

**GEOTECHNICAL INVESTIGATION REPORT
BEARTOOTH HIGHWAY PROJECT
TASK ORDER NO. DTFH68-04-T-00015
SHOSHONE NATIONAL FOREST
PARK COUNTY, WYOMING**



KLEINFELDER
An employee owned company

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SHOSHONE NATIONAL FOREST
PARK COUNTY, WYOMING**

November 5, 2004



November 5, 2004
Kleinfelder Project No: 47377

Federal Highway Administration
Central Federal Lands Highway Division
Building 52, Denver Federal Center
Denver, CO 80228

Attention: Mr. Matthew DeMarco, Geotechnical Engineer

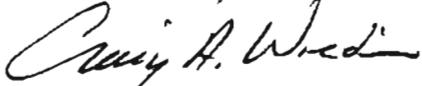
**SUBJECT: Geotechnical Investigation Report
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Shoshone National Forest
Park County, Wyoming**

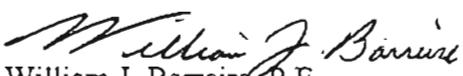
Gentlemen:

The attached report presents the results of our geotechnical investigation performed for the Beartooth Highway Project located in Park County, Wyoming. Our work consisted of a subsurface exploration including logging of test pits, sample collection and preparation of this report. Our work was performed in general accordance with the Scope of Work for Engineering Services (Contract No. DTFH68-02-D-00002, Task Order No. DTFH68-04-T-00015) dated July 12, 2004.

We appreciate this opportunity to be of service to you, and look forward to future endeavors. If you have any questions regarding this report or need additional information or services, please feel free to call us.

Very truly yours,
KLEINFELDER, INC.


Craig A. Wieden, P.E.
Project Geotechnical Engineer


William J. Barreire, P.E.
Senior Geotechnical Engineer

CAW/WJB/lab
Enclosures

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1 INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical investigation performed along portions of the Beartooth Highway Project, located in the Shoshone National Forest, in Park County, Wyoming. Our investigation was performed for the Federal Highway Administration (FHWA) - Central Federal Lands Highway Division (CFLHD).

The report includes our recommendations relating to the geotechnical aspects of project design and construction. The conclusions and recommendations stated in this report are based upon the subsurface conditions found at the locations of our test pits at the time our exploration was performed. They also are subject to the provisions stated in the report sections titled **Additional Services** and **Limitations**. Our findings, conclusions and recommendations should not be extrapolated to other areas or used for other projects without our prior review. Furthermore, they should not be used if the alignments have been altered, or if a prolonged period has elapsed since the date of the report, without Kleinfelder's prior review to determine if they remain valid.

1.2 PROJECT DESCRIPTION

It is understood the project will consist of improvements to approximately 13 kilometers (km) of the existing roadway. The improvements are generally to consist of widening the existing roadway, construction of retaining walls to support new fill slopes, and construction of new bridges along the alignment. More specifically, at the sites of our investigation, the improvements will largely consist of the construction of new roadway embankments, culverts, and retaining walls over wet meadow or wetland areas. We understand that additional geotechnical investigation reports have been previously completed for this project, and the primary purposes of our investigation was to: 1) refine previous material source information developed for the project; 2) characterize anticipated soft soils conditions beneath planned roadway embankments (sub-excavation locations); and 3) recommend general embankment construction alternatives on soft soils, particularly where seasonal near-surface ground water may be problematic. Additionally, we were asked to identify any potential roadway constructability issues (as determined at the time of test pit excavation). Therefore, this report includes a

summary of our field investigation procedures, including test pit logs, photo documentation of the field investigation, descriptions (field classification) of the subsurface conditions encountered, and our opinions on potential constructability issues at our investigation locations. All samples of the subsurface materials collected were transported to the FWHA-CFLHD upon completion of the test pit excavation. Therefore, no laboratory testing was performed by our office on any of the subsurface materials collected during this investigation.

1.3 PURPOSE AND SCOPE

The purpose of our investigation was to explore and evaluate the surface and subsurface conditions at specific locations along and near the existing roadway alignment at locations determined by personnel of CFLHD. Based upon the conditions encountered in the test pits, we have formulated our opinions regarding roadway embankment construction at these areas, as well as potential constructability issues at our investigation locations. Our conclusions and recommendations in this report are based upon analysis of the data from our field exploration and our experience with similar soil and geologic conditions.

Kleinfelder's scope of services included:

- A visual reconnaissance to observe surface and geologic conditions along the roadway alignment;
- The excavation of fifteen (15) backhoe test pits along the proposed roadway alignment as close as reasonably possible to the locations specified in the Scope of Work for Engineering Services;
- The excavation of four (4) backhoe test pits within a proposed material source borrow area (Ghost Creek Sample Area) at locations as directed by Mr. Matthew DeMarco while in the field;
- Collection of hard rock samples at three (3) locations along existing road cuts for evaluation by the FHWA-CFLHD for material source suitability;
- Collection of one (1) additional sample of material from within an existing stream channel adjacent the current roadway alignment.
- Evaluation of the field data to develop our geotechnical conclusions and recommendations; and

- Preparation of this report, which includes a brief description of the proposed project, a description of the surface and subsurface conditions found during our investigation at our test pit locations, our opinions related to potential constructability issues, and appendices which summarize our field investigations.

2 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 FIELD INVESTIGATION

A field investigation performed between July 19, 2004 and July 23, 2004 included excavating and logging a total of nineteen (19) backhoe test pits as close as possible to the locations indicated in the Scope of Work for Engineering Services as provided to us and at locations directed by Mr. Matthew DeMarco, with the FHWA-CFLHD. The test pits, labeled TP-1 through TP-19, were advanced to depths ranging from approximately 1.07 meters to 3.05 meters below existing site grades. All test pits were excavated using a John Deere 210C backhoe. Samples of the subsurface materials, where required, were obtained by bulk methods and by pushing Shelby tubes into the subsurface strata using the buckets on the backhoe. Additionally, hard rock samples were collected from the base of existing road cuts at three (3) locations along the project alignment, and a sample was also obtained from within an existing stream channel at one (1) location along the project alignment. As the samples from the base of the existing road cuts and the existing stream channel were obtained from the ground surface, no test pit logs were required or prepared for these sample areas. The locations of the test pits as determined in relation to project stationing and in the field using a Global Positioning System (GPS) unit are as follows:

Test Pit	Approximate Location of Test Pit	Latitude	Longitude
TP-1	Station 45+880, on centerline	44.94192°	109.55667°
TP-2	Station 46+020, on centerline	44.94207°	109.55495°
TP-3	Station 45+440, on centerline	44.94308°	109.56192°
TP-4	Station 45+090, on centerline	44.9438°	109.5661°
TP-5	Little Bear Creek No. 1 Bridge West Approach - Station 45+280, on centerline	44.94333°	109.56388°
TP-6	Island Lake Moraine - Station 46+740, offset 10 meters right	44.93890°	109.54733°
TP-7	Station 46+500, on centerline	44.94008°	109.54992°
TP-8	Island Lake Moraine - Station 46+800, offset 20 meters right	44.93863°	109.54658°
TP-9	Island Lake Wetland Crossing - Station 47+650, on centerline	44.93765°	109.53638°
TP-10	Island Lake Wetland Crossing - Station 47+700, on centerline	44.9373°	109.5359°
TP-11	Island Lake Wetland Crossing - Station 47+570, on centerline	44.93817°	109.5371°
TP-12	Island Lake Wetland Crossing - Station 47+520, on centerline	44.9384°	109.53762°
TP-13	Station 47+100, on centerline	44.93885°	109.54278°
TP-14	Long Lake Retaining Wall - Station 50+380, offset 6 meters right	44.9402°	109.5072°
TP-15	Long Lake Retaining Wall - Station 50+320, offset 14 meters right	44.93985°	109.5079°
TP-16	Ghost Creek Material Source Sample Area, North Pit, Upper Bench	44.92517°	109.64588°
TP-17	Ghost Creek Material Source Sample Area, North Pit, Lower Bench	44.9244°	109.64532°
TP-18	Ghost Creek Material Source Sample Area, South Pit, Lower Bench	44.92145°	109.64322°
TP-19	Ghost Creek Material Source Sample Area, South Pit	44.92192°	109.6431°

Appendix B to this report includes logs describing the subsurface conditions encountered at our test pit locations. Also included in Appendix B is a legend describing the symbols used on the test pit logs. The lines defining boundaries between soil types on the logs were based on visual observation and classification of the backhoe test pit spoils and are therefore approximate. The soils encountered in the test pits were classified in accordance with ASTM D 2488 – Description and Identification of Soils (Visual-Manual Procedure).

2.2 LABORATORY TESTING

All samples collected during our field investigation were transported to the FHWA-CFLHD lab in Denver, Colorado. Therefore, no laboratory testing was performed by Kleinfelder for this investigation.

3 SITE CONDITIONS

3.1 SURFACE

As mentioned earlier, this project consists of improvements to approximately 13 kilometers of the existing Beartooth Highway alignment. The project begins at approximately Station 39+450 and extends to approximately Station 52+420. The topography along the project alignment varies from gently to moderately rolling hills and swales in a high alpine environment, to relatively steep, mountainous terrain including large boulder talus and colluvial slopes. Through the upper portions of the project, where the majority of the test pits were excavated during this investigation, the road alignment will sometimes require the roadway embankment be constructed through wetland areas and wet meadows, all with potential shallow groundwater and soft subgrade soil conditions.

3.2 SUBSURFACE

Kleinfelder explored the subsurface conditions by excavating and sampling a total of fifteen (15) backhoe test pits along the proposed roadway alignment as near as possible to the locations specified in the Scope of Work that was provided to us. In addition, four (4) backhoe test pits were excavated within the Ghost Creek Sample Area at locations requested in the field. The test pits were excavated to depths ranging from approximately 1.07 meters to 3.05 meters below existing grades. The following provides a brief description of the subsurface conditions encountered at our test pit locations. Additional information on the subsurface conditions encountered at each test pit location may be found by reviewing the individual test pit logs contained in Appendix B, and reviewing photographs of the materials recovered in the test pits, where applicable, contained in Appendix C. A legend that describes the terminology and symbols used on the test pit logs as well as the descriptions contained below can be viewed at the start of Appendix B.

3.2.1 Groundwater

Seepage and/or free groundwater was encountered in several of the test pits excavated during this investigation. Twenty-four hour groundwater measurements obtained in Test Pits TP-1 through

TP-15, where groundwater was present, show groundwater is at depths ranging from approximately 0.38 meters to 2.57 meters below the existing ground surface at the locations explored. No groundwater was encountered in test pits TP-1, TP-6, TP-8, TP-11, TP-13, or TP-16 through TP-19 within the depths explored. The depths below existing grade where groundwater and/or seepage were encountered in the test pits during excavation and at the time of the 24-hour readings have been provided in the following table. For the purpose of this report, we have considered seepage as visible moisture exiting from the walls of the test pit excavations. The amount of seepage was inadequate to cause a standing water condition at the time the test pits were excavated; however, 24-hour water level readings often corresponded to depths where seepage was observed at the time of excavation.

It should be noted that soil moisture levels and groundwater levels commonly vary over time and space depending upon seasonal precipitation and runoff conditions. Due to the granular nature of much of the material encountered during this investigation, we would anticipate groundwater levels will fluctuate seasonally and with precipitation events. Additionally, it is possible that a seasonal or "perched" groundwater condition may develop in areas underlain by less permeable soil or where bedrock is present at shallow depths.

Test Pit Number	Water Conditions at Time of Test Pit Excavation (shown as depth in meters below existing grade)	Water Conditions 24 Hours After Excavation (shown as depth in meters below existing grade)	Excavated Pit Depth (meters)
TP-1	None	None	3.35
TP-2	Groundwater at 2.90 meters	Groundwater at 2.57 meters	3.05
TP-3	Seepage at 0.91 meters	Groundwater at 1.22 meters	3.05
	Groundwater at 2.54 meters		
TP-4	Groundwater at 1.68 meters	Groundwater at 1.22 meters	2.44
TP-5	Seepage at 0.46 meters	Groundwater at 2.03 meters	3.05
	Seepage at 2.29 meters		
TP-6	None	None	2.44
TP-7	Groundwater at 1.83 meters	Groundwater at 1.6 meters	2.13
TP-8	None	None	3.05
TP-9	Seepage from 1.68 to 1.98 meters	Groundwater at 1.83 meters	3.05
TP-10	Seepage at 0.61 meters	Groundwater at 0.86 meters	3.05
	Seepage at 1.52 meters		
TP-11	None	None	1.83
TP-12	Groundwater at 0.61 meters	Groundwater at 0.61 meters	2.13
TP-13	None	None	2.44
TP-14	Seepage at 0.48 meters	Groundwater at 1.14 meters	2.44
	Seepage at 1.22 meters		
TP-15	Seepage at 0.61 meters	Groundwater at 0.38 meters	1.07
TP-16	None	Backfilled, N/A	3.05
TP-17	None	Backfilled, N/A	3.05
TP-18	None	Backfilled, N/A	3.05
TP-19	None	Backfilled, N/A	3.05

If over-excavation or sub-excavation and replacement of soft subgrade soils is utilized for construction of the roadway embankments for this project, shallow groundwater may present construction related difficulties in some areas. In general, of the areas that were evaluated during this investigation, we anticipate they will be around the Island Lake Access road, and near the Long Lake outlet structure. Shallow groundwater was encountered at or near the depths we would anticipate the over-excavation would extend to remove the soft subgrade soils. Shallow

groundwater is likely present in other areas along the project alignment, which were not evaluated with test pit excavations, and could present similar construction related difficulties. Measures to reduce the amount of surface water collecting near or adjacent all of the project improvement areas will likely be important to achieving a satisfactory end project as well as reducing maintenance costs. The soil moisture and groundwater data in this report pertain only to the locations and times at which exploration was performed. They should not be extrapolated to other locations on the project. Additional discussion regarding the potential construction related difficulties associated with shallow groundwater is presented in Section 4 of this report.

3.2.2 Site Stratigraphy

Subsurface conditions encountered in the test pits varied somewhat from location to location; however, the majority of the materials consisted of granular soils (sands and gravels), with varying percentages of cobbles and boulders, or cobbles and boulders with a sand and gravel matrix. Topsoil depths or highly organic soil depths in the upper profile of the test pits generally ranged from approximately 0.15 meters to as much as 0.61 meters below the existing ground surface at the test pit locations. A brief description of the subsurface conditions encountered and the approximate depth intervals they were encountered in the test pits are as follows:

- TP-1 (Station 45+880) – Topsoil from 0.0 to 0.20 meters, overlying silty sand with gravel and cobbles from 0.20 to 1.07 meters, overlying silty sand with gravel and some clayey sand and gravel pockets from 1.07 to 3.35 meters. No groundwater or seepage was encountered in TP-1 within the depths explored.
- TP-2 (Station 46+020) – Topsoil from 0.0 to 0.25 meters, overlying silty sand with some gravel from 0.25 to 0.91 meters, overlying silty sand with gravel and cobbles from 0.91 to 1.83 meters, overlying silty sand with gravel, cobbles and boulders from 1.83 to 3.05 meters. Groundwater was encountered in TP-2 at a depth of 2.90 meters at the time of excavation, and was present at a depth of 2.57 meters when checked the following day.
- TP-3 (Station 45+440) – Topsoil from 0.0 to 0.30 meters, overlying silty to clayey sand with gravel and some cobbles from 0.30 to 1.73 meters; overlying a layer of silt to lean clay from 1.73 to 2.54 meters, overlying well-graded sand with gravel from 1.73 to 3.05 meters. Both seepage and groundwater were encountered in the test pit at the time of excavation at depths of 0.91 meters and 2.54 meters, respectively. Groundwater was present at a depth of 1.22 meters when checked the following day.

- TP-4 (Station 45+090) – Topsoil from 0.0 to 0.25 meters, overlying silty sand with gravel, cobbles and small boulders from 0.25 to 0.76 meters, overlying cobbles and boulders with a sand and gravel matrix from 0.76 to 2.44 meters. Seepage was encountered at a depth of 1.68 meters at the time of excavation. Groundwater was present at a depth of 1.22 meters when checked the following day. The test pit was terminated at a depth of approximately 2.44 meters below existing grade at the test pit location due to large boulders or possible granitic bedrock that prevented further excavation with the equipment being utilized.
- TP-5 (Station 45+280) – Topsoil from 0.0 to 0.25 meters, overlying silty sand with gravel from 0.25 to 0.61 meters, overlying a layer of silt to lean clay from 0.61 to 1.52 meters, overlying silty sand and gravel with cobbles and boulders from 1.52 to 3.05 meters. Seepage was observed at 0.46 meters and 2.29 meters at the time of excavation. Groundwater was present at a depth of 2.03 meters when checked the following day.
- TP-6 (Station 46+740, offset 10 meters right) – Silty sand with gravel from 0.0 to 0.61 meters, overlying sandstone bedrock from 0.61 to 2.44 meters. No groundwater or seepage was encountered in TP-6 within the depths explored. The test pit was terminated at a depth of approximately 2.44 meters below existing grade at the test pit location due to hard sandstone that prevented further excavation with the equipment being utilized.
- TP-7 (Station 46+500) – Topsoil from 0.0 to 0.1 meters, overlying cobbles and boulders with a sand and gravel matrix from 0.1 meters to 2.13 meters. Groundwater was encountered at a depth of 1.83 meters at the time of excavation, and was present at a depth of 1.6 meters when checked the following day. The test pit was terminated at a depth of approximately 2.13 meters below existing grade at the test pit location due to large boulders that prevented further excavation with the equipment being utilized.
- TP-8 (Station 46+800, offset 20 meters right) – Silty sand with gravel from 0.0 to 0.25 meters, overlying silty sand with gravel, cobbles and small boulders from 0.25 to 3.05 meters. No groundwater or seepage was encountered in TP-8 within the depths explored.
- TP-9 (Station 47+650) – Topsoil from 0.0 to 0.20 meters, overlying silty sand with gravel and cobbles from 0.25 to 1.22 meters, overlying silty sand with gravel, cobbles and boulders from 1.22 to 3.05 meters. Seepage was observed in the excavation at a depth of 1.68 to 1.98 meters. Groundwater was present in the excavation at a depth of 1.83 meters when checked the following day.
- TP-10 (Station 46+700) – Topsoil from 0.0 to 0.20 meters, overlying silty sand with gravel, cobbles and boulders from 0.25 to 3.05 meters. Seepage was observed in the

excavation at depths of 0.61 and 1.52 meters. Groundwater was present in the excavation at a depth of 0.86 meters when checked the following day.

- TP-11 (Station 47+570) – Topsoil from 0.0 to 0.20 meters, overlying silty sand with gravel and cobbles from 0.25 to 0.76 meters, overlying silty sand and gravel with cobbles and boulders from 0.76 to 1.83 meters. No groundwater or seepage was encountered in TP-11 within the depths explored. The test pit was terminated at a depth of approximately 1.83 meters below existing grade at the test pit location due to large boulders that prevented further excavation with the equipment being utilized.
- TP-12 (Station 47+520) – Topsoil from 0.0 to 0.30 meters, overlying silty sand with gravel, cobbles and boulders from 0.20 to 1.68 meters, overlying a large boulder or possible bedrock which extended from 1.68 meters to a test pit bottom depth of 2.13 meters. Groundwater was encountered at a depth of 0.61 meters at the time of excavation and was present at a depth of 0.61 meters when checked the following day. The test pit was terminated at a depth of approximately 2.13 meters below existing grade at the test pit location due to large boulders or possible granitic bedrock that prevented further excavation with the equipment being utilized.
- TP-13 (Station 47+100) – Topsoil from 0.0 to 0.25 meters, overlying silty to clayey sand with gravel and cobbles from 0.25 meters to 1.07 meters, overlying silty sand with gravel, cobbles and boulders from 1.07 to 2.44 meters. No groundwater or seepage was observed in the test pit at the time of excavation. No groundwater was present in the test pit when checked the following day; however, seepage was observed at a depth of 1.37 meters. The test pit was terminated at a depth of approximately 2.44 meters below existing grade at the test pit location due to large boulders that prevented further excavation with the equipment being utilized.
- TP-14 (Station 50+380, offset 6 meters right) – Topsoil from 0.0 to 0.20 meters, overlying sandy lean clay from 0.20 to 0.56 meters, overlying silty sand with gravel, cobbles and boulders from 0.56 to 2.44 meters. Seepage was observed in the excavation at depths of 0.48 and 1.22 meters at the time of excavation. Groundwater was present at a depth of 1.14 meters when checked the following day. The test pit was terminated at a depth of approximately 2.44 meters below existing grade at the test pit location due to large boulders that prevented further excavation with the equipment being utilized.
- TP-15 (Station 50+320, offset 14 meters right) – Topsoil from 0.0 to 0.61 meters, overlying cobbles and boulders with a sand and gravel matrix from 0.61 to 1.07 meters. Seepage was observed at a depth of 0.61 meters at the time of excavation. Groundwater

was present at a depth of 0.38 meters when checked the following day. The test pit was terminated at a depth of approximately 1.07 meters below existing grade at the test pit location due to large boulders that prevented further excavation with the equipment being utilized.

- TP-16 (Ghost Creek, North Pit, Upper Bench) – Silty sand and gravel fill from 0.0 to 1.52 meters, with cobbles, boulders and some organics, overlying possible fill consisting of silty to slightly clayey sand with gravel, cobbles and small boulders from 1.52 to 3.05 meters. No groundwater was encountered in the test pit within the depths explored.
- TP-17 (Ghost Creek, North Pit, Lower Bench) – Silty sand and gravel fill from 0.0 to 1.83 meters, with gravel, cobbles and small boulders, overlying well-graded sand with gravel and some cobbles from 1.83 to 3.05 meters. No groundwater was encountered in the test pit within the depths explored.
- TP-18 (Ghost Creek, South Pit, Lower Bench) – Silty sand with gravel fill from 0.0 to 0.46 meters, overlying probable fill consisting of silty sand with gravel, cobbles and small boulders, with some organics from 0.46 to 1.37 meters, overlying well-graded sand with gravel and some cobbles from 1.37 to 3.05 meters. No groundwater was encountered in the test pit within the depths explored.
- TP-19 (Ghost Creek, South Pit, Upper Bench) – Silty sand and gravel fill from 0.0 to 0.91 meters, with cobbles, boulders and some organics, overlying well-graded sand with gravel, cobbles and some boulders from 0.91 to 3.05 meters. No groundwater was encountered in the test pit within the depths explored.

Additional samples of proposed material sources were also obtained during our site visit. However, because the samples were collected from the ground surface, no test pit logs were prepared for those sample locations.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 GENERAL INFORMATION

As mentioned previously, the purpose of our investigation was to collect additional subsurface information at various locations along the project alignment and provide our opinions on potential construction related difficulties. In general, we were to focus on construction of new roadway embankments through existing wetland or wet meadow areas along the project alignment, paying particular attention to the area of the project adjacent the existing Island Lake access road. The following provides a discussion of anticipated construction related difficulties we feel may be encountered through the portions of the project area at the locations explored during this investigation. We have also provided our recommendations for general construction of roadway embankments in these areas.

4.2 ANTICIPATED CONSTRUCTION RELATED DIFFICULTIES ASSOCIATED WITH WETLAND OR WET MEADOW ROADWAY EMBANKMENT CONSTRUCTION

As previously mentioned, new roadway embankments will be constructed through existing wetland or wet meadow areas. Based on the test pits excavated for this project, the following provides the most prominent construction related issues that we feel may be encountered during construction in these areas.

- Relatively thick topsoil and/or organic clay was encountered in the test pits excavated. The topsoil/organic clay ranged in thickness from approximately 0.1 to 0.3 meters in depth at the locations explored (excluding borrow area test pits). If the embankment is constructed over topsoil that is left in place, long-term degradation of the organic matter, as well as the varying thickness of material could cause differential settlement of the embankment, as well as potential stability issues. **Additionally, we would consider the topsoil/organic clay materials to be more susceptible to frost heave which, in conjunction with the settlement, could cause severe distress to the constructed roadway in some areas if not removed.**
- Shallow groundwater was encountered in two of the test pits (TP-12 and TP-15) within or just below the upper topsoil/organic clay layer. Removal and replacement of this material

may be difficult in areas of shallow groundwater. Additionally, movement of construction equipment across areas where shallow groundwater is present may cause degradation of the more stable subgrade materials, and could result in a deeper over-excavation to stabilize the embankment subgrade.

- Large boulders were encountered in the upper profile of some test pits. Large boulders were also observed along the roadway alignment at or near the ground surface. These large boulders should be removed prior to construction of the roadway embankment to reduce the potential for point loading and distress to the overlying pavement.
- A layer of silt/lean clay was encountered in the test pits located on either side of the proposed Little Bear Creek Bridge No. 1. Roadway embankments up to approximately 2 meters in height are proposed at the approach to this bridge structure. We recommend global stability analysis of the proposed embankments at this location should be performed assuming appropriate strength parameters for this layer of soil to evaluate its affect. This layer of soil is likely more compressible than the surrounding granular materials; therefore, some consolidation settlement may occur beneath the roadway embankment loads, causing a differential settlement condition at the approaches to the proposed bridge. This layer of material appears to have created a "perched" water table as well, potentially making removal of this layer difficult.

Additional construction related difficulties may be associated with construction of the various project components. However, without knowing further details regarding construction methods, we cannot identify these at this time.

4.3 GENERAL RECOMMENDATIONS FOR ROADWAY EMBANKMENT CONSTRUCTION IN WETLAND OR WET MEADOW AREAS

We understand that, in addition to constructability issues in the wetland areas, environmental impact of the proposed construction must also be considered. Therefore, based on the conditions observed in the test pits at the time of excavation, we recommend the following be implemented into the design and construction of roadway embankments crossing the wetland/wet meadow areas.

- To reduce the potential for differential movement (caused by settlement or frost heave) occurring along the embankment alignment, excavation of all existing topsoil or organic clay from below the proposed roadway embankment prism should be accomplished prior

to placing any new fill. The depth of removal required will vary with location. We also recommend removal of this material be performed for embankment stability purposes.

- In areas where soft subgrade is present after removal of the topsoil/organic clay, the subgrade should be stabilized prior to placement of any new fill. Stabilization may be accomplished through over-excavation and replacement of the soft soils with a suitable granular fill, placement of over-size rock into the soft subgrade areas until stabilized, or placement of geogrid over the soft soils prior to placement of new fill.
- In areas of the embankment where groundwater is at or near the ground surface, the embankment should be constructed with a capillary break to reduce or prevent groundwater from entering the embankment. This may lead to softening of embankment fills and the potential for damaging frost heave during colder winter months.
- In areas where the longitudinal direction of the roadway embankment will be constructed perpendicular to surface water flow pathways, the roadway embankment should be constructed using the document "Managing Roads for a Wet Meadow Ecosystem Recovery", FHWA-FLP-96-016, as a guideline. In general, we feel that use of a permeable fill embankment system will be suitable to maintain the wetland/wet meadow systems in areas where no defined channel is present. In areas where higher flow is anticipated, use of raised culverts, or multiple raised culverts may be considered. Additional discussion regarding embankments located in wetland/wet meadow areas paralleling the direction of surface water flow is given below.
- In areas where the longitudinal direction of the roadway embankment will be constructed parallel or near parallel (diagonal) to the direction of surface water flow pathways, such as the proposed embankment near the Island Lake access road, additional construction considerations should apply. Over-excavation of the topsoil/organic clay soils may result in a man-made feature that intercepts surface and subsurface water, causing drying of downstream wetland areas. In these areas, we recommend the embankment be constructed by "floating" the embankment fill across the wetland areas on a geotextile separation fabric, in conjunction with a relatively clean (minimal soil fines) permeable fill to act as a capillary break between the embankment and the underlying wet soils. The average depth of the topsoil/organic clay in this particular area was approximately 0.23 meters. This limited depth of organic material should not cause detrimental settlement of the embankment material. Strengthening of the embankment with regards to stability may be accomplished through placement of geogrid between the fill and the geotextile

separator. Additionally, the use of cross drains/culverts should be considered where existing channel crossings intersect the roadway embankment.

5 ADDITIONAL SERVICES

5.1 ADDITIONAL SERVICES

In most cases, other services beyond completion of a geotechnical report are necessary or desirable to complete a project satisfactorily. It also sometimes happens that, while performing our services, we discover conditions or circumstances that require the performance of additional work that was not anticipated when the geotechnical report was written. Kleinfelder offers a range of environmental, geological, geotechnical and construction services to suit the varying needs of our clients, and will provide proposals for these services if requested.

6 LIMITATIONS

The conclusions and recommendations in this report are based on our field observations and our present understanding of the proposed construction. It is possible that subsurface conditions can vary between or beyond the points explored. If the conditions found during construction differ from those described in this report, our recommendations may not be appropriate and we may need to review our report in light of those conditions and provide supplemental recommendations as necessary. We should also review the report if the scope of the proposed construction, or alignment plans change from that described in this report.

Kleinfelder has prepared this report for the exclusive use of the Central Federal Lands Highway Division for the proposed improvements along portions of the Beartooth Highway, in Park County, Wyoming. The report was prepared in substantial accordance with the generally accepted standards of practice for geotechnical engineering as exist in the alignment area at the time of our investigation. No warranty is expressed or implied. We recommend a qualified engineer be on-site during construction to verify the conditions encountered are as described herein.

This report may be used only by the Client, and only for the purposes stated, within a reasonable time from its issuance. Land use, alignment conditions (both on- and off-site), or other factors may change over time, so that additional investigation or revision of our recommendations may be required with the passage of time. It is the Client's responsibility to see that all parties to the project including the designer, contractor and subcontractors, are made aware of this report in its entirety. The use of information contained in this report for bidding purposes shall be at the Contractor's option and risk. Any party other than the Client who wishes to use this report must notify Kleinfelder of such intended use. Based on that intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Noncompliance with these requirements by the Client or anyone else will release Kleinfelder from any liability resulting from the use of this report by an unauthorized party.

APPENDIX A

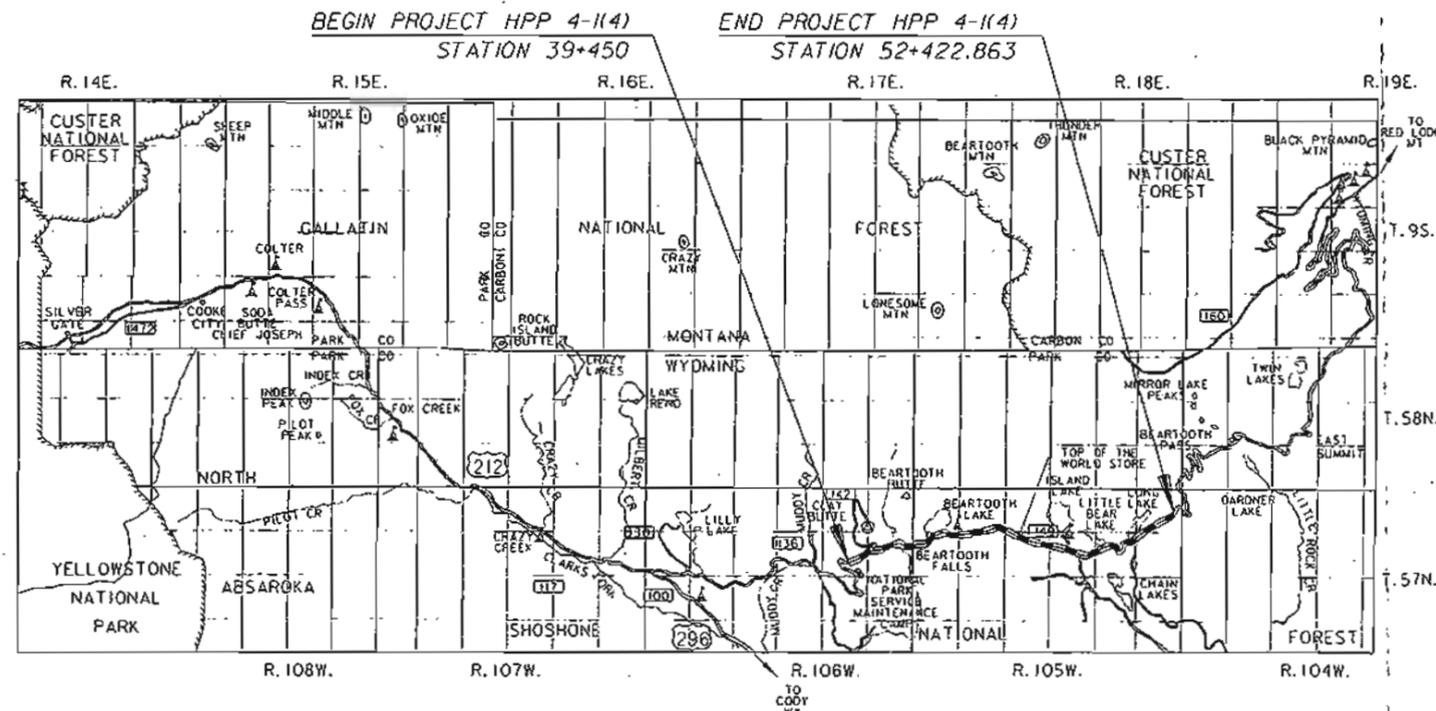
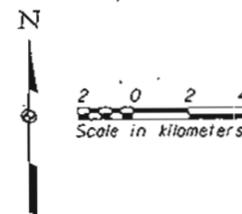
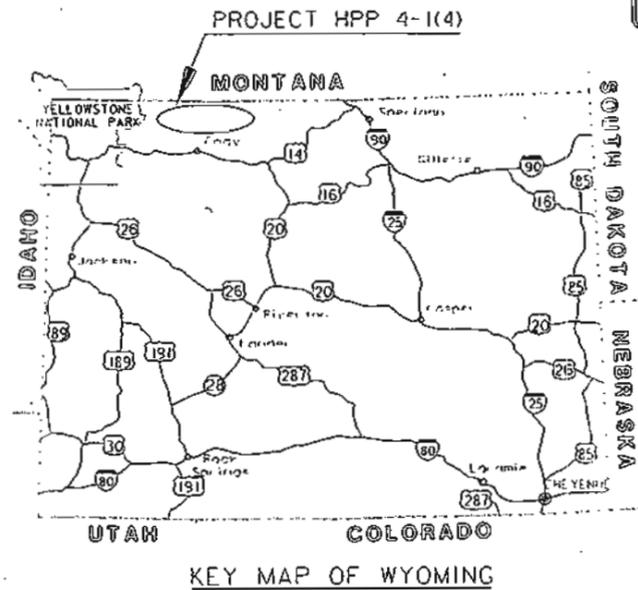
Site Vicinity Map, Test Pit Legend and Test Pit Location Plans

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
16	WY	HPP 4-1(4) BEARTOOTH HIGHWAY		

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION



PLANS FOR PROPOSED WYOMING FOREST PROJECT PROJECT HPP 4-1(4) BEARTOOTH HIGHWAY (U.S. 212) SHOSHONE NATIONAL FOREST PARK COUNTY WYOMING LENGTH 12.97 KILOMETERS



PLANS PREPARED FOR:
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION
DENVER, COLORADO



NAME	DATE	BEARTOOTH HIGHWAY PARK COUNTY, WYOMING FHWA	
DESIGN	C. WEDER	08/04	
GRAPH	D. FRESER	08/04	
CHECKED	C. WEDER	08/04	
R. EINFELDER		SITE VICINITY MAP	
ROUTE	LOCATION	STRUCTURE NO.	SHEET NO.
PROJECT NO. 47377	HPP 4-1(4)		A-1

LEGEND OF SYMBOLS USED ON TEST PIT LOGS

LOG SYMBOLS

-  BULK / GRAB SAMPLE
-  MODIFIED CALIFORNIA SAMPLER (63.5-mm inside diameter)
-  STANDARD PENETRATION SPLIT SPOON SAMPLER (51-mm O.D. X 36-mm I.D.)
-  SHELBY TUBE (76-mm outside diameter)
-  BDBGM SIZE CORE BARREL (42-mm I.D.)
-  NX SIZE CORE BARREL (48-mm I.D.)
-  HQ-3 SIZE CORE BARREL (61-mm I.D.)
-  WATER LEVEL (depth where first encountered)
-  WATER LEVEL (depth after completion)

GENERAL NOTES

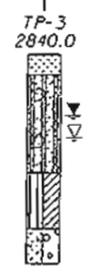
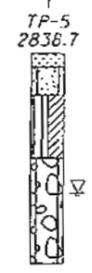
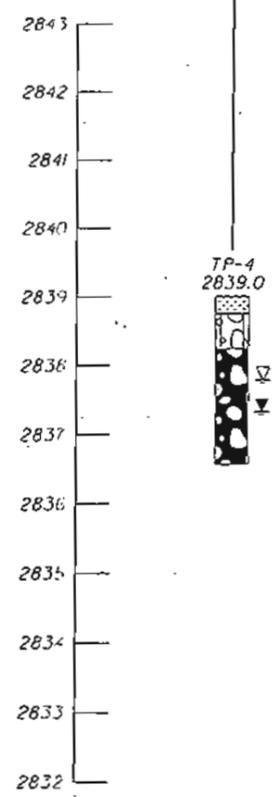
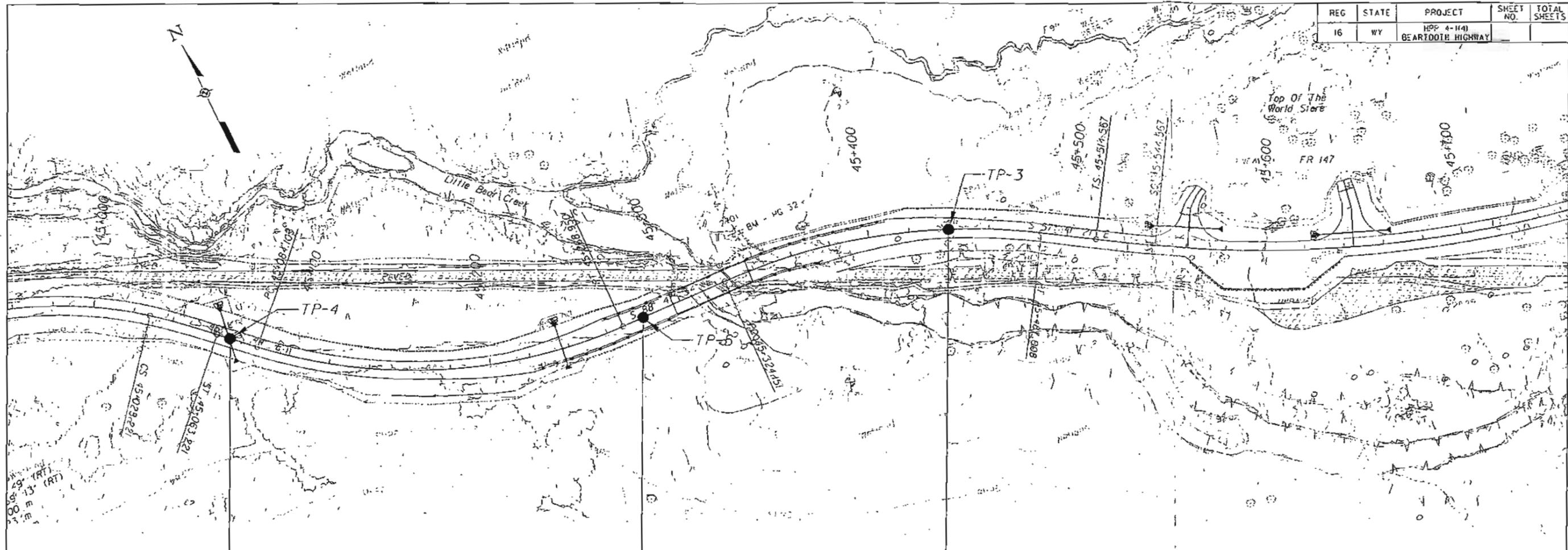
1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.
2. No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.
3. Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.
4. In general, Unified Soil Classification designations presented on the logs were based on visual classification in the field and were modified where appropriate by visual classifications in the office, and/or laboratory gradation and index property testing.
5. NV = No Value; NA = Not Analyzed; NP = No Plasticity
6. Exp = percent expansion under defined surcharge pressure.
7. Com = Percent compression under defined surcharge pressure.
8. 50/X indicates number of blows required to drive the identified sampler X millimeters with a 63.5 kg hammer falling 762 millimeters.

USCS SYMBOL	SOIL DESCRIPTIONS
GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
--	CLAYSTONE
--	SANDSTONE
--	BOULDER/COBBLE WITH SAND AND GRAVEL MATRIX
--	TOPSOIL OR SOIL WITH HIGH ORGANIC CONTENT
--	FILL

Note: Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing the No. 200 sieve require dual USCS symbols, i.e., GW-GM, GP-GM, GW-GC, GP-GC, GC-GM, SW-SM, SP-SM, SW-SC, SP-SC, SC-SM.

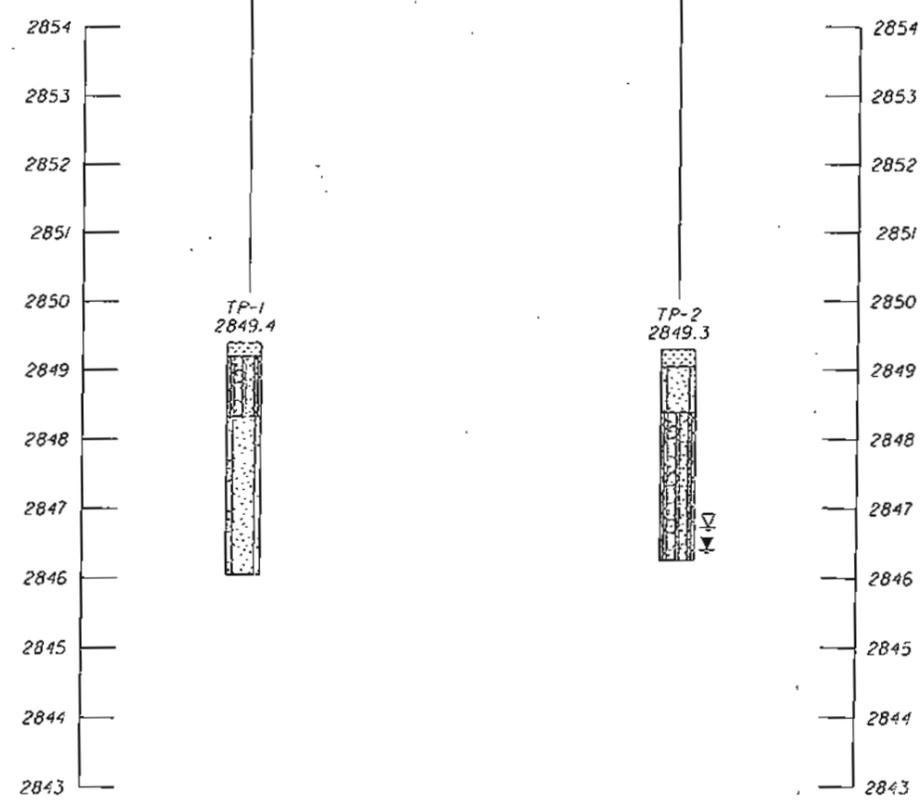
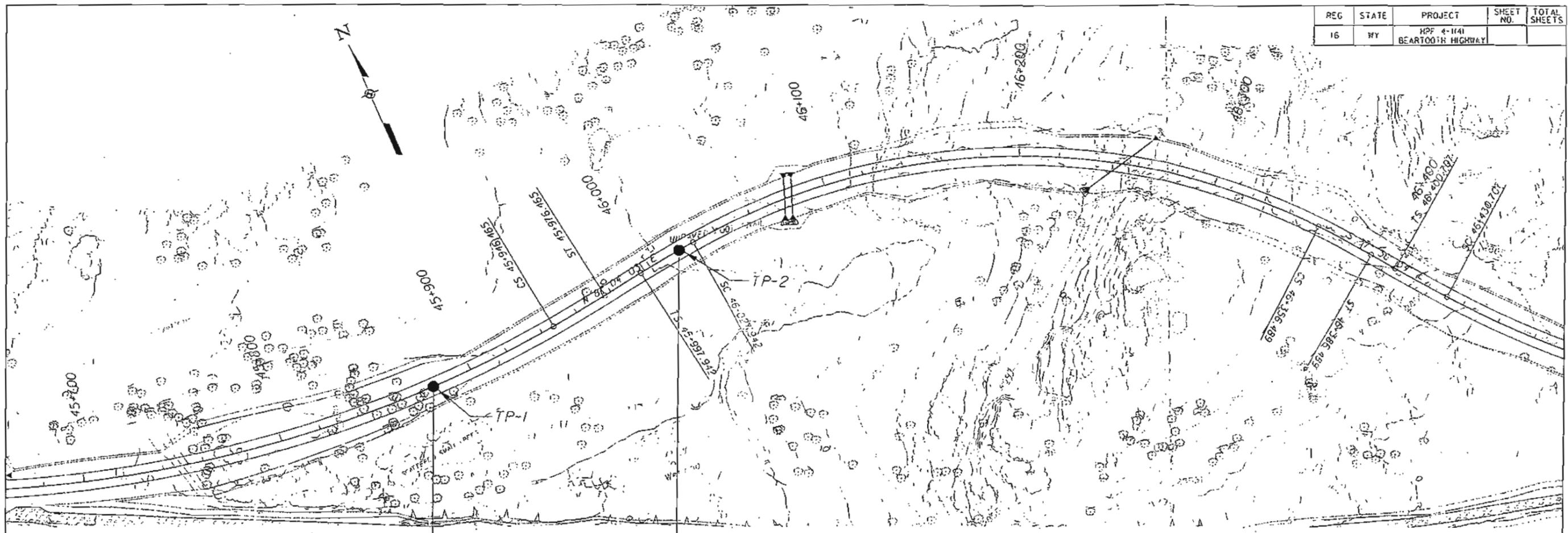
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DRAWN	D. FRIESE	08/04	
CHECKED	C. WEDEN	08/04	
			TEST PIT LEGEND
ROUTE	LOCATION	STRUCTURE NO.	BEAR TOOTH HIGHWAY
PROJECT NO. 47377		HPP 4-1143	A-2

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
16	WY	HPP 4-1141 BEARTOOTH HIGHWAY		



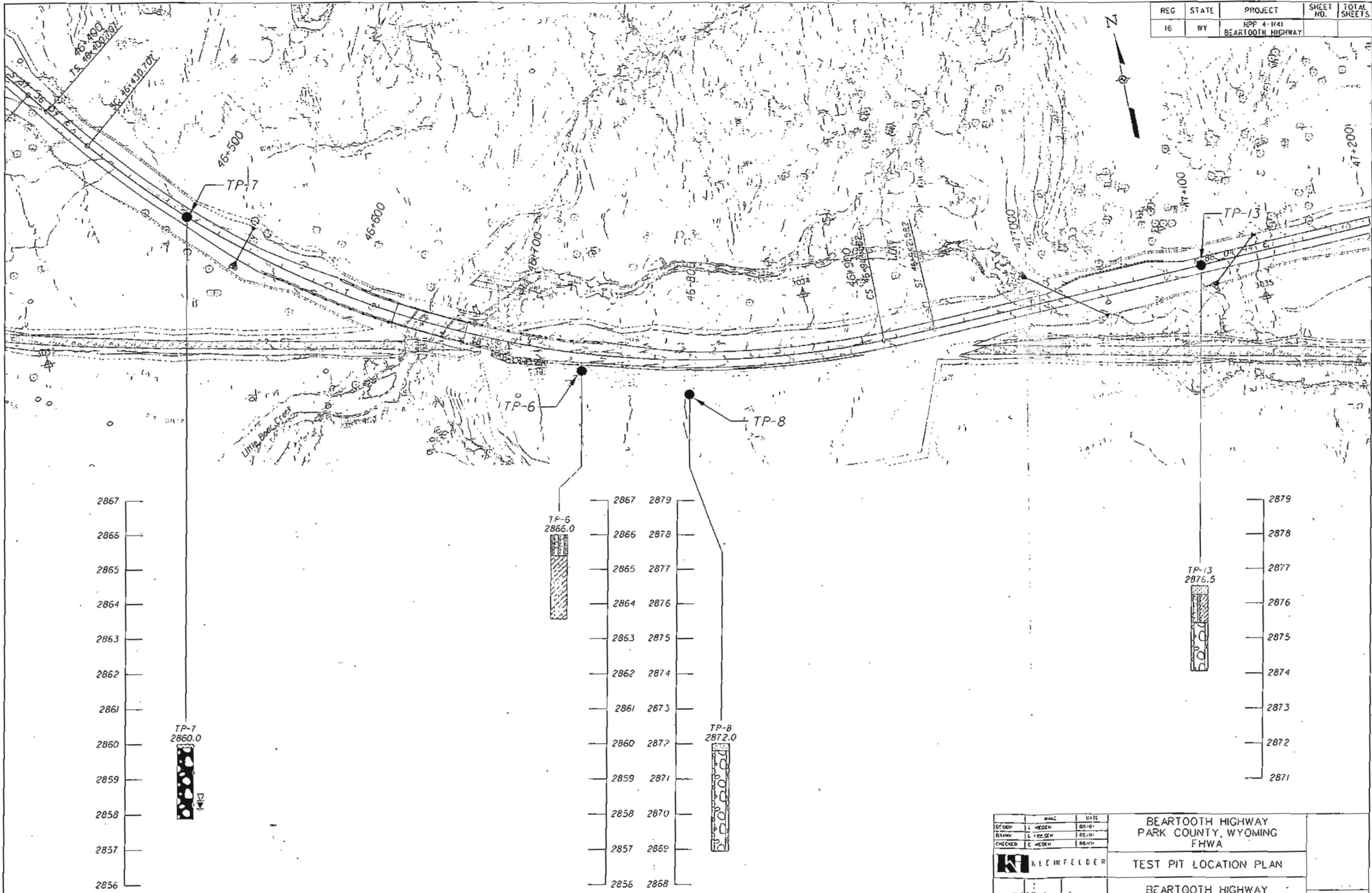
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DRAWN	MEDEM	05/10/11	
CHECKED	MEDEM	05/10/11	
			TEST PIT LOCATION PLAN
ROUTE	LOCATION	STRUCTURE NO.	BEARTOOTH HIGHWAY
PROJECT NO. 47377			SHEET NO. A-3

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
16	WY	HPP 4-1(4) BEARTOOTH HIGHWAY		

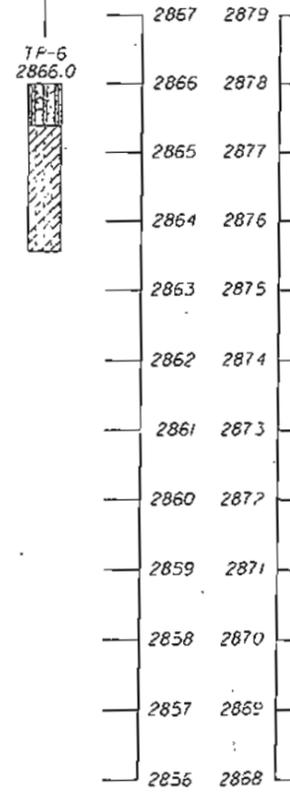


DESIGN	I. C. WEDEN	DATE	08/04	BEARTOOTH HIGHWAY PARK COUNTY, WYOMING FHWA
DRAWN	D. FRESER	DATE	08/04	
CHECKED	I. C. WEDEN	DATE	08/04	
				TEST PIT LOCATION PLAN
ROUTE	LOCATION	STRUCTURE NO.		BEARTOOTH HIGHWAY
PROJECT NO. 47377				SHEET NO.
			HPP 4-1(4)	A-4

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
16	WY	HPP 4-1(4) BEARTOOTH HIGHWAY		

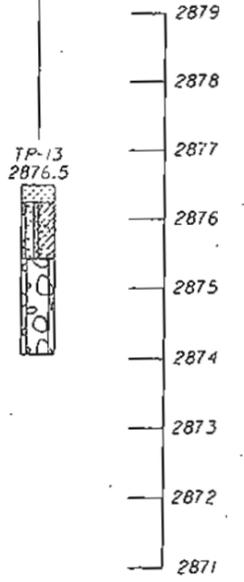


TP-7
2860.0



TP-6
2866.0

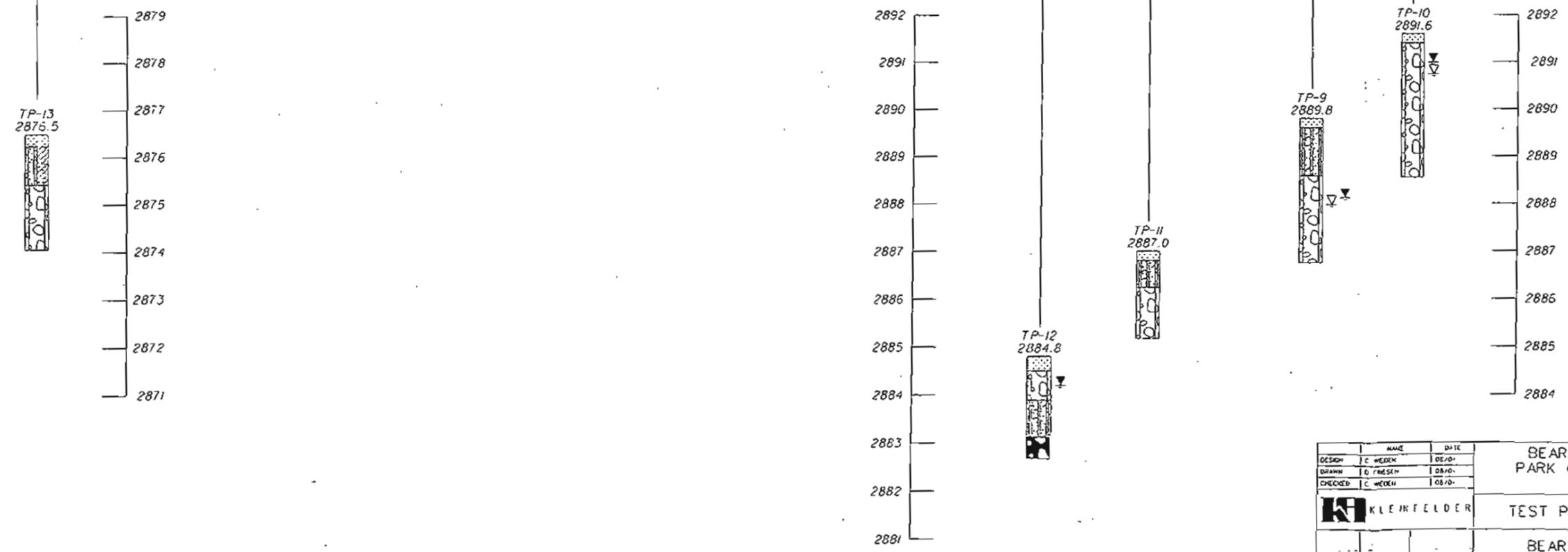
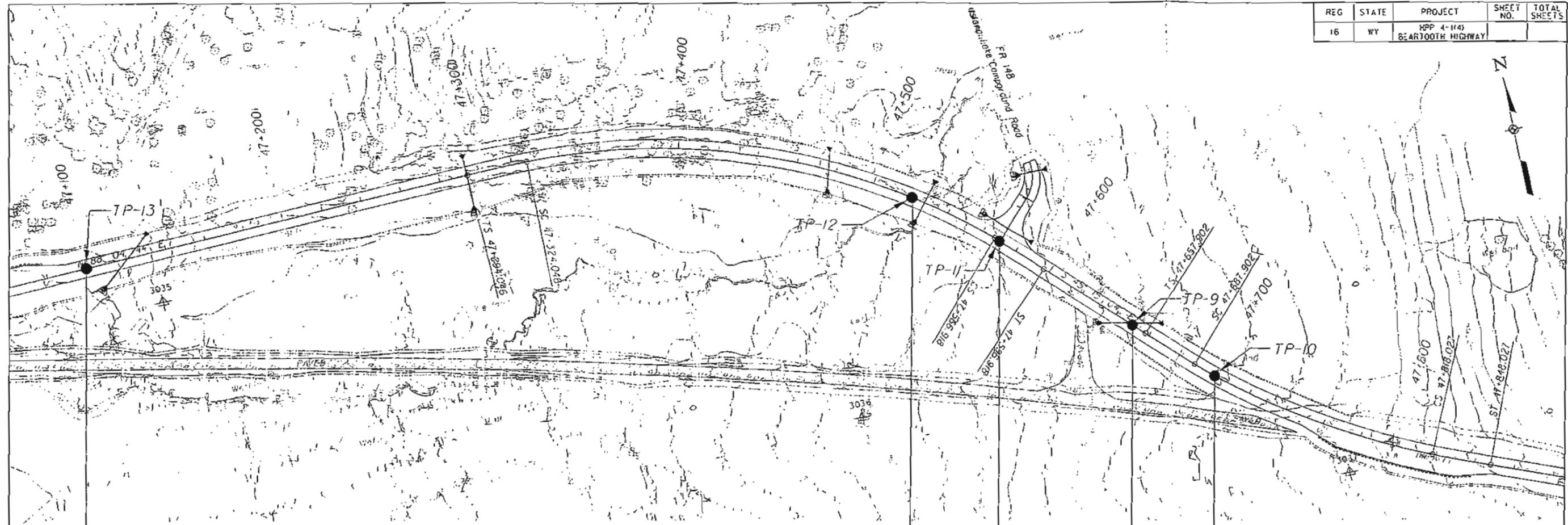
TP-8
2872.0



TP-13
2876.5

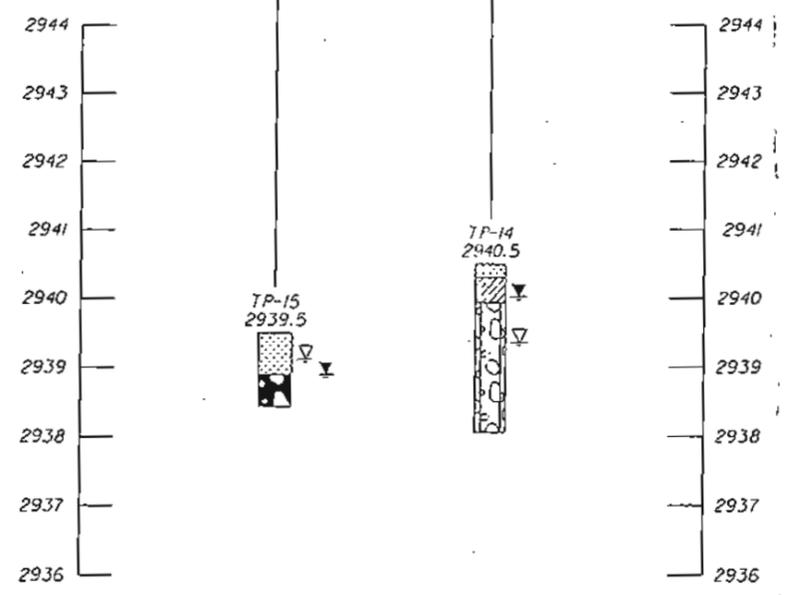
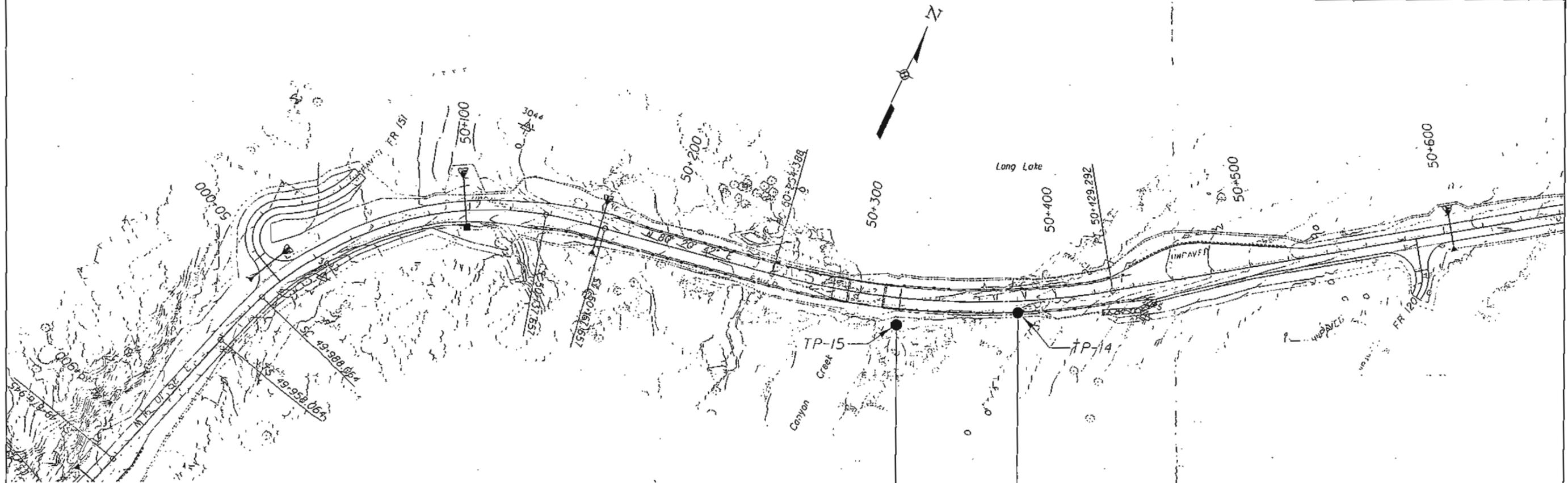
DESIGN	C. WEDEN	05/01	BEARTOOTH HIGHWAY PARK COUNTY, WYOMING FHWA	TEST PIT LOCATION PLAN
DRAWN	C. WEDEN	05/01		
CHECKED	C. WEDEN	05/01		
			BEARTOOTH HIGHWAY	SHEET NO.
PROJECT NO 47377			HPP 4-1(4)	A-5

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
16	WY	HPP 4-1(4) BEARTOOTH HIGHWAY		



DESIGN	C. WEDEN	08/0-	BEARTOOTH HIGHWAY PARK COUNTY, WYOMING FHWA
DRAWN	D. WEDEN	08/0-	
CHECKED	C. WEDEN	08/0-	
			TEST PIT LOCATION PLAN
ROUTE	LOCATION	STRUCTURE NO.	BEARTOOTH HIGHWAY
PROJECT NO 47377		HPP 4-1(4)	SHEET NO A-6

REG	STATE	PROJECT	SHEET NO.	TOTAL SHEETS
16	WY	HPP 4-11(4) BEARTOOTH HIGHWAY		



DESIGN	C. WEDEN	05/01	BEARTOOTH HIGHWAY PARK COUNTY, WYOMING FHWA
DRAWN	G. FICSDEN	08/01	
CHECKED	C. WEDEN	08/01	
			TEST PIT LOCATION PLAN
ROUTE	LOCATION	STRUCTURE NO.	BEARTOOTH HIGHWAY
PROJECT NO. 47377			SHEET NO. A-7

APPENDIX B

Logs of Test Pits

Latitude & Longitude: 44.941917° 109.556667°
 Groundwater (m): No groundwater during excavation or when checked at 24 hours
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/19/2004
 Date Backfilled: 7/20/2004
 Logged By: C. Wieden
 Station/Offset: 45+880
 Total Depth: 3.35 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY				Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)			
												0.00 to 3.35 meters Appx. Surface Elevation (m): 2849.4 Surface Conditions: Grass
2849												Grass covered topsoil.
	1											Silty sand with gravel, some cobbles, moist, reddish-tan.
2848												
	2											Silty sand with some gravel, slightly clayey pockets, moist, mottled grayish-yellow.
2847												
	3											
2846												
	4											

1 47377 - BEARTOOTH HIGHWAY TESTPITS.GPJ cwieden@kleinfelder.com 1/12/2004



TEST PIT TP-1

TEST PIT

TP-1

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number:
 47377

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

Latitude & Longitude: 44.942067° 109.55495°
 Groundwater (m): Groundwater at 2.90 m at time of excavation, and 2.57 m at 24 hours.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/19/2004
 Date Backfilled: 7/20/2004
 Logged By: C. Wieden
 Station/Offset: 46+020
 Total Depth: 3.05 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY				Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)			Passing #200 Sieve (%)
												Appx. Surface Elevation (m): 2849.3 Surface Conditions: Grass
2849												Grass covered topsoil.
												Silty sand with some gravel, moist, reddish-tan.
	1											Silty sand with gravel and cobbles, moist, brownish-tan.
2848												
	2											Silty sand with gravel, cobbles, and boulders, moist, reddish-brown to purple.
2847												
	3											
2846												
	4											

1 47377 - BEARTOOTH HIGHWAY TESTPITS.GPJ cwiiden@kleinfelder.com 11/22/2004



TEST PIT TP-2

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TEST PIT

TP-2

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number:
 47377

Latitude & Longitude: 44.943083° 109.561917°
 Groundwater (m): Seepage at 0.91 m, GW at 2.54 m at time of exc., GW at 1.22 m at 24 hours.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/19/2004
 Date Backfilled: 7/20/2004
 Logged By: C. Wieden
 Station/Offset: 45+440
 Total Depth: 3.05 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY				Graphical Log	Rock Fracturing	DESCRIPTION 0.00 to 3.05 meters Appx. Surface Elevation (m): 2840.0 Surface Conditions: Grass
		Sample Interval	Blow Counts per 150 mm interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)			
2839	1											Grass covered topsoil.
												Silty/clayey sand with gravel and some cobbles, moist to wet (seepage at 0.9 meters in test pit), reddish-brown.
2838	2											Silt/lean clay, sandy, moist, dark gray.
2837	3											Well-graded sand with gravel, wet, brown.
2836	4											

1-47377 - BEARTOOTH HIGHWAY TESTPITS.GPJ cwieden@kleinfelder.com 11/7/2004



TEST PIT TP-3

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TEST PIT

TP-3

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number:
47377

Latitude & Longitude: 44.9438° 109.5661°
 Groundwater (m): Groundwater at 1.68 m at time of excavation, and 1.22 m at 24 hours.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/19/2004
 Date Backfilled: 7/20/2004
 Logged By: C. Wieden
 Station/Offset: 45+090
 Total Depth: 2.44 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY					Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)			
													0.00 to 2.44 meters
													Appx. Surface Elevation (m): 2839.0 Surface Conditions: Grass
													Grass covered topsoil.
				BULK									Silty sand with gravel, cobbles, and small boulders, moist, reddish-tan.
2838	1												Cobbles and boulders with sand and gravel matrix, moist, tan, becoming harder and more dense with depth.
2837	2												
2836	3												
2835	4												Test pit terminated on large boulders or possible granitic bedrock at a depth of approximately 2.44 meters.

147377 - BEARTOOTH HIGHWAY TESTPITS.GPJ cwieden@kleinfelder.com 11/8/2004



TEST PIT TP-4

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TEST PIT

TP-4

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number:
 47377

Latitude & Longitude: 44.943333° 109.563883°
 Groundwater (m): Seepage at 0.46m at excavation, water at 2.03 m at 24 hours.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/19/2004
 Date Backfilled: 7/20/2004
 Logged By: C. Wieden
 Station/Offset: 45+280
 Total Depth: 3.05 meters

Elevation (meters)	Depth (meters)	FIELD					LABORATORY					Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests			
														0.00 to 3.05 meters Appx. Surface Elevation (m): 2838.7 Surface Conditions: Grass
														Grass covered topsoil.
2838	1													Silty sand with gravel, moist, brownish-tan (seepage at 0.46 meters at time of excavation).
														Silt/lean clay, with sand and gravel, moist, mottled gray/tan.
2837	2													Silty sand and gravel with cobbles and boulders, some clayey sand pockets, moist to wet, brownish-tan to reddish-brown.
2836	3													
2835	4													

147377 - BEARTOOTH HIGHWAY TESTPITS GP | c.wieden@kleinfelder.com | 11/22/2004



KLEINFELDER

TEST PIT TP-5 Little Bear Creek No. 1 Bridge
 West Approach
 Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TEST PIT

TP-5

Drafted By: C. Wieden Project Number: 47377
 Date: 8/2/2004

Latitude & Longitude: 44.9389° 109.547333°
 Groundwater (m): No groundwater during excavation or when checked at 24 hours
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/20/2004
 Date Backfilled: 7/21/2004
 Logged By: C. Wieden
 Station/Offset: 46+740, 10 m right
 Total Depth: 2.44 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY				Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)			
												0.00 to 2.44 meters Appx. Surface Elevation (m): 2866.0 Surface Conditions: Sparse vegetation
2865	1											Silty sand with gravel, moist, brownish-tan.
2864	2			BULK								Sandstone bedrock, weathered from 0.61m to 0.91m, hard below 0.91m, moist, blueish-gray, with brownish-tan iron stained layers.
2863	3											Test pit terminated on hard sandstone bedrock at a depth of approximately 2.44 meters.
2862	4											

147377 - BEARTOOTH HIGHWAY TESTPITS.GPJ.cwieden@kleinfelder.com 11/8/2004



TEST PIT TP-6 Island Lake Moraine

TEST PIT

TP-6

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number:
 47377

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

Latitude & Longitude: 44.940083° 109.549917°
 Groundwater (m): Groundwater at 1.83 m at time of excavation, and 1.6 m at 24 hours.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/20/2004
 Date Backfilled: 7/21/2004
 Logged By: C. Wieden
 Station/Offset: 46+500
 Total Depth: 2.13 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY					Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)			
													0.00 to 2.13 meters Appx. Surface Elevation (m): 2860.0 Surface Conditions: Grass
													Grass covered topsoil, sandy, dark brown.
													Cobbles and boulders with sand and gravel matrix, moist, dark brown. - same as at 0.1 meters, but tan to reddish-tan in color, and wet below 1.83 meters.
2859	1												
2858	2												
2857	3												
2856	4												Test pit terminated on large boulders at a depth of approximately 2.13 meters.

147377 - BEARTOOTH HIGHWAY TESTPITS.GPJ c.wieden@kleinfelder.com 11/8/2004



TEST PIT TP-7

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TEST PIT
TP-7

Drafted By: C. Wieden Project Number: 47377
 Date: 8/2/2004

Latitude & Longitude: 44.938633° 109.546583°
 Groundwater (m): No groundwater during excavation or when checked at 24 hours
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/20/2004
 Date Backfilled: 7/21/2004
 Logged By: C. Wieden
 Station/Offset: 46+800, 20 m right
 Total Depth: 3.05 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY				Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)			
2871	1											Silty sand with gravel, moist, brown.
2870	2			BULK								Silty sand and gravel with cobbles, some small boulders (0.2m - 0.3m), moist, reddish-brown.
2869	3											
2868	4											

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TEST PIT TP-8 Island Lake Moraine

TEST PIT

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TP-8

Drafted By: C. Wieden Project Number: 47377
 Date: 8/2/2004

Latitude & Longitude: 44.93765° 109.536383°
 Groundwater (m): Seepage from 1.68 to 1.98 m at time of excavation, GW at 1.83 m at 24 hours.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/20/2004
 Date Backfilled: 7/21/2004
 Logged By: C. Wieden
 Station/Offset: 47+650
 Total Depth: 3.05 meters

Elevation (meters)	Depth (meters)	FIELD					LABORATORY					Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests			
														0.00 to 3.05 meters
														Appx. Surface Elevation (m): 2889.8 Surface Conditions: Grass
				SHELLY										Grass covered topsoil, dark brown.
				BULK										Silty sand with gravel and cobbles, moist, dark brown. - same as at 0.2 meters, but yellow-tan in color.
2889	1													
2888	2													
2887	3													Silty sand and gravel, with cobbles and boulders, moist to wet, brown.
2886	4													

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TEST PIT TP-9 Island Lake Wetland Crossing

TEST PIT

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TP-9

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number:
 47377

Latitude & Longitude: 44.9373° 109.5359°
 Groundwater (m): Seepage at 0.61 m and 1.52 m at time of exc., GW at 0.86 m at 24 hours.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/20/2004
 Date Backfilled: 7/21/2004
 Logged By: C. Wieden
 Station/Offset: 47+700
 Total Depth: 3.05 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY					Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)			
													0.00 to 3.05 meters Appx. Surface Elevation (m): 2891.6 Surface Conditions: Grass
2891	1												Grass covered topsoil.
2890	2												Silty sand with gravel, cobbles and boulders, moist, tan to reddish-brown.
2889	3												
2888	4												

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TEST PIT TP-10 Island Lake Wetland Crossing

TEST PIT

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TP-10

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number:
 47377

Latitude & Longitude: 44.938167° 109.5371°
 Groundwater (m): No groundwater during excavation or when checked at 24 hours
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/20/2004
 Date Backfilled: 7/21/2004
 Logged By: C. Wieden
 Station/Offset: 47+570
 Total Depth: 1.83 meters

Elevation (meters)	Depth (meters)	FIELD					LABORATORY					Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests			
														0.00 to 1.83 meters Appx. Surface Elevation (m): 2887.0 Surface Conditions: Grass
				SHELBY										Grass covered topsoil.
				BULK										Silty sand with gravel and cobbles, moist, brown to brownish-tan.
2886	1													Silty sand and gravel, with cobbles and boulders, moist, brownish-tan to reddish-tan.
2885	2													Test pit terminated on large boulders at a depth of approximately 1.83 meters.
2884	3													
2883	4													

1 47377 - BEARTOOTH HIGHWAY TESTPITS.GPJ c:wieden@kleinfelder.com 11/18/2004



TEST PIT TP-11 Island Lake Wetland Crossing

TEST PIT

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TP-11

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number:
 47377

Latitude & Longitude: 44.9384° 109.537617°
 Groundwater (m): Groundwater at 0.61 m at time of excavation and at 24 hours.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/20/2004
 Date Backfilled: 7/21/2004
 Logged By: C. Wieden
 Station/Offset: 47+520
 Total Depth: 2.13 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY				Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)			
2884	0											0.00 to 2.13 meters Appx. Surface Elevation (m): 2884.8 Surface Conditions: Grass
	1											Grass covered topsoil.
												Silty sand with some gravel, cobbles and boulders, moist to very moist, brown.
	2											Silty sand and gravel, with cobbles, wet, brownish-tan.
2883												Large boulder or possible bedrock, very hard, red.
	3											Test pit terminated on large boulders or possible granitic bedrock at a depth of approximately 2.13 meters.
2882												
2881	4											

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TEST PIT TP-12 Island Lake Wetland Crossing

TEST PIT

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number:
 47377

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TP-12

Latitude & Longitude: 44.93885° 109.542783°
 Groundwater (m): No groundwater during excavation or when checked at 24 hours.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/20/2004
 Date Backfilled: 7/21/2004
 Logged By: C. Wieden
 Station/Offset: 47+100
 Total Depth: 2.44 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY				Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)			
												0.00 to 2.44 meters Appx. Surface Elevation (m): 2876.5 Surface Conditions: Grass
												Grass covered topsoil.
2876	1											Silty to clayey sand with gravel and cobbles, moist, brown to brownish-tan.
2875	2											Silty sand with gravel, cobbles and boulders (1.21m size), moist, brownish-tan. - seepage at 1.37 meters at 24 hours.
2874	3											Test pit terminated on large boulders at a depth of approximately 2.44 meters.
2873	4											

1 47377 - BEARTOOTH HIGHWAY TESTPITS.GPJ.cwieden@kleinfelder.com 11/16/2004



TEST PIT TP-13

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TEST PIT

TP-13

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number: 47377

Latitude & Longitude: 44.9402° 109.5072°
 Groundwater (m): Seepage at 0.48 m and 1.22 m at time of exc, GW at 1.14 m at 24 hours.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/21/2004
 Date Backfilled: 7/22/2004
 Logged By: C. Wieden
 Station/Offset: 50+380, 6 m right
 Total Depth: 2.44 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY				Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)			
2940												0.00 to 2.44 meters Appx. Surface Elevation (m): 2940.5 Surface Conditions: Grass and brush
												Grass covered topsoil.
												Lean clay, sandy, soft, very moist, brown.
2939	1											Silty sand and gravel with cobbles and boulders (0.3m to 0.9m), very moist to wet, brown, gray, and reddish-brown.
2938	2											Test pit terminated on large boulders at a depth of approximately 2.44 meters.
	3											
2937												
	4											

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TEST PIT TP-14 Long Lake Retaining Wall
 Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TEST PIT
TP-14

Drafted By: C. Wieden Project Number: 47377
 Date: 8/2/2004

Latitude & Longitude: 44.93985° 109.5079°
 Groundwater (m): Seepage at 0.61 m at time of excavation, Groundwater at 0.38 m at 24 hours.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/21/2004
 Date Backfilled: 7/22/2004
 Logged By: C. Wieden
 Station/Offset: 50+320, 14 m right
 Total Depth: 1.07 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY				Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)			
												0.00 to 1.07 meters Appx. Surface Elevation (m): 2939.5 Surface Conditions: Grass and brush
2939												Grass/brush covered topsoil.
	1											Cobbles and boulders with sand and gravel matrix, very moist to wet, brownish-gray.
2938	2											Test pit terminated on large boulders at a depth of approximately 1.07 meters.
2937	3											
2936	4											

1 47377 - BEARTOOTH HIGHWAY TESTPITS.GPJ cwieden@kleinfelder.com 11/2/2004



TEST PIT TP-15 Long Lake Retaining Wall

TEST PIT

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number:
 47377

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TP-15

Latitude & Longitude: 44.925167° 109.645883°
 Groundwater (m): No groundwater during excavation.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/21/2004
 Date Backfilled: 7/21/2004
 Logged By: C. Wieden
 Station/Offset: N/A
 Total Depth: 3.05 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY				Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)			Passing #200 Sieve (%)
												Surface Conditions: Sparse vegetation
	1											Fill: Silty sand with gravel, cobbles and small boulders, moist, dark brown with some organics.
	2			BULK								Possible Fill: Silty sand, slightly clayey, with gravel, cobbles and small boulders, brownish-tan.
	3											
	4											

1:47377 - BEARTOOTH HIGHWAY TESTPITS.GPJ cwieden@kleinfelder.com 11/2/2004



TEST PIT TP-16 Ghost Creek Material Source

TEST PIT

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TP-16

Drafted By: C. Wieden Project Number: 47377
 Date: 8/2/2004

Latitude & Longitude: 44.9244° 109 645317°
 Groundwater (m): No groundwater during excavation.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/21/2004
 Date Backfilled: 7/21/2004
 Logged By: C. Wieden
 Station/Offset: N/A
 Total Depth: 3.05 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY					Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests			0.00 to 3.05 meters
													Surface Conditions: Sparse vegetation
	1												Fill: Silty sand with gravel, cobbles, and small boulders, moist, dark brown with organics.
	2			BULK									Well-graded sand with gravel, some cobbles, moist, brownish-tan.
	3												
	4												

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TEST PIT TP-17 Ghost Creek Material Source

TEST PIT

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TP-17

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number: 47377

Latitude & Longitude: 44.92145° 109.643217°
 Groundwater (m): No groundwater during excavation.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/21/2004
 Date Backfilled: 7/21/2004
 Logged By: C. Wieden
 Station/Offset: N/A
 Total Depth: 3.05 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY					Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	RQD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)			Other Tests
													Surface Conditions: Sparse vegetation
													Fill: Silty sand with gravel, moist, brown.
	1												Probable Fill: Silty sand with gravel, cobbles and small boulders, moist, dark brown with organics.
	2			BULK									Well-graded sand with gravel and cobbles, moist, brownish-tan.
	3												
	4												

1-47377 - BEARTOOTH HIGHWAY TESTPITS.GPJ c.wieden@kleinfelder.com 11/2/2004



TEST PIT TP-18 Ghost Creek Material Source

TEST PIT

TP-18

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number:
 47377

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

Latitude & Longitude: 44.921917° 109.6431°
 Groundwater (m): No groundwater during excavation.
 Drilling Company: Rocky Mountain Bldrs Equipment: John Deere 210C
 Hole Diameter (mm): N/A Drilling Method: Backhoe
 Hammer Type: N/A

Date Started: 7/21/2004
 Date Backfilled: 7/21/2004
 Logged By: C. Wieden
 Station/Offset: N/A
 Total Depth: 3.05 meters

Elevation (meters)	Depth (meters)	FIELD				LABORATORY				Graphical Log	Rock Fracturing	DESCRIPTION
		Sample Interval	Blow Counts per 150 mm Interval	Sample Type	Percent Recovery	ROD	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)			Passing #200 Sieve (%)
												Surface Conditions: Sparse vegetation
	1											Fill: Silty sand with gravel, cobbles and boulders, moist, dark brown with organics.
	2			BULK								Well-graded sand with silt, gravel, cobbles and boulders, moist, brownish-tan.
	3											
	4											

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TEST PIT TP-19 Ghost Creek Material Source

TEST PIT

Project: Beartooth Highway Testpits
 Client: FHWA - Central Federal Lands Highway Division
 Location: Highway 212, Wyoming

TP-19

Drafted By: C. Wieden
 Date: 8/2/2004

Project Number:
 47377

APPENDIX C

Photographs



Rock Cut Sample Area - Station 42+020



Rock Cut Bucket Samples - Station 42+020



Test Pit 4 - Station 45+100



Test Pit 4 - Station 45+100 - Bucket Samples



Test Pit 5 - Station 45+280



Test Pit 3 - Station 45+440



Test Pit 1 - Station 45+880



Test Pit 2 - Station 46+020



Test Pit 7 - Station 46+500



Test Pit 7 - Station 46+500 - Profile



Test Pit 6 - Station 46+740, offset 10 meters right of centerline



Test Pit 6 - Station 46+740 Profile



Test Pit 6 - Station 46+740 - Bucket Samples



Test Pit 8 - Station 46+800, 20 meters right of centerline



Test Pit 8 - Station 46+800 - Bucket Samples



Test Pit 13 - Station 47+100



Test Pit 12 - Station 47+520



Test Pit 11 - Station 47+570 - Pushing Shelby Tube



Test Pit 11 - Station 47+570 - Bucket and Shelby Tube Samples



Test Pit 9 - Station 47+650



Test Pit 9 - Station 47+650 - Bucket and Shelby Tube Samples



Test Pit 10 - Station 47+700



Rock Cut Sample Area - Station 49+690



Rock Cut Bucket Samples - Station 49+690



Rock Cut Sample Area - Station 49+820



Rock Cut Bucket Samples - Station 49+820



Test Pit 15 - Station 50+320, offset 14 meters right of centerline



Test Pit 15 - Station 50+320 - View of Large Boulders



Test Pit 14 - Station 50+380, offset 6 meters right of centerline



Test Pit 16 - Ghost Creek Sample Area - North Pit - Upper Bench



TP-16 - Ghost Creek - North Pit - Upper Bench - Bucket Samples



Test Pit 17 - Ghost Creek Sample Area - North Pit - Lower Bench



TP-17 - Ghost Creek - North Pit - Lower Bench - Bucket Samples



Test Pit 18 - Ghost Creek Sample Area - South Pit - Lower Bench



TP-18 - Ghost Creek - South Pit - Lower Bench - Bucket Samples



Test Pit 19 - Ghost Creek Sample Area - South Pit - Upper Bench



TP-19 - Ghost Creek - South Pit - Upper Bench - Bucket Samples



Beartooth samples delivered to FHWA-CFLHD lab



Beartooth samples delivered to FHWA-CFLHD lab



Beartooth samples delivered to FHWA-CFLHD lab