Bitter Creek to back up and over fill onto a series of spreader dikes. The water is diverted for approximately eight to nine days, at which time the head gate is opened and Bitter Creek is allowed to continue to flow downstream. Mr. Oedekoven confirmed that this area is actively irrigated from this diversion system and is used for the production of alfalfa and hay.

A black line, located near the bottom right of the picture, was used to depict the course of Bitter Creek prior to reaching the head gate. Another black line located in the upper portion of the picture was used to depict the top of the diversion where the head gate is located.

---

[10] Powder/Tongue River Basin Plan – 1:24,000-scale Irrigated Lands, in Decimal Degrees – NAD 1927, (Shapefile, metadata), 2002 Final Report; and Powder/Tongue River Basin Plan – 1:24,000-scale Irrigation Points of Diversion (Service Area), in Decimal Degrees – NAD 192, (Shapefile and metadata), 2002 Final Report; http://waterplan.state.wy.us/basins/powder/powder.html

Figure 21. Site P looking northeast towards diversion for Irrigated Area #8.

Figures 22, 23, and 24, show detailed pictures of the spreader dike system from Sites P and Q. Black lines were used in the photos and were placed across the tops of the spreader dikes to aid in showing the intricate spreader dike system.

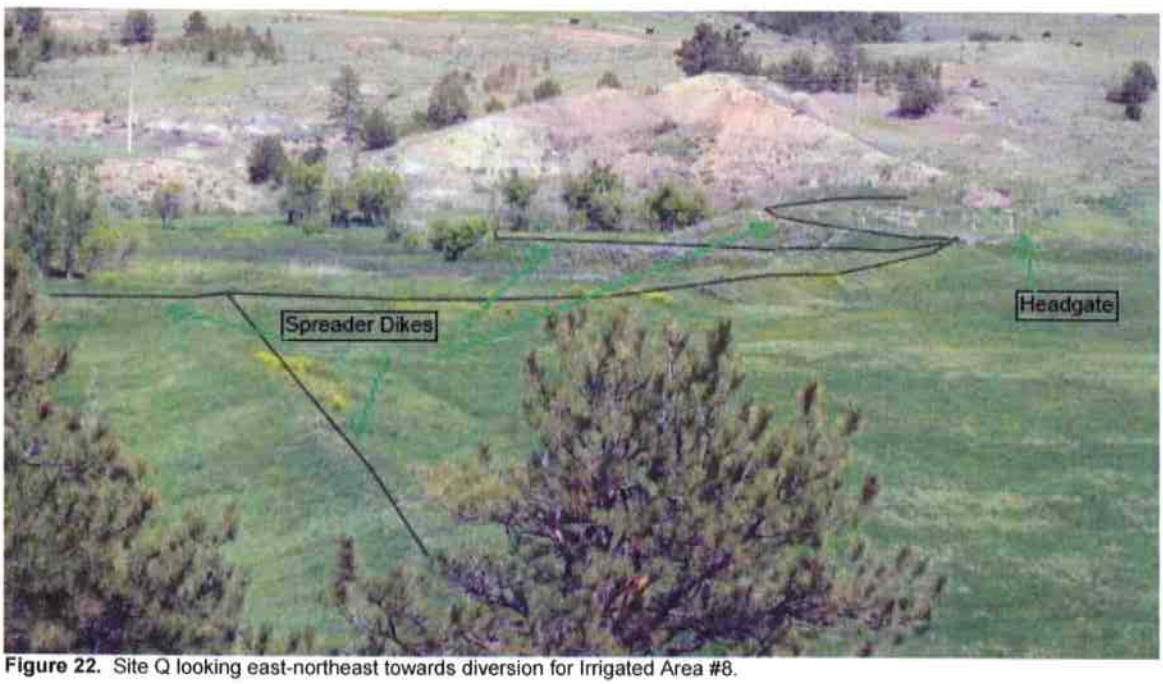


Figure 22. Site Q looking east-northeast towards diversion for Irrigated Area #8.

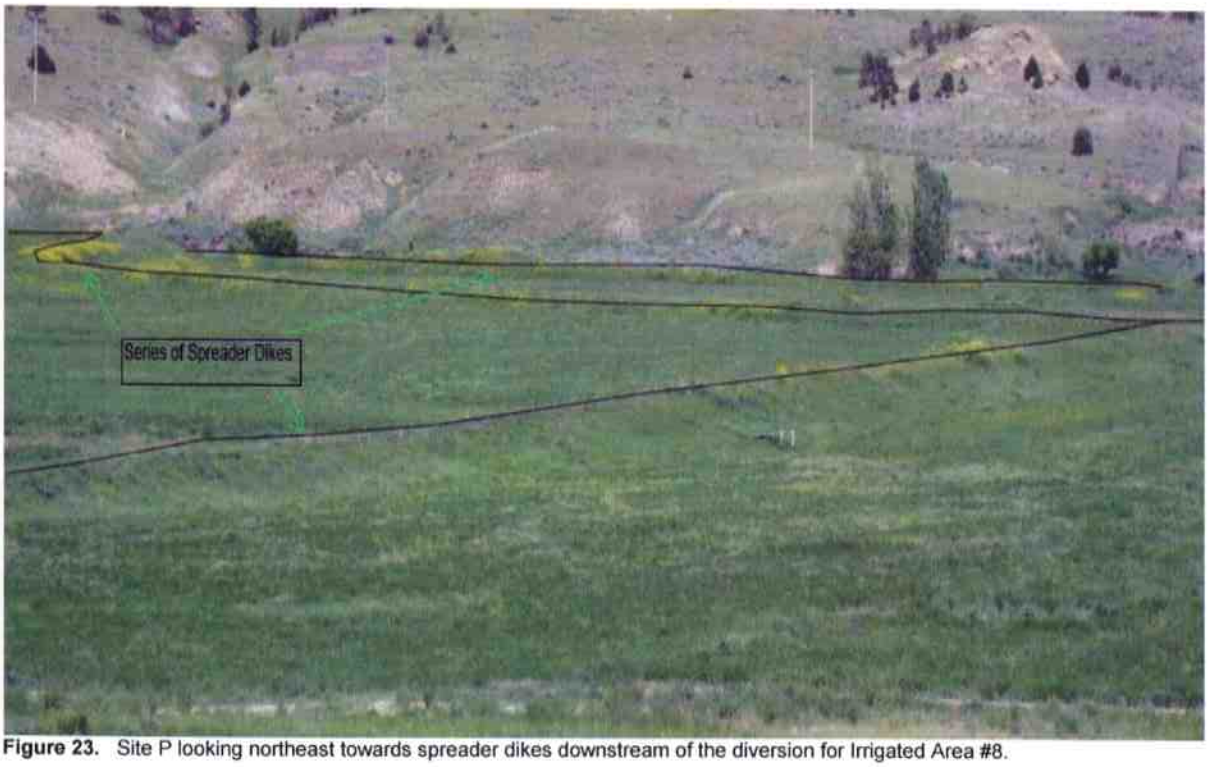


Figure 23. Site P looking northeast towards spreader dikes downstream of the diversion for Irrigated Area #8.

Figure 24. Site P looking north-northeast towards spreader dikes downstream of the diversion for Irrigated Area #8.

Site R

Figure 25 represents the photo documentation of Site R. The black line in the photo was used to depict the location of Bitter Creek. Bitter Creek is located in the bottom of the draw and can not be seen from the angle that this photo was taken. The dirt road in the upper left part of the picture is a J.M. Huber access road across Mr. Oedekoven's property, and is used for maintaining the CBNG facility's wells and outfalls in this area. The head gate is located on the western bench of the drainage where Bitter Creek cuts through; therefore, it can not collect water from Bitter Creek for irrigation, but rather collects runoff from a precipitous hill located to the west of this photo in southern part of Section 6 and northern part of Section 7 of T57N, R74W.

Figure 25. Site R looking northeast towards Bitter Creek.

Irrigated Area #9

The Irrigated Area #9 is defined as irrigation type S, which is spreader dike irrigation that utilizes dikes constructed across ephemeral streams to spread infrequent flows over the land to increase beneficial use.[11] The location of this diversion and Irrigated Area #9 was situated so that no pictures could be taken from Bitter Creek county road. This diversion appears to be located off of Bitter Creek on the eastern bench of the drainage where Bitter Creek flows, see Appendix C. With the diversion located off the bottom of Bitter Creek, or the far edge of the flood plain, this diversion will not be able to collect water directly from Bitter Creek.

---

[11] Powder/Tongue River Basin Plan – 1:24,000-scale Irrigated Lands, in Decimal Degrees – NAD 1927, (Shapefile, metadata), 2002 Final Report; and Powder/Tongue River Basin Plan – 1:24,000-scale Irrigation Points of Diversion (Service Area), in Decimal Degrees – NAD 192, (Shapefile and metadata), 2002 Final Report; http://waterplan.state.wy.us/basins/powder/powder.html

Figures 26 and 27 represent the photo documentation of Site S, which shows Bitter Creek in the background, while Figure 27 shows Bitter Creek as it continues to meander its way to the Montana state line. The black line in the photos was used to depict the location of Bitter Creek in reference to where this photo was taken.

Figure 26. Site S looking east towards Bitter Creek.

Figure 27. Site S looking northeast towards Bitter Creek.

Irrigated Area #10

The Irrigated Area #10 is defined as irrigation type E, which is idle irrigation of lands not currently receiving water, typically due to nonfunctional delivery facilities.[12] Figure 28 represents the photo documentation of Site T, which shows the diversion system located on an unnamed tributary to Bitter Creek. A black line was used in the picture to depict the top of the diversion. This diversion is used to divert runoff water from the unnamed tributary for the Irrigated Area #10.

Figure 28. Site T looking east-southeast towards Bitter Creek, Irrigated Area #10.

[12] Powder/Tongue River Basin Plan – 1:24,000-scale Irrigated Lands, in Decimal Degrees – NAD 1927, (Shapefile, metadata), 2002 Final Report; and Powder/Tongue River Basin Plan – 1:24,000-scale Irrigation Points of Diversion (Service Area), in Decimal Degrees – NAD 192, (Shapefile and metadata), 2002 Final Report; http://waterplan.state.wy.us/basins/powder/powder.html

Figure 39 represents the photo documentation of Site U, which shows the diversion system in the background in the right portion of the picture. The black line was used in the picture to depict the top of the diversion system. The land in the foreground shows the Irrigation Area #10.

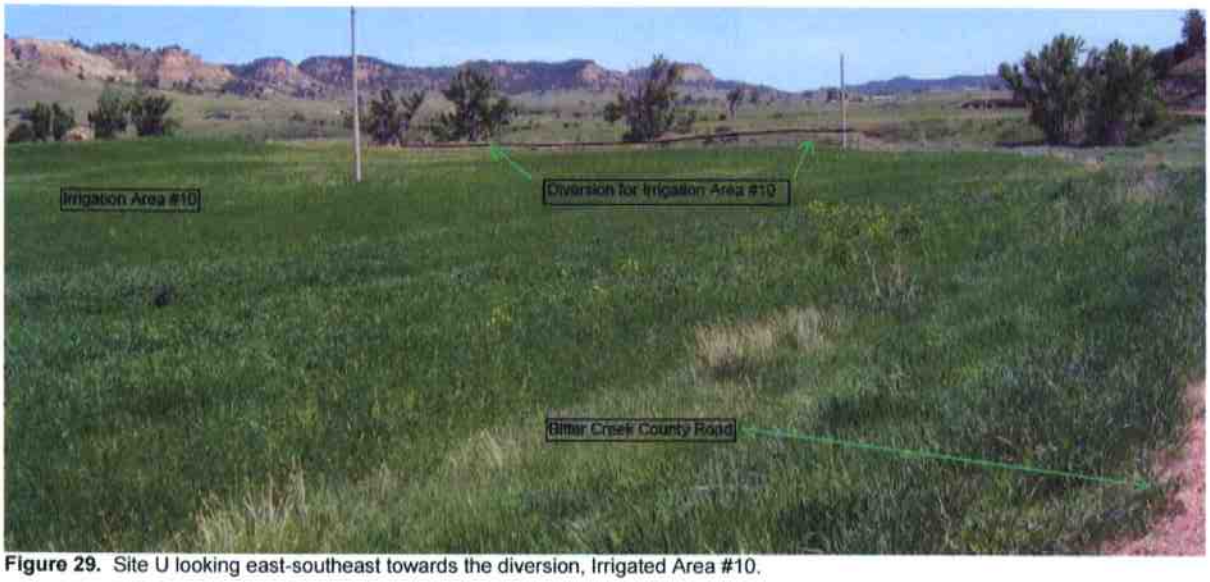


Figure 29. Site U looking east-southeast towards the diversion, Irrigated Area #10.

Sites V and W

Figures 30, 31 and 32 represents the photo document of Site V, which show no indication of active irrigation from Bitter Creek. This land is owned by Sheila Jeremiah, Cain Living Trust.

Figure 30. Site V looking northeast towards Bitter Creek.

Figure 31 shows Bitter Creek just prior to crossing into Montana. The bottom of the photo shows the amount of water that is in Bitter Creek as it flows downstream into Montana. A black line was used to depict Bitter Creek as is meanders towards the Montana state line. This picture shows no indication of active irrigation from Bitter Creek.

Figure 31. Site V looking east-southeast towards Bitter Creek.

Figure 32 shows the natural bottom lands of Bitter Creek prior to entering into Montana. This picture shows no indication of active irrigation. A black was used to depict Bitter Creek in the far left of the picture as it continues to meander towards the Montana state line.

Figure 32. Site W looking east-northeast towards Bitter Creek.

Summary

This Bitter Creek downstream irrigation assessment was prepared to accompany J.M. Huber's April 27, 2007, renewal application of WYPDES permit WY0049131, Bitter Creek 2. This renewal application requests to consolidate WYPDES permit WY0050024, Recluse Project (Bitter Creek North #1) into WYPDES permit WY0049131. Based on this Bitter Creek irrigation assessment, field investigation, and conversation with Mr. Oedekoven, the presence of active irrigation downstream of J.M. Huber's WY0049131 facility was verified on Oedekoven's land within Section 8, T57N, R74W, and protection of this designated use would need to be addressed within the WYPDES permit for WY0049131, Bitter Creek 2. This analysis was based on public information and public access along the Bitter Creek county road. Further field analysis will need to be completed to inventory an accurate use of the other potential irrigated areas by conducting a site specific Section 20 analysis.

Per current understanding of the administration of WYPDES permits and the implementation of the new Agricultural Use Policy (Chapter 1 Section H, Section 20), J.M. Huber requests to establish an interim period of end of pipe effluent limits for one year after the issuance of this renewal for all associated outfalls. J.M Huber requests to continue to operate under current permit conditions for end of pipe electrical conductivity (EC) and sodium adsorption ratio (SAR) effluent limits as stated in the original permit, which are EC of 7500 micromohs/cm and no effective SAR limit. The interim period will allow J.M Huber adequate time to re-evaluate their water management strategy, and to further investigate other potential downstream irrigation uses by conducting site specific soil investigations, Section 20 analysis, to protect for potential downstream irrigation.

APPENDIX A

Irrigation Land Classification

Irrigation Land Classification

Assigned Area Number	Quarter / Quarter	Section	Township (North)	Range (West)	Acreage of Defined Irrigated Lands	Irrigation Type	Irrigation Type Classification
1	SESW	36	57	74	22.21	B	Partial Service Irrigation - Typically receives a reduced water supply due to limited water availability or the inability to provide complete field coverage
2	SWSE	36	57	74	62.05	S	Spreader Dike Irrigation - Dikes constructed across ephemeral streams to spread infrequent flows over the land to increase beneficial use
3	NESE	26	57	74	42.85	H	Minor beneficial use - lands that receive some beneficial use on occasion such as lands served by "kick-out" ditches on ephemeral streams
4	SWSW	15	57	74	54.98	B	Partial Service Irrigation - Typically receives a reduced water supply due to limited water availability or the inability to provide complete field coverage
5	NENW	22	57	74	5.11	S	Spreader Dike Irrigation - Dikes constructed across ephemeral streams to spread infrequent flows over the land to increase beneficial use
6	SESE	16	57	74	12.71	H	Minor beneficial use - lands that receive some beneficial use on occasion such as lands served by "kick-out" ditches on ephemeral streams
7	NESE	16	57	74	18.28	H	Minor beneficial use - lands that receive some beneficial use on occasion such as lands served by "kick-out" ditches on ephemeral streams
8	SESE	8	57	74	29.64	S	Spreader Dike Irrigation - Dikes constructed across ephemeral streams to spread infrequent flows over the land to increase beneficial use
9	SESE	31	58	74	2	S	Spreader Dike Irrigation - Dikes constructed across ephemeral streams to spread infrequent flows over the land to increase beneficial use
10	SESE	25	58	75	21.39	E	Idle irrigation - lands not currently receiving water, typically due to nonfunctional delivery facilities

**** Please note the Location (Qrt/Qrt, Section, Township, Range), Acreage of Defined Irrigated Land, Irrigation Type, and Irrigation Type Classification information is from the "Powder/Tongue River Basin Plan - 1:24,000-scale Irrigated Lands, in Decimal Degrees - NAD 1927" metadata file from 2002 report titled "Powder/Tongue River Basin Plan Final Report".***

APPENDIX B

State Engineers Office Permits

11,997

THE STATE OF WYOMING

CERTIFICATE OF APPROPRIATION OF WATER CERTIFICATE RECORD NO. 34 PAGE 188

WHEREAS, Mrs. Fannie L. Berry has presented to the Board of Control of the State of Wyoming proof of the appropriation of water from Bitter Creek tributary of Powder River through the Bitter Creek Ditch under Permit No. 10662 for irrigation of the lands herein described, lying and being in Campbell County, Wyoming, and for stock and domestic purposes.

NOW KNOW YE, That the Board of Control, under the provisions of Division 1, Title 9, Chapters 10 and 14 of the Revised Statutes of Wyoming, 1899, has, by an order duly made and entered on the 22nd day of November, A. D. 1912, in Order Record No. 4 Page 615, determined and established the priority and amount of such appropriation as follows:

Name of Appropriator Mrs. Fannie D. Berry; Postoffice Address Morse, Wyoming; Amount of Appropriation 0.97 cu. ft. per. sec.; Date of Appropriation May 6, 1911; Description of land to be irrigated and for which this appropriation is determined and established; Total Acreage Sixty-eight (68) acres.

7 A. SW¼ NW¼ Sec. 25, Tp. 57 N. R. 74 W.
12 A. NE¼ SW¼ Sec. 25, Tp. 57 N. R. 74 W.
10 A. NW¼ SW¼ Sec. 25, Tp. 57 N. R. 74 W.
8 A. SE¼ SW¼ Sec. 25, Tp. 57 N. R. 74 W.
20 A. SW¼ SE¼ Sec. 25, Tp. 57 N. R. 74 W.
6 A. NE¼ NE¼ Sec. 26, Tp. 57 N. R. 74 W.
5 A. SE¼ NE¼ Sec. 26, Tp. 57 N. R. 74 W.
68 A. Total acreage.

Said appropriation of water before being used to irrigate said land is stored in the Bitter Creek Reservoir, Permit No. 2143 Res., Certificate Record No. 34, page 187.

The right to water hereby confirmed and established is limited to irrigation, stock and domestic purposes, and the use is restricted to the place where acquired and to the purpose for which acquired; rights for irrigation not to exceed one cubic foot per second for each seventy acres of land for which appropriation is herein determined and established.

IN TESTIMONY WHEREOF, I, A. J. Parshall, President of the State Board of Control, have hereunto set my hand this 25th day of January, A. D. 1913, and caused the seal of said Board to be hereunto affixed.

ATTEST: LOUISE ZABELMANN, *Secretary*. A. J. Parshall, *President*.

247

10,662

Application for a Permit to Divert and

Cert. Record 24 p 189 No. 68

NOV 1912

Water Division No. 2 District No.

1. Royal D Salisbury of Upton, County of Weston, State of Wyoming, being duly sworn according to law, upon my oath say:

1. The name of the applicant Mrs. Fannie L Berry

2. The postoffice address of the applicant Morse, Wyoming

3. The use to which the water is to be applied is Irrigation Stock and Domestic

4. The name of the ditch or canal is Butter Creek Ditch

5. The source of the proposed appropriation is Butter Creek

6. The headgate of the proposed ditch or canal is located N 82° W. 2200 feet from the South East corner of Section 36, Township 57 N Range 74 W

7. The said ditch or canal is to be two miles long and to pass through the following lands (give route by courses and distances, or by naming legal subdivisions crossed):
W½ E½ Sec 36, W½ SE¼ NE¼ SW¼, S½ NW¼ Sec. 25 and E½ NE¼ Sec. 26,
all in Tp. 57 N. R. 74 W. of the 6th P.M.

8. The dimensions of said works are: (a) [At headgate] Width on top (at water-line) 14 feet; width on bottom 10 feet; depth of water two feet; grade 5 feet per mile.

(b) Give dimensions at each point where reduced in size, stating miles from headgate:

[At one mile] width on top (at water-line) 10 feet; width on bottom " feet; depth of water two feet; grade 5 feet per mile.
[At one one fourth miles] width on top (at water-line) " feet; width on bottom " feet; depth of water one feet; grade 5 feet per mile.
[At] width on top (at water-line) feet; width on bottom feet; depth of water feet; grade feet per mile.

9. Describe the character of proposed works, stating: 1st. The nature of material to be moved. 2nd. Number and length of tunnels, if any. 3rd. Amount of fluming, if any.
material to be moved is earth
no tunnels
no fluming

10. The estimated cost of said ditch is $300.00 Dollars.

11. The land to be irrigated has a total area of Sixty eight and no/100 acres, described as follows (Give estimated acreage in fractions of subdivisions.)

In Sec. 25, Tp. 57 N. R 74 W		In Sec. 26, Tp. 57 N. R. 74 W	
SW¼ SE¼	20 acres	SE¼ NE¼	5 acres
SE¼ SW¼	8 "	NE¼ NE¼	6
NE¼ SW¼	12 "		18 acres
NW¼ SW¼	10 "		
SW¼ NW¼	7 "		

The ditch is turned into the creek in the SE¼ NE¼ Sec 26, and the creek is used for the ditch from this point. This is the only way that the land can be served with water at this place

12. Construction will begin on proposed works on or before June 15th, 1911

13. The time required for the completion of ditches and other distributing works is one year from Dec. 31st, 1911

14. The time required to complete the application of water to the beneficial use stated in this application is one year from May 1st, 1912

15. A map of the proposed ditch or canal, prepared in accordance with Chapter 14, R. S. 1899, accompanies this application.

Signed: Royal D. Salisbury
Surveyor No. 135

NOTE.—The statements in the foregoing application must comply with the requirements of Chapter 14, R. S. 1899.

777

Appropriate the Water of the State of Wyoming

THE STATE OF WYOMING, }
County of Weston } ss.

I hereby certify that the foregoing application was signed in my presence and sworn to before me by
Royal D. Salisbury this Fifth day of May, 1911.

S. A. Young
Notary Public

Seal. My commission expires March 2 1912

Powder R. Basin

THE STATE OF WYOMING, }
State Engineer's Office. } ss.

This is to certify that I have examined the foregoing application and have returned the same without my approval for the following reasons:

Witness my hand this ____ day of ____, A. D. 191__

State Engineer.

THE STATE OF WYOMING, }
State Engineer's Office. } ss.

This is to certify that I have examined the foregoing application and do hereby grant the same subject to the following limitations and conditions: * as follows

Secondary Permit, See Primary Permit # 2143 Pro
This application approved only for one diversion of water, namely, the diversion of water in the SW¼ SE¼ Sec 36 as indicated on accompanying maps

Construction of proposed works shall begin within one year from date of approval.

The time for completing the work shall terminate on December 31, 1912

The time for completing the appropriation of water for beneficial use shall terminate on December 31, 1912

The amount of the appropriation shall be limited to one cubic foot per second of time for each seventy acres of land reclaimed on or before December 31, 1912, and the additional volume used for domestic & stock purposes on or before said date.

Witness my hand this 15th day of July, A. D. 1911.

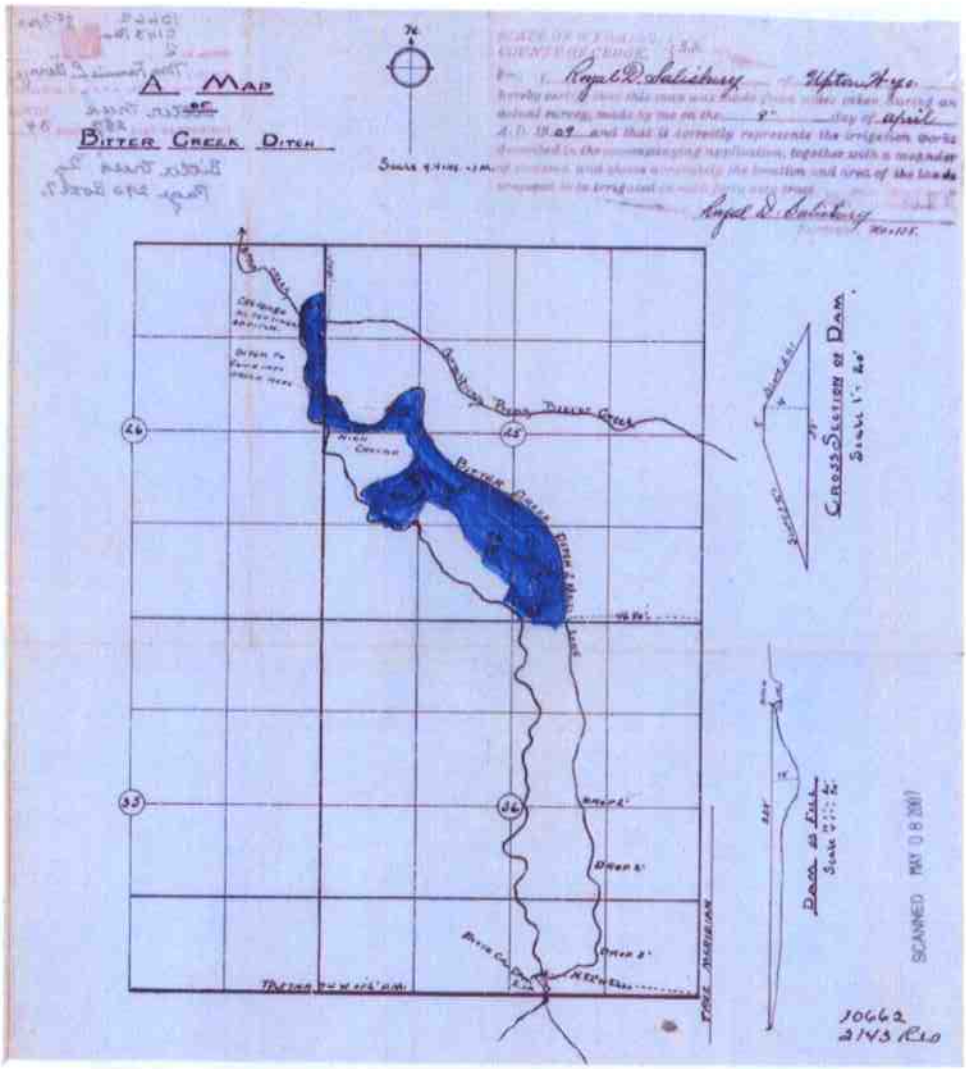
a. j. Parshall
State Engineer.

THE STATE OF WYOMING, }
State Engineer's Office. } ss.

This instrument was received and filed for record on the 6th day of May, A. D. 1911, at 1:30 o'clock P. M., and duly recorded in Book 34 of Applications on Page 247

a. j. Parshall
State Engineer.

A Map of Bitter Creek Ditch



I, Royal D. Salisbury of Upton, Wyo. hereby certify that this map was made from notes taken during an actual survey, made by me on the 2nd day of April A.D. 1909 and that it correctly represents the irrigation works described in the accompanying application, together with a map and profile, and shows correctly the location and area of the lands proposed to be irrigated as such lands were then staked.

Royal D. Salisbury
Engineer.

SCANNED MAY 08 2007

10662
2143 R.D

11996

THE STATE OF WYOMING

CERTIFICATE OF APPROPRIATION OF WATER

CERTIFICATE RECORD No. 34 PAGE 187

WHEREAS, Mrs. Fannie L. Berry has presented to the Board of Control of the State of Wyoming proof of the appropriation of water from Bitter Creek tributary of Powder River through the Bitter Creek Reservoir Ditch under Permit No. 2143 Res. for irrigation of the lands herein described, lying and being in County, Wyoming, and for stock and domestic purposes.

NOW KNOW YE, That the Board of Control, under the provisions of Division 1, Title 9, Chapters 10 and 14 of the Revised Statutes of Wyoming, 1899, has, by an order duly made and entered on the 22nd day of November, A. D. 1912, in Order Record No. 4 Page 615, determined and established the priority and amount of such appropriation as follows:

Name of Appropriator Mrs. Fannie L. Berry; Postoffice Address Morse, Wyoming; Amount of Appropriation 4.4 A.ft. cu. ft. per. sec.; Date of Appropriation May 6, 1911; Description of land to be irrigated and for which this appropriation is determined and established; Total Acreage

Said reservoir is located in the SW¼ SE¼ Sec. 36, Tp. 57 N. R. 74 W., Campbell County, Wyoming, and said appropriation of water stored therein is used for the irrigation of land described under the Bitter Creek Ditch, Permit No. 10662, Certificate Record No. 34, page 188.

The right to water hereby confirmed and established is limited to irrigation, stock and domestic purposes, and the use is restricted to the place where acquired and to the purpose for which acquired; rights for irrigation not to exceed one cubic foot per second for each seventy acres of land for which appropriation is herein determined and established.

IN TESTIMONY WHEREOF, I, A. J. Parshall, President of the State Board of Control, have hereunto set my hand this 25th day of January, A. D. 19 13, and caused the seal of said Board to be hereunto affixed.

ATTEST: EUGENE JAHELMANN, *Secretary*. A. J. Parshall, *President*.

290

RESERVOIR APPLICATIONS

Application for a Permit to Construct the Bitter Creek Reservoir, and to Store the Unappropriated Water of the State of Wyoming

Water Division No. 2 Ditch No.

I, Royal D. Salisbury

of Upton County of Weston State of Wyoming

being duly sworn according to law, upon my oath say:

1. The name of the applicant is Mrs. Fannie L. Berry

2. The postoffice address of the applicant is Moorcroft, Wyoming

3. The name of stream from which reservoir is to be filled and appropriation made is Bitter Creek

4. The use to which the water is to be applied is Irrigation

5. The location of the proposed reservoir will be in Sec (36) Thirty Six T. N., R. W., described as follows:

(a) State whether situated in channel of running stream, and give character of material at outlet.

Reservoir not situated in the channel of a running stream. (This creek does not run continuously during the season)

(b) If not in channel of running stream state how it is to be filled. If through canal give name and dimensions.

Reservoir to be filled with melting snow and rain water

(c) The construction of dam, the material of which it is to be built and the method of protecting from waves are as follows:

Dam to be built of earth riprapped with brush and stone

6. The area of reservoir is 2.1 acres with maximum depth of 5 feet and approximate mean depth of water of 2.1 feet.

7. The dimensions of dam are: Length on top, 228 feet. Length on bottom, feet. Width on top, 8 feet. Width on bottom, 58 feet. Depth, 10 feet. Slope of front, 3 To 1 Slope of back, 2 To 1 Height of dam above water line when full, 5 feet.

8. The outlet and waterway, with dimensions of each, are as follows:

Outlet to be a ditch 14 ft. wide on top and 10 ft. on bottom. The ditch will be sufficient to carry the ordinary floods. along the ditch will be waste weirs to dispose of unusual floods.

9. The outlet of the proposed reservoir is located N. 82° W. 2200 feet from the South East corner of Section thirty six Township 57 North, Range 74 West.

10. The estimated cost of said reservoir is $ 120.00

11. Construction will begin on proposed works on or before July 1st, 1911, 19

12. The time required for the completion of the works is one year from Dec 31st, 1911, 19

Signed: Royal D. Salisbury
Surveyor No. 135

NOTE.—*The statements in the foregoing application, together with the maps and plans, must comply with the requirements of Chapter 60, Session Laws 1905.*

STATE OF WYOMING

THE STATE OF WYOMING,
County of Weston } ss.

I hereby certify that the foregoing application was signed in my presence and sworn to before me by
Roycal D. Salisbury this fifth day of May 1911. 19

S. A. Young
Notary Public. Seal.

My commission expires March 6th 1912.

Notice of completion received OCT 28 1912 SCANNED MAY 08 2007

The records of the State Engineer's Office show the waters of Powder R. a Tributary

THE STATE OF WYOMING,
State Engineer's Office } ss.

This is to certify that I have examined the foregoing application and have returned the same without my approval for the following reasons:

Witness my hand this day of , A. D. 19

State Engineer.

THE STATE OF WYOMING,
State Engineer's Office } ss.

This is to certify that I have examined the foregoing application and do hereby grant the same subject to the following limitations and conditions:

Primary Permit, See Secondary Permit # 10, 662 # See above

Construction of proposed works shall begin within one year from date of approval.

The time for completing the work shall terminate on December 31, 1912.

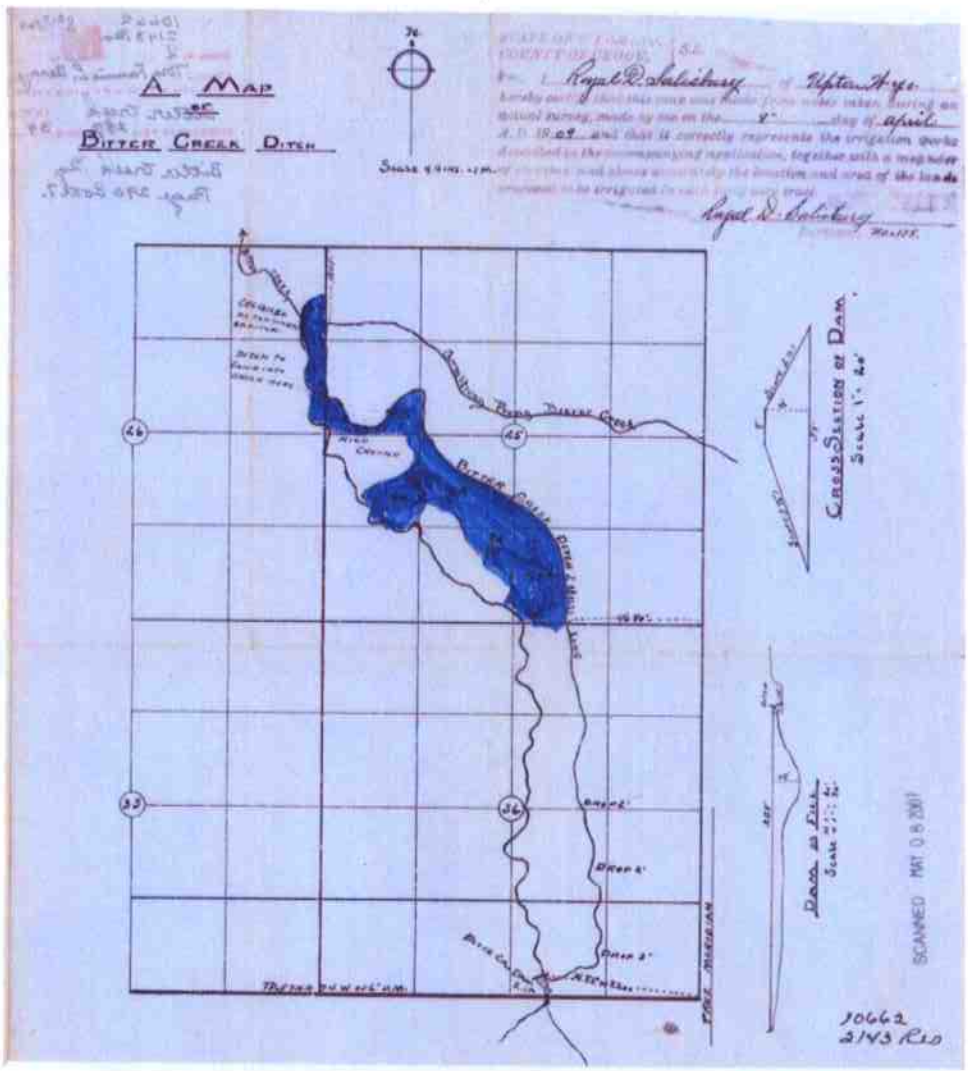
Witness my hand this 15th day of July A. D. 1911

a. J. Parshall
State Engineer.

THE STATE OF WYOMING,
State Engineer's Office } ss.

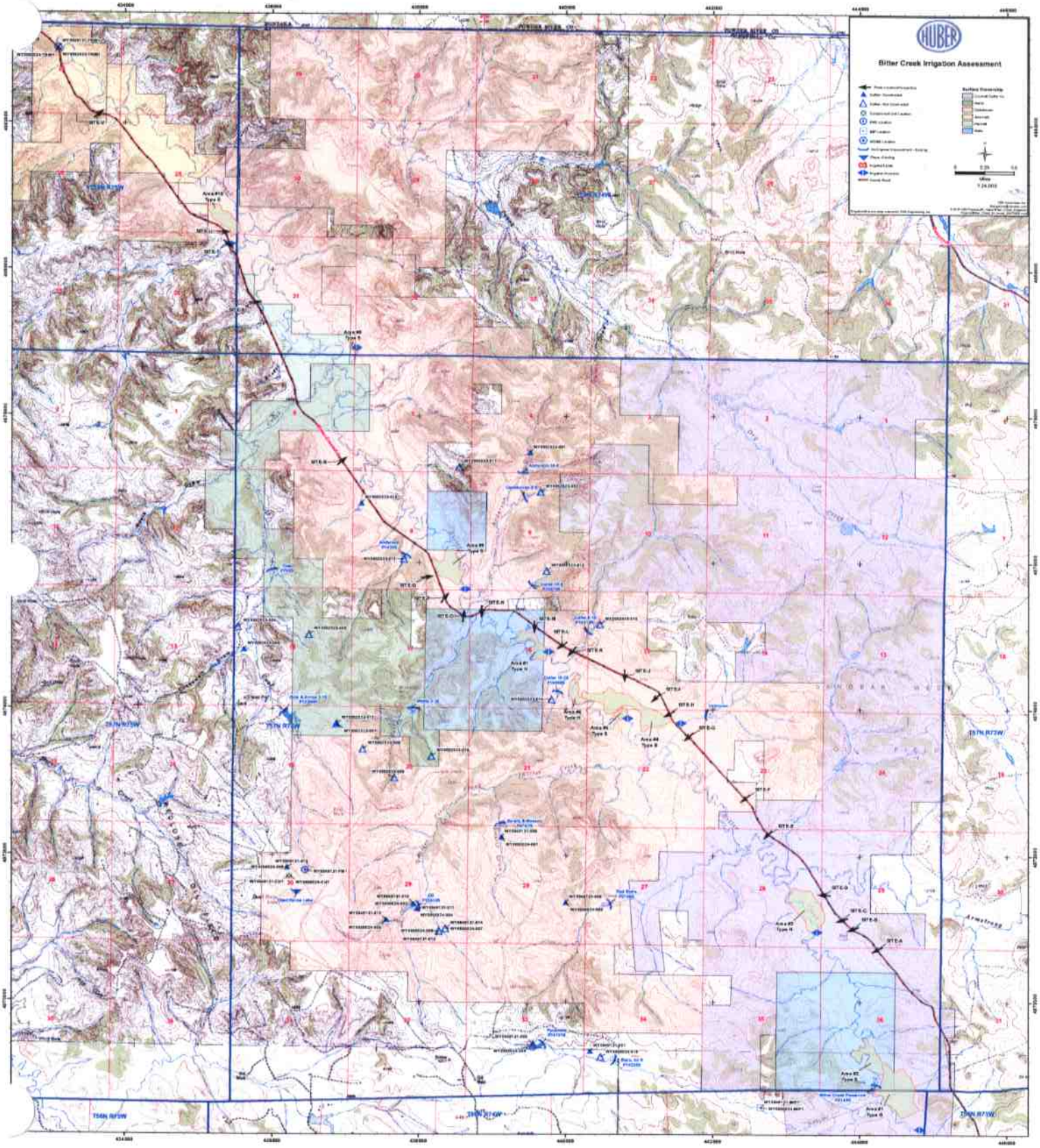
This instrument was received and filed for record on the 6th day of May A. D. 1911, at 11:30 o'clock A. M., and duly recorded in Book 7 of Reservoirs on Page 290

a. J. Parshall.
State Engineer.


A Map of Bitter Creek Ditch
Royal D. Salisbury
Upton, Wyo.
April
1909
Bitter Creek
26
25
35
36
Drop 2'
Drop 4'
Cross Section of Dam
Dam as Fill
SCANNED MAY 08 2007
10662
2143 Rec

APPENDIX C

Bitter Creek Irrigation Assessment Map


HUBER
Bitter Creek Irrigation Assessment

From: "Jaime Scharnowske" <jscharnowske@cbmainc.com>
To: "Dena Hicks" <DHICKS@state.wy.us>
Date: 7/18/2007 10:56 AM
Subject: RE: JM Huber's WY0049131 (Irrigation Report Mailed)
Attachments: 2007_07_18_WY0049131_Consolidated_Tble_1A.pdf; 2007_07_18_WY0049131_Consol

idated_Tble_1B.pdf; 2007_07_18_WY0049131_Map.pdf

Hi Dena -

As per your request I have updated the IMP locations to reflect all Option 2 outfalls. I have included new Tables 1A/1B and permit map that reflect these changes. Please replace the current permit documents with the attached documents. For confirmation, JM Huber requests to remove outfalls WY0050024-009 and WY0050024-010 from the permit as indicated within Tables 1A/1B and the permit map.

Please let me know if you have any additional questions regarding this permit.

Thanks,

CBM Associates, Inc.

Jaime Scharnowske

500 W. Lott

Buffalo, WY 82834

Office: (307) 684-0252

Cell: (307) 620-0032

Fax: (307) 684-0254

Email: jscharnowske@cbmainc.com

www.cbmainc.com

SUPPLEMENTAL

-----Original Message-----

From: Dena Hicks [mailto:DHICKS@state.wy.us]

Sent: Tuesday, July 17, 2007 10:26 AM

To: Jaime Scharnowske

Subject: Re: JM Huber's WY0049131 (Irrigation Report Mailed)

Hi Jamie,

Could you please check your table 1 again? The IMPs should reflect all option 2 outfalls. Also, I just wanted to confirm that Huber requested to remove outfalls WY0050024-009 and WY0050024-010 since they appeared on the Bitter Creek Irrigation Assessment supplement map.

Please send me a revised Table 1 and map with the IMP locations.

Thanks,

Dena

SUPPLEMENTAL

Table 1A - Outfall Information as Proposed: WY0049131 - Bitter Creek #2												
Desired Changes	Discharge Point (Outfalls) #	Immediate Receiving Stream	Mainstem	Distance to Closest 2AB Channel & Mainstem (Miles)	Quarter / Quarter	Section	Twn (N)	Rng (W)	Nad 83 Latitude	Nad 83 Longitude	County	Reservoir Name and Type
Moved From	001	Tributary to Bitter Creek	Powder River	22.4	SESW	34	57	74	44.872449	-105.748663	Campbell	Baco, lot 8 On-Channel Reservoir
Moved To	**001**	**Pyramid Draw**	**Powder River**	**22.4**	**SWSW**	**34**	**57**	**74**	**44.874846**	**-105.755454**	**Campbell**	**Baco, lot 8 On-Channel Reservoir**
Updated From	002	Tributary to Bitter Creek	Powder River	22.2	NESE	4	56	74	44.858793	-105.759768	Campbell	Del Rae On-Channel Reservoir
Updated To	**002**	**Del Rae Draw**	**Powder River**	**22.9**	**NESE**	**4**	**56**	**74**	**44.861048**	**-105.763907**	**Campbell**	**Del Rae On-Channel Reservoir**
Updated From	003	Arco Draw	Powder River	23.6	NESW	4	56	74	44.859372	-105.770772	Campbell	Johnson #13 On-Channel Reservoir
Updated To	**003**	**Arco Draw**	**Powder River**	**23.6**	**NWSE**	**4**	**56**	**74**	**44.859372**	**-105.770772**	**Campbell**	**Johnson #13 On-Channel Reservoir**
Updated From	004	Tributary to Bitter Creek	Powder River	23.7	NENW	9	56	74	44.852828	-105.772648	Campbell	Becky's Butte Pond On-Channel Reservoir
Updated To	**004**	**Bronco Draw**	**Powder River**	**23.7**	**NENW**	**9**	**56**	**74**	**44.851510**	**-105.773172**	**Campbell**	**Becky's Butte Pond On-Channel Reservoir**
Moved From	005	Tributary to Bitter Creek	Powder River	22.9	SWSE	33	57	74	44.875867	-105.764245	Campbell	Pyramids On-Channel Reservoir
Moved To	**005**	**Pyramid Draw**	**Powder River**	**22.9**	**SWSE**	**33**	**57**	**74**	**44.875669**	**-105.765202**	**Campbell**	**Pyramids On-Channel Reservoir**
Moved From	006	Tributary to Bitter Creek	Powder River	23.8	NESW	4	56	74	44.860727	-105.773614	Campbell	Peppy Pond On-Channel Reservoir
Moved To	**006**	**Arco Draw**	**Powder River**	**23.8**	**SENW**	**4**	**56**	**74**	**44.861658**	**-105.775067**	**Campbell**	**Peppy Pond On-Channel Reservoir**
Moved From	007	Tributary to Bitter Creek	Powder River	23.4	SENE	4	56	74	44.862171	-105.763924	Campbell	Kendall On-Channel Reservoir
Moved To	**007**	**Del Rae Draw**	**Powder River**	**23.4**	**SENE**	**4**	**56**	**74**	**44.862890**	**-105.764653**	**Campbell**	**Kendall On-Channel Reservoir**
Transferred from WY0050024-001	**008**	**Swartz Draw**	**Powder River**	**14.9**	**NENW**	**28**	**57**	**74**	**44.901106**	**-105.771087**	**Campbell**	**Swartz & Beason On-Channel Reservoir**
Transferred from WY0050024-002	**009**	**Tributary to Bitter Creek**	**Powder River**	**16.8**	**NESE**	**28**	**57**	**74**	**44.893142**	**-105.759874**	**Campbell**	**Red Butte On-Channel Reservoir**
Transferred from WY0050024-003	**010**	**Quarter Circle Prong Bitter Creek**	**Powder River**	**16.0**	**NWSE**	**29**	**57**	**74**	**44.892776**	**-105.786046**	**Campbell**	**ER On-Channel Reservoir**
Transferred from WY0050024-004	**011**	**Quarter Circle Prong Bitter Creek**	**Powder River**	**16.0**	**NWSE**	**29**	**57**	**74**	**44.892168**	**-105.785493**	**Campbell**	**ER On-Channel Reservoir**
Transferred from WY0050024-005	**012**	**Tributary to Quarter Circle Prong**	**Powder River**	**16.4**	**SESW**	**29**	**57**	**74**	**44.890817**	**-105.790781**	**Campbell**	**ER On-Channel Reservoir**
Transferred from WY0050024-006	**013**	**Tributary to Quarter Circle Prong**	**Powder River**	**16.2**	**SESE**	**29**	**57**	**74**	**44.889465**	**-105.781676**	**Campbell**	**--**
Transferred from WY0050024-007	**014**	**Tributary to Quarter Circle Prong**	**Powder River**	**16.2**	**SESE**	**29**	**57**	**74**	**44.889785**	**-105.780576**	**Campbell**	**--**
Transferred from WY0050024-008	**015**	**Natural Playa**	**Powder River**	**Natural Playa**	**SENW**	**30**	**57**	**74**	**44.897106**	**-105.808003**	**Campbell**	**Dead Horse Lake Natural Playa**
Removed Non-Constructed Outfall	**WY0050024 - 009**	**Pyramid Draw**	**Powder River**	**22.9**	**NWSE**	**33**	**57**	**74**	**44.875635**	**-105.765226**	**Campbell**	**Pyramids On-Channel Reservoir**
Removed Non-Constructed Outfall	**WY0050024 - 010**	**Pyramid Draw**	**Powder River**	**22.3**	**SWSW**	**34**	**57**	**74**	**44.874134**	**-105.753605**	**Campbell**	**Baco, lot 8 On-Channel Reservoir**

SUPPLEMENTAL

Table 1A - Outfall Information as Proposed: WY0049131 - Bitter Creek #2									
Desired Changes	Station Name	Station Description	Quarter / Quarter	Section	Twn (N)	Rng (W)	Nad 83 Latitude	Nad 83 Longitude	Notes regarding water quality monitoring station types
Added	CU1	Containment Unit Water Quality Monitoring Station	SENW	30	57	74	44.896029	-105.807593	Dead Horse Lake Natural Playa
Added	FM1	Flow Monitoring Station	SWNE	30	57	74	44.896790	-105.804898	Dead Horse Lake Natural Playa
Added	IMP1	Irrigation Monitoring Point	SENW	1	56	74	44.866131	-105.710633	Downstream of Outfalls 001 through 007; upstream of irrigation
Added	IMP2	Irrigation Monitoring Point	SWNE	22	57	74	44.912292	-105.746116	Downstream of Outfalls 008 through 014
Moved From	TRIB1	Tributary Water Quality Monitoring Station	NENW	23	58	75	44.997310	-105.848836	–
Moved To	TRIB1	Tributary Water Quality Monitoring Station	SENW	23	58	75	44.997481	-105.848995	–

Please note that not all station types may be applicable for a particular facility. Additional spaces may be added if necessary. Use the format provided. Please denote reservoir type(s) - on channel, off-channel, playa, headwater Option 1B - in the appropriate column. Please note that reservoir information is not required if reservoir containment is not part of the facility's water management plan - for instance, information about existing "incidental" downstream reservoirs is not required.

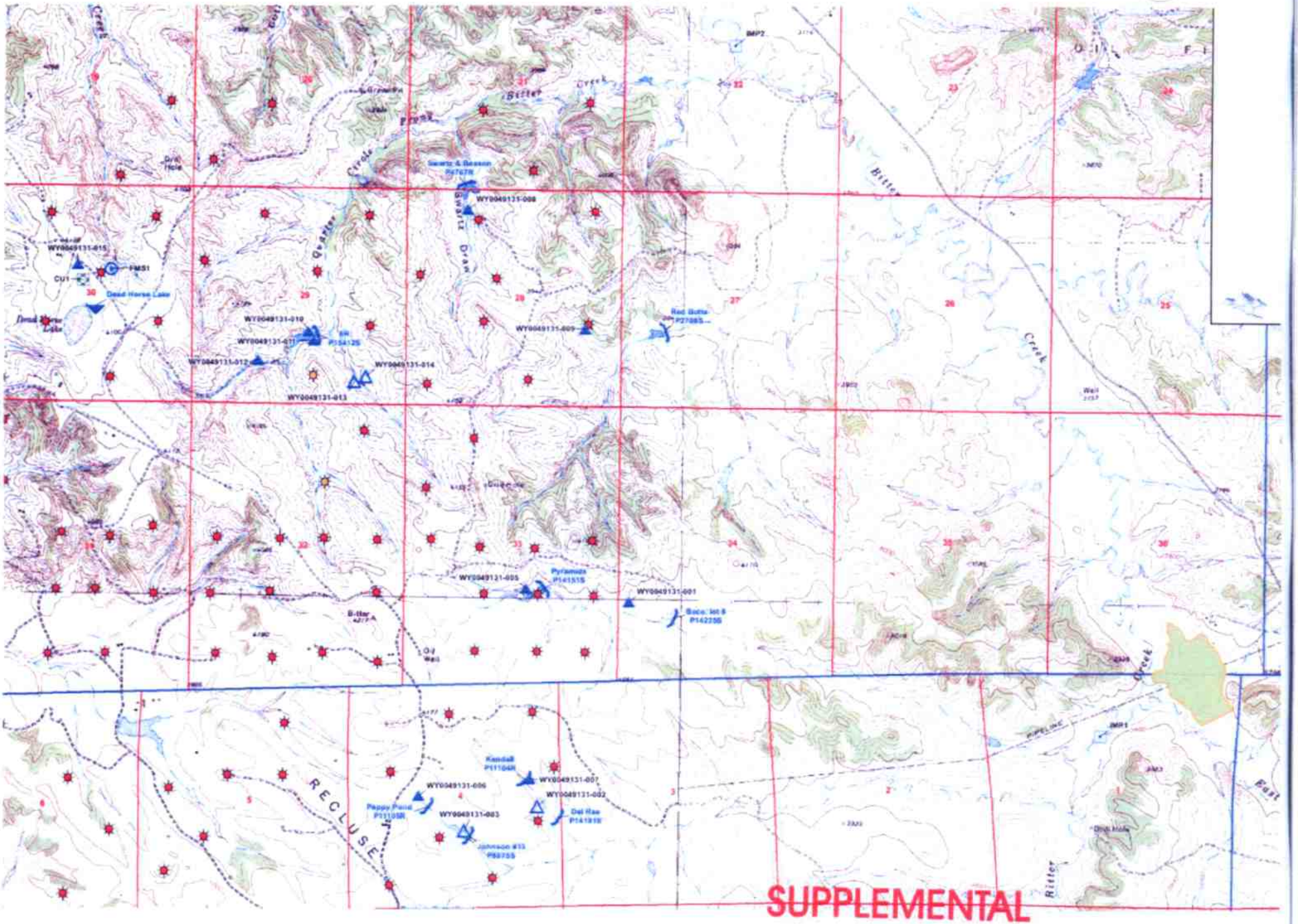
SUPPLEMENTAL

Table 1B - Outfall Information as Permitted: WY0049131 - Bitter Creek #2											
Discharge Point (Outfalls) #	Immediate Receiving Stream	Mainstem	Distance to Closest 2AB Channel & Mainstem (Miles)	Quarter / Quarter	Section	Twn (N)	Rng (W)	Nad 83 Latitude	Nad 83 Longitude	County	Reservoir Name and Type
001	Pyramid Draw	Powder River	22.4	SWSW	34	57	74	44.874846	-105.755454	Campbell	Baco, lot 8 On-Channel Reservoir
002	Del Rae Draw	Powder River	22.9	NESE	4	56	74	44.861048	-105.763907	Campbell	Del Rae On-Channel Reservoir
003	Arco Draw	Powder River	23.6	NWSE	4	56	74	44.859372	-105.770772	Campbell	Johnson #13 On-Channel Reservoir
004	Bronco Draw	Powder River	23.7	NENW	9	56	74	44.851510	-105.773172	Campbell	Becky's Butte Pond On-Channel Reservoir
005	Pyramid Draw	Powder River	22.9	SWSE	33	57	74	44.875669	-105.765202	Campbell	Pyramids On-Channel Reservoir
006	Arco Draw	Powder River	23.8	SENW	4	56	74	44.861658	-105.775067	Campbell	Peppy Pond On-Channel Reservoir
007	Del Rae Draw	Powder River	23.4	SENE	4	56	74	44.862890	-105.764653	Campbell	Kendall On-Channel Reservoir
008	Swartz Draw	Powder River	14.9	NENW	28	57	74	44.901106	-105.771087	Campbell	Swartz & Beason On-Channel Reservoir
009	Tributary to Bitter Creek	Powder River	16.8	NESE	28	57	74	44.893142	-105.759874	Campbell	Red Butte On-Channel Reservoir
010	Quarter Circle Prong Bitter Creek	Powder River	16.0	NWSE	29	57	74	44.892776	-105.786046	Campbell	ER On-Channel Reservoir
011	Quarter Circle Prong Bitter Creek	Powder River	16.0	NWSE	29	57	74	44.892168	-105.785493	Campbell	ER On-Channel Reservoir
012	Tributary to Quarter Circle Prong	Powder River	16.4	SESW	29	57	74	44.890817	-105.790781	Campbell	ER On-Channel Reservoir
013	Tributary to Quarter Circle Prong	Powder River	16.2	SESE	29	57	74	44.889465	-105.781676	Campbell	–
014	Tributary to Quarter Circle Prong	Powder River	16.2	SESE	29	57	74	44.889785	-105.780576	Campbell	–
015	Natural Playa	Powder River	Natural Playa	SENW	30	57	74	44.897106	-105.808003	Campbell	Dead Horse Lake Natural Playa

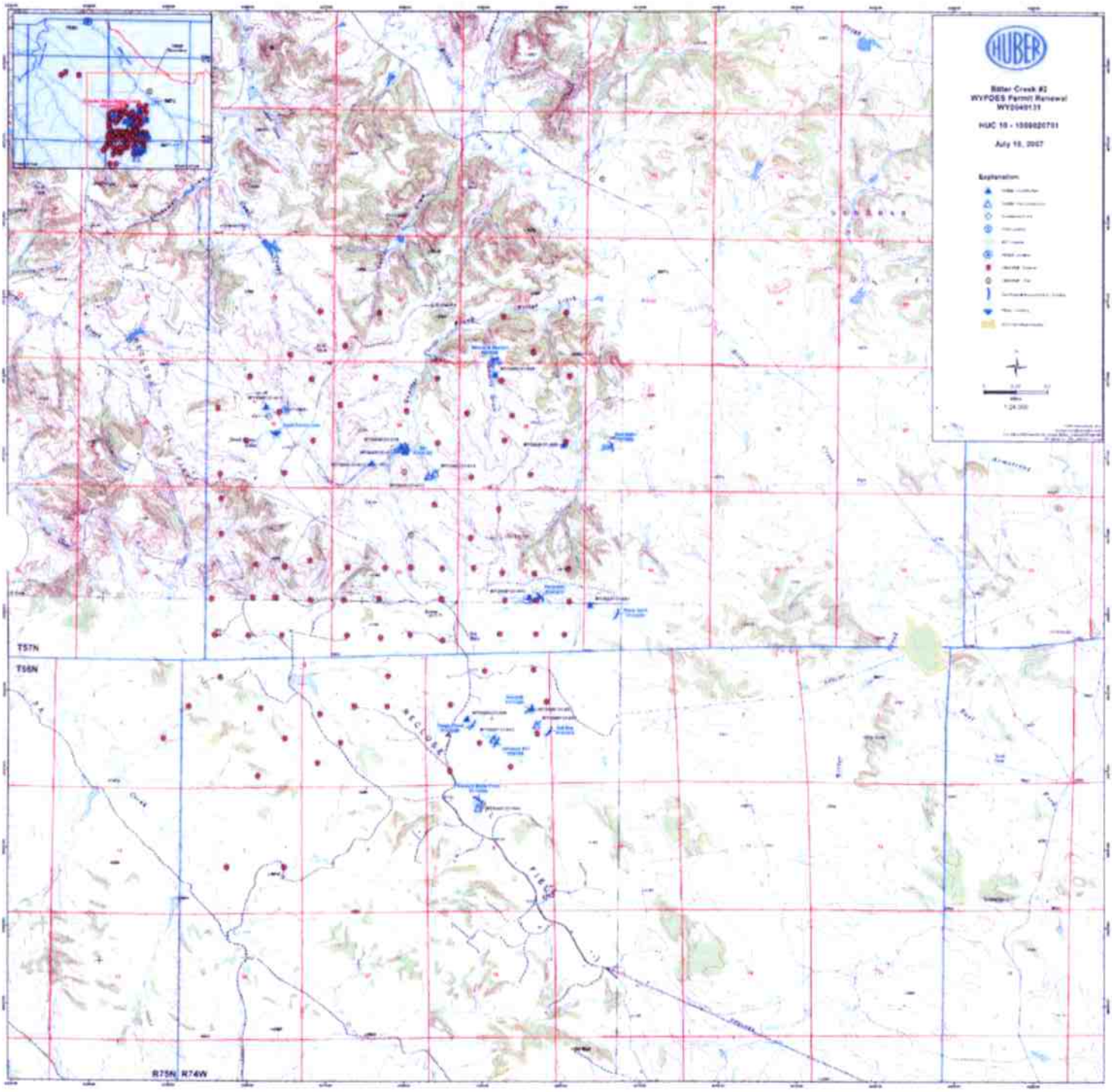
Station Name	Station Description	Quarter / Quarter	Section	Twn (N)	Rng (W)	Nad 83 Latitude	Nad 83 Longitude	Notes regarding water quality monitoring station types
CU1	Containment Unit Water Quality Monitoring Station	SENW	30	57	74	44.896029	-105.807593	Dead Horse Lake Natural Playa
FM1	Flow Monitoring Station	SWNE	30	57	74	44.896790	-105.804898	Dead Horse Lake Natural Playa
IMP1	Irrigation Monitoring Point	SENW	1	56	74	44.866131	-105.710633	Downstream of Outfalls 001 through 007; upstream of irrigation
IMP2	Irrigation Monitoring Point	SWNE	22	57	74	44.912292	-105.746116	Downstream of Outfalls 008 through 014
TRIB1	Tributary Water Quality Monitoring Station	SENW	23	58	75	44.997481	-105.848995	–

Please note that not all station types may be applicable for a particular facility. Additional spaces may be added if necessary. Use the format provided. Please denote reservoir type(s) - on channel, off-channel, playa, headwater Option 1B - in the appropriate column. Please note that reservoir information is not required if reservoir containment is not part of the facility's water management plan - for instance, information about existing "incidental" downstream reservoirs is not required.

SUPPLEMENTAL



SUPPLEMENTAL



SUPPLEMENTAL

The Termo Company

Appeal of WY0055158
RULE 408 CONFIDENTIAL
SETTLEMENT
DOCUMENT

Points of Appeal

- Section 20 Analysis
- Characterization of Downstream Irrigation
- SEO Determination of Irrigation Rights
- Landowner's within Homestead Draw II
- Reservoirs within Homestead Draw II
- Water Quality Analysis in Bitter Creek

Section 20 Analysis

On March 7, 2007 the Wyoming Department of Environmental Quality issued WYPDES Permit WY055158 to The Termo Company for water discharge from their Homestead Draw II CBNG project. In this permit, WDEQ established effluent limits based in part on default values that are designed to protect downstream irrigation uses. Based on knowledge of the Bitter Creek drainage, Termo suspects that the default water quality standards may be more restrictive than the natural water quality available in Bitter Creek. Moreover, Termo feels that WDEQ may be attempting to protect irrigation uses that are not occurring on Bitter Creek. Therefore, SWCA Environmental Consultants, on behalf of Termo, and in consultation with WDEQ, have prepared this Tier 2, Section 20 study for Bitter Creek downstream of the Homestead Draw II project, in Section 36, Township 57N, Range 74W. We ask that WDEQ review this study to determine if there are, in fact, irrigation uses downstream of the project area that WDEQ is required to protect, and if there are, if less restrictive effluent limits would be appropriate.

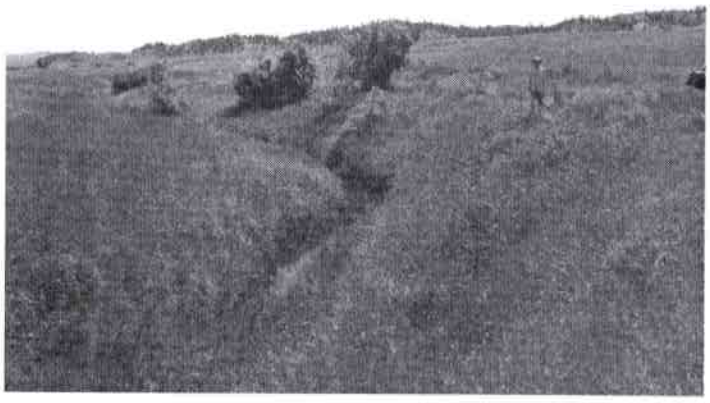
Section 20 Analysis

Although this Tier 2, Section 20 analysis focused on the use of soil chemistry to ascertain the quality of historic irrigation water to protect current irrigation uses, WDEQ should consider whether protecting irrigation uses is appropriate given the lack of current irrigation activity. Additionally, since it is apparent that none of the land adjacent to the creek is being irrigated by Bitter Creek, these lands are only being irrigated by natural precipitation which is almost certainly of better quality than the water in the creek.

Characterization of Downstream Irrigation

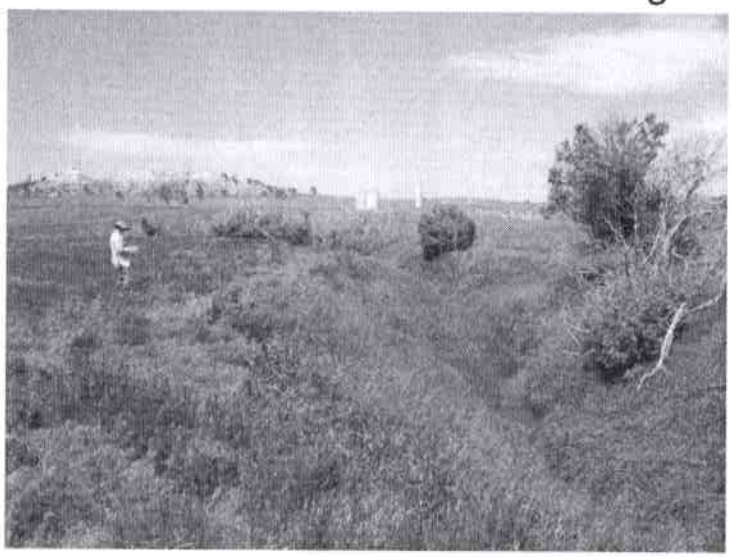
- Site 1, Zone 2 Facing Downstream

Characterization of Downstream Irrigation



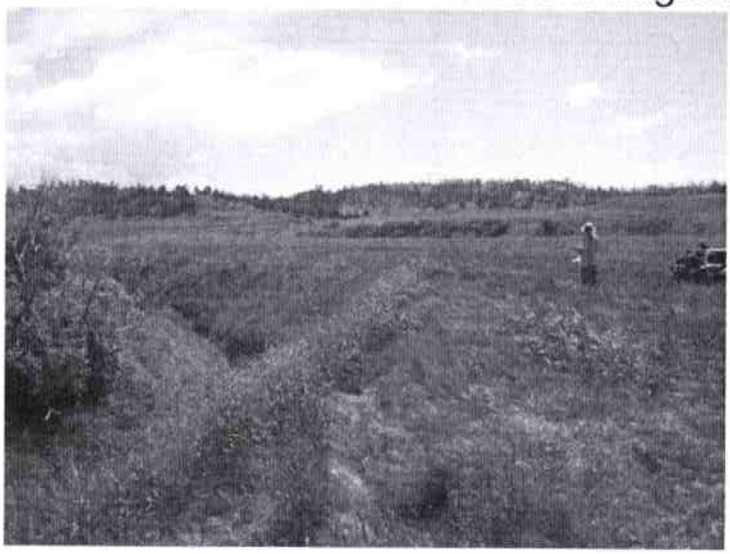
- Site 1, Zone 2 Facing Upstream

Characterization of Downstream Irrigation



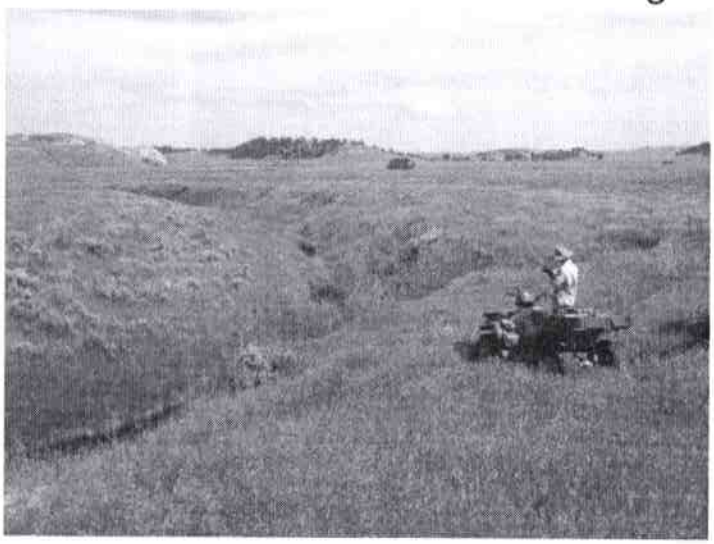
- Site 3, Zone 2 Facing Downstream

Characterization of Downstream Irrigation



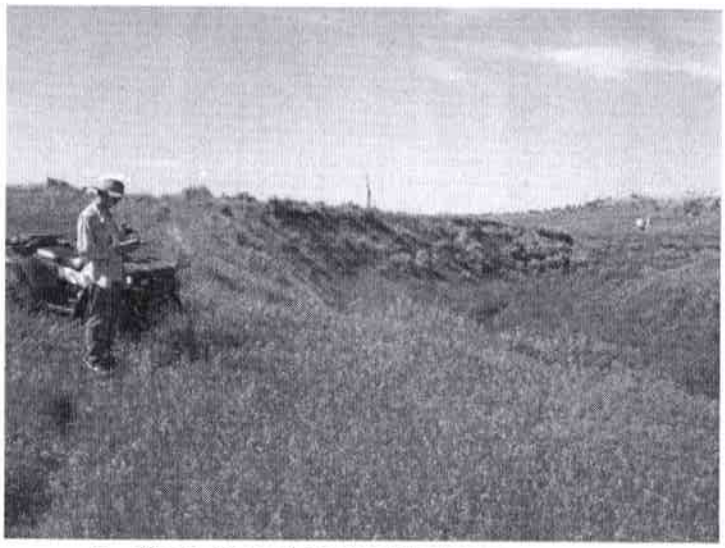
- Site 3, Zone 2 Facing Upstream

Characterization of Downstream Irrigation



- Site 5, Zone 2 Facing Downstream

Characterization of Downstream Irrigation



- Site 5, Zone 2 Facing Upstream

SEO Determination of Irrigation Rights

- On April 19, 2007 RT Cox on behalf of Crockett Cattle Company protested The Termo Company's reservoir applications to the SEO
  - The protest centered on the protection of Crockett downstream water rights and irrigation by the Crockett Cattle Company

SEO Determination of Irrigation Rights

- The SEO responded May 16, 2007:

1. Our field personnel did inspect the water rights on Bitter Creek and the Armstrong Prong of Bitter Creek. Based on this inspection we have protected the Armstrong Prong of Bitter Creek.

4. The point of diversion on Bitter Creek for Permit No. 10662D appears on the aerial photo. Some remnants of the ditch appear but the ditch does not extend to the lands to be irrigated under the permit.

5. More lands are being farmed than are shown on the permit maps.

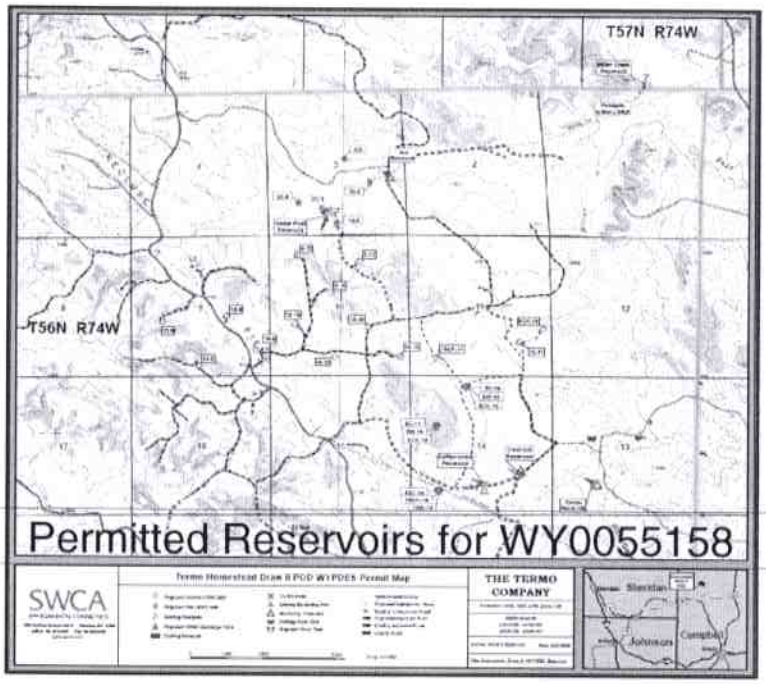
6. No evidence of spreader dike systems could be found on the aerial photographs. The lands appear to be dry land farmed or sub-irrigated from the various creeks. Additionally, we do not have any permits where spreader dikes are identified as the official points of diversion.

SEO Determination of Irrigation Rights

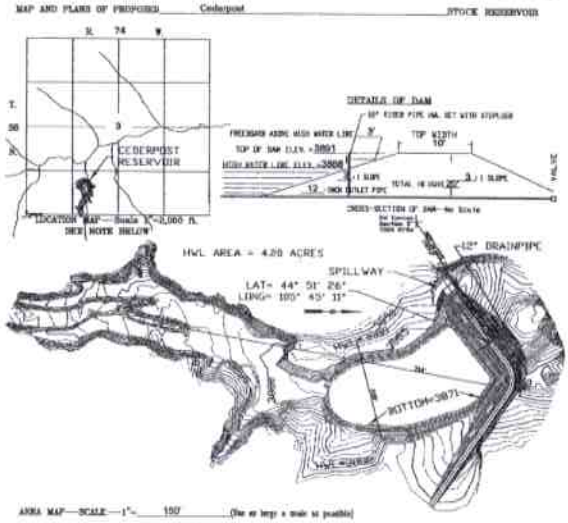
Your client's facilities on the ground do not conform to the records of this office, and in many cases appear inactive. Without up-to-date information on what lands are being irrigated and how the water is delivered to the lands, this office cannot determine if the upstream reservoir should be constructed to allow the natural flow in the drainage to reach the adjudicated lands. Your clients should have the appropriate petitions prepared to correct the records of this office to reflect the on-the-ground conditions. Updated records will allow this office to assess how to have an upstream reservoir constructed to protect natural flows to your client's adjudicated rights.

Landowner Support and Use of Water

- Manigualt (7) Ranch – Gabrielle Manigault
- Brug Land and Livestock – Robert Brug
  - Support and desire in-channel reservoirs
  - Desire beneficial use of water – livestock and potential irrigation
  - Support Termo in its appeal

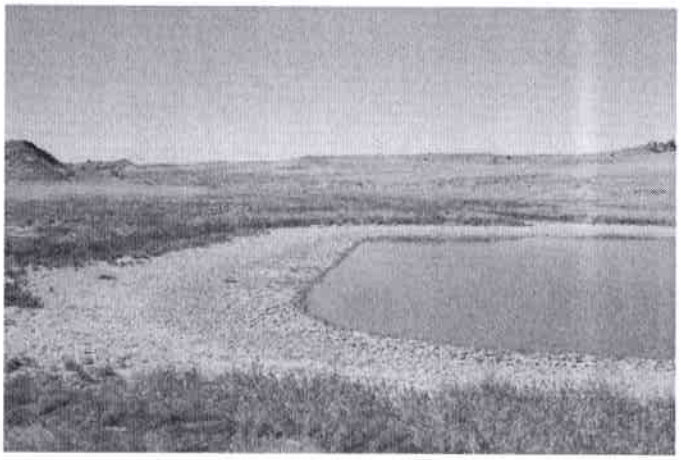


Permitted Reservoirs for WY0055158



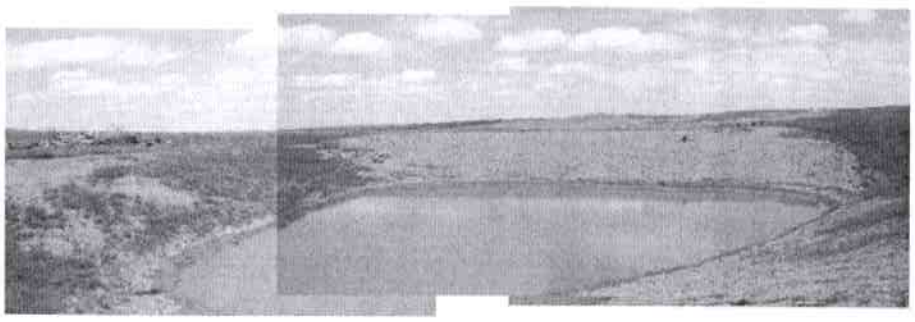
- (7) Ranch Cedar Post Pond

Permitted Reservoirs for WY0055158



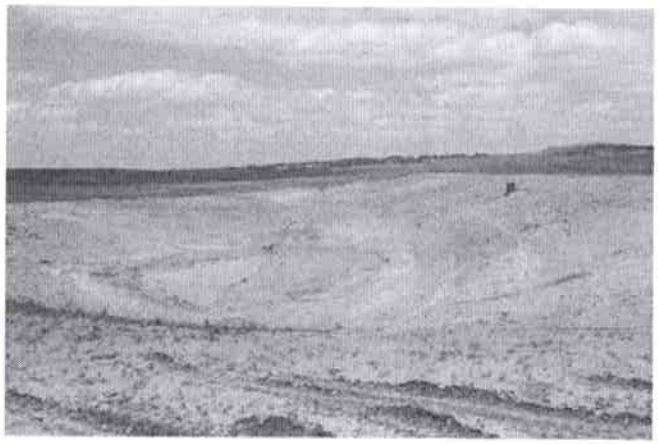
- (7) Ranch AJ Pond

Permitted Reservoirs for WY0055158



- Brug Ranch Cottonwood Pond

Permitted Reservoirs for WY0055158



- Brug Ranch Cleanout Pond

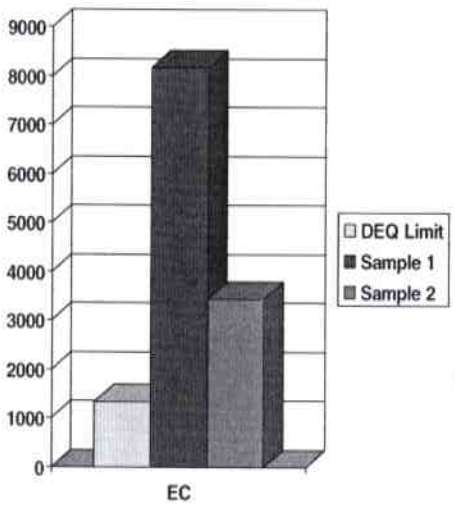
Permitted Reservoirs for WY0055158

- Brug Ranch Center Pond

Permitted Reservoirs for WY0055158

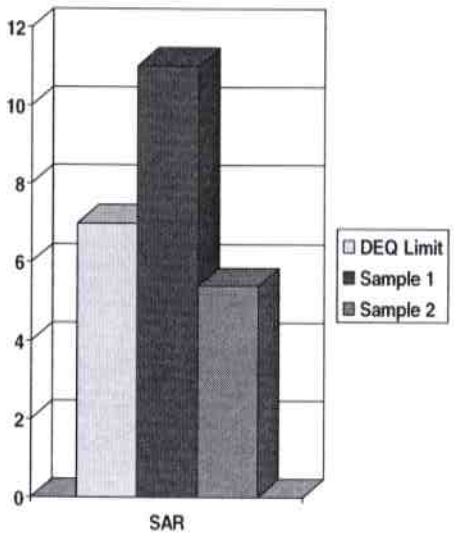
- Brug Ranch Center Pond

Water Quality Analysis Bitter Creek



- <u>EC Effluent Limit and Samples</u>
- DEQ Limit – Default EC Limit in HD II permit
- Sample 1 – Taken from Bitter Creek May 18th, 2007 by CBMA
- Sample 2 – Taken from Bitter Creek at Trib 1 Monitoring Station May 14th, 2007 by CBMA

Water Quality Analysis Bitter Creek



- SAR Effluent Limit and Samples
- DEQ Limit – Default EC Limit in HD II permit
- Sample 1 – Taken from Bitter Creek May 18th, 2007 by CBMA
- Sample 2 – Taken from Bitter Creek at Trib 1 Monitoring Station May 14th, 2007 by CBMA

Water Quality Analysis Bitter Creek

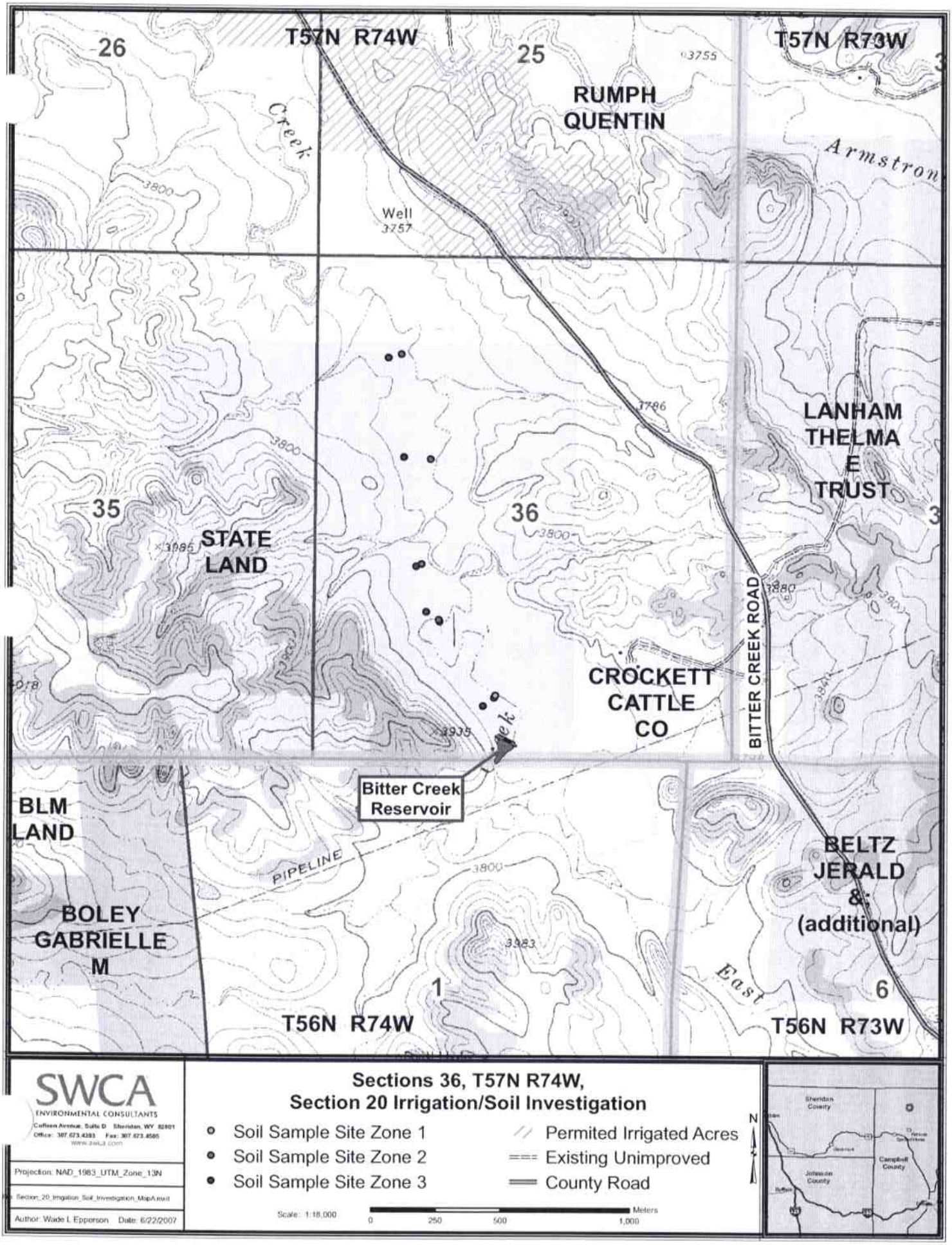
- Permit restricts discharge to an EC of 1330 / SAR of 7. Natural streamflow Bitter Creek Monitoring station - EC of 3430 / 2.5 times limit.
- Odekoven site showed an EC of 8170 / SAR of 11. SAR exceeds limit / EC is 6 times the limit.
- No Recordable flow in Bitter Creek for nearly four years.
- Considering that this data is from natural conditions, how could HD II project impact irrigation uses?

Water Quality Analysis Bitter Creek

- WDEQ is trying to protect irrigation for alfalfa, which cannot tolerate EC greater than 2000. A small amount of alfalfa is present, and if it were being irrigated with Bitter Creek water that natural water would exceed the 2000 EC limit.
- It appears that the normal "natural" condition for Bitter Creek is dry, so there is rarely water available for irrigation.
- Produced water would only hit the creek in the event of a significant runoff event, and at that point, it would be diluted with natural water.
- There is no surface irrigation occurring in the study area. But the concern was that the alfalfa on the lower end of the study area could be being sub-irrigated by Bitter Creek, since it is well known that alfalfa has a deep tap root that can find water very deep down. However, if DEQ has data showing that alfalfa can't tolerate an EC over 2000, and we've got data showing that the water in Bitter Creek exceeds 2000, then logic says that the alfalfa can't be getting water from the creek.

Conclusions

- Section 20 Analysis shows irrigation protection is overly restrictive for current use and system
- Bitter Creek channel is deeply incised and rarely floods over
- SEO finds limited irrigation in Bitter Creek
- Landowners want in-channel ponds, use of water, and oppose bypasses
- Existing storm events showed sufficient capacity of reservoirs
- Background water quality in Bitter Creek exceeds HD II effluent limits


T57N R74W
T57N R73W
26
25
RUMPH
QUENTIN
Armstron
Well
3757
3755
3800
LANHAM
THELMA
E
TRUST
35
36
STATE
LAND
3985
3935
1786
3880
BITTER CREEK ROAD
CROCKETT
CATTLE
CO
Bitter Creek
Reservoir
BLM
LAND
PIPELINE
BELTZ
JERALD
&
(additional)
BOLEY
GABRIELLE
M
3983
East
1
6
T56N R74W
T56N R73W
SWCA
ENVIRONMENTAL CONSULTANTS
Coffeen Avenue, Suite D Sheridan, WY 82801
Office: 307.673.4393 Fax: 307.673.4585
www.swca.com
Projection: NAD_1983_UTM_Zone_13N
Section_20_Irrigation_Soil_Investigation_MapA.mxd
Author: Wade L Epperson Date: 6/22/2007
Sections 36, T57N R74W,
Section 20 Irrigation/Soil Investigation
Soil Sample Site Zone 1
Soil Sample Site Zone 2
Soil Sample Site Zone 3
Permited Irrigated Acres
Existing Unimproved
County Road
N
Scale: 1:18,000
0
250
500
1,000
Meters
Sheridan County
Johnson County
Campbell County

State Engineer's Office

HERSCHLER BUILDING, 4-E CHEYENNE, WYOMING 82002
(307) 777-7354 FAX (307) 777-5451
seoleg@seo.wyo.gov

DAVE FREUDENTHAL
GOVERNOR

PATRICK TYRRELL
STATE ENGINEER

May 16, 2007

Mr. Randall T. Cox
Cox Law Office
400 South Kendrick Ave., Suite 101
Gillette, WY 82716

Re: Termo Company proposed reservoirs

Dear Mr. Cox,

This letter is in response to your letter of April 19, 2007 which included pages 357 & 358 from the Division II tab book and the Homestead Draw III North POD Water Management Plan. The information has been reviewed and the following comments are offered:

1. Our field personnel did inspect the water rights on Bitter Creek and the Armstrong Prong of Bitter Creek. Based on this inspection we have protected the Armstrong Prong of Bitter Creek.
2. 2006 aerial photos of this area have been reviewed. The point of diversion for Permit No. 10012D on Corral Creek, tributary to Armstrong Prong was found but there appeared to be no evidence of the ditches that irrigated the permitted lands.
3. The aerial photos did not reveal the points of diversion for Permit Nos. 11587D and 11588D diverting from Armstrong Prong. The lands being farmed do not match the lands shown on the permit map.
4. The point of diversion on Bitter Creek for Permit No. 10662D appears on the aerial photo. Some remnants of the ditch appear but the ditch does not extend to the lands to be irrigated under the permit.
5. More lands are being farmed than are shown on the permit maps.
6. No evidence of spreader dike systems could be found on the aerial photographs. The lands appear to be dry land farmed or sub-irrigated from the various creeks. Additionally, we do not have any permits where

spreader dikes are identified as the official points of diversion.

Your client's facilities on the ground do not conform to the records of this office, and in many cases appear inactive. Without up-to-date information on what lands are being irrigated and how the water is delivered to the lands, this office cannot determine if the upstream reservoir should be constructed to allow the natural flow in the drainage to reach the adjudicated lands. Your clients should have the appropriate petitions prepared to correct the records of this office to reflect the on-the-ground conditions. Updated records will allow this office to assess how to have an upstream reservoir constructed to protect natural flows to your client's adjudicated rights.

Please feel free to contact me at 307-777-6168 if you have any questions regarding this matter.

With best regards,

John R. Barnes
Administrator, Surface Water

and

Engineering Division

JRB/ra

Cc: Patrick T. Tyrrell, State Engineer
✓Harry LaBonde, Deputy State Engineer
Mike Whitaker, Superintendent - Water Division No. 2

COX LAW OFFICE
RANDALL T. COX, P.C.
A Professional Corporation

Randall T. Cox*
Clinton D. Beaver

Attorneys and Counselors At Law

Admitted in Wyoming
****Also admitted in Montana***

Kendrick Professional Building
400 South Kendrick Ave., Suite 101
Gillette, Wyoming 82716
Telephone (307) 682-2500
Telecopier (307) 685-0527
e-mail: rt@coxhorning.com
clint@coxhorning.com

April 19, 2007

Patrick Tyrrell
State Engineer
Herschler Building, 4th Floor East
Cheyenne, Wyoming 82002

RE: Termo Company proposed reservoirs

Dear Mr. Tyrrell:

This office represents Scott and Jodean Crockett and the Crockett Cattle Company. They own land in the northern portions of T56N, R73 and 74W, together with other lands. The Termo Company is proposing to build a number of reservoirs for impoundment of CBM produced water in the Bitter Creek watershed upstream of the places of use of the Crocketts' adjudicated water rights. We believe there is a chance that these reservoirs would interfere with natural flows which supply established, permitted spreader dikes in the Bitter Creek drainage.

The Termo Company is proposing that these reservoirs be flow-through reservoirs, such that storm events could be permitted to flow through. However, their information indicates that their produced water has a sodium adsorption ratio (SAR) of 34.6. If the reservoirs are drained this water would run down the channels to the Crocketts' irrigation systems. The Crocketts do not want to try to irrigate their land with water with such an extremely high SAR.

I am enclosing a copy of the water management plan which has been submitted by Termo to the Bureau of Land Management in January of 2007. Included is information regarding locations of discharge points and proposed reservoirs.

I am also enclosing copies of two pages from the Tab Book for Division 2, which lists the irrigation permits and secondary permits held by the Crocketts, all of which are, of course,

adjudicated water rights.

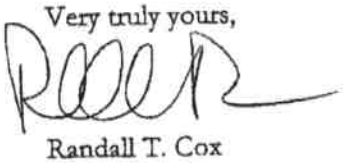
The Termo Water Management Plan reveals that the watersheds above these reservoirs contribute substantial amounts of irrigation water on a mean annual basis. It appears that these watersheds are a significant source of flows for the Crocketts' irrigation systems.

The Crocketts request that you do not approve any of these reservoir permits until it is determined that such reservoirs will not cause any interference with natural flows to the Crocketts' irrigation systems, or, if the permits have been approved, that you require Termo to bypass all natural flows around these reservoirs, which are, of course, junior to the Crocketts' adjudicated rights.

Further, the Crocketts will not consent to the construction of the proposed Crockett 15-42 Reservoir in Section 12, T56N R74W.

Please feel free to contact me if you have any questions.

Very truly yours,



Randall T. Cox

RTC/dw

cc: Termo Company
Mr. and Mrs. Crockett

Enclosures

CBM Associates, Inc.
920 E. Sheridan St. • Laramie, WY 82070 • Office: (307) 742-4991 • Fax: (307) 745-1582

GROUNDWATER & SURFACE WATER HYDROLOGY • WATER RESOURCE MANAGEMENT • ENVIRONMENTAL PERMITTING & COMPLIANCE

June 26, 2007

Mr. Ralph Combs
The Termo Company
1900 W. Warlow, Suite C
Gillette, WY 82716

Mr. Combs,

CBM Associates, Inc. (CBMA) has conducted monthly monitoring at the WQMS TRIB1 on Bitter Creek near the Wyoming-Montana border for numerous operators since July 30, 2003. The TRIB1 site is located at latitude 44.997495 and longitude -105.848995 NAD 83 in the SENW quarter/quarter in section 23, township 58N, range 75W. Please see the attached map for locations.

From July 30, 2003 until May 14, 2007 Bitter Creek experienced no flow. For this published data, please refer to the publication prepared by CBMA for the Wyoming Department of Environmental Quality – Water Quality Division entitled, "Surface Water Monitoring Report Water Quality Monitoring Stations Including Upstream and Downstream Monitoring Locations July 2006 to December 2006."

On May 14, 2007, flow was detected and measured at 1.316 cubic feet per second or 0.851 million gallons per day on Bitter Creek at the TRIB1 station using a Global Flow Probe. A water sample was collected for analysis and results are on the attached lab report with Client Sample ID: DP_BitterCK_WY0052523_Trib1.

A non-WQMS water sample was collected for analysis from Bitter Creek on May 18, 2007 by CBMA at the NESE quarter/quarter in section 22, township 57N, range 74W on land owned by The Fred and Mary Ann Oedekoven Family Trust. Results from this analysis are on the attached lab report with Client Sample ID: SW_BitterCK.

Sincerely,
CBM Associates, Inc.

Lawrence Boram
Geochemist

920 E. Sheridan St.
Laramie, WY 82070
(307)742-4991 Office
(307) 745-1582 Fax
lboram@cbmainc.com

Enclosures: Bitter Creek Map
Lab Report Client Sample ID: DP_BitterCK_WY0052523_Trib1
Lab Report Client Sample ID: SW_BitterCK

ENERGY LABORATORIES, INC. * 1105 West First Street. * Gillette, WY 82716
Toll Free 866.686.7175 * 307.686.7175 * Fax 307.682.4625 * gillette@energylab.com

LABORATORY ANALYTICAL REPORT

Client: JM Huber Corporation
Site Name: S_Joe_Creek
Project: WYPDES_WQMS
Client Sample ID: DP_BitterCk_WY0052523_Trib1
Location: SENW_23_58N_75W
Samp FRQ/Type: M
Lab ID: G07050556-001

Report Date: 05/23/07
Collection Date: 05/14/07 11:00
DateReceived: 05/16/07
Sampled By: Todd Adams
Matrix: AQUEOUS
Tracking Number: 102949

Analyses	Result	Units	Result	Units	Qualifier	Method	Analysis Date / By
FIELD PARAMETERS							
Flow	0.851	mgd				FIELD	05/14/07 11:00 / ***
pH, field	8.30	s.u.				FIELD	05/14/07 11:00 / ***
Temperature °C, field	17.2	Deg C				FIELD	05/14/07 11:00 / ***
Temperature °F, field	63.0	Deg F				FIELD	05/14/07 11:00 / ***
*** Performed by Sampler							
MAJOR IONS, DISSOLVED							
Calcium	169	mg/L	8.44	meq/L		E200.7	05/22/07 05:34 / eli-b
Magnesium	177	mg/L	14.5	meq/L		E200.7	05/22/07 05:34 / eli-b
Sodium	420	mg/L	18.3	meq/L		E200.7	05/22/07 05:34 / eli-b
NON-METALS							
Conductivity @ 25 C	3430	umhos/cm				A2510 B	05/16/07 11:53 / mtb
Sodium Adsorption Ratio (SAR)	5.4	unitless				Calculation	05/23/07 08:53 / tlc

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

ENERGY LABORATORIES, INC. * 1105 W First St * Gillette, WY 82716
Toll Free 866.686.7175 * 307.686.7175 * FAX 307.682.4625 * gillette@energylab.com

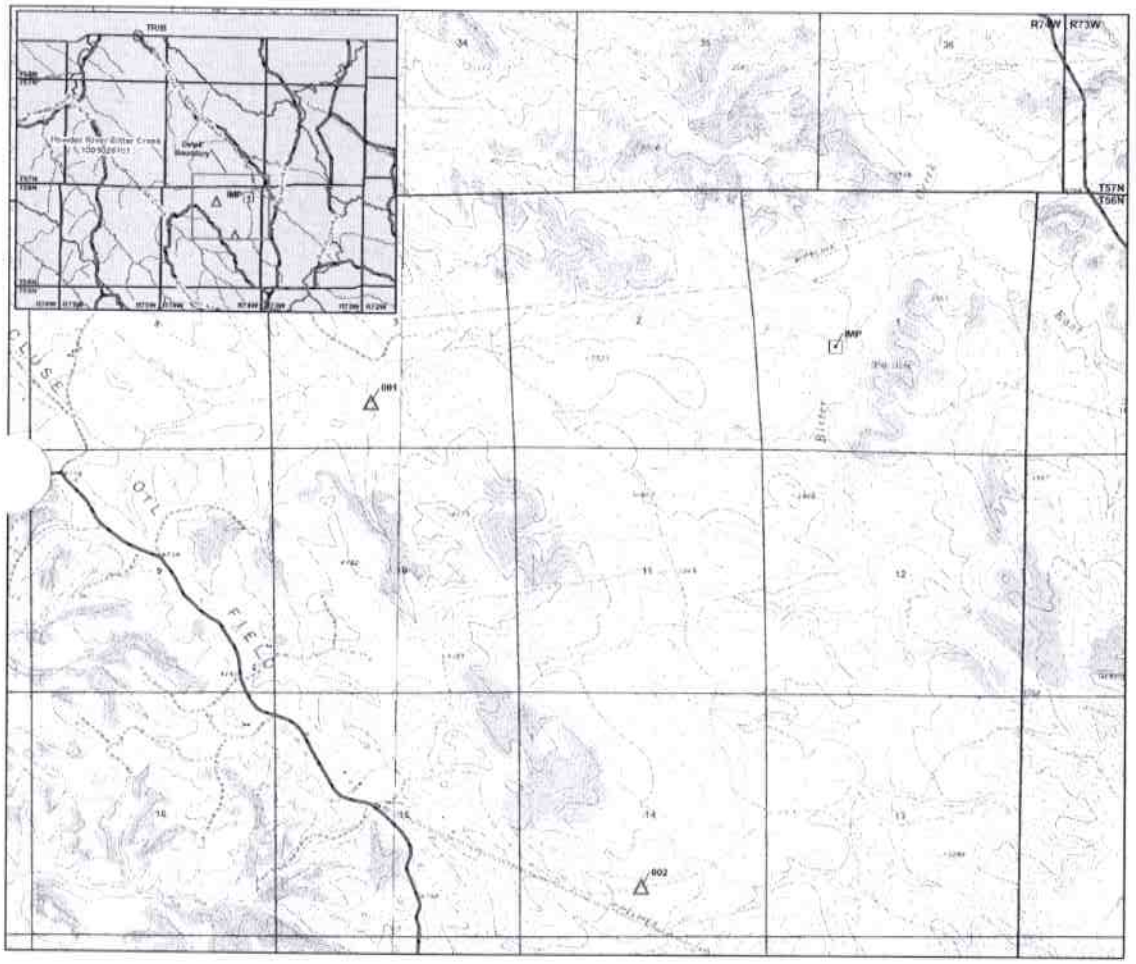
LABORATORY ANALYTICAL REPORT

Client: Storm Cat Energy USA Corp
Site Name: SW_BitterCk
Project: Surface_Water
Client Sample ID: SW_BitterCk
Location: NESE_22_57N_74W
Samp FRQ/Type: SP
Lab ID: G07050760-001

Report Date: 05/31/07
Collection Date: 05/18/07 10:00
DateReceived: 05/22/07
Sampled By: Manoj Patil
Matrix: Aqueous
Tracking Number: 100391

Analyses	Result	Units	Result	Units	Qualifier	Method	Analysis Date / By
MAJOR IONS, DISSOLVED							
Bicarbonate as HCO3	642	mg/L	10.5	meq/L		A2320 B	05/23/07 18:52 / mli
Chloride	39	mg/L	1.09	meq/L		E300.0	05/29/07 13:05 / mli
Fluoride	0.4	mg/L	0.02	meq/L		E300.0	05/29/07 13:05 / mli
Sulfate	4800	mg/L	99.9	meq/L		E300.0	05/24/07 14:31 / mli
Calcium	263	mg/L	13.1	meq/L		E200.7	05/25/07 23:36 / eli-b
Magnesium	536	mg/L	44.1	meq/L		E200.7	05/25/07 23:36 / eli-b
Potassium	25	mg/L	0.64	meq/L		E200.7	05/25/07 23:36 / eli-b
Sodium	1350	mg/L	58.6	meq/L		E200.7	05/25/07 23:36 / eli-b
NON-METALS							
Alkalinity, Total as CaCO3	526	mg/L				A2320 B	05/23/07 18:52 / mli
Conductivity @ 25 C	8170	umhos/cm				A2510 B	05/22/07 15:38 / jjb
Sodium Adsorption Ratio (SAR)	11.0	unitless				Calculation	05/30/07 12:48 / tlc
DATA QUALITY							
A/C Balance	2.16	%				A1030 E	05/30/07 12:47 / tlc
Anions	112	meq/L				A1030 E	05/30/07 12:47 / tlc
Cations	116	meq/L				A1030 E	05/30/07 12:47 / tlc

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



The Termo Company
Bitter Creek Watershed

WY0055018

HUC 10 - 1009020701

June 26, 2007

Explanation:

- Outfall, As Permitted
- Trib, As Permitted
- IMP, As Permitted
- County Road

N

0 0.25 0.5
Miles
1:24,000

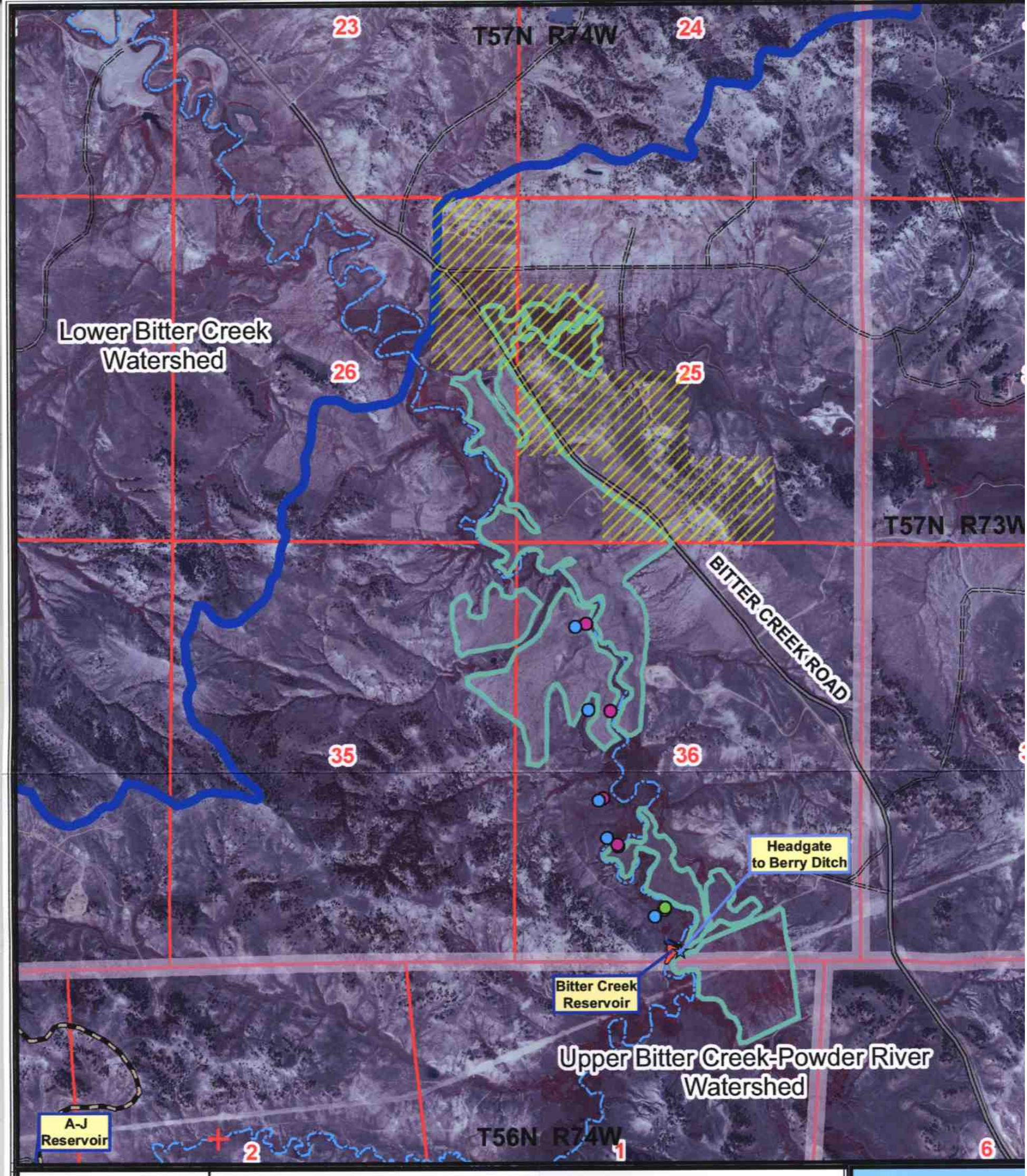
Bitter Creek Soils Data:

		Soil Depth (inches)		
Sampler / Date	**Sample Location**	**Upper**	**Lower**	**EC (µmhos/cm)**
SWCA / August 2007	Odekoven Flood-Irrigated	0	12	488
		12	24	446
		24	36	1664
		36	48	1940
		48	60	1902
		60	72	1936
SWCA / August 2007	Odekoven Sub-Irrigated	0	12	390
		12	24	3000
		24	36	8010
		36	48	7060
		48	60	6090
		60	72	6540
SWCA / June 2007	Crockett Section 36 (Field 3, Zone 1)	0	12	3050
		12	24	5630
		24	36	4780
		36	48	5300
KC Harvey / Dec 2007	Crockett Section 26 (Field 7)	0	12	1350
		12	24	6380
		24	36	8920
		36	48	8870
		48	60	7820
		60	72	7510
KC Harvey / Dec 2007	Crockett Sections 23 + 26 (Field 6)	0	12	7540
		12	24	11800
		24	36	10700
		36	48	7600
		48	60	8300
		60	72	6110

Observed Average **5397**
AVEDEV **2752**

Effluent Limit Calcs

0.05	1 - 0.95
2752	AveDev
28	Sample Pop (n)
1019	Conf Int
4378	Observed Average minus conf interval
2919	Calculated EC Limit: (Adjusted average / 1.5)



SWCA
ENVIRONMENTAL CONSULTANTS

1043 Coffeen Avenue, Suite D Sheridan, WY 82801
Office: 307.673.4383 Fax: 307.673.4505
www.swca.com

Projection: NAD_1983_UTM_Zone_13N

File: Homestead_Draw_II_Section_20_Maps.mxd

Author: Wade L Epperson Date: 6/29/2007

Sections 25, 26, 35, and 36, T57N R74W, Homestead Draw II Section 20 Map

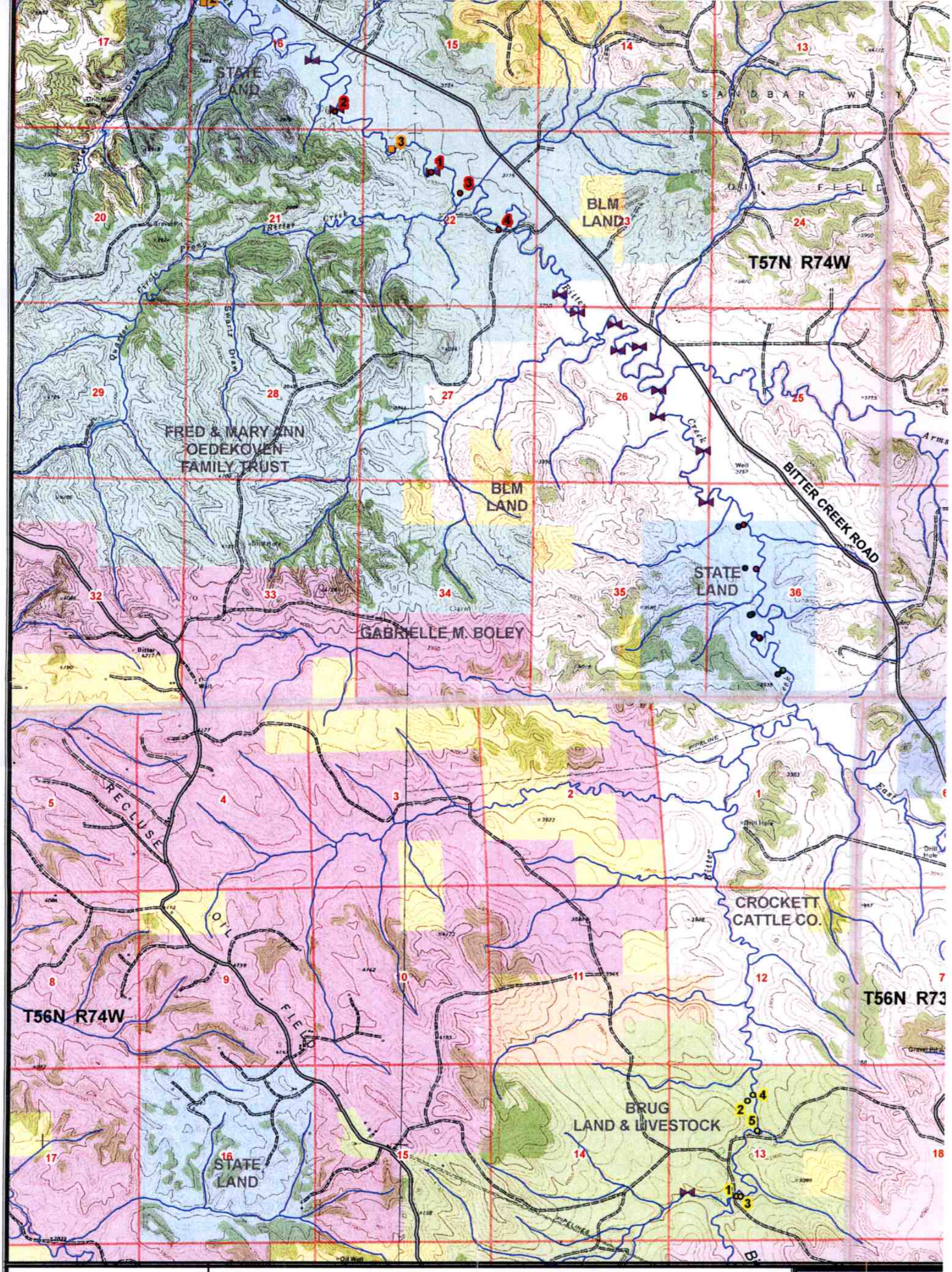
- Soil Sample Site Zone 1
- Soil Sample Site Zone 2
- Soil Sample Site Zone 3
- Permitted Irrigated Acres, but not used
- Existing Dryland Irrigation
- Stream Channel
- County Road
- Wyoming 5th & 6th Level Watershed

N

Scale: 1:24,000

0 250 500 1,000 Meters

Section 20 Soil Investigation Map



SWCA
ENVIRONMENTAL CONSULTANTS
1043 Coffeen Avenue, Suite D Sheridan, WY 82801
Office: 307.673.4303 Fax: 307.673.4505
www.swca.com

Projection: NAD_1983_UTM_Zone_13N

File: Section_20_Irrigation_Soil_Investigation_Map_withBrug.mxd

Author: Wade L Epperson Date: 8/10/2007

- Soil Sample Site Zone 1
- Soil Sample Site Zone 2
- Soil Sample Site Zone 3
- Supplemental Soil Sample Site
- Brug Soil Sample Site
- Photo Reference Site
- Unpermitted Spreader Dike
- USGS NHD Stream Channel
- Existing Unimproved Road
- County Road

Scale: 1:33,000

0 250 500 1,000 1,500 Meters

N

Section 20 Irrigation Soil Investigation Map

SWCA
ENVIRONMENTAL CONSULTANTS

1043 Coffeen Avenue, Suite D Sheridan, WY 82801
Office: 307.673.4303 Fax: 307.673.4505
www.swca.com

Projection: NAD_1983_UTM_Zone_13N

Author: Wade L Epperson

Date: 9/12/2007

- Brug Soil Sample Site
- Soil Sample Site Zone 1
- Soil Sample Site Zone 2
- Soil Sample Site Zone 3
- Supplemental Soil Sample Site
- Photo Reference Sites
- Observed Headgate
- Unpermitted Spreader Dike
- Irrigated Area
- USGS NHD Stream Channel
- Existing Unimproved Road
- County Road

N

Scale: 1:19,000

0 1,000 2,000 4,000 Meters

File: Section_20_Irrigation_Soil_Investigation_Map.mxd

Sheridan County
Campbell County
Johnson County
Sheridan
Buffalo
Gillette
Clearmont
Recluse
Spotted Horse
I-90
I-25
14
16