SW134

Div of Waste Management
and Radiation Control

JUL 21 2015

2015-007778

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June 18, 2015
File No. 84794

Ms. Deborah Barton, District Manager
Solid Waste Special Service District #1
PO Box 980
Moab, Utah 84532

SUBJECT: Permit Renewal Application
Klondike Landfill
Located 20 miles north of Moab, UT

Dear Ms. Barton:

This letter serves to transmit the Klondike Landfill permit renewal application prepared by Kleinfelder for the Solid Waste Special Service District #1.

This permit renewal application updates the estimated closure costs for the Klondike Landfill, the census data and includes revision to address comments by the Utah Division of Solid and Hazardous Waste (UDSHW) on August 10, 2010. This permit renewal application does not update material submitted for the initial permit application to operate the Klondike Landfill.

Kleinfelder's scope of services included evaluations based on previous work and data generated by others. The Solid Waste Special Service District personnel evaluated and completed the landfill closure Financial Assurance and Mechanism Cost Estimates found in Appendix E.

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same locality, under similar conditions and at the date the services were provided. Conclusions, opinions and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

Sincerely,

KLEINFELDER

Kerry L. Ruebelmann

Kerry L. Ruebelmann, PG
Project Manager

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Div of Waste Management
and Radiation Control

JUL 21 2015

CLASS I PERMIT RENEWAL
KLONDIKE LANDFILL
GRAND COUNTY, UTAH

Part I–General Information
Part II–General Report
Part III–Technical and Engineering Report

June 18, 2015

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ONLY THE CLIENT OR ITS DESIGNATED REPRESENTATIVES MAY USE THIS DOCUMENT AND ONLY FOR THE SPECIFIC PROJECT FOR WHICH THIS REPORT WAS PREPARED.

A report prepared for:

Deborah Barton
Solid Waste Special Service District #1
PO Box 980
Moab, Utah 84532

CLASS I PERMIT RENEWAL
KLONDIKE LANDFILL
GRAND COUNTY, UTAH

File No.: 84794.3

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June 18, 2015

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Part I
General Information

Utah Division of Solid and Hazardous Waste
Solid Waste Management Program

Mailing Address
P.O. Box 144880
Salt Lake City, Utah 84114-4880

Office Location
288 North 1460 West
Salt Lake City, Utah 84116

Phone (801) 538-6170
Fax (801) 538-6715
www.deq.utah.gov

APPLICATION FOR A PERMIT TO OPERATE A CLASS I OR CLASS V LANDFILL

Please read the instructions that are found in the document, INSTRUCTIONS FOR APPLICATION FOR A PERMIT TO OPERATE A CLASS I OR CLASS V LANDFILL. This application form shall be used for all Class I or V solid waste disposal facility permits and modifications. Part I GENERAL INFORMATION must accompany a permit application. Part II, application checklist, is provided to assist applicants and, if included with the application, will assist review. **Please note** the version date of this form found on the lower right of the page; if you have received this form more than six months after this date it is recommended you contact our office at (801) 538-6170 to determine if this form is still current. When completed, please return this form and support documents, forms, drawings, and maps to:

Dennis R. Downs, Director
Division of Solid and Hazardous Waste
Utah Department of Environmental Quality
PO Box 144880
Salt Lake City, Utah 84114-4880

(Note: When the application is determined to be complete, submittal of two copies of the complete application will be required.)

Utah Class I and V Landfill Permit Application Form

Part I General Information APPLICANT: PLEASE COMPLETE ALL SECTIONS.

I. Landfill Type		II. Application Type		
☒ Class I ☐ Class V		☐ New Application ☒ Renewal Application		☐ Facility Expansion ☐ Modification

For Renewal Applications, Facility Expansion Applications and Modifications Enter Current Permit Number 9509R1

III. Facility Name and Location

Legal Name of Facility: Klondike Landfill

Site Address (street or directions to site): 20 miles north of Moab, west of State Route 191 | County: Grand

City: Moab | State: UT | Zip Code: 84532 | Telephone: (435) 259-3867

Township: 23 S | Range: 19 E | Section(s): 14 | Quarter/Quarter Section: NW ¼ | Quarter Section: S ½

Main Gate Latitude: degrees minutes seconds | Longitude: degrees minutes seconds

IV. Facility Owner(s) Information

Legal Name of Facility Owner: Solid Waste Special Service District #1

Address (mailing): PO Box 980

City: Moab | State: UT | Zip Code: 84532 | Telephone: (435) 259-3867

V. Facility Operator(s) Information

Legal Name of Facility Operator: Same as Owner

Address (mailing):

City: | State: UT | Zip Code: | Telephone:

VI. Property Owner(s) Information

Legal Name of Property Owner: Same as Owner

Address (mailing):

City: | State: | Zip Code: | Telephone:

VII. Contact Information

Owner Contact: Robert Greenburg | Title: Member, Administrative Control Board

Address (mailing): PO Box 980

City: Moab | State: UT | Zip Code: 84532 | Telephone: (435) 260-9665

Email Address: gcswmss@yahoo.com | Alternative Telephone (cell or other): (435) 259-7013

Operator Contact: Same as Owner | Title:

Address (mailing):

City: | State: UT | Zip Code: | Telephone:

Email Address: | Alternative Telephone (cell or other):

Property Owner Contact: Same as Owner | Title:

Address (mailing):

City: | State: | Zip Code: | Telephone:

Email Address: | Alternative Telephone (cell or other):

Utah Class I and V Landfill Permit Application Form

Part I General Information (Continued)

VIII. Waste Types (check all that apply)

☒ All non-hazardous solid waste (see R315-315-7(3) for PCB special requirements) **OR** the following specific waste types:

Waste Type	Combined Disposal Unit	Monofill Unit
☐ Municipal Waste	☐	☐
☐ Construction & Demolition	☐	☐
☐ Industrial	☐	☐
☐ Incinerator Ash	☐	☐
☐ Animals	☐	☐
☐ Asbestos	☐	☐
☐ PCB's (R315-315-7(3) only)	☐	☐
☐ Other _____	☐	☐

IX. Facility Area

Facility Area..... 80 acres

Disposal Area..... _____ acres

Design Capacity

Years..... 60-90

Cubic Yards..... _____

Tons..... _____

X. Fee and Application Documents

Indicate Documents Attached To This Application ☐ Application Fee: Amount $

☒ Facility Map or Maps ☒ Facility Legal Description ☒ Plan of Operation ☒ Waste Description
☐ Ground Water Report ☒ Closure Design ☒ Cost Estimates ☒ Financial Assurance

Class V Special Requirements

☐ Documents required by UCA 19-6-108(9) and (10)

I HEREBY CERTIFY THAT THIS INFORMATION AND ALL ATTACHED PAGES ARE CORRECT AND COMPLETE.

Signature of Authorized Owner Representative Robert Greenberg Name typed or printed	Title Member Administrative Control Board Address PO Box 980 Moab, UT 84532	Date
Signature of Authorized Land Owner Representative (if applicable) Robert Greenberg Name typed or printed	Title Member ACB Address PO Box 980 Moab, UT 84532	Date
Signature of Authorized Operator Representative (if applicable) Robert Greenberg Name typed or printed	Title Member ACB Address PO Box 980 Moab, UT 84532	Date

Utah Class I and V Permit Application Checklist

Important Note: The following checklist is for the permit application and addresses only the requirements of the Division of Solid and Hazardous Waste. Other federal, state, or local agencies may have requirements that the facility must meet. The applicant is responsible to be informed of, and meet, any applicable requirements. Examples of these requirements may include obtaining a conditional use permit, a business license, or a storm water permit. The applicant is reminded that obtaining a permit under the *Solid Waste Permitting and Management Rules* does not exempt the facility from these other requirements.

An application for a permit to construct and operate a landfill is the documentation that the landfill will be located, designed, constructed, and operated to meet the requirements of Rules R315-302, R315-303, R315-308, R315-309, and R315-315 of the *Utah Solid Waste Permitting and Management Rules* and the *Utah Solid and Hazardous Waste Act* (UCA 19-6-101 through 123). The application should be written to be understandable by regulatory agencies, landfill operators, and the general public. The application should also be written so that the landfill operator, after reading it, will be able to operate the landfill according to the requirements with a minimum of additional training.

Copies of the *Solid Waste Permitting and Management Rules*, the *Utah Solid and Hazardous Waste Act*, along with many other useful guidance documents can be obtained by contacting the Division of Solid and Hazardous Waste at 801-538-6170. Most of these documents are available on the Division's web page at www.hazardouswaste.utah.gov. Guidance documents can be found at the solid waste section portion of the web page.

When the application is determined to be complete, the original complete application and one copy of the complete application are required along with an electronic copy.

Part II **Application Checklist**

***I.* Facility General Information**	
Description of Item	Location In Document
Completed Part I General information	Part I
General description of the facility (R315-310-3(1)(b))	Part II, Section 1.1
Legal description of property (R315-310-3(1)(c))	Part II, Section 3
Proof of ownership, lease agreement, or other mechanism (R315-310-3(1)(c))	Part II, Section 3
Area served by the facility including population (R315-310-3(1)(d))	Part II, Section 1.2
If the permit application is for a class I landfill a demonstration that the landfill is not a commercial facility	Part II, Section 4
Waste type and anticipated daily volume (R315-310-3(1)(d))	Part II, Section 4
Intended schedule of construction (R315-302-2(2)(a))	Part II, Section 4
Name and address of all property owners within 1000 feet of the facility boundary (R315-310-3(2)(i))	Part II, Section 1
Documentation that a notice of intent to apply for a permit has been sent to all property owners listed above (R315-310-3(2)(ii))	Part II, Section 1
Name of the local government with jurisdiction over the facility site (R315-310-3(2)(iii))	Part II, Section 1
Demonstration That The Facility Meets The Location Standards (R315-302-1)	
Land use compatibility	Part III, Section 4

I. Facility General Information	
Description of Item	Location In Document
Maps showing the existing land use, topography, residences, parks, monuments, recreation areas or wilderness areas within 1000 feet of the site boundary	Appendices B, C
Certifications that no ecologically or scientifically significant areas or endangered species are present in site area	Part III, Section 4.1
List of airports within five miles of facility and distance to each	Part III, Section 4.1
Geology	Part III, Section 4.2
Geologic maps showing significant geologic features, faults, and unstable areas	Appendices F, H
Maps showing site soils	Appendices F, H
Surface water	Part III, Sections 3.1-3.3
Magnitude of 24 hour 25 year and 100 year storm events	Part III, Section 4.3
Average annual rainfall	Part III, Section 3.12
Maximum elevation of flood waters proximate to the facility	Part III, Section 4.3
Maximum elevation of flood water from 100 year flood for waters proximate to the facility	Part III, Section 4.3
Wetlands	Part III, Section 3.5
Ground water	Part III, Section 3.6
Plan of Operations (R315-310-3(1)(e) and R315-302-2(2))	
Forms and other information as required in R3315-302-2(3) including a description of on-site waste handling procedures and an example of the form that will be used to record the weights or volumes of waste received (R315-302-2(2)(b) And R315-310-3(1)(f))	Appendix D
Schedule for conducting inspections and monitoring, and examples of the forms that will be used to record the results of the inspections and monitoring (R315-302-2(2)(c), R315-302-2(5)(a), and R315-310-3(1)(g))	Appendix D, Section 3
Contingency plans in the event of a fire or explosion (R315-302-2(2)(d))	Appendix D, Sections 4.1, 4.2
Corrective action programs to be initiated if ground water is contaminated (R315-302-2(2)(e))	Appendix D, Section 4.5
Contingency plans for other releases, e.g. explosive gases or failure of run-off collection system (R315-302-2(2)(f))	Appendix D, Sections 4.3, 4.4
Plan to control fugitive dust generated from roads, construction, general operations, and covering the waste (R315-302-2(2)(g))	Appendix D, Section 6.2
Plan for letter control and collection (R315-302-2(2)(h))	Appendix D, Section 6.3
Description of maintenance of installed equipment (R315-302-2(2)(i))	Appendix D, Section 2.5
Procedures for excluding the receipt of prohibited hazardous or PCB containing wastes (R315-302-2(2)(j))	Appendix D, Section 7

I. **Facility General Information**	
Description of Item	Location In Document
Procedures for controlling disease vectors (R315-302-2(2)(k))	Appendix D, Section 6.1
A plan for alternative waste handling (R315-302-2(2)(l))	Appendix D, Section 4.6
A general training and safety plan for site operations (R315-302-2(2)(o))	Not applicable
Any recycling programs planned at the facility (R315-303-4(6))	Part III, Section 6
Closure and post-closure care Plan (R315-302-2(2)(m))	Appendix D, Section 2.2
Procedures for the handling of special wastes (R315-315)	Appendix D, Section 2.2
Plans and operation procedures to minimize liquids (R315-303-3(1)(a) and (b))	Appendix D
Plans and procedures to address the requirements of R315-303-3(7)(c) through (i) and R315-303-4	Not applicable
Any other site specific information pertaining to the plan of operation required by the Executive Secretary (R315-302-2(2)(p))	Not applicable
SPECIAL REQUIREMENTS FOR A CLASS V LANDFILL (R315-310-3(2))	
Submit information required by the *Utah Solid and Hazardous Waste Act* Subsections 19-6-108(9) and 19-6-108(10) (R315-310-3(2)(a))	Not applicable
Approval from the local government within which the solid waste facility sits	Not applicable

II **Facility Technical Information**	
Description of Item	Location In Document
Maps	
Topographic map drawn to the required scale with contours showing the boundaries of the landfill unit, ground water monitoring well locations, gas monitoring points, and the borrow and fill areas (R315-310-4(2)(a)(i))	Appendix B
Most recent U.S. Geological Survey topographic map, 7-1/2 minute series, showing the waste facility boundary; the property boundary; surface drainage channels; any existing utilities and structures within one-fourth mile of the site; and the direction of the prevailing winds (R315-310-4(2)(a)(ii))	Appendix B
Geohydrological Assessment (R315-310-4(2)(b))	
Local and regional geology and hydrology including faults, unstable slopes and subsidence areas on site (R315-310-4(2)(b)(i))	Part III, Section 2
Evaluation of bedrock and soil types and properties including permeability rates (R315-310-4(2)(b)(ii))	Part III, Section 2.1
Depth to ground water (R315-310-4(2)(b)(iii))	Part III, Section 3.8
Direction and flow rate of ground water (R315-310-4(2)(b)(iv))	Part III, Section 3.8
Quantity, location, and construction of any private or public wells on-site or within 2,000 feet of the facility boundary (R315-310-4(2)(b)(v))	Part III, Section 4.4

// Facility Technical Information	
Description of Item	Location In Document
Tabulation of all water rights for ground water and surface water on-site and within 2,000 feet of the facility boundary (R315-310-4(2)(b)(vi))	Part III Sections 3.2, 3.3, 3.7
Identification and description of all surface waters on-site and within one mile of the facility boundary (R315-310-4(2)(b)(vii))	Part III, Section 3.1
Background ground water and surface water quality assessment and, for an existing facility, identification of impacts upon the ground water and surface water from leachate discharges (R315-310-4(2)(b)(viii))	Part III, Section 3.9
Ground Water Monitoring (R315-303-3(7)(b) and R315-308)	Appendix D, Section 3.2
Statistical method to be used (R315-308-2(7))	Not applicable
Calculation of site water balance (R315-310-4(2)(b)(ix))	Part III, Section 3.12
ENGINEERING REPORT - PLANS, SPECIFICATIONS, AND CALCULATIONS	
Documentation that the facility will meet all of the performance standards of R315-303-2	Appendix D
Engineering reports required to meet the location standards of R315-302-1 including documentation of any demonstration or exemption made for any location standard (R315-310-4(2)(c)(i))	Part III, Section 4, Appendices A, B, C, F, G, H, I
Anticipated facility life and the basis for calculating the facility's life (R315-310-4(2)(c)(ii))	Part II, Section 1.2
Cell design to include liner design, cover design, fill methods, elevation of final cover including plans and drawings signed and sealed by a professional engineer registered in the State of Utah (R315-303-3(3), R315-303-3(6) and (7)(a), R315-310-3(1)(b) and R315-310-4(2)(c)(iii))	Part III, Section 5
Leachate collection system design and calculations showing system meets the requirements of R315-303-3(2)	Part III, Section 5.5
Equipment requirements and availability (R315-310-4(2)(c)(iii))	Part III, Section 5.4
Identification of borrow sources for daily and final cover and for soil liners (R315-310-4(2)(c)(iv))	Part III, Section 5.2
Run-On and run-off diversion designs (R315-303-3(1)(c), (d) and (e))	Part III, Section 5.6
Leachate collection, treatment, and disposal and documentation to show that any treatment system is being or has been reviewed by the Division of Water Quality (R315-310-4(2)(c)(v) and R315-310-3(1)(i))	Part III, Section 5.5
Ground water monitoring plan that meets the requirements of Rule R315-308 including well locations, design, and construction (R315-310-4(2)(b)(x) and R315-310-4(2)(c)(vi))	Part III, Section 4.4
Landfill gas monitoring and control plan that meets the requirements of Subsection R315-303-3(5) (R315-310-4(2)(c)(vii))	Part III, Section 5.7
Slope stability analysis for static and under the anticipated seismic event for the facility (R315-310-4(2)(b)(i) and R315-302-1(2)(b)(ii))	Appendices G, H

// Facility Technical Information	
Description of Item	Location In Document
Design and location of run-on and run-off control systems (R315-310-4(2)(c)(viii))	Part III, Section 5.6
CLOSURE PLAN (R315-310-3(1)(h))	
Closure Plan (R315-302-3(2) and (3))	Part II, Section 7
Post-Closure Plan (R315-302-3(5) and (6))	Part II, Section 8
Closure schedule (R315-310-4(2)(d)(i))	Part II, Section 7.3
Design of final cover (R315-303-3(4) and R315-310-4(2)(c)(iii))	Part II, Section 7.1
Capacity of site in volume and tonnage (R315-310-4(2)(d)(ii))	Part II, Section 7.2
Final inspection by regulatory agencies (R315-310-4(2)(d)(iii))	Part II, Section 7.5
POST-CLOSURE CARE PLAN (R315-310-3(1)(h))	
Site monitoring of landfill gases, ground water, and surface water, if required (R315-310-4(2)(e)(i))	Part II, Section 8.1
Changes to record of title, land use, and zoning restrictions (R315-310-4(2)(e)(ii))	Part II, Section 9
Maintenance activities to maintain cover and run-on/run-off control systems (R315-310-4(2)(e)(iii))	Part II, Section 8.2
List the name, address, and telephone number of the person or office to contact about the facility during the post-closure care period (R315-310-4(2)(e)(vi))	Part II, Section 8.1, Part I
FINANCIAL ASSURANCE (R315-310-3(1)(j))	
Identification of closure costs including cost calculations (R315-310-4(2)(d)(iv)) and (R315-302-2(2)(n))	Part II, Section 7.4
Identification of post-closure care costs including cost calculations (R315-310-4(2)(e)(iv))	Part II, Section 8.4
Identification of the financial assurance mechanism that meets the requirements of Rule R315-309 and the date that the mechanism will become effective (R315-309-1(1))	Part II, Section 6

Part II
General Report

1. GENERAL DATA

1.1 GENERAL FACILITY DESCRIPTION

The Grand County Landfill site, also known as the Klondike Landfill, is located 20 miles northwest of Moab, Utah, and approximately 1.2 miles west of Highway 191. The site can be reached from Moab by traveling north on Highway 191 to a turnoff on the west side of the highway at the AT&T microwave communications tower. The County-improved gravel road continues about 1.2 miles to the site (see Appendix A for site location map). The Solid Waste Special Service District #1 has provided an improved road from the County road into the landfill site.

Based on data collected in 1994 for the original permit application (hereafter referenced by the year 1994), elevations at the site range from 4,600 feet at the west quarter corner of Section 14 to 4,800 feet in the northeast quarter of the same section. As stated in 1994, the site slopes gently to the southwest at about 200 feet per mile, or 4 percent. The general slope is broken locally by resistant siltstone beds that stand somewhat higher than the more easily weathered shale bedrock. Vegetation on the site is limited to sparse grasses and low-lying sagebrush.

No permanent structures are currently planned for the landfill; however, the District may develop buildings to house the Landfill Attendant or maintenance facilities in the future. Facility plans showing the site location, permanent roads, and cell placement are provided in Appendix B.

1.1.1 Background

Because the quantities of Grand County waste warrant disposal in a Class I facility, the District authorized a feasibility study in early 1994. That study considered:

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1. Retrofitting the current landfill located on the outskirts of Moab, Utah, to meet State of Utah Class I solid waste disposal facility criteria;

2. Transporting the County's waste to a permitted commercial facility in East Carbon County, Utah;

3. Permitting and constructing a Class I facility at Blue Hill in San Juan County adjacent to Grand County, Utah; and

4. Permitting and constructing a Class I facility at Klondike Flats in Grand County, Utah.

After considering the alternatives and their ramifications, the District concluded that Option #4, constructing a Class I Landfill at Klondike Flats in Grand County, Utah was the preferred action.

1.2 AREA SERVED

The service area for the Klondike Landfill is comprised of one significant population center (Moab, Utah), several small-sized communities (Thompson, Castle Valley, Crescent Junction, and Cisco Utah), and various ranching, agricultural, and recreational properties. The total population of these areas is approximately 9,429 people (2014 census data for Grand County; www.census.gov).

Current trends in Grand County indicate increased recreational visitation and immigration. As summarized in Table I, the proposed 80-acre landfill site will provide waste disposal capacity for 50 to 100 years, depending on the rate of long-term population change (see Appendix C for more detail.)

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Table 1
Projected Landfill Acreage

Period	Zero Percent Growth	2.5 Percent Growth
50 Years	20 acres	48.5 acres
100 Years	48.5 acres	184 acres

Assumptions:
1994 solid waste generation = 25 tons per day, not including recycled materials and C and D wastes
Minimum growth rate = 0 percent
Maximum growth rate = 2.5 percent
Planning period of 50 and 100 years

1.3 WASTE TYPES

Wastes that are accepted in the Landfill include residential, commercial, yard, and farm wastes. Hazardous and other prohibited wastes will not be accepted at the Landfill. Industrial use in the area is extremely limited.

The District conducted a waste generation study at the Moab City Landfill between August 1993 and May 1994. The results show that Grand County produces an average of 37.5 tons of solid waste per day, which is consistent with the current volume of waste generation. Of the 37.5 tons, approximately 25 tons per day go to the Klondike Landfill. Table 2 shows the total amount of waste, categorized by waste type, generated between August 17, 1993 and February 16, 1994.

Table 2
Waste Generation Survey

Type of Waste (tons)	Source						Total by Type (tons)
	Bob	City Res	Contrctr	Cnty Res	Govt	Fed	
Commercial	1211.6	211.2	56.3	64.8	10.8	2.8	1557.5
Construction	495.1	187.9	810.5	124.8	298.8	39.7	1956.8
Household	1715.9	127.7	1.9	240.4	10.5	3.0	2099.4
Sludge/Carcass	10.6	4.4	1.0	29.8	7.4	5.2	58.4
Yard/Farm	18.2	270.7	91.4	214.4	407.3	49.9	1051.0
TOTALS	**3451.4**	**801.9**	**961.1**	**674.2**	**734.8**	**99.7**	**6723.1**

Where: Bob = Bob's Sanitation, City Res = Moab City residents, Contrtr = Contractor, Cnty Res = Grand County residents, Govt = City, County, and State government agencies, Fed = Federal government agencies.

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2. SOLID WASTE MANAGEMENT

During 1992, Grand County contracted with Beehive Enterprises in Panguitch, Utah, to conduct the studies necessary to produce a Solid Waste Management Plan (SWMP). The SWMP was developed in response to Senate Bill 255 to address county-wide planning for solid waste disposal over the next 20-year period.

Copies of this SWMP were submitted to the Utah Division of Solid and Hazardous Waste on June 22, 1993. Activities discussed in this permit application are consistent with the SWMP.

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3. LEGAL DESCRIPTION

The Klondike Landfill consists of the following parcels:

S ½ of the NW ¼ of Section 14, T 23 S, R 19 E as shown on the Valley City Quadrangle, 7.5 Minute Series (Topographic) (U.S. Geological Survey; Provisional Edition, 1991). The District has acquired these parcels from the Bureau of Land Management.

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4. OPERATIONS PLAN

The Operations Plan, required by Utah Administrative Code (UAC) R315-302-2(2) is contained in an Operator's Manual and is included in this permit application as Appendix D and summarized below.

The Klondike Landfill will be developed in six phases, each consisting of a separate 4- to 5-acre landfill cell. Each cell will have a service life of 9 to 11 years and will be filled in a manner designed to reduce windblown litter and conserve cover soil. Intermediate cover consisting of native material will be applied over any area of the Landfill not used for a period of 30 days or more. Final cover will be applied on intermediate cover left in place for more than two years. As adjoining cells are completed, proper slope will be achieved with additional waste and final cover as required. A 100-foot buffer zone will surround the active and closed portions of the Landfill and may include the access road and stormwater conveyance ditches and a stormwater pond. Excavation of successive cells will occur during filling of the previous, thereby lowering the costs associated with development of the cells.

Access is restricted to prevent illegal dumping of hazardous materials, vandalism, and unauthorized dumping of refuse. The Landfill, including the entrance, is fenced and the entrance includes a locking gate. Appropriate signs are posted at intervals along the fence and on the gate to inform people of the nature of the site and warn off trespassers. Access to the Landfill is provided via the County-improved gravel road. No buildings are located at the Landfill, and none are planned.

The Landfill will accept more than 20 tons per day of municipal solid waste from contracted waste haulers only. The Landfill is generally not open to the public. A schedule will be maintained for contracted waste haulers.

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Landfill personnel descriptions are addressed in Appendix D, as well as more detailed operations of the Landfill, including daily tasks, waste acceptance and disposal procedures, inspections and monitoring tasks, contingency and corrective active plans, system maintenance, nuisance control, and safety.

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5. RECORDS

As specified in section UAC 315-302-2(3) of the Administrative Rules, the District will maintain on-site, at their offices, or at another location approved by the UDEQ the following permanent records:

- Daily logs;
- Deviations from the approved plan of operation;
- Training and notification procedures;
- Landfill gas monitoring results;
- Inspection logs;
- Documentation in support of the groundwater exemption;
- Closure and post-closure care plans;
- Cost estimates and financial assurance documentation;
- Weights or volumes (possibly estimated), number of vehicles entering and, if available, the types of waste received each day; and
- Design documentation for the placement or recirculation of landfill leachate or gas condensate into the landfill.

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6. FINANCIAL ASSURANCE PLAN

6.1 COST ESTIMATE FOR CLOSURE AND POST-CLOSURE CARE

Appendix E presents estimates of the costs for closure and post-closure care of the Klondike landfill.

6.2 FINANCIAL CAPABILITIES

The District has established a closure/post-closure fund to finance future closure and post-closure activities using monies collected from the landfill users. Over a period of years, this fund will grow to provide funds sufficient to meet the closure and post-closure cost estimates. However, these funds will not be fully available within the period of this permit application.

6.3 FINANCIAL ASSURANCE MECHANISM

To meet its Financial Assurance requirements, the District uses a Governmental Guarantee to supplement the monies available in its closure/post-closure fund. Grand County and the City of Moab have agreed to guarantee closure and post-closure funding until the District's fund is sufficient to guarantee these activities. Documentation on the agreements among the County, City, and District are also presented in Appendix E, together with documentation that the County and City meet the Financial Test requirements of the Governmental Guarantee.

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7. CLOSURE PLAN

Landfill closure will be supervised by a State of Utah licensed professional engineer. The registered engineer will be employed by the District, or will be a District-hired qualified contractor. This section describes the final cover construction, site capacity, schedule of closure implementation, estimated costs for closure, and final inspection procedures for the existing and new expansion cells of the Klondike Landfill. Appendix L describes the Final Cover Construction Specifications and Appendix M outlines the Construction Quality Assurance Plan for the Final Cover Construction.

7.1 FINAL COVER INSTALLATION

7.1.1 Cover Design

The preliminary design of the capping system for both currently active cells and future cells has been completed. Final design of the capping system for new cells will be prepared prior to closure of the facility, which is not expected to occur during the current permit. The previously permitted preliminary cap design was a capillary barrier. Because of the high cost of the capillary barrier cap, and UDEQ's request to readdress its justification as an alternative final cover, the capping system for the landfill has been changed to a modified form of the final cover described in UAC 315-303-3 (4).

The capping system is described in Section 5.2 of Part III of this permit, cost estimates are contained in Appendix E, and the justification of the cap is in Appendix K. The capping system is designed to control the emission of gas, promote the establishment of vegetative cover, minimize infiltration and percolation of water into the waste, and prevent erosion of the waste throughout the post-closure care period.

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The capping system will be constructed when one or more phases of the landfill have reached final elevations and when closure will not impede future operations in adjacent phases.

7.1.2 Seeding

Early establishment of vegetation on the landfill's final slope surface will impede soil erosion and promote evapotranspiration. The District will periodically evaluate vegetative growth, vigor, and color so that the integrity of the final cover system is maintained. If stress signs on vegetation caused by landfill gas and leachate seeps are noted, the problem will be corrected. Corrective procedures will be conducted based on current design recommendations and will be built consistent with construction specifications. Typically, this will be addressed through placement of additional fill and reseeded.

The District will inspect the vegetative cover monthly during active filling on the site, and quarterly following final closure of all phases of the landfill. District staff or a licensed landscape contractor will make repairs.

7.1.3 Landscaping

The landfill facility, including all surrounding grounds, will be maintained in conjunction with any scheduled maintenance activities (i.e., vegetative control, road improvements, etc.). The landscape of the landfill will be designed to be both functional and aesthetically pleasing.

7.1.4 Contouring

The landfill's final grade will be inspected and maintained in order to ensure landfill integrity.

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Evaluation and inspection of the landfill final grades will include the items specified in Section 7.1.1.

Areas where water has collected (ponded) will be regraded. District staff will inspect and maintain the final grading on a quarterly basis.

7.2 SITE CAPACITY

The Landfill is designed in six phases and each phase is designed as a separate 4- to 5-acre cell. Standard engineering calculations for the volume or capacity of landfill cells assume that daily and intermediate cover will consume approximately 20 percent of the available air space within the landfill, and that each cubic yard placed and compacted in the landfill will contain approximately 1,000 pounds of waste. Grand County currently disposes of approximately 25 tons per day of solid waste, not including C&D and recycled wastes. The facility has approximately 25 acres of disposal capacity in the initial 40-acre portion of the site planned for landfill development, resulting in more than an estimated 48 years of useful life, based on current disposal rates (described in the Phase 1 through 6 drawings in Appendix C). Phase 1 was filled level in approximately 2.5 years. Each of the remaining phases will be active for an estimated 9 to 11 years. The site will have additional capacity as additional phases are planned in the second 40-acre parcel. This additional capacity is expected to extend the useful life of the landfill site by 30 to 60 years beyond the life of the currently planned phases, giving the total site an expected life of 60 to 90 years.

7.3 CLOSURE SCHEDULE

Closure activities, including construction of the final cover and permanent drainage facilities, will be implemented periodically as areas of the landfill are filled to final grade. A Work Sequence Plan is included in the Klondike Landfill drawings provided in Appendix C.

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7.4 CLOSURE COST ESTIMATES

Closure cost estimates are discussed in Section 6, Financial Assurance Plan.

7.5 FINAL INSPECTION PROCEDURES

Upon final closure, the District will submit to the Executive Secretary the following:

Facility or unit closure plan sheets signed by a professional engineer licensed in the State of Utah and modified as necessary to represent as-built changes to final closure construction as approved in the closure plan; and

Certification by the District and a professional engineer licensed in the State of Utah that the site or unit has been closed in accordance with the approved closure plan.

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8. POST-CLOSURE CARE PLAN

Post-closure care for the Landfill will consist of long-term maintenance of the cover and long-term gas monitoring in accordance with UAC R315-302-3 (General Closure and Post Closure Requirements).

This post-closure care period will be 30 years unless unexpected conditions requiring corrective action arise.

8.1 MONITORING AND MAINTENANCE

The following subsections offer a description of the monitoring program, which includes groundwater monitoring systems and leachate and gas collection and systems.

8.1.1 Groundwater

Groundwater is not currently monitored at points inside or outside the limits of the landfill. Based on the Recreational and Public Purpose Report to the Bureau of Land Management (November, 1994), the depth to groundwater is unknown but greater than 503 feet below ground surface (bgs). Due to the combination of depth to groundwater, arid climate, and impermeable underlying geology (Appendices F through H), as explained in 1994, leachate infiltration into groundwater is not expected (Dames & Moore, 1994). Therefore, groundwater monitoring is not considered necessary at the site at this time.

8.1.2 Surface Water

Although no surface water sampling activities are scheduled for the Landfill, District staff will inspect any surface drainage system monthly. The District or a licensed general contractor will repair or replace surface drainage facilities if necessary.

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8.1.3 Leachate Collection and Treatment

As illustrated on the Landfill drawings in Appendix C, developed in 1994, a leachate collection sump was installed in Cell 1. However, sumps are not planned for future cells. This sump will be monitored monthly for the presence of leachate. The sump will also be monitored for leachate within one week after intense storm events. The first time leachate is detected in the sump, it will be sampled and analyzed to determine if it is hazardous. Monthly monitoring of the sump for presence of leachate will continue, and leachate will be sampled and analyzed annually thereafter.

Any leachate, whether determined to be hazardous or non-hazardous, will be pumped from the sump onto the surface of Cell 1 for evaporation. After evaporation is complete, soil will be placed over the evaporated area. When constructed, the final cover will be applied to the entire cell, including the area from which the leachate evaporated.

Records of monitoring events, analytical results, and leachate quantity pumped from the landfill will be maintained in the operating record.

8.1.4 Landfill Gas

The decomposition of solid waste produces landfill gas, typically comprised of carbon dioxide and methane, a potentially explosive gas. The accumulation of methane in landfill structures can result in fire and explosions that can injure or kill employees, users of the landfill, and occupants of nearby structures. Due to the arid climate, very little decomposition of the waste is expected and, therefore, very little methane is expected to be produced as a byproduct.

No buildings exist adjacent to or near the Klondike Landfill. The nearest structure, the AT&T radio tower, is located approximately 3,000 feet east of the Landfill. Gas migration to this structure is not expected based on local geological conditions.

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No permanent on-site buildings or structures are currently planned. However, the District may develop buildings to house the Landfill Attendant or to perform maintenance for the facilities in the future. Any future on-site buildings will be designed with active or passive methane protection, as appropriate, and structures will be monitored for methane in accordance to UAC R315-303-3(5).

UAC R315-302-3 requires the implementation of a routine monitoring program that is based on site-specific geology and facilities and/or list site-specific criteria that control the rate and extent of gas migration. These criteria should be considered in determining the type and frequency of monitoring, which in some instances may be more than quarterly. These factors include soil conditions, hydrogeological conditions, hydraulic conditions, and the location of facility structures relative to property boundaries.

The UAC R315-303-3(5) requires the landfills to monitor for landfill gas at least quarterly to ensure methane control at the perimeter of a landfill. Gas will be monitored using a hand-held methane detection probe. If methane exceeds the specified limits as stated in UAC R315-303-2(2)(a), the District must immediately notify UDEQ of the detection and take steps to protect human health. The District must implement a gas control or remediation plan to UDEQ within 60 days of the discovery of exceedance of methane limits.

District landfill personnel will be responsible for the inspection of all methane gas monitoring points and facility landmarks. Such inspections shall involve searching for vegetation suspected of being affected by landfill gas(es). In the event that yellowing or dead vegetation is noted or the gas monitoring program indicates that explosive gases are leaving the site, additional assessments will need to be undertaken to determine the quantity and extent of landfill gas migration. In the event of suspected gas migration, documentation of the incident will be placed in the operating record.

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In addition to visual inspections of the facility, District landfill personnel shall conduct routine methane gas monitoring utilizing portable combustible gas indicators (e.g., Lumidor). In the event that readings are obtained that exceed 25 percent of the LEL, the District shall notify UDEQ immediately and undertake corrective actions.

The concentration of methane gas generated by the landfill must not exceed 25 percent of the LEL for methane in the facility structures (excluding gas control or recovery system components). The concentration of methane gas generated by the landfill must not exceed the LEL for methane at the facility boundary.

The location of site boundaries are illustrated in the Klondike Landfill drawings included as Appendix B.

8.2 MAINTENANCE PROGRAM

The following subsections offer a description of the maintenance of installed equipment including ground-water monitoring systems, and leachate and gas collection systems.

8.2.1 Groundwater

A groundwater monitoring system is not planned for the landfill. The site's geology and its extremely arid climate are consistent with an exemption from groundwater monitoring (Dames & Moore, 1994).

All future groundwater monitoring wells, if deemed necessary, will be inspected for signs of failure or deterioration during each sampling event. If damage is discovered, the nature and extent of the problem will be recorded. A decision will be made to replace or repair the well. Possible repairs include redevelopment, chemical treatment, partial casing replacement or repair, sealing the annulus, or pumping and testing. If a well needs to be replaced, it will be properly decommissioned in accordance with Utah

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Administrative Rule R655-4-12 (Abandonment of Wells). Damaged wells will be scheduled for repair or replacement within 1 month after the damage is identified.

8.2.2 Surface Water

Drainage control problems can result in accelerated erosion of a particular area within the landfill. Differential settlement of drainage control structures can limit their usefulness and may result in a failure to properly direct stormwater off the site.

Implementation of a post-closure maintenance program will maintain the integrity of the final drainage system throughout the post-closure maintenance period. The final surface water drainage system will be routinely evaluated and inspected for ponded water, and blockage of and damage to drainage structures and swales. Where erosion problems are noted or drainage control structures need repair, proper maintenance procedures will be implemented as soon as site conditions permit so that further damage is prevented. Damaged drainage pipes and broken ditch linings will be removed.

District staff will inspect the drainage system monthly during active landfilling on the site, and quarterly following closure of the landfill. Temporary repairs will be made until permanent repairs can be scheduled. The District or a licensed general contractor will repair or replace drainage facilities.

8.2.3 Leachate Collection

The leachate control and recovery system must be maintained so that it operates during the post-closure maintenance period. The system will be inspected quarterly by District staff for signs of deterioration. Needed repairs will be made by the District or a licensed contractor.

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8.2.4 Landfill Gas

A landfill gas monitoring system is not included as part of the design for the Klondike Landfill. However, if in the future UDEQ requires landfill gas collection and treatment, the landfill gas system will be inspected quarterly in conjunction with the scheduled monitoring tasks. The system will be repaired and parts replaced as required to maintain system capabilities. The program described previously for inspecting and maintaining the gas monitoring system will be followed during the post-closure maintenance period.

The landfill gas monitoring system will be inspected quarterly. Quarterly maintenance will include cutting weeds in a 2-foot radius around each monitoring location.

8.2.5 Facility and Facility Structures

The location of leachate and surface water management facilities are shown on the 1994 drawings included in Appendix B. The leachate facilities will consist of underground piping and sumps. The piping will transmit the leachate in Cell 1 to the collection sump. The piping will be constructed and tested to meet sanitary sewer specifications for leakage control.

The stormwater management facilities will consist of surface water ditches and a detention pond. The surface water ditches will transmit stormwater from the vicinity of the landfill to the retention pond (Sheets 2 and 3, Appendix B). The retention pond will allow settlement of sediments contained in the stormwater run off, and will discharge by overflow into intermittent streams south of the landfill site. Water in the stormwater retention pond will be tested annually for contaminants which may originate from the landfill.

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8.2.6 Landfill Cover and Run-on/Run-off Systems

The final grades and capping system will incorporate features to manage stormwater, minimize erosion, and provide for efficient removal of stormwater collected in the drainage layer. Sheets 4 through 6 of the drawings provided in Appendix B show proposed final grades and Sheets 2 and 3 illustrate the extent of stormwater collection and surface water and erosions control systems on the surface of the cap. Calculations for run-on and run-off controls are included in Appendix O.

Stormwater that percolates through the topsoil and vegetative layer will be impeded from further downward percolation and will be stored in the vegetative layer until the next growing season.

Placement of all permanent drainage facilities will be completed during, or immediately following, installation of the final soil cover. Permanent drainage facilities, as shown on Drawings 2 and 3 (Appendix B), were designed to provide adequate drainage after settlement of the fill area(s).

8.3 SCHEDULE OF POST-CLOSURE ACTIVITIES

Post-closure activities, consisting of monitoring and maintaining the final cover and permanent drainage facilities, will be implemented periodically as areas of the landfill are filled to final grade. A Work Sequence Plan is included in the Klondike Landfill Permit drawings in Appendix B.

8.4 POST-CLOSURE COSTS

The District has developed a financial assurance plan for closure and post-closure of the landfill. A summary of this plan is included in Section 6.

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9. LAND TITLE, LAND USE, AND ZONING RESTRICTIONS

The District will notify the Grand County Recorder's Office at any such time when there is a change to the Record of Title, land use plan, or zoning restrictions. In addition, the District will notify the Recorder at that time when the post-closure care period has expired and has been accepted by the State.

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Part III
Technical and Engineering Report

1. MAPS AND DRAWINGS

Maps and drawings of the landfill were developed in 1994 as part of the original permit application. These maps and drawings have not been updated, as conditions have remained the same as those under which the permit was issued.

Appendix B (Sheet 2 of 6) contains a topographic map of the landfill. UDEQ requested a current topographic survey of the detention basin and it has been included in Appendix B.

Appendix A contains a copy of a 7.5' quadrangle topographic map from the Utah Automated Geographic Reference Center (AGRC). The boundaries of the property are shown on this map. Appendix B presents the engineering drawings for the Landfill. These plans were prepared under the supervision of a Professional Engineer registered in the State of Utah during the initial permit application (HDR Engineering, Inc. and Grand County Solid Waste, 2001).

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2. GEOHYDROLOGIC EVALUATION

The geohydrological evaluation was performed as part of the original permit application in 1994. This evaluation was not reviewed or updated for this permit renewal, as conditions have remained the same as those under which the original permit was issued.

2.1 STRATIGRAPHY

As found in 1994, the Klondike Landfill site is founded on the Upper Member of the Mancos Shale, overlain by varying thicknesses of residual clay soils and alluvial sand. Bedrock bedding surfaces dip gently (7 degrees) to the southwest, away from a resistant ridge of Ferron Sandstone that underlies the Upper Member of the Mancos Shale and borders the landfill site on the east (Tahoma, 1994).

As explained by Tahoma in 1994, the following fossils were recovered from test pits in the Mancos Shale at the Klondike Landfill site north of Moab, Utah:

Ammonites

Gastroplites sp.
Clioscaphites vermiformis
Scaphites warreni
Baculites sweetgrassensi

Pelecypods

Gryphaea newberryi
Inoceramus labiatus

These fossils are characteristic of the Mancos Shale. More specifically, these fossils suggest a Turonian (early Late Cretaceous) age equivalent to the age of the uppermost part of the Tununk (lower) Member of the Mancos Shale.

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Where exposed at the surface, Mancos Shale bedrock at the landfill site is undergoing active weathering and erosion (Tahoma, 1994).

2.2 INSTABILITY AND SEISMICITY

From the original permit application, the Klondike Landfill does not appear to be adjacent to geologic features that could compromise the structural integrity of the facility. The landfill is not located in a known subsidence area, a dam failure flood area, or a known underground mine, salt dome, or salt bed.

2.2.1 Fault Areas

From the original permit application, the Klondike Landfill is not located within 200 feet of a known or observed active or inactive Holocene fault. Suzanne Hecker (1993) located the closest known probable Holocene fault activity along the Salt Valley graben, approximately 3 miles northeast of the site.

2.2.2 Seismic Impact Zones

Ground acceleration is a measurement of the rate of change in velocity the ground exhibits. Areas more likely to exhibit high intensity seismic activity typically exhibit a greater ground acceleration measurement. Based on a site-specific hazard query (U.S. Geological Survey Web Page, 2002), the Klondike Landfill is located in an area where there is an estimated 2% probability that ground accelerations will exceed 0.108%g in a 50-year period (or, equivalently, there is a 10% probability of exceedance in 250 years). This estimate of potential seismic activity reflects changes in prediction modeling methodology that took place over the past three or four years since Klondike Landfill was opened. Based on this estimate, Klondike Landfill (and all of Grand County) is now considered to be within a Seismic Impact Zone. Klondike Landfill is located in the portion of Grand County where the lowest potential ground accelerations are predicted

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to occur (see map in Appendix G) (USGS, National Seismic Hazard Mapping Project, 2002).

All containment structures at the Klondike Landfill will be designed to resist the maximum probable horizontal acceleration in lithified earth material for the site (0.06 %g).

2.2.3 Unstable Areas

Engineering measures will be incorporated into the facility design to ensure that the integrity of the structural components of the facility will not be disrupted. Information discussed in the following sub-paragraphs demonstrates that the site is stable.

On-Site or Local Soil Conditions

The Landfill site is founded on the Upper Member of the Mancos Shale, overlain by varying thicknesses of residual clay soils and alluvial sand.

Where exposed at the surface, Mancos Shale bedrock at the landfill site is undergoing active weathering and erosion. Soils formed on the Mancos are poorly developed residual silty clays, less than five feet thick. Soils on the Mancos Shale have been described by McGregor (1985):

> Rs – Residuum from shale. Gray to grayish-brown silty clay derived from underlying Mancos Shale. Contains sodium slats and gypsum that inhibit plant growth. The silty clays undergo hydration and dehydration with changes in humidity and moisture content and the particles of sediment swell and contract which contributes to the weathering process. The mixed-layer clay in the residuum allows only slight penetration of water below the surface and forces much precipitation to run off. During heavy rains, the residuum surfaces are impassable to vehicles due to formation of mud, although the material may be

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dry a few centimeters below. The surface generally dries out within a few hours after a drenching rainstorm. As an engineering unit the residuum is considered troublesome because of moderate to high shrink-swell potential, moderate to high susceptibility to erosion on slopes, low permeability, high salinity and high pH. Commonly a thin veneer overlying shale. Generally not more than 2 meters thick.

As indicated in the original permit application, the Mancos Shale is overlain locally at the Klondike Landfill by less than 2 to 9 feet of silty, gypsiferous alluvial sand. The sand is light brown to brown and massively to crudely bedded. Layers of sand are unconsolidated (loose) to moderately cemented with gypsum (calcium sulfate) and caliche (calcium carbonate).

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3. HYDROLOGY

The Hydrology Study was performed as part of the original permit application in 1994. This evaluation was not reviewed or updated for this permit renewal, as conditions have remained the same as those under which the original permit was issued.

3.1 SURFACE WATER

As explained in the original permit application, no permanent impoundments of surface water or perennial streams are present within a 1-mile radius of the site.

3.2 PUBLIC WATER SYSTEMS OR SURFACE IMPOUNDMENTS

As explained in the original permit application, no public water systems or impoundments are present at the landfill site. The land utilized by the landfill is not part of a watershed utilized for municipal drinking water, nor is it in a location that could cause contamination to a potable lake, reservoir, or pond.

3.3 SURFACE WATER RIGHTS

Water rights files of the Utah Division of Water Rights for section 14 and all eight sections surrounding the landfill were studied for the original permit application. No surface water rights have been claimed for surface waters at the site or within a 2,000-foot radius of the site.

The U. S. Bureau of Land Management has claimed water from intermittent streams for a stock-watering pond in section 22, T 23 S, R 19 E. The location is approximately 1-mile southwest of the center of section 14.

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3.4 FLOODPLAINS

As explained in the original permit application, the Klondike Landfill site is not situated in a floodplain. However, minor intermittent tributary drainages to Tenmile Canyon cross the site. The drainage area of the intermittent streams is very limited: the northwest to southeast trending ridgeline of Ferron Sandstone along the east edge of Section 14 is the eastern drainage divide.

Runoff from rainfall landing east of the ridge line flows northeasterly, away from the Landfill site, towards U. S. Highway 191. Any runoff that does not evaporate is then deflected to the northwest by the highway fill.

Runoff from rainfall landing in the northeast quarter of Section 14, west of the Ferron Sandstone ridge, flows southwesterly towards the Landfill site. Runoff that does not evaporate can accumulate in an intermittent wash that crosses the center of section 14 from northeast to southwest.

3.5 WETLANDS

As explained in the original permit application, the Landfill site is not situated in a wetland.

3.6 GROUNDWATER

As explained in the original permit application, the Upper Member of the Mancos Shale is that portion of the Mancos Shale that occurs at the surface and/or directly underlies sandy soils at the Klondike Landfill. Usable quantities of potable quality groundwater are rare in the Upper Member of the Mancos Shale (Tahoma 1994).

The Upper Member is underlain by the Ferron Sandstone Member of the Mancos Shale approximately 250 to 525 feet below ground surface (bgs) at the Landfill (1994).

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For the original permit application, geophysical logs from nearby exploratory oil wells were utilized to establish the depth below ground to the Ferron Sandstone. Appendix H includes a structural contour map from the original permit application showing the elevation of the Top of the Ferron Sandstone (Tahoma 1994). Known well data points are shown at each well location, and elevations between data points are interpolated.

Appendix H presents a map, developed for the original permit application, showing the estimated thickness of Upper Member shales above the Ferron Sandstone. This map was prepared by calculating the difference between elevations shown on the Top Ferron Sandstone structural contour map and ground surface elevations taken from published topographic maps.

For example, the elevation of the Ferron Sandstone at test boring GCL #1 near the west quarter of Section 14 is approximately 4,370 feet above sea level. The Valley City, Utah topographic map shows that the ground level elevation at GCL #1 is about 4,625 feet. The difference between the two elevations is 255 feet, the approximate thickness of Upper Member shale above the Ferron Sandstone at the site of the test boring.

A cross section of the geology beneath the Landfill (Appendix H) also shows the depth to Ferron Sandstone at the site (Tahoma 1994). The cross section was constructed by reference to surface topography, geologic materials exposed at the surface and geophysical logs from the nearest exploratory oil well, and the log of the test boring (GCL #1).

As explained in the original permit application, the results of a testing boring (GCL #1) indicate that thin, fine-grained sandstones in the Ferron Sandstone member do not contain groundwater under the Landfill.

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3.7 GROUNDWATER RIGHTS

As explained in the original permit application, water rights files of the Utah Division of Water Rights for Section 14 and all eight sections surrounding the landfill were studied. One point of diversion has been constructed in the northwest quarter of Section 13, T 23 S, R 19 E for American Telephone and Telegraph (AT&T).

3.8 STATIC WATER LEVELS

Based on the Recreational and Public Purpose Report for the BLM (November, 1994), the depth to groundwater is unknown but greater than 503 feet bgs.

No other data points are available near the Landfill site for water levels. However, river channels in the deep canyons of the Green and Colorado rivers west and south of the site are at elevations of approximately 4,000 feet.

3.9 GROUNDWATER CHEMISTRY

Water from a well at the AT&T site, which is 3,000 feet west of the Landfill, was sampled on June 21, 1994. A complete culinary analysis was completed by the Southern Utah University water laboratory. Total dissolved solids (TDS) concentration was 2,600 milligrams per liter (mg/L), exceeding Utah's Primary Limit for Drinking Water Standards by 600 mg/L and the Federal Secondary Limit by 2,100 mg/L.

Other constituents exceeding Utah's Secondary Limit for Drinking Water Standards included chloride, sulfate, and pH. The analytical data for water from the AT&T well is included as Table 3.

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Table 3
Analytical Water Data, AT&T Well

Analyte	Units mg/L
Alkalinity as CaCO3	343.00
Bicarbonate as CaCO2	258.00
Calcium, dissolved	1.60
Carbonate as CaCO3	557.00
Chloride	651.00
Hardness as CaCO3	5.20
Iron	0.23
Magnesium, dissolved	< 1.00
Nitrate/Nitrite, dissolved	0.02 (by addition)
Nitrite as N, dissolved	< 0.02
Nitrate as N, dissolved	0.02
Potassium, dissolved	2.60
SAR in water	ND
Sodium, dissolved	914.00
Sulfate	767.00
Cations (SUM)	ND
Anions (SUM)	ND
Cation/Anion Balance	ND
Solids, Total Dissolved	2600.00
Antimony, total	ND
Arsenic, total	0.001
Barium, total	< 0.10
Beryllium, total	ND
Cadmium, total	< 0.002
Chromium, total	< 0.01
Cobalt, total	ND
Copper, total	0.01
Lead, total	< 0.001
Nickel, total	ND
Selenium, total	0.004
Silver, total	< 0.005
Thallium, total	ND
Vanadium, total	ND
Zinc, total	1.50
pH	10.50
Temperature, F	ND
Specific Conductance (mhos/cm)	3860.00

Date Sampled: June 21, 1994

mho = The SI derived unit of electrical conductance, equal to one ampere per volt. It is equivalent to the reciprocal of the **ohm** unit.

ND = not determined

mg/L = milligrams per liter

F = Fahrenheit

< = less than

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3.10 SOLE SOURCE AQUIFERS

Based on subsurface exploratory drilling in 1994 (Appendix H), the Klondike Landfill is not underlain by a Sole Source Aquifer (Tahoma, 1994).

3.11 GROUNDWATER CLASSIFICATION

As explained in the original permit application, revised rules for Groundwater Quality Protection have been promulgated by the UDEQ, Division of Water Quality, effective date April 15, 1994. The rules suggest that water in the AT&T well would be classified as Class III: Limited Use Groundwater. Class III groundwater has one or both of the following characteristics:

A) TDS greater than 3,000 mg/L and less than 10,000 mg/L; or

B) One or more contaminants that exceed the groundwater quality standards listed in Table 3 (of the April 15, 1994, Rule).

Water from the AT&T well has pH of 10.5, exceeding the groundwater quality standard of 6.5-8.5.

3.12 WATER BALANCE

The Utah Climate Center at Utah State University maintains data on eight Utah Cooperative Climate Stations in Grand County. Table 4 summarized the date from these eight stations, as well as for the Green River Aviation station in Emery County.

The Cisco, Green River Aviation, and Thompson stations most nearly approximate the conditions at the Klondike Landfill site, since all three stations are also located on the Mancos Shale plains. These stations are located 300 feet lower, 500 feet lower, and 500 feet higher than the Klondike Landfill, respectively. Because it nestles against the

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Book Cliffs and may experience high precipitation due to the much higher elevation of the cliffs, the Engineering Report produced in 1994 as part of the original permit application used the Thompson data in estimating climatic conditions.

Table 4
Climatological Data for Grand County

Station	Period	Average Temperature	Average Precipitation	Evaporation*
Arches	1980-92	56.8	8.92	67.71 (53.95)
Castleton	1963-78	50.2	13.63	(45.82)
Castle Valley	1978-92	53.9	11.50	(51.03)
Cisco	1852-67	51.7	7.11	(55.09)
Dewey	1967-92	53.3	8.62	(57.49)
Green River Aviation	1893-1992	51.9	6.51	54.89 (55.86)
Harley Dome	1959-63	51.1	9.20	(51.64)
Moab	1893-1992	56.8	9.00	73.52 (56.38)
Thompson	1948-92	52.8	9.19	(49.18)

*Values in parentheses are evapotranspiration calculations using temperature and wind data. Values not in parentheses are actual pan evaporation data.

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4. LOCATION STANDARDS

UDEQ has adopted specific location restrictions that include the criteria specified in the federal Subtitle D regulations. The Utah location restrictions for municipal solid waste landfills are outlined below. Subtitle D criteria are indicated with an asterisk (*).

1. Land Use Compatibility (R315-302-1 (2) (a))
   - Parks and protected areas
   - Ecologically and scientifically significant areas
   - Prime farmland
   - Dwellings and structures*
   - Airport runways*
   - Archeological sites
   - Land use planning or zoning

2. Geology (R315-302-1 (2) (b))
   - Fault areas*
   - Seismic impact zones*
   - Unstable areas*

3. Surface Water (R315-302-1 (2) (c))
   - Floodplains*
   - Wetlands*

4. Groundwater (R315-302-1 (2) (d))
   - Groundwater/landfill separation
   - Sole source aquifer
   - Groundwater quality
   - Source protection areas

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The following sections present the State of Utah location restrictions and discuss the Klondike Landfill's compliance with those requirements.

4.1 LAND USE COMPATIBILITY

The facility meets all criteria outlined in the Utah Administrative Rules R315-302-1 (2) (a) as shown below. Documentation of the items listed below is found in Appendix I.

- The facility is not within 1,000 feet of a national, state or county park, monument, or recreation area; designated wilderness or wilderness study area; or wild and scenic river area.

  Source: Ms. Mary Von Koch, Grand Resource Area, U.S. Bureau of Land Management, Moab, Utah. See letter dated September 20, 1994, from Tahoma Companies to Ms. Koch.

- The facility is not within an ecologically and scientifically significant natural area, including wildlife management areas and habitat for threatened or endangered species as designated pursuant to the Endangered Species Act of 1982.

  Source: Messrs. Clark D. Johnson, Henry Maddox and Larry England, U.S. Fish and Wildlife Service, Salt Lake City, Utah. See letter dated September 20, 1994 from Tahoma Companies to Mr. Robert Williams of the U.S. Fish and Wildlife Service.

- The facility is not within farmland classified as "prime," "unique," or "of statewide importance" by the U.S. Department of Agriculture Soil Conservation Service under the Prime Farmland Protection Act.

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Source: Mr. Kyle "Jake" Jacobson, Utah Department of Agriculture, Salt Lake City, Utah. See letter dated September 20, 1994 from Tahoma Companies to the Utah Department of Agriculture.

- The facility is not within one-quarter mile of:

  - Existing permanent dwellings, residential areas and other incompatible structures such as schools or churches.

    Source: Field investigation by Gary F. Player, Principal Geologist, Tahoma Companies, Inc., 1994

  - Historic structures or properties listed or eligible to be listed in the State or National Register of Historic Places.

    Source: Mr. James L. Dykmann, Compliance Archaeologist, Utah Division of State History; and the National Register of Historic Places for Utah, September 27, 1993. See letter dated September 29, 1994 from Dykmann to Tahoma Companies.

- The facility is not within 10,000 feet of any airport runway end used by turbojet aircraft or within 5,000 feet of any airport runway end used only by piston-type aircraft.

  Source: Mr. Phillip Ashbaker, Director, Utah Division of Aeronautics, Salt Lake City. Utah. See letter dated September 20, 1994 from Tahoma Companies to Mr. Ashbaker.

- The facility is not within an archaeological site that would violate Section R9-8-204.

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Source: Mr. Jim Dykmann of the Utah State Historical Preservation Office, Salt Lake City, Utah. See letter dated September 29, 1994 from Dykmann to Tahoma Companies.

- The facility is not within an area that is at variance with the Grand County land use plan or zoning requirements. The current zoning is I-1 (light industrial). This zoning allows use of the property as a landfill.

  Source: Mr. Jeff Whitney, Grand County Building Inspector, 1994. The ordinance rezoning the Klondike Flats property is attached in Appendix I.

4.2 GEOLOGY

When originally permitted, the Klondike Landfill was not located within a Seismic Impact Zone according to the definition at that time. At the first permit renewal, due to changes in prediction modeling methodology, the Klondike Landfill (and all of Grand County) was considered to be within a Seismic Impact Zone (USGS, National Seismic Hazard Mapping Project, 1996). Since the landfill is exempt from liner and leachate requirements, this change is expected to create no significant issues involving containment structures or systems at the landfill.

The facility meets all other criteria outlined in UAC R315-302-1 (2) (b) as described in the following paragraphs.

The Landfill is not located in a known subsidence area, a dam failure flood area, or a known underground mine, salt dome, or a salt bed. Nor is it on or adjacent to known geologic features that could compromise the structural integrity of the facility.

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The Landfill is not within:

- Fault Areas. The landfill is not located within 200 feet of a Holocene fault. Based on Utah Geological Survey records, no active faults have been recorded in this portion of Grand County.

- Unstable Areas. The landfill is not located within an unstable area as defined by the regulations.

4.3 SURFACE WATER AND WETLANDS

The facility meets all criteria outlined in UAC 315-302-1 (2) (c) and (d) as described in the following paragraphs.

The Landfill is not located in a public water system watershed, or a 100-year floodplain. No public water system watersheds exist in this portion of Grand County. The dry washes transecting the site may represent 100-year floodplains; however, these dry washes have been designed to flow around the landfill footprint.

The Landfill is not located in a wetland. No wetlands are indicated on the USGS Topographic Map.

4.4 GROUNDWATER

The facility meets all criteria outlined in UAC R315-302-1 (2) (e) as described in the following paragraphs.

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The Landfill is not located at a site:

- Where the bottom of the liner is less than five feet above the historical high level of groundwater; or where the waste is less than ten feet above the historical level of groundwater for an unlined site. Groundwater appears to be at a depth of greater than 500 feet at the site.

- Above a sole source aquifer as defined in 40 CFR 149.

- Over groundwater classed as 1B under UAC R317-6-3.3

The facility is located approximately 3,000 feet east of the AT&T site, which has drilled to an aquifer containing groundwater with TDS content between 1,000 and 3,000 mg/L. However, this aquifer exceeds at least one secondary contaminant standard (pH), and is at a depth of greater than 50 feet below the bottom of the planned landfill. The District has been granted a waiver of groundwater monitoring requirements because of the depth and quality of the uppermost aquifer.

4.5 CERTIFICATION

The analysis of the Landfill compliance with the location standards was certified exactly as written in this section, being Section 4.1 and its subsections, by a professional engineer licensed in the State of Utah during the initial permit application. No certifications other than those as written are expressed or implied in this permit renewal.

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5. ENGINEERING DESIGN

The following sections discuss individual components and details involved in the landfill construction and closure design.

5.1 GENERAL DAILY OPERATION

The filling operation is specified in the Operator's Manual and is provided as an appendix to this application (Appendix D). Progressive lift filling techniques will be utilized to raise the landfill to its rough grade elevation prior to closure.

The cover details for closing the landfill cells are described in Section 5.2 below.

5.2. SOURCES FOR DAILY AND FINAL COVER

5.2.1 Daily and Intermediate Soil Cover

Daily and intermediate cover in the landfill will originate from on-site sources. Usually, the cover and capping material will come from the excavation provided by the preparation of the next operating phase (cell).

The cover soils will be obtained from excavation of expansion areas of the landfill. Based upon the nature of soils in the landfill area, as well as laboratory testing of on-site soils, these soils will meet the specifications referenced in Utah regulations. (Appendix F.)

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5.2.2 Final Cover

The District will place a final cover system on each phase within 180 days after waste disposal ceases in the final lift or as soon thereafter, weather permitting, as possible. The final cover system is a cost-effective alternative to the "prescriptive cap" described in UAC R315-303-3 (4). The evaporative-transpiration (ET) cap will be constructed using on-site native materials and will consist of one 30-inch thick layer of native soil overlain by a vegetative layer of 6 inches. Soils used for the ET layer will consist of on-site native silty clay materials for the cover which will act as an infiltration barrier. Topsoil for the vegetative layer will come from adjoining areas on-site. The top layer will be vegetated to minimize erosion and enhance transpiration from established plants.

This engineered final cover system will prevent migration of rain and snow melt water into the wastes following closure of each cell. Appendices K and L describe this design.

5.3 SOURCES FOR SOIL LINERS

The first landfill cell (Phase 1) was lined with a 6-inch thick compacted liner constructed using selected on-site soils. This Phase 1 cell was also constructed with a leachate collection system. Justification for exemptions from further liner and leachate collection system requirements for all future cells (Phases 2-6) is presented in Appendix J. The landfill cells will be excavated to the depth indicated on the Landfill drawings (Appendix C) and waste will be landfilled directly on the excavated surface.

5.4 EQUIPMENT REQUIREMENTS AND AVAILABILITY

Each landfill phase will be designed with a planned operating life of 9 to 11 years. This operating life is calculated using the annual solid waste generation (refer to Section 2.1.4), and an in-place density of 1,000 pounds per cubic yard for the compacted solid waste. These are conservative estimates of the expected in-place density since this is

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the lower range of density commonly achieved using roll-over compactors. The District will attempt to maximize the compacted density of the solid waste.

The District will maintain equipment on site to facilitate compaction of the solid wastes, placement of daily cover on the wastes, and excavation of soils for daily cover. This type of equipment may include the following: a dozer or drum compactor with waste cleats, a front-end loader, and a scraper.

5.5 LEACHATE COLLECTION SYSTEM DESIGN

The first cell was constructed with a leachate collection system. Future cells will not include a leachate collection system.

As part of the original permit application, several HELP model runs were completed, and indicated that the maximum amount of post-closure leachate is expected to occur during the first year of filling (100,000 gallons). During the operation of a cell, a 25-year 24-hour storm is expected to deliver approximately 29,500 gallons of water that could also be treated as leachate. Any stormwater will be temporarily stored in the cell and allowed to evaporate. Given the high evaporation rates of the region, this method of stormwater control is considered acceptable. Since these are small quantities of leachate, and since evaporation rates are generally very high in the vicinity of the Klondike Landfill, additional leachate control facilities are not considered necessary. However, the leachate system in Cell 1 will provide an early warning of significant leachate being produced in the Landfill, should that situation arise.

If UDEQ requires additional leachate control facilities, these will be engineered to meet the design of future cells. All leachate that is pumped from the landfill will be transported to an approved facility for disposal.

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5.6 RUN-ON AND RUN-OFF CONTROLS SYSTEMS DESIGN

5.6.1 Run-On from a 24-Hour, 25-Year Storm

The design for the expansion of cells of the Klondike Landfill incorporates a run-on control system, which is capable of directing the flow away from the active portion of the landfill during the peak discharge of a 24-hour, 25-year storm (0.19 inch). The purpose of the run-on control is to minimize the amount of surface water entering the landfill facility. Run-on controls prevent: (1) erosion, which may damage the physical structure of the landfill; (2) surface discharge of wastes in solution or suspension; and (3) downward percolation of run-on through wastes, creating leachate.

District personnel will be responsible for the maintenance of the slopes and drainage systems to keep the run-on control systems operable.

5.6.2 Run-Off from a 24-Hour, 25-Year Storm

The design for the new expansion cells of the Klondike Landfill incorporates a run-off control system that will collect and contain the water volume that falls on the active landfill area but does not contact the working areas of the landfill resulting from a 24-hour, 25-year storm. Calculations for run-on and run-off controls are included in a technical memorandum in Appendix O. As noted in the memorandum, the detention basin does not have sufficient capacity to store the runoff based on its current design. However, if the detention basin outlet is lowered by 1 foot from an elevation of 4617 to 4616, the detention basin would provide a storage volume that would be sufficient to detain the 24-hour, 25 year rainfall event. Therefore, the District intends to lower the drainage pipe to an elevation of 4616 feet. Uncontrolled run-off water from the active portion of the landfill will be directed to the stormwater detention basins located at the southwest corner of the site. Berms and ditches will be incorporated into the active landfill areas to shed the precipitation away from the working faces and leachate

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collection system. This will greatly reduce the volume of precipitation that will need to be treated as leachate.

District landfill personnel will be responsible for the maintenance of the slopes and drainage systems to ensure the efficient operations of the run-off system. Precipitation that contacts the working face or otherwise enters the leachate collection system will be transported by the leachate collection system to the evaporation pond.

The Klondike Landfill is designed and shall be constructed so as not to cause point or non-point source discharges to surface waters, including wetlands, in violation of the Clean Water Act (CWA) or in violation of State of Utah water quality management plans approved under section 208 or 319 of the CWA.

5.7 LANDFILL GAS CONTROL

Landfill gases will be monitored using combustible gas indicators along the perimeter of the site and at leachate collection system cleanouts. Should routine monitoring of the site indicate gas conditions exceeding the regulatory requirements, a horizontal or vertical gas extraction system may be installed. Gas monitoring of the site since 1997 has shown no detectible gas levels. Due to the arid climate, very little decomposition of the waste is likely to occur and it is expected that no measurable volume of methane gas will accumulate under the final cover.

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6. CLOSURE AND POST-CLOSURE

6.1 CLOSURE AND POST-CLOSURE DESIGN

Section 5.2 of this Part describes the closure cap design for the Klondike Landfill. Appendix K provides the rationale used in formulating this design, construction specifications, and the Construction Quality Assurance Plan for the final cover.

6.2 CLOSURE AND POST-CLOSURE CONSTRUCTION

Sections 7 ("Closure Plan") and 8 ("Post Closure Care Plan"), located in Part II, detail the closure and posts-closure construction activities for the Klondike Landfill.

6.3 CLOSURE AND POST-CLOSURE MAINTENANCE

The District intends to close the existing Landfill under UAC R315-302-3. The Facility Supervisor will inspect the closed landfill cells on a monthly basis, and correct any erosion or settlement deficiencies observed during this inspection.

A post-closure maintenance program will be implemented at the Landfill in order to maintain the integrity of the Landfill's final cover. The final cover areas will be routinely evaluated for any evidence of erosion, ponded water, odor, disposed refuse, cracks, settlement, slope failure, and leachate seeps.

Any erosion damage, which may be caused by extremely heavy rainfall, will be repaired. Temporary berms, ditches, and straw mulch will be used to prevent further erosion damage to soil cover areas until site conditions permit the final cover to be reestablished and vegetation to be reseeded. Preventive maintenance for the final

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cover should preclude problems regarding infiltration of surface water, gas venting through the cover, and vectors attracted by exposed refuse.

6.3.1 Drainage System

Drainage control problems can result in accelerated erosion of a particular area within the landfill. Differential settlement of drainage control structures can limit their usefulness and may result in a failure to properly direct storm water off the site.

Implementation of the post-closure maintenance program will maintain the integrity of the final drainage system throughout the post-closure maintenance period. The final drainage system will be routinely evaluated and inspected for ponded water, and blockage of and damage to drainage structures and swales. Where erosion problems are noted or drainage control structures need repair proper maintenance procedures will be implemented as soon as site conditions permit so that further damage is prevented and the cause of the damage is eliminated. Damaged drainage pipes and broken ditch linings will be removed and replaced.

District staff will inspect the drainage systems monthly. Temporary repairs will be made until permanent repairs can be scheduled. The District or a licensed general contractor will repair drainage facilities.

6.3.2 Vegetative Cover

Early establishment of vegetation on the landfill's final slope surface will impede soil erosion and promote evapotranspiration. The District will periodically evaluate vegetative growth, vigor, and color so that the integrity of the final cover system is maintained. If stress signs on vegetation caused by landfill gas and leachate seeps are noted, the problem will be corrected. Corrective procedures will be conducted based on current design recommendations and will be built consistent with construction specifications.

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The District will inspect the vegetative cover monthly. District staff or a licensed landscape contractor will make repairs.

6.3.3 Leachate Control System

The leachate control and recovery system in the first cell must be maintained so that is operates during the post-closure maintenance period. The system will be inspected periodically by District staff for signs of deterioration. Needed repairs will be made by the District or a licensed contractor.

6.3.4 Gas Monitoring System

The landfill gas monitoring system, if required in the future by UDEQ, will be regularly inspected in conjunction with the scheduled monitoring tasks. The system will be repaired and parts replaced as required to maintain system capabilities. The program described below for inspecting and maintaining the gas monitoring system will be followed during the post-closure maintenance period.

The landfill gas monitoring system will be inspected quarterly. Quarterly maintenance will include cutting weeds in a 2-foot radius around each well, if wells are required. Preventive maintenance will be performed on all mechanical equipment at manufacturer-recommended intervals. These tasks include cleaning, lubrication, and replacement of worn parts.

6.3.5 Ground-Water Monitoring System

All ground-water monitoring wells, if required in the future by UDEQ, will be inspected for signs of failure or deterioration during each sampling event. If damage is discovered, the nature and extent of the problem will be recorded. A decision will be made to replace or repair the well. Possible repairs include redevelopment, chemical treatment, partial casing replacement or repair, sealing the annulus, or pumping and

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testing. If a well needs to be replaced, it will be properly decommissioned. Damaged wells will be scheduled for repair or replacement within 1 month after the problem is identified.

6.3.6 Final Grading

The landfill's final grades will be inspected and maintained in order to maintain their integrity. At the completion of closure activities, the surface of the cap will be surveyed to provide a reference basis for monitoring settlements and movements.

Areas where water has collected (ponded) will be regraded. Erosion damage resulting from extremely heavy rainfall will be repaired. District staff will inspect the final grading quarterly.

6.4 CLOSURE AND POST-CLOSURE LAND USE

District staff or a District contractor shall design a post-closure end use plan for the landfill. It is anticipated that the District will select an end use that will be limited to those that do not threaten the integrity of the existing control systems. All activities will be approved by the County prior to implementation. Typical end uses range from recycling operations (which complement existing operations) to recreational activities. At a minimum, the site should be restored to its pre-landfill condition as much as possible. Although contours among the site may have chanted, an effort to introduce native materials can help the site blend in with surrounding land uses. Since the closure of the site is 30 to 90 years in the future, it is not currently possible to develop these land use plans.

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7. REFERENCES

Dames & Moore, December 22, 1994. Permeability Test – Grand County, Utah.

Grand County Solid Waste, 2001. Facility Plans and Drawings.

HDR Engineering, Inc., 2001. Facility Plans and Drawings.

Tahoma Companies, Inc., WDBE, 1994. Geologic Cross Sections.

United States Geological Survey (USGS), 2002. National Seismic Hazard Mapping Project.

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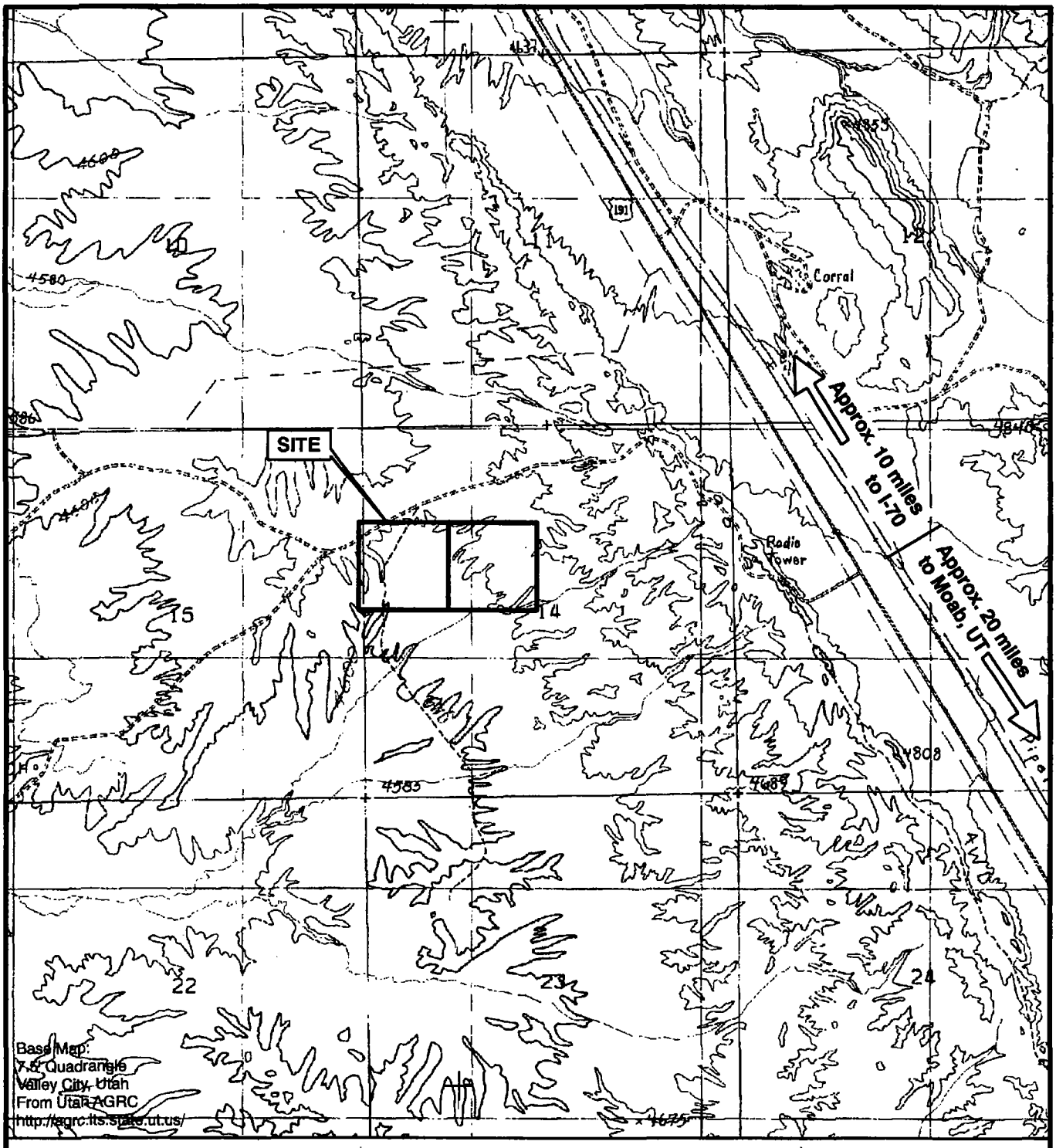
APPENDIX A

Site Location Map



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UTAH

QUADRANGLE LOCATION

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SITE VICINITY MAP

KLONDIKE FLATS LANDFILL
GRAND COUNTY SOLID WASTE
MANAGEMENT SPECIAL SERVICE DISTRICT # 1
P.O. BOX 980 MOAB, UTAH

FIGURE 1

Cartography By: S.C. | 10/24/2008 | Project Number: 84794.3 | File Name: SLC8A225

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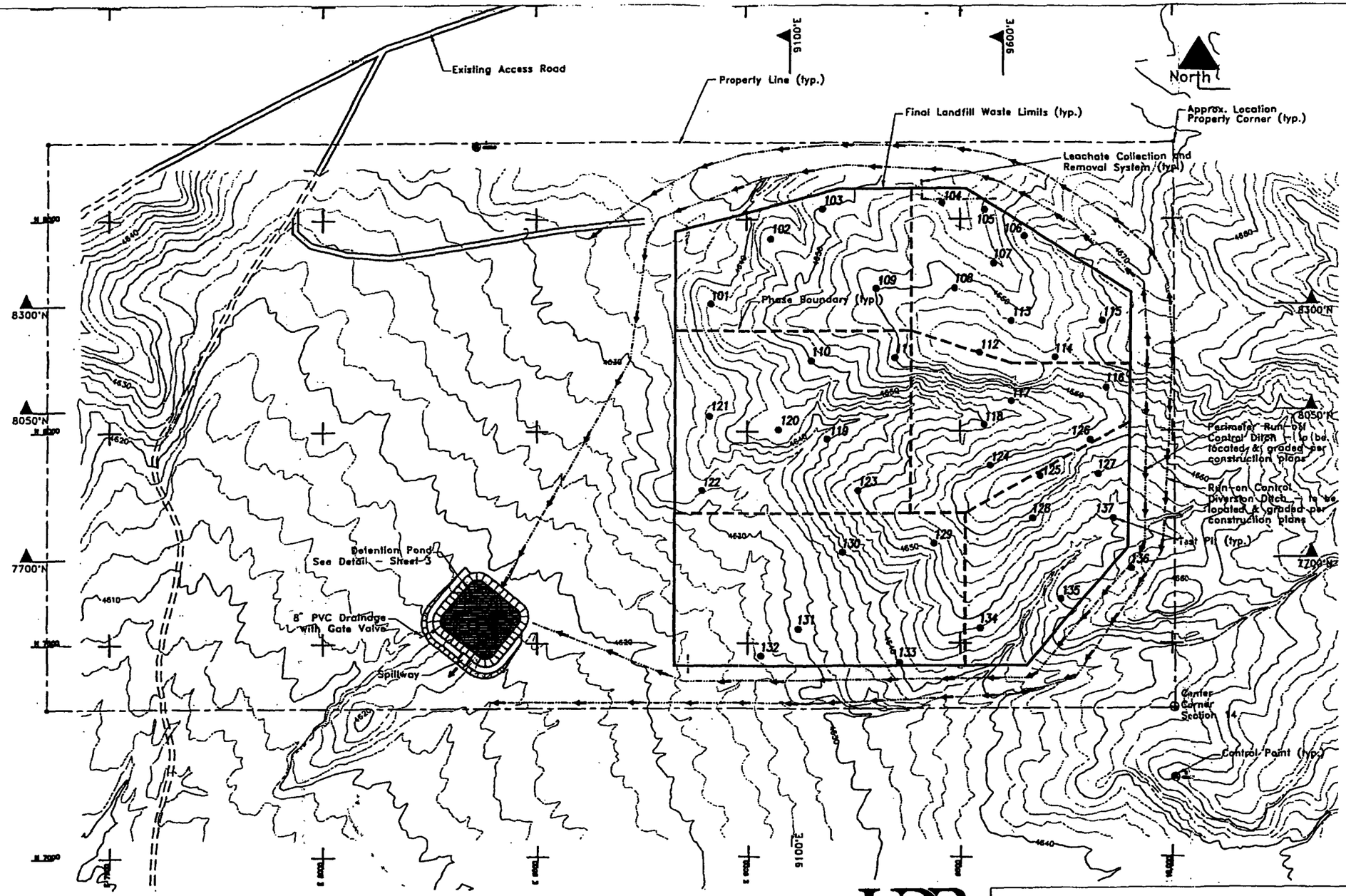
APPENDIX B

Facility Plans and Drawings

Oversized Drawings/Maps

associated with this document are located elsewhere in the DSHW files.

For assistance, please contact the GRAMA Coordinator.



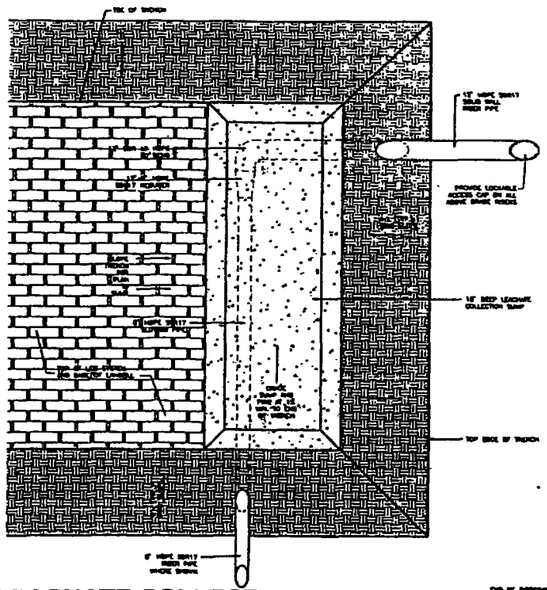
For Permit / Regulatory Compliance Only

HDR Engineering, Inc.

Plan View
Klondike Landfill

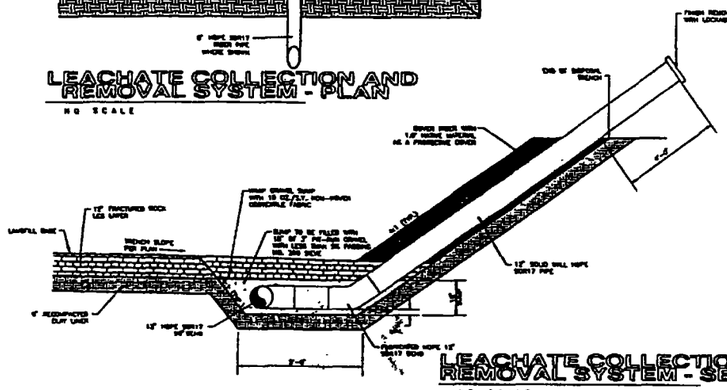
Date

Sheet 2



LEACHATE COLLECTION AND REMOVAL SYSTEM - PLAN

NO SCALE

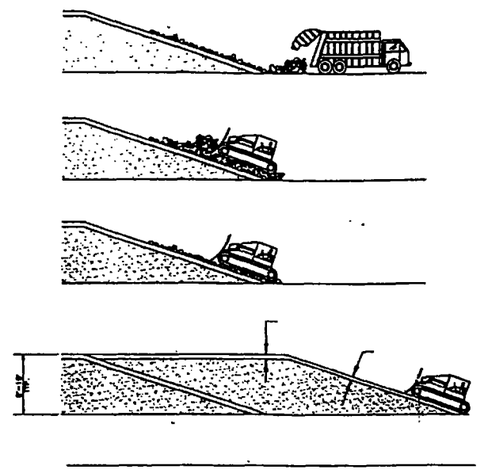


LEACHATE COLLECTION AND REMOVAL SYSTEM - SECTION

NO SCALE

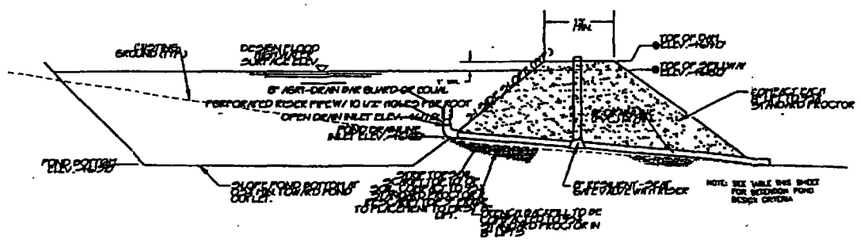
DETENTION POND DESIGN CRITERIA	
HYDROLOGICAL DATA	
RUNOFF MODEL	SCS METHOD
RAINFALL EVENT	25 YR./24 HR.
DESIGN RAINFALL	3.5"
RUNOFF CURVE NUMBER	79
DESIGN RUNOFF	0.8"
DETENTION POND	
DRAINAGE AREA	36 ACRES
RUNOFF FROM DESIGN EVENT	107,000 CU. FT.
MAXIMUM CAPACITY	125,000 CU. FT.
MAXIMUM DEPTH	5 FT.
MAXIMUM HYDROSTATIC HEAD ON FILL	3 FT.
SIDE SLOPES	3:1
TOP WIDTH	15 FT.
POND AREA WHEN FULL	0.55 ACRES
TOP OF DAM ELEVATION	4614.0'
POND BOTTOM ELEVATION	4613.0'
SPILLWAY ELEVATION	4613.0'
SPILLWAY CAPACITY	50 CFS
PEAK DISCHARGE	38 CFS
DRAINLINE INLET INVERT	4611.0'
DRAINLINE TYPE	8" PVC W/ E.V.

CONCEPTUAL DESIGN VOLUMES	
WASTE PARAMETERS	
QUANTITY	9100 TONS/YEAR
COMPACTED WASTE DENSITY	1000#/C.Y.
WASTE-TO-SOIL RATIO	3:1
QUANTITIES	
TOTAL EXCAVATION	279,000 C.Y.
FINAL COVER	63,000 C.Y.
DAILY COVER	197,000 C.Y.
WASTE VOLUME	360,000 C.Y.
WASTE QUANTITY	293,000 TONS
ESTIMATED LIFE	32 YEARS



TYPICAL DITCH SECTION

NO SCALE



DETENTION POND DETAIL

For Permit / Regulatory Compliance Only

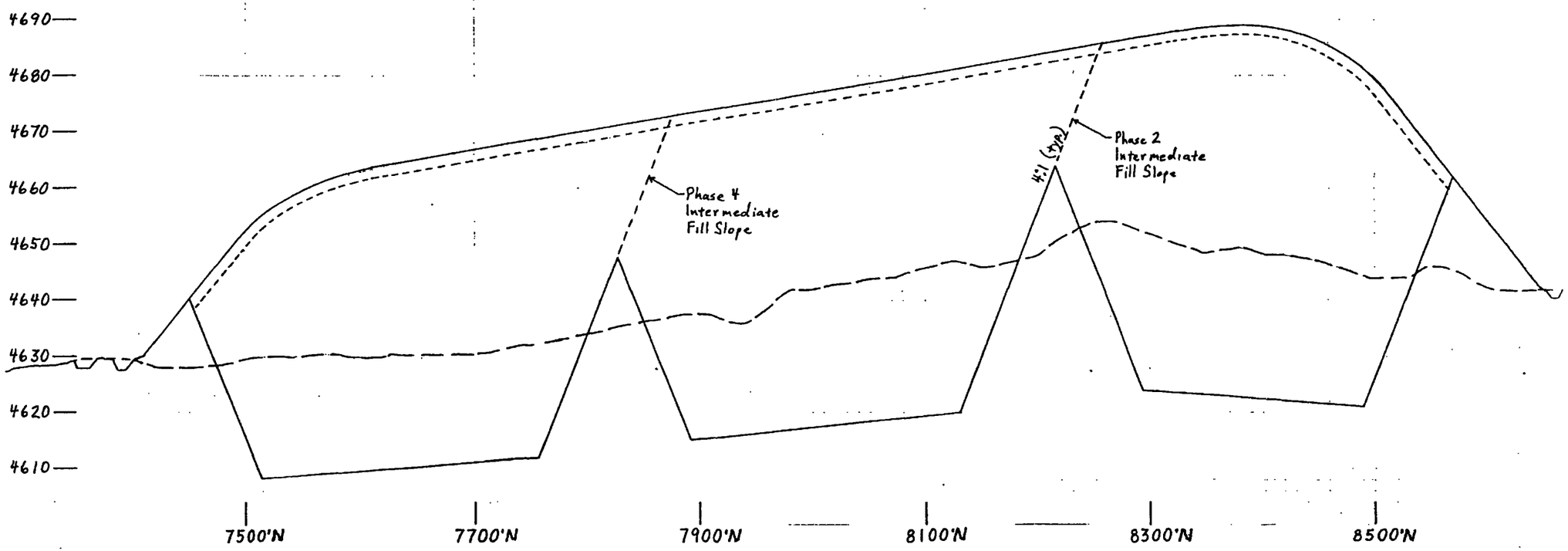
HDR

HDR Engineering, Inc.

Details
Klondike Landfill

Date

Sheet 3



For Permit/
Regulatory Compliance Only

Scale: Horizontal 1" = 100'
Vertical 1" = 20'

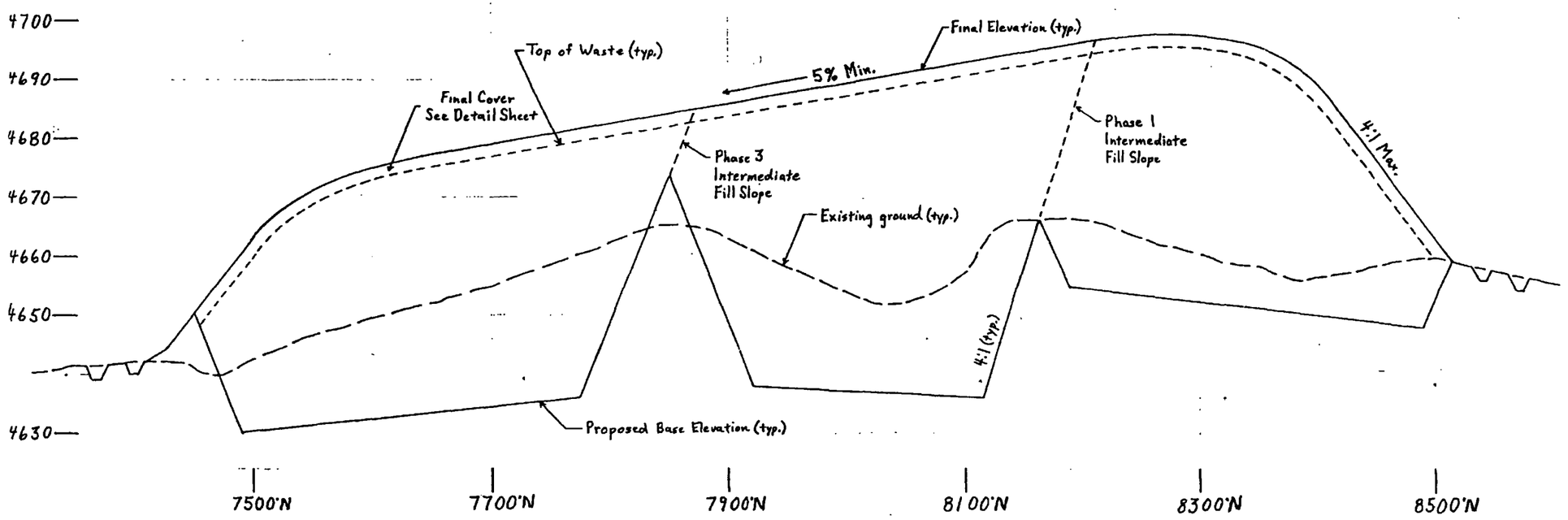
Grand County Solid Waste
Management Special Service District #1
P.O. Box 980 Moab, Ut. 84532
(435) 259-3867

North–South Cross Sections
9100E
Klondike Landfill

Date: 20 Apr 2001

Drawn by:
Anthony Martineau

REVISED SHEET 4 (TDD)



For Permit/
Regulatory Compliance Only

Scale: Horizontal 1" = 100'
Vertical 1" = 20'

Grand County Solid Waste
Management Special Service District #1
P.O. Box 980 Moab, Ut. 84532
(435) 259-3867

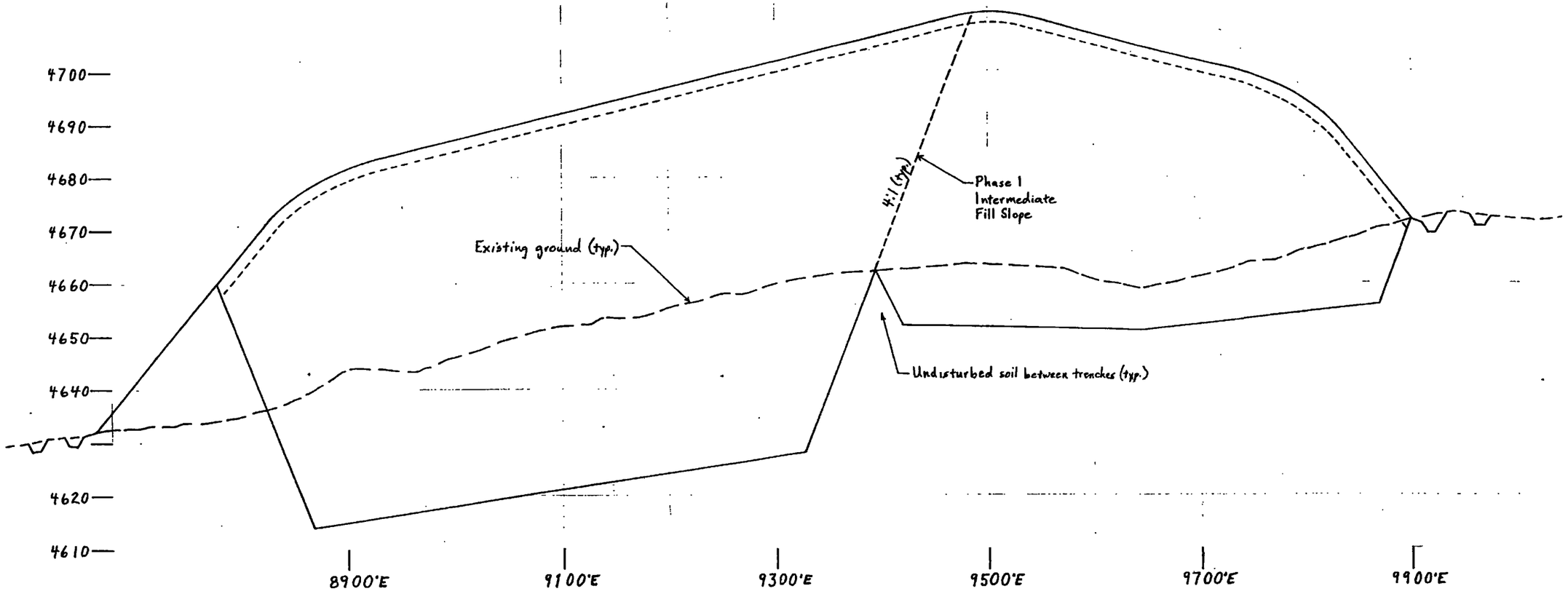
North–South Cross Sections
9600E
Klondike Landfill

Date: 20 Apr 2001

Drawn by:
Anthony Martineau

DENIED (BOTTOM)

SHEET 4



For Permit/
Regulatory Compliance Only

Scale: Horizontal 1" = 100'
Vertical 1" = 20'

Grand County Solid Waste
Management Special Service District #1
P.O. Box 980 Moab, Ut. 84532
(435) 259-3867

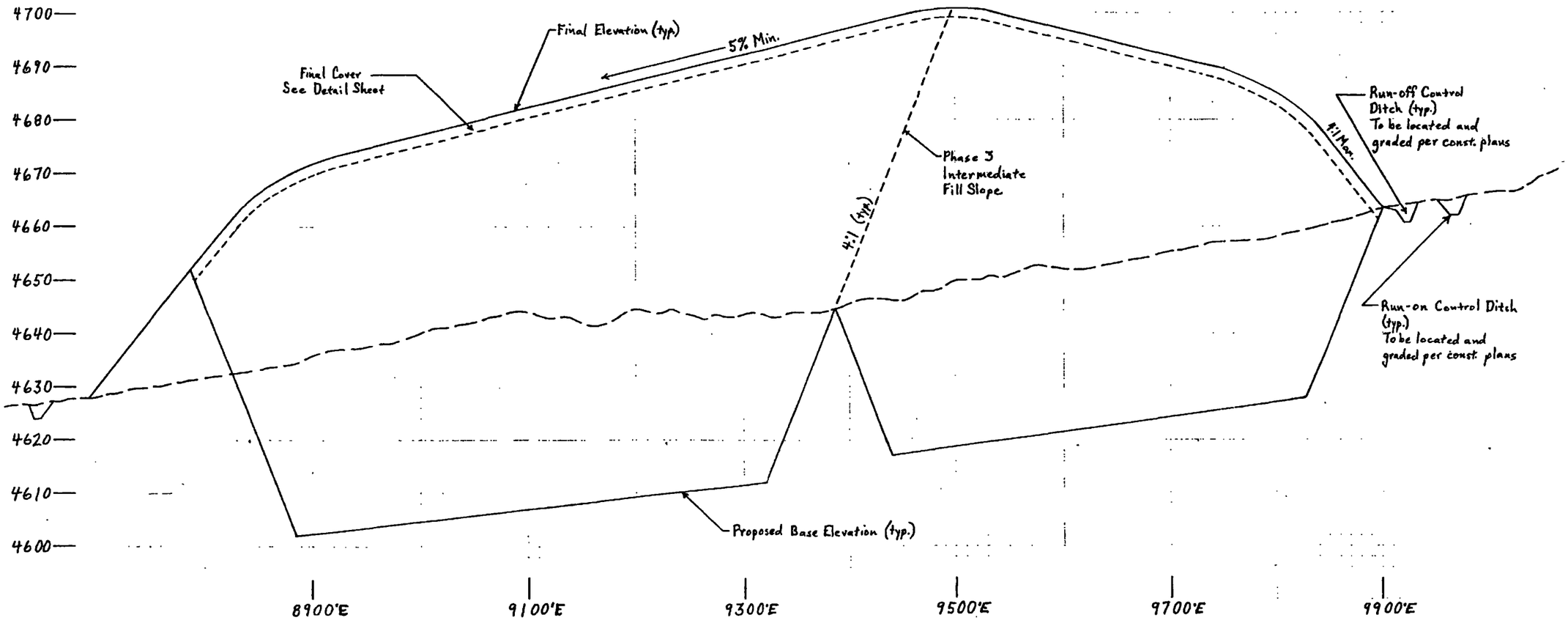
East–West Cross Sections
8300N
Klondike Landfill

Date: 20 Apr 2001

Drawn by:
Anthony Martineau

(TOP)

SHEET 5



For Permit/
Regulatory Compliance Only

Scale: Horizontal 1" = 100'
Vertical 1" = 20'

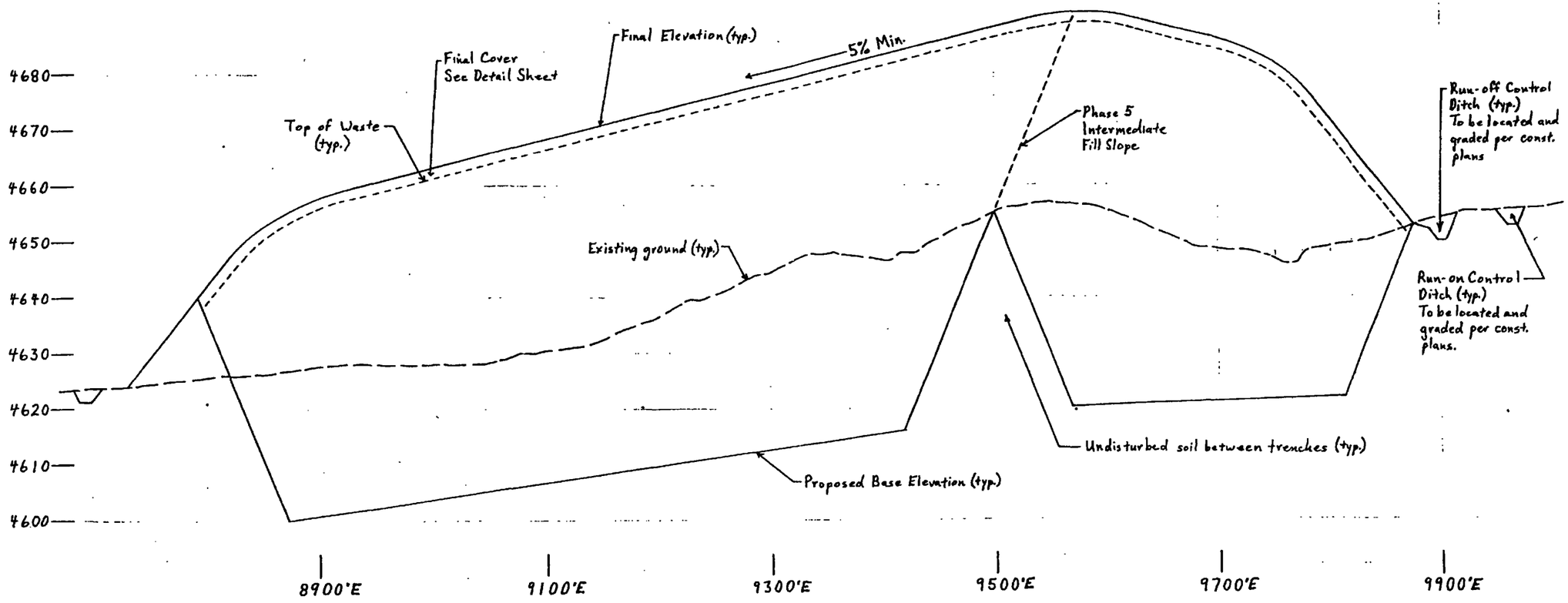
Grand County Solid Waste
Management Special Service District #1
P.O. Box 980 Moab, Ut. 84532
(435) 259-3867

East–West Cross Sections
8050N
Klondike Landfill

Date: 20 Apr 2001

Drawn by:
Anthony Martineau

REVISED SHEET 5 (MID)



For Permit/
Regulatory Compliance Only

Scale: Horizontal 1" = 100'
Vertical 1" = 20'

Grand County Solid Waste
Management Special Service District #1
P.O. Box 980 Moab, Ut. 84532
(435) 259-3867

East–West Cross Sections
7700N
Klondike Landfill

Date: 20 Apr 2001

Drawn by:
Anthony Martineau

REVISED

SHEET 6 (BOTTOM)

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Bright People. Right Solutions.

APPENDIX C

Property Acquisition and Zoning

ORDINANCE NO. 270

AN ORDINANCE AMENDING THE GENERAL ZONING ORDINANCE AND ACCOMPANYING MAP KNOWN AS ORDINANCE NO. 134, PASSED SEPTEMBER 18, 1978. BY REZONING THE FOLLOWING PROPERTY FROM A-1 TO I-1.

THE BOARD OF COUNTY COUNCILMEN OF THE COUNTY OF GRAND, STATE OF UTAH, ORDAINS AS FOLLOWS:

The following property be rezoned from A-1 to I-1 (Light Industrial):

T23S, R19E, SLMSection 14, S1/2 NW 1/4

Subject to all easements and right-of-way of record.

(Solid Waste District)

PASSED, ADOPTED, AND APPROVED by the Grand County Council in open session this 10th, day of July 1995 by the following vote:

Those voting aye: All

Those voting nay: _____

Ken Ballantyne, Chairman

ATTEST: Peggy R. Layton

Fran Townsend, Grand County Clerk/Auditor

Published in the Times Independent, July 13, 1995.

To: Sandi Sturm

From: Dick Sprague

Subject: BLM Property Acquisition

Date: May 11, 1994

I have evaluated the landfill "footprint" requirements to assist you in your discussions with the BLM. To accomplish this, I needed to make some assumptions regarding the growth over time of solid waste generation. I have calculated required acreage using the following assumptions:

- 1994 solid waste generation = 25 tons per day (Class I wastes)
- Minimum growth rate = 0%
- Maximum growth rate = 2.5%
- Planning period of 50 to 100 years

The following table summarizes the acreage requirements under the various assumptions:

	Growth	
Period	0%	2.5%
50 years	20 acres	48.5 acres
100 years	48.5 acres	184 acres

Based on this table, I recommend that you purchase 80 acres. This acreage will provide the District with assured landfill volume for a 50- to 100-year planning period, with reasonable assumptions on the future growth.

I also have evaluated Section 14 for the most favorable acreage for the initial acquisition. I recommend that the District pursue acquisition of the SW¼ of the NE¼ and the SE¼ of the NW¼ of Section 14. This property best combines accessibility, usable acreage, and minimization of visual impacts on the county road (dirt). The next acquisition will probably be the two quarter section directly south (the NW¼ of the SE¼ and the NE¼ of the SW¼).

BKE SC14 T23S R19E PM 1 Ln 23

Form 1860-9
(January 1988)

The United States of America

To all to whom these presents shall come, Greeting:

RECEIVED
AUG 15 1995
Ans'd.....

UTU-71889

WHEREAS,

Grand County Solid Waste Management Special Service District #1

is entitled to a land patent pursuant to the Recreation and Public Purposes Act of June 14, 1926 (44 Stat. 741), as amended by the Act of January 25, 1988 (102 Stat. 3815; 43 U.S.C. 869) for the Following described land:

Entry No. 435167
Recorded 11-3-95 11:47 AM.
Bk. 480 Pg. 405-407 Fee N/A
Marlene Mosher
Recorder of Grand County

Salt Lake Meridian, Utah

T. 23 S., R. 19 E.,
sec. 14, S½NW¼.

containing 80.00 acres

NOW KNOW YE, that the UNITED STATES OF AMERICA, in consideration of the premises, and in conformity with said Act of Congress, HAS GIVEN AND GRANTED, and by these presents DOES GIVE AND GRANT unto the said Grand County Solid Waste Management Special Service District #1, the land above described for use as a regional sanitary landfill: TO HAVE AND TO HOLD the same, together with all rights, privileges, immunities, and appurtenances, of whatsoever nature, thereunto belonging, unto the same Grand County Solid Waste Management Special Services District #1, forever; and

EXCEPTING AND RESERVING TO THE UNITED STATES

1. A right-of-way thereon for ditches or canals constructed by the United States pursuant to the Act of August 30, 1890 (43 U.S.C. 945).

2. All minerals, including oil and gas, in the land so patented with the right to prospect for, mine and remove the same. The Secretary of the Interior reserves the right to determine whether such mining and removal of minerals will interfere with the development, operation and maintenance of the sanitary landfill.

SUBJECT TO:

1. Outstanding oil and gas lease UTU-66023, issued October 1, 1989, for a 10 year period, and so long thereafter as quantities or other extensions granted consistent with the terms of the lease and applicable laws and regulations, with any funds generated under the lease for fees or royalties from production accruing to benefit of the United States;

Patent Number 43-95-0027

23-19-14-104.11

2. Grand County Solid Waste Management Special Service District #1, its successors or assigns, assumes all liability for and shall defend, indemnify, and save the United States and its officers, agents, representatives, and employees (hereinafter referred to in this clause as the United States),from all claims, loss, damage, actions, causes of action, expense, and liability (hereinafter referred to in this clause as claims) resulting from, brought for, or on account of, any personal injury, threat of personal injury, or property damage received or sustained by any person or persons (including the patentee's employees) or property growing out of, occurring, or attributable directly or indirectly, to the disposal of solid waste on, or the release of hazardous substances from the land described above, regardless of whether such claims shall be attributable to: (1) the concurrent, contributory, or partial fault, failure, or negligence of the United States, or (2) the sole fault, failure, or negligence of the United States.

3. Provided, that title shall revert to the United States upon a finding, after notice and opportunity for a hearing, that the patentee has not substantially developed the lands on or before the date five years after the date of conveyance. No portion of the land shall under any circumstance revert to the United States if any such portion has been used for solid waste disposal or for any other purpose which may result in the disposal, placement, or release of any hazardous substance.

4. If, at any time, the patentee transfers to another party ownership of any portion of the land not used for the purpose specified in this document, the patentee shall pay the Bureau of Land Management the fair market value, as determined by the authorized officer, of the transferred portion as of the date of transfer, including the value of any improvements thereon.

5. The above described land has been conveyed for utilization as a regional sanitary landfill. Upon closure, the site may contain small quantities of commercial and household hazardous waste as determined in the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. 6901), and defined in 40 CFR 261.4 and 261.5. Although there is no indication these materials pose any significant risk to human health or the environment, future land uses should be limited to those which do not penetrate the final cover of this area unless excavation is conducted subject to applicable State and Federal requirements.

6. The Secretary of the Interior may take action to revest title in the United States if the patentee directly or indirectly permits its agents, employees, contractors, or subcontractors (including without limitation lessees, sublessees and permittees) to prohibit or restrict the use of any part of the patented land or any of the facilities thereon by any person because of such person's race, creed, sex,or national origin.

In addition to the above the grant of the herein described land is subject to the following reservations, conditions, and limitations:

1. The patentee and its successors or assigns in interest shall comply with and shall not violate any of the terms or provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 241), and requirements of the regulations, as modified or amended, of the Secretary of the Interior issued pursuant thereto (43 CFR 17) for the period that the lands conveyed herein are for the purpose for which the grant was made pursuant to the act cited above, or for another purpose involving the provision of similar services or benefits;

Form 1860-10
(April 1988)

2. The United States shall have the right to seek judicial enforcement of the requirements of Title VI of the Civil Rights Act of 1964, and the terms and conditions of the regulations, as modified or amended, of the Secretary of the Interior issued pursuant to said Title, in the event of their violation by the patentee;

3. The patentee and its successors or assigns in interest will, upon request of the Secretary of the Interior or his delegate, post and maintain on the property conveyed by this document signs and posters bearing legend concerning the applicability of Title VI of the Civil Rights Act of 1964 to the area or facility conveyed;

4. The reservations, conditions, and limitations contained in paragraphs (1) through (3) shall constitute a covenant running with the land, binding on the patentee and its successors or assigns in interest for the period for which the land described herein is used for the purpose for which this grant was made, or for another purpose involving the provision of similar services or benefits;

5. The assurances and covenant required by sections (1) through (4) above shall not apply to ultimate beneficiaries under the program for which this grant is made. "Ultimate beneficiaries" are identified in 43 CFR 17.12(h).

IN TESTIMONY WHEREOF, the undersigned authorized officer of the Bureau of Land Management, in accordance with the provisions of the Act of June 17, 1948 (62 Stat. 476), has, in the name of the United States, caused these letters to be made Patent, and the Seal of the Bureau to be hereunto affixed.

GIVEN under my hand, in Salt Lake City, Utah
the Seventh day of August
in the year of our Lord one thousand nine hundred and
Ninety-Five and of the Independence of the
United States the two hundred and Twentieth

By _____
Chief, Branch of Lands
and Minerals Operation

Patent Number 43-95-0027

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APPENDIX D

Operations Plan

APPENDIX D
OPERATIONS PLAN
KLONDIKE LANDFILL

INTRODUCTION

This Operations Plan (Plan) was prepared for the Klondike Landfill. It was written to conform to the requirements of Utah Administrative Rule (UAC) 315-302-2(2) (Plan of Operation). The purpose of the Plan is to provide the Grand County Solid Waste Management Special Service District #1 (the District) with standard operating procedures for day-to-day operation of the landfill. Because of this, the Plan may be synonymously termed as the "Operator's Manual" throughout this document.

A copy of this Plan is required to be kept on-file at the landfill, the District's offices, or another location approved by the UDEQ. All employees or subcontractors of the District are required to read the manual as soon as possible after being hired, and will sign and date a training log sheet.

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1. GENERAL DESCRIPTION

1.1 BACKGROUND

On October 9, 1991, the U.S. Environmental Protection Agency (EPA) published revisions within the Resource Conservation and Recovery Act (RCRA) specifically to the Criteria for Classification of Solid Waste Disposal Facilities. These regulations, developed in response to requirements of Subtitle D of the 1984 RCRA Hazardous and Solid Wastes Amendments (HSWA), defined minimum criteria for municipal solid waste landfills, including facility design and operational requirements. Subtitle D regulations became effective on October 9, 1993.

RCRA Subtitle D establishes a framework for federal, state, and local government cooperation in controlling the management of non-hazardous solid wastes. The federal government sets minimum standards for protection of human health and the environment. In conjunction with this role, the federal government provides technical assistance for individual states to plan and develop waste management practices. However, the actual planning, direct implementation, and enforcement remain in the hands of state and local governments.

On February 1, 1994, the Utah Department of Environmental Quality (UDEQ) issued final Administrative Rules implementing Subtitle D at the state level. These rules, titled *Solid Waste Permitting and Management Rules,* are found in the UAC R315-301 through 315; they have been reviewed and approved by the EPA.

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1.2 FACILITY DESCRIPTION

1.2.1 General Facility Description

The Klondike Landfill will accept more than 20 tons per day (TPD) of municipal solid waste (MSW) from contracted haulers only. The public, private garbage haulers, and commercial/industrial customers will not generally have access to the landfill unless by franchise agreement. However, the District may grant limited direct access to the landfill to municipal or industrial facilities to protect public welfare or provide for orderly operation of the landfill.

The 80-acre site will be used as a Class I Landfill. In the Utah State Solid Waste Rule, R315-301-2, a Class I Landfill is described as:

> *A non-commercial landfill or a landfill solely under contract with a local government taking municipal solid waste generated within the boundaries of the local government that is permitted by the Executive Secretary to receive for disposal municipal solid waste; any other non-hazardous solid waste, not otherwise limited by rule or solid waste permit; and in conjunction with municipal solid waste or other non-hazardous solid waste, waste from a conditionally exempt small quantity generator of hazardous waste, as defined by Section R315-2-5.*

No permanent structures or buildings are currently planned for the landfill; however, the District may develop buildings to house the landfill attendant, maintenance, or other facilities in the future. The entire site will be surveyed and marked to ensure that all improvements are performed within the boundaries of the property.

The landfill will be developed in six phases, each consisting of a four to five acre landfill cell. Each successive cell, constructed to a depth of approximately 40 feet, will have a service life of nine to eleven years. Cells will be filled in a manner designed to reduce

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windblown litter and conserve cover soil. Intermediate cover consisting of 12 inches of soil will be applied over any area of the landfill not used for a period of 30 days or more; final cover will be applied on intermediate cover left in place for more than two years. As adjoining cells are completed, proper slope will be achieved with additional waste and final cover as required (see Appendix C – Facility Plans and Drawings). A 100-foot buffer zone will surround the active and closed portions of the landfill site, and may include the landfill access road and stormwater conveyance ditches and a stormwater retention pond.

The active life of the 40 acre landfilling area is expected to be approximately 48 years. Excavation of successive cells will occur during filling of the previous, thereby lowering the costs associated with development of both cells.

1.2.2 Fencing

A 100-foot buffer zone will be kept around the landfill cells at all times. This will provide an area on landfill property in which the District can maintain its stormwater and litter control facilities, and monitor the landfill facilities. The active and closed portions of the landfill will be fenced to allow the District to control access to the landfill, and to assist in controlling litter blowing from the active portions of the landfill.

Access to the landfill will be restricted to prevent illegal dumping of hazardous materials, vandalism, and unauthorized dumping of refuse. The entrance will be fenced and will include a lockable gate.

Appropriate signs will be posted at intervals along the fence and on the gate to inform people about the nature of the site and warn off trespassers.

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1.2.3 Roads

Access to the site will be provided via the existing County-improved gravel road and new gravel access road.

1.2.4 Buildings

No buildings are currently planned to be constructed at the landfill site; however, the District may develop buildings to house the landfill attendant, for vehicle maintenance facilities, or other purposes in the future.

1.2.5 Operating Hours

The landfill is generally not open to the public. A schedule will be maintained for contracted haulers. The following information is to be posted at the gate:

KLONDIKE LANDFILL

FRANCHISED HAULERS ONLY • NO PRIVATE HAULERS OR RESIDENTS • SCAVENGING IS STRICTLY FORBIDDEN • LIQUIDS AND HAZARDOUS WASTES ARE PROHIBITED

IN CASE OF EMERGENCY, CONTACT:
Grand County Solid Waste Management Special Service District #1
(435) 259-DUMP (3867)

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1.3 LANDFILL PERSONNEL

1.3.1 Job Descriptions

The following people are responsible and/or available for on-site operations at the Klondike Landfill:

Facility Supervisor (FS) or District Manager (DM). The FS or DM manages the overall operation of the solid waste management system, including the landfill; and production of annual environmental and financial reports. The FS or DM reports to and takes direction from the District's Board of Directors. The other District personnel report directly to the FS or DM.

Landfill Attendant (Attendant). The Attendant is responsible for all day-to-day operations at the landfill. His/her responsibilities include inspection/certification of wastes at the landfill and routine inspection of the facilities for compliance with permit requirements. The District may delegate this responsibility to its Landfill Contractor, if desired.

Landfill Contractor. The Landfill Contractor is responsible for the safe operation and daily maintenance of equipment; visual inspection of waste loads for unauthorized or hazardous wastes; daily operation on the working face of the landfill; directing traffic to the working face; and control of litter and dust generated from the landfilling operations. The District may self perform this function, if desired.

1.3.2 Personnel Training

Adequate training will be provided to ensure all personnel associated with the operation of the Klondike Landfill comply with the approved Operations Plan (Operator's Manual) and the Permit. At least one employee of the District or its Contractor will be trained in proper landfill operations. Other landfill personnel will receive an initial on-the-job

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training from the trained staff member(s), and will receive an 8-hour refresher training annually covering landfill operations and waste screening. Refresher training will be provided as needed to ensure continued compliance. Certificates of completion are to be kept on file with the personnel records.

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2. SOLID WASTE HANDLING PROCEDURES

2.1 DAILY TASKS

2.1.1 Prior to Opening

- Unlock the gate.
- Start a new page in the Daily Log with the correct date and time.
- Inventory equipment to be sure that all is on-site and ready for day's operation.
- Briefly check the fire extinguisher and other safety equipment. Once a week conduct this check more thoroughly.

2.1.2 During Operating Hours

- Visually inspect each incoming load. Certify no prohibited wastes are present. Reject materials or loads as necessary.
- Record the weight or volume, and description in the daily log and note the time of entry.
- Fill out records on incoming loads, i.e., the daily log and the driver's manifest.
- Clean/maintain equipment according to manufacturer's recommendations.

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- Ensure waste is compacted as soon as practical after delivery.

- Apply cover material.

2.1.3 Closing

- Visually check the operating face and grounds to ensure no persons or animals are locked inside.

- Make necessary summaries in log book.

- Recheck grounds, and then lock the gate.

2.2 WASTE ACCEPTANCE PROCEDURES

2.2.1 General Procedure

No hazardous wastes will be accepted at the Landfill. Section 7.2 of this plan describes these prohibited wastes. The Landfill Attendant will visually inspect all loads whether from direct haul or from a transfer station and will screen out prohibited and/or special wastes. The attendant will then certify, along with the waste hauler, that no prohibited wastes are present in the load being accepted.

Log all vehicles entering the landfill into the Daily Log. Record the hauler's license number, a description of the wastes, weight or volume, and the time of entry.

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2.2.2 Special Wastes

Special wastes are materials that require special handling if they are received at a landfill. Special wastes may require immediate burial, separation for recycling or recovery, or other non-routine handling. Special wastes are different than hazardous wastes, which are prohibited and are not acceptable at the Klondike Landfill even under special handling. (See Section 7.2)

Asbestos and Medical Wastes

Friable asbestos and biohazard medical wastes will generally not be accepted by the Landfill since these special wastes require special training and unusual handling procedures. Both types of wastes can transmit or cause diseases. Direct anyone inquiring about disposing of friable asbestos and medical wastes to a proper disposal facility. Under specific conditions to promote public welfare, the Board may approve limited disposal of friable asbestos or medical wastes.

Friable asbestos is material containing more than 1 percent asbestos which can easily be broken into dust-like particles. The EPA has a definition of this material which all asbestos removal contractors are required to understand. Since friable asbestos is the dangerous form of asbestos, the disposer must be asked if it is friable asbestos; if the answer is "yes," the waste must be rejected to protect landfill workers. The District will accept non-friable asbestos since this form of asbestos is expected to present little risk to landfill employees.

Bulky Wastes

Bulky wastes such as automobile bodies, furniture, and appliances should be recycled or reused wherever possible. Designated areas at the Landfill will be set aside for separating these items. Recyclers may pick them up periodically. Bulky wastes that are not recycled at least once each year must be disposed of properly at either the

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Klondike Landfill or at the Class IV Moab Landfill. The Utah State Rule R315-301-2 defines a Class IV Landfill as:

> *A non-commercial landfill that is permitted by the Executive Secretary to receive for disposal only construction/demolition waste/ yard waste; inert waste; dead animals, as approved by the Executive Secretary and upon meeting the requirements of Section R315-315-6; waste tires and materials derived from waste tires, upon meeting the requirements of Section 19-6-804 and Section R315-320-3; and petroleum contaminated soils, upon meeting the requirements of Subsection R315-315-8(3).*

If bulky wastes must be disposed of in the Class I landfill, crush them and push them onto the working face near the bottom of the cell. The preferred destination for disposal of bulky wastes is the Class IV landfill.

Used Oil and Anti-Freeze

Direct any one inquiring about disposing of used oil and anti-freeze to a proper facility. Do not accept used oil or anti-freeze.

Automobile Batteries

Automobile batteries, and similar lead-acid batteries, have a significant recycle value and cannot be landfilled in accordance with UAC 19-6-601. Collect and place any lead-acid batteries discovered at the working face onto a skid for future disposal.

Tires

Tires are accepted and stockpiled for recycling at the Class IV Moab Landfill; this is the preferred place to send tires. If tires are disposed of in the Class I landfill, spread tires out along the working face, cover with other waste, and compact.

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Grease Trap Waste

The City of Moab Waste Water Treatment Plant (WWTP) cannot currently accept restaurant grease trap wastes. The WWTP is the preferred disposal site for this material and the City of Moab is considering expansion that may include the capability for grease trap waste handling. Until the WWTP can accept it, grease trap waste from franchised haulers is accepted at the landfill and applied by spraying onto a separate managed area approved by the Southeastern Utah District Health Department. The area is within the fenced portion of the landfill site and is designed for run-on and run-off control, to prevent pooling of waste, and to facilitate liquid evaporation and infiltration within 24 hours of application. Once the waste has dehydrated, it will be landfilled. A random testing procedure is in place to prevent disposal of hazardous wastes. Refer to Appendix L of the solid waste permit for documentation and drawings.

Septage

In the past, the City of Moab WWTP has experienced temporary conditions that prevent its acceptance of septage, such as high Total Suspended Solids. Under a Memorandum of Understanding with the City of Moab, the District has agreed to accept emergency septage that qualifies under the agreement at the landfill, on a case by case basis as requested in writing by the City of Moab. The septage will be delivered by franchised hauler to the landfill, and will be applied by spraying onto a separate managed area approved by the Southeastern Utah District Health Department. The area is within the fenced portion of the landfill site and is designed for run-on and run-off control, to prevent pooling of waste, and to facilitate liquid evaporation and infiltration within 24 hours of application. Once the waste has dehydrated, it will be landfilled. A random testing procedure is in place to prevent disposal of hazardous wastes. Refer to Appendix L of the solid waste permit for documentation and drawings.

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2.3 WASTE DISPOSAL PROCEDURES

2.3.1 Working Face

Wastes should be deposited by trucks at the toe of the working face and spread up the slope in 1- to 2-foot layers. Keep the slope no stepper than at a 3:1 ratio (horizontal feet to vertical feet).

Keep working face dimensions narrow enough to minimize blowing litter and reduce the amount of soil needed for cover. Dimensions should be wide enough to safely accommodate vehicles bringing garbage into the landfill. The Solid Waste Association of North America (SWANA) recommends the width of the working face to be no less than three times the width of the dozer blade.

It is recommended the dozer be operated with the blade facing uphill when spreading and compacting wastes. Avoid sideways movements as the equipment may be susceptible to tipping over. In addition, an uphill orientation provides the following benefits:

- Litter blows onto the face reducing litter problems;
- There is better visibility for waste placement and compaction; and
- Loaded equipment moves up the face more easily.

Use grade stakes when necessary to control cell height and top surface grade. The top of the surface grade should range from 2 to 5 feet in 100 feet, while the cell height is commonly 8 to 10 feet.

2.3.2 Waste Compaction

Compact wastes by making three to five passes up and down slope. Compaction reduces litter, differential settlement, and the quantities of cover soil needed.

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Compaction also extends the life of the site, reduces unit costs, and leaves fewer voids where vectors can breed. Avoid holes in the compacted waste; fill these with additional waste as they develop.

2.4 COVER

Landfill cover provides many benefits: it limits the production of leachate by keeping lain water from coming in contact with the wastes, reduces odors, prevents scavenging, cuts down on litter, prevents fires from spreading, and controls vermin.

2.4.1 Daily Cover

At least 6 inches of soil, or an alternate daily cover approved by the UDEQ, must be placed over the wastes by the end of each day. Use grade stakes when necessary to control cell height and top surface grade for proper drainage.

Daily cover material will be borrowed from other portions of the landfill site.

2.4.2 Intermediate Cover

Place intermediate cover when the cell will be idle for an extended period of time (30 days or more) in order to prevent water from coming in contact with waste materials. Intermediate cover consists of an additional 6 inches of soil for a total of 12 inches of soil. Intermediate cover material may be the same material as that used for daily cover.

2.4.3 Final Cover

Cover Placement

When the final planned grade height has been reached, or the time comes to close the landfill or section of the landfill, the final cover specified in the Engineering Report

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section of the Landfill Permit Application must be placed. This final cover is intended to prevent rain from seeping into the waste during the post-closure life of the landfill. It allows light traffic and some settlement to occur without the risk of exposing buried waste. This cover should only be placed under the direct supervision of a registered professional engineer.

Revegetation

Each closed cell should be revegetated with native grasses and plants. After the final cover is compacted, spread and grade a six-inch layer of uncompacted top soil to form the base for reseeding. The seed mixture should include a minimum of four of the native grasses and plants. The exact mixture will depend on availability at the time of revegetation.

Plant the soil in accordance with current local Bureau of Land Management (BLM) recommendations for the Klondike Flats area.

Drainage

The upper surface of the closed cell/section should slope outward at a minimum of 2 percent slope grade, but not more than 5 percent slope grade. The 2 percent slope grade keeps water from pooling; greater than 5 percent would lead to erosion problems.

2.5 EQUIPMENT

It is recommended that any equipment utilized at the landfill be sufficiently sized for the operation of the Landfill, and that it contains an Occupational Safety and Health Administration (OSHA) approved safety cab, a fire extinguisher, a first aid kit, and a backup alarm.

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All earthmoving and heavy equipment operation will be contracted, including waste compaction and daily cover operations. The contractor will be responsible for safe operation and maintenance of their equipment.

All landfill personnel are to be provided with two-way communication devices to facilitate communication with each other and the District. Emergency services can also be contacted if the need arises.

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3. INSPECTIONS AND MONITORING

3.1 INSPECTIONS

The Landfill Attendant, District Manager, or Contractor is responsible for conducting and recording routine inspections of the landfill facilities according to the schedule outlined below:

Daily Inspection:

- Daily and Intermediate Cover Integrity
- Main Gate Integrity
- Condition of Equipment

Weekly or Monthly (As Needed):

- Litter Control (inside and outside fences)

Monthly Inspection:

Perimeter Fence Integrity
Stormwater Drainage System (Run-On/Run-Off Control System)
Final Cover Integrity (closed cells)
Leachate Sump in Phase I

Quarterly Inspections:

- Equipment Maintenance (Contractor)

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- Site Road Integrity
- Methane Gas Monitoring

It is the responsibility of the FS to make sure all records are complete on at least a quarterly basis.

3.2 GROUNDWATER MONITORING

Because of depth to groundwater, the impermeable nature of the underlying soils, low rainfall, and high evaporation rates, the Klondike Landfill site has been exempted from groundwater monitoring.

3.3 METHANE GAS MONITORING

The Landfill will be monitored on a quarterly basis for methane gas releases using a hand-held photoionization detector (PID). A PID will be made available upon request by contacting the Southeastern District Engineer for the UDEQ at (435) 637-3671. The DM will coordinate the monitoring events, and will arrange for interpretation of the monitoring results if combustible gasses are detected at any station.

The monitoring procedure will be to walk the perimeter fence of the landfill and record PID readings at each corner of the fence line. The readings will be recorded and kept at the District office. If methane releases are detected in excess of 25 percent of the lower explosive limit (LEL) in a landfill building or structure, or more than 100 percent LEL at the property boundary, follow the procedure outlined in Section 4.4, Release of Explosive Gases. If concentration of methane exceeds the standard set in UDEQ Rules, the District will implement mitigation requirements imposed on the District by UDEQ regulations in effect at the time of the permit or revisions of the permit.

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3.4 LEACHATE MONITORING

A gravity flow leachate collection system has been installed in the Phase 1 landfill cell and will be monitored monthly. The first time leachate is detected in the collection sump, it will be sampled and analyzed to assess if it is hazardous. Leachate will be sampled and analyzed annually thereafter.

If the leachate is assessed to be non-hazardous, it will be pumped from the sump and used for dust control within the footprint of the landfill cells, or transported to the local wastewater treatment plant for disposal. If the leachate is determined to be hazardous, it will be transported to an approved facility for disposal.

Records of leachate monitoring results, analytical results, leachate quantity pumped from the landfill, and ultimate disposition will be maintained in the operating record.

3.5 RUN-ON/RUN-OFF

District staff will inspect the stormwater drainage system monthly. The run-on/run-off collection and drainage system will be routinely evaluated and inspected for ponded water, blockage, and damage to drainage structures and swales. Temporary repairs will be made until permanent repairs can be scheduled.

Water in the stormwater detention pond will be tested annually for contaminants which may originate from the landfill.

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4 CONTINGENCY AND CORRECTIVE ACTION PLANS

The following sections outline procedures to be followed in the event of fire, explosion, groundwater contamination, release of explosive gases, or failure of the run-off containment system. If emergency procedures are in effect and the landfill is not operational for more than an hour or two, franchise haulers will be notified by landfill personnel.

4.1 FIRE

If a fire is detected on board an incoming truck, direct the driver to the specified area where the load can be dumped and covered with soil. If the fire cannot be controlled, call the fire department. Allow the load to cool completely before transporting it to the working face.

Unfortunately, most "hot" loads are not detected until after the load has been dumped. If such a situation arises, evacuate all non-essential personnel from the area. If possible, isolate the burning material and smother it with soil. Allow the burned material to cool completely before returning it the working face. Call the fire department if the fire cannot be controlled.

If a fire is burning below the soil cover and is difficult to access or isolate, call the fire department.

In the event of fire, call the District Manager. Notify the UDEQ immediately and submit a written report within 14 days of the fire.

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4.2 EXPLOSION

If an explosion occurs, evacuate the landfill and account for all personnel and customers. Shut down and abandon any equipment if it is in the vicinity of the explosion. Corrective action will be immediately evaluated and implemented as soon as practicable. Call the fire department and the District Manager. Notify the UDEQ immediately and submit a written report within 14 days.

4.3 FAILURE OF RUN-OFF/RUN-ON SYSTEM

The purpose of the run-off/run-on systems is to prevent water from entering or leaving the landfill. Inspect the systems regularly and make repairs as soon as practicable after discovery. In the case of run-on system failure, use temporary berms, ditches, sandbags, or other water diversion methods to divert water from the landfill.

Use these same methods to prevent water from leaving the landfill if the run-off system is breached. Assess the impact of any release as soon as practicable.

Monitor and inspect any temporary berms or other structures at least every two hours. Make any needed permanent improvements or repairs as soon as practicable.

As soon as any breach is discovered, call the District Manager. Notify the UDEQ immediately of any releases and submit a written report within 14 days.

4.4 RELEASE OF EXPLOSIVE GASES

Methane gas is not expected to be produced in large quantities at the Klondike Landfill. However, landfill gas production will be monitored quarterly. If a release is detected in excess of 25 percent of the LEL in a future-developed landfill building, or more than 100 percent LEL at the property boundary, the following procedure will be followed:

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- Halt landfill operations immediately. If personnel or buildings appear to be threatened, evacuate the landfill.

- If gas is detected in a building, open the doors and windows to allow the gas to escape.

- If off-site buildings or structures appear to be threatened, call the fire department, evacuate the property, and notify the property owners.

- Call the District Manager. Monitor the release and determine temporary corrective action as soon as possible. Implement permanent corrective action as soon as practicable.

- Notify the UDEQ immediately and submit a written report within 14 days of detecting the release.

4.5 GROUNDWATER CONTAMINATION

Due to the extreme depth to groundwater at the site (greater than 500 feet below ground level) and the small quantities of leachate produced, it is unlikely that leachate will ever contaminate the groundwater. If groundwater contamination is ever suspected, a program to confirm this contamination will be developed and the extent of contamination documented. This program may include the installation of vadose or groundwater monitoring wells. A groundwater monitoring program will be developed and corrective action taken as deemed necessary.

4.6 ALTERNATIVE WASTE HANDLING/DISPOSAL SYSTEM

Landfill operations will be adapted for wet weather by constructing an all-weather roadway from the site entrance to the active cell. The site soils, including those used as

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daily cover, consist primarily of clays derived by the weathering of Mancos shales. These soils may be impassable when wet. Given the arid climate at the Landfill site, wet weather is not often expected to be a problem. If the access roads become impassable during storms or for other reasons, waste may be temporarily (i.e. less than 24 hours) stored at the Moab transfer station.

All reasonable caution and prudence will be exercised to not dispose of wastes during any unreasonable weather conditions. If unforeseen weather conditions occur, the FS, or a designee, shall be informed and shall coordinate any changes in operation. The District will consider the system-wide requirements (including transfer station requirements) in determining what changes, if any, need to be made in operations at the landfill.

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5 SYSTEM MAINTENANCE

5.1 LEACHATE COLLECTION SYSTEM

A gravity flow leachate collection system is installed in the Phase 1 cell and will be monitored monthly. The system will be inspected periodically by District staff for signs of deterioration. Needed repairs will be made by the District or a licensed contractor.

5.2 GAS COLLECTION SYSTEM

Gas collection is not planned for the Landfill. However, gas monitoring locations will be maintained on a routine basis to keep them free of weeds and debris. Weeds should be pulled at least two weeks prior to scheduled monitoring events.

5.3 RUN-ON/RUN-OFF COLLECTION SYSTEM

The run-on/run-off collection and drainage system will be routinely evaluated and inspected for ponded water and blockage of/damage to drainage structures and swales. Where erosion problems are noted or drainage control structures need repair, proper maintenance procedures will be implemented as soon as site conditions permit so that further damage is prevented. Damaged drainage pipes and broken ditch linings will be removed.

District staff will inspect the drainage system monthly. Temporary repairs will be made until permanent repairs can be scheduled. The District or a licensed general contractor will replace drainage facilities.

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6. PROCEDURES FOR NUISANCE CONTROL

6.1 VECTOR CONTROL

Preventative measures for controlling disease vectors are outlined in the sections below.

6.1.1 Insects

Flies and mosquitoes can transmit disease and are nuisances. They enter the landfill with garbage and breed in moist areas. Flies and mosquitoes can be controlled by eliminating their food, shelter, and breeding areas.

Daily cover is the most effective way to control insects. If flies become a problem use fly bait. As long as there is no place for water to stagnate, mosquitoes should not be a problem.

6.1.2 Rodents

Rats, mice, and other rodents come into the landfill in loads or through natural migration. Appliance storage areas, poorly compacted cover soils, and spaces within bulky items provide refuge, and MSW provides food. Once a colony of rodents is established, it is very difficult to eliminate it.

Look for tooth marks or other signs of gnawing, droppings, holes, burrows, or nests. Rodents are usually not active during daylight hours, so if a rat or mouse is seen during daylight hours, the problem is serious. Notify the District Manager. A professional exterminator will be called who will establish a protocol for pest control in accordance with any state, county, or federal (such as FIFRA) regulations that may apply.

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6.1.3 Birds

Scavenging birds, such as seagulls and crows, pose few problems around the Landfill. A control program will be implemented if the need should arise.

6.2 FUGITIVE DUST EMISSIONS

Dust is caused by traffic on unpaved roads, heavy equipment loading and unloading, compaction and cover activities, and moderate to high winds. The County-improved road into the landfill from U.S. 191 is unpaved and is the major dust source other than the landfill itself; however, dust control on this road is not the responsibility of the District. If fugitive dust becomes a problem, apply water to problem areas on the landfill or call County Road Department for water trucks that may water the unpaved road areas upon request.

6.3 LITTER CONTROL

Litter is unsightly, can clog machinery, and causes environmental as well as public relations problems. It is your responsibility as a Landfill Attendant to keep litter under control and cleaned up. Keep the working face downwind as much as possible so the wind will blow loose litter back onto the working face. Prompt compaction also reduces litter.

Effective use of litter fences also keeps blowing litter under control. These fences prevent litter from leaving the landfill site. Place the litter fences downwind and as close as possible to the working face. Constantly shifting high velocity winds accompanying storms, and thermals known as "dust devils," are common at this site. Small litter control catch fences are the most effective barrier method to control wind-blown litter. Several rows of fencing will be placed within the perimeter fence of the landfill, to break up wind patterns and allow litter to be contained and retrieved within the landfill site.

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District landfill attendants will regularly patrol the catch fences and terrain surrounding the landfill.

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7. SPOTTING AND WASTE SCREENING

7.1 INTRODUCTION

The municipal waste stream consists of many different types of waste. Some wastes are acceptable, some are regulated, and some are prohibited.

A vital part of your job is to know what is considered hazardous waste, how to recognize it, and how to exclude it. Landfill Attendants, or the District's contractor personnel, are required to receive periodic training in waste screening. This training consists of initial training and periodic refresher courses. Certificates of completion are to be kept on file with personnel records.

7.2 IDENTIFICATION OF REGULATED HAZARDOUS WASTE

Hazardous wastes have either physical or chemical characteristics that could harm human health or the environment. A waste is considered hazardous if it falls into either of two categories: 1) a listed waste, or 2) a characteristic waste. Although these wastes are banned from disposal in the Klondike Landfill, various small quantity generators (less than 100 kg/month) of hazardous wastes and household hazardous wastes are exempt from hazardous waste regulation. Hazardous wastes are most likely to enter the landfill mixed in with common household waste.

Any material contaminated by a hazardous waste is also deemed to be a hazardous waste and must be managed as such. RCRA permits are also required to store, transport, and treat hazardous waste.

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7.2.1 Listed Wastes

Listed wastes have been defined as hazardous waste by the EPA because they present significant risks to human health and the environment. They are listed in 40 CFR 261, subpart D.

7.2.2 Characteristic Wastes

Characteristic wastes are those considered hazardous because of their nature. Characteristic wastes exhibit one or more of the following characteristics:

- Ignitable. A flash point at temperature less than 140 degrees F; kindles under normal friction; or oxidizes. Examples are solvents, peroxide, and petroleum products. Dry cleaning establishments, machine shops and repair shops are common producers of these wastes.

- Corrosive. Acidic or alkaline, with a pH of less than 2 or greater than 12.5. Examples are car batteries, oven cleaners, and drain decloggers.

- Reactive. Normally unstable, these wastes react violently with water and may contain cyanide or sulfur. They may be easily detonated or exploded. Electroplating operations and munitions manufacturers produce reactive wastes.

- TCLP toxicity (Toxicity Characteristic Leaching Procedure). TCLP is a laboratory test designed to measure the "leachability" of heavy metals, pesticides, and some other inorganic compounds. If wastes fail the TCLP test, they may be identified as characteristic hazardous wastes.

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7.2.3 Other Prohibited Wastes

The U.S. EPA has developed lists of specific types of wastes that may not be disposed of in MSW landfills. However, these lists exempt "household quantities" as hazardous wastes, and permit the disposal of household quantities in municipal landfills. Generally speaking, it is not possible to exclude "household quantities" of hazardous wastes generated in commercial establishments from landfills, since it may not be possible to determine exactly where a load originated. Therefore, small quantities of these wastes are generally considered acceptable for disposal in the Klondike Landfill.

PCBs

Polychlorinated biphenyls (PCBs) are toxic chemical compounds that do not degrade over time. Materials that may contain PCBs include power transformers, capacitors, and hydraulic systems that use PCB-containing oils. PCBs may also be found in debris, rags, or soil contaminated by a PCB spill.

Small quantities of PCBs are found in fluorescent light ballast capacitors and household appliances or other common consumer electrical products. These are not considered regulated PCB waste and can be landfilled. However, commercial facilities may not dispose of large quantities of these wastes in the landfill.

Liquids

Liquids and wastes containing free moisture cannot be put in the landfill. These wastes have the potential to increase leachate production. A waste is classified as a liquid if it readily separates from the solid portion of a waste under ambient temperature and pressure or as determined by EPA test method 9095 (the Paint Filter Test).

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Radioactive Waste

Radioactive wastes are strictly controlled by the Nuclear Regulatory Commission and are banned from the landfill.

Pesticides

All pesticides are prohibited from the landfill, except those that originate at the household level. Empty pesticide containers originating from commercial or agricultural operations are prohibited unless they have been triple-rinsed, with the ends punctured or removed.

7.3 PROCEDURES FOR SCREENING WASTE

The Landfill Attendant will visually inspect all loads when unloaded and will screen out prohibited and/or special wastes for proper handling. He/she will then certify, along with the waste hauler, that no prohibited wastes are present in the load being accepted.

The Landfill Attendant will receive periodic training in detecting prohibited wastes. This training will consist of an initial training and annual refresher training.

7.4 HAZARDOUS WASTES DISCOVERED AFTER THE FACT

If hazardous wastes or wastes containing PCBs are discovered to have been inadvertently accepted (i.e., during the application of daily cover), the following shall apply:

- Restrict access to the area and conduct an inspection to assess the situation. If the waste can be safely removed from the working face, the equipment operator will transport it to a secure zone.

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- Immediately contact the District Manager for further disposition of the waste.

- Try to identify the waste and the generator. Note your observations in the daily log, including a description of the material, in the daily log.

- The Executive Secretary, the hauler, and the generator (if known) will be notified within 24 hours of the discovery.

- If known, the generator will be responsible for proper cleanup, transport, and disposal of the waste. If the generator cannot be determined, the District is responsible for proper disposal of the material.

7.5 NOTIFICATION PROCEDURES

The following agencies and people must be notified if any type of banned material is discovered during a screening procedure:

District Manager.....	(435) 259-3867
County Health Department.....	(435) 259-5602
David Ariotti, District Engineer, UDEQ.....	(435) 637-3671
Sheriff's Office.....	(435) 259-8115
Highway Patrol.....	(435) 259-5441

The persons or agencies contacted with the dates should be clearly recorded in the Daily Log.

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8. SAFETY

8.1 SAFETY EQUIPMENT

The following safety equipment is on-site at the landfill. It is the responsibility of all personnel to know where the equipment is located and how to use it properly.

8.1.1 Fire Extinguishers

The following fire extinguishers are to be kept on site during operating hours:

- Two 5-pound Powder-Sentry Fire Extinguishers attached to each piece of equipment.

- One 20-pound Powder-Sentry fire extinguisher is to be stored in the landfill gatehouse or in the District's on-site vehicle. In the event that the District delegates this responsibility to its contractor, the contractor shall maintain a 20-pound fire extinguisher on site.

8.1.2 Protective Gear

The following protective gear is to be kept on site during operating hours for use by Landfill Attendants or the District Manager:

- Earplugs;
- Safety glasses;
- Gloves;
- Hard hats;
- Two-way communication devices;

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- Safety shoes (steel-toed);
- Coveralls or long-sleeved shirts and full-length pants;
- Respirators or dust masks; and
- Fluorescent vests or jackets.

The District's contractor must maintain safety equipment on-site required by OSHA for general construction contractors and for all contractor personnel.

8.2 SAFETY PROGRAM

The District and any contractors of the District are responsible for obtaining the necessary training for their employees operating heavy equipment and working on a construction site. This training must comply with OSHA, and NIOSH regulations as applicable.

The District is responsible for maintaining a safe working environment. Periodic safety audits of District and contractor facilities will be performed by the District Manager.

8.3 EMERGENCY PROCEDURES

If an accident occurs, respond as directed by your supervisor. The following numbers may be useful in reporting an emergency:

EMERGENCY FIRE AND RESCUE	**911**
Fire Department	259-5557
Highway Patrol	259-5441
Sheriff's Office	259-8115
Hospital (Moab, Utah)	259-7191
Grand County Solid Waste Management Special Service District #1	259-3867

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WASTE INSPECTION REPORT

DATE: _____

TIME: _____

INSPECTOR: _____

LOCATION: _____

Hauler	License #	Time/Trans #	Vehicle	Material	Amount

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LANDFILL INSPECTION

DATE:_____

TIME:_____

INSPECTOR:_____

LOCATION:_____

Daily Cover_____

Litter_____

Public Access_____

Liquid Waste_____

Hazardous Waste_____

Asbestos Site_____

Transfer Station_____

Leachate_____

Stormwater_____

Roads_____

Intermediate Cover_____

Erosion_____

Other_____

_____

Repairs or Corrections_____

_____

Signed_____

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APPENDIX E

Financial Assurance and Mechanism Cost Estimates

2014 multiplier 1.014

SOLID WASTE SPECIAL SERVICE DISTRICT #1 --
KLONDIKE LANDFILL
ESTIMATED CLOSURE COST -- Revised for Annual Landfill Report Submitted 2014

ITEM NO.	ITEM	UNITS	$/UNIT	QTY	COST
1.0	**ENGINEERING**				
1.1	Topographic Survey	LS	$2,578	1	$2,578
1.2	Boundary Survey	LS	$2,113	1	$2,113
1.3	Site Evaluation	LS	$2,866	1	$2,866
1.4	Development of Plans	LS	$11,462	1	$11,462
1.5	Contract Administration, Bidding, and Award	LS	$2,113	1	$2,113
1.6	Administration Costs for Certification of Final	LS	$1,434	1	$1,434
	Cover and Affidavit to Public				
1.7	Project Management, Construction	LS	$14,329	1	$14,329
	Observation, and Testing				
1.8	Monitor Well				
1.9	Other Environmental Permit Costs				
	Subtotal				**$36,897**
	Contingency		10%		**$3,690**
	Total -- Engineering				**$40,587**
2.0	**CONSTRUCTION**				
2.1	Final Cover System	Acre		4	
2.1.1	Completion of Sidewall Liner				
2.1.1a	Soil Placement				
2.1.1b	Soil Processing				
2.1.1c	Soil Amendment				
2.1.1d	Soil Purchase				
2.1.1e	Soil Transportation				
2.1.2	Drainage Layer on Sidewall				
2.1.2a	Geotextile Filter Fabric				
2.1.2b	Geonet/Geotextile Composite				
2.1.2c	Geomembrane Sidewall Liner				
2.2	Completion of Top Cover				
2.2.1	Infiltration Layer				
2.2.1a	Soil Placement	Cu. Yd.	$ 3.61	19,360	$69,957
2.2.1b	Soil Processing (Compaction & Permeability Testing	LS	$ 13,913	1	$13,913
2.2.1c	Soil Amendment				
2.2.1d	Soil Purchase				
2.2.1e	Soil Transportation				
2.2.2	Flexible Membrane Cover				
2.2.2a	Drainage Layer on Top				
2.2.2b	Sand Layer				
2.2.2c	Geotextile Filter Fabric				
2.2.3	Drainage Layer				
2.2.3a	Geonet/Geotextile				
2.2.3b	Collection Pipe				
2.2.3c	Soil Cover				
2.2.3d	Geonet/Geotextile Composite				
2.2.3e	Gravel Capillary Barrier				
2.3	Erosion Layer Placement				
2.4	Revegetation	Acre	$ 574	4	$2,297
2.4.1	Seeding Included in 2.4				
2.4.2	Fertilizer Included in 2.4				
2.4.3	Mulch Included in 2.4				

2014 multiplier 1.014

SOLID WASTE SPECIAL SERVICE DISTRICT #1 --
KLONDIKE LANDFILL
ESTIMATED CLOSURE COST -- Revised for Annual Landfill Report Submitted 2014

ITEM NO.	ITEM	UNITS	$/UNIT	QTY	COST	
2.5	Site Grading and Drainage	LS	$ 2,866	1	$2,866	
2.6	Site Fencing and Security					
2.7	Leachate Collection System Completion					
2.8	Completion of Gas Monitoring System					
	Subtotal				**$89,034**	
	Contingency		10%		**$8,903**	
	Total Construction				**$97,937**	
3.0	**GAS COLLECTION SYSTEM**					
3.1	System Design					
3.2	Equipment Installation					
	Subtotal				**$0**	
	Contingency		10%		**$0**	
	Total Gas Collection				**$0**	
4.0	**MONITOR WELL INSTALLATION COST**					
4.1	Monitoring Well Installation					
4.2	Piezometer and Monitor Well Plugging					
	Subtotal				**$0**	
	Contingency		10%		**$0**	
	Total -- Ground Water Installation				**$0**	
	Calculation of Total Closure Costs					
	Total -- Engineering				**$40,587**	
	Total -- Construction				**$97,937**	
	Total -- Gas Collection				**$0**	
	Total -- Monitor Well				**$0**	
	Performance Bond		2.50%		**$3,463**	
	Subtotal				**$141,987**	
	Legal Fees		2.50%		**$3,550**	
	Total Closure Cost				**$145,537**	

6/19/2015 ST

SOLID WASTE SPECIAL SERVICE DISTRICT #1 -- KLONDIKE CLASS I LANDFILL
ESTIMATED POST-CLOSURE CARE COST
Revised For Annual Landfill Report Submitted 2014

ITEM NO.	ITEM	UNITS	$/UNIT	QUANTITY	COST
1.0	**ENGINEERING**				
1.1	Post-Closure Plan	LS	$1,434	1	$1,434
1.2	Site Inspection and Recordkeeping	Annual	$1,434	30	$43,023
1.3	Correctional Plans and Specifications				
1.4	Site Monitoring (semi-annual)				
1.4.1	Groundwater Monitoring				
1.4.1a	Groundwater Sample Collection				
1.4.1b	Groundwater Sample Analysis				
1.4.1c	Groundwater Sample Analysis and Review				
1.4.1d	Reporting				
1.4.2	Landfill Gas Monitoring				
1.4.2a	Gas Monitoring Date Collection				
1.4.2b	Gas Monitoring Date Review and Reporting				
2.0	**MAINTENANCE COSTS**				
2.1	Cover Maintenance Costs				
2.1.1	Soil Replacement	Annual	$646	10	$6,459
2.1.2	Vegetation Replacement	Annual	$430	10	$4,299
2.2	Equipment Maintenance				
2.2.1	Groundwater Well Maintenance and Replacement				
2.2.2	Gas Collection System Operation				
2.2.3	Gas Collection System Maintenance and Repair				
2.2.4	Leachate Collection System Operation				
2.2.5	Leachate Collection System Maintenance and Repair				
3.0	**LEACHATE DISPOSAL**				
4.0	**SITE MAINTENANCE**				
4.1	Repair of Surface Water Diversion Structures				
4.2	Repair of Fences and Gates	Hour	$20.58	240	$4,940
4.3	Other Site Maintenance				
	Calculation of Total Post-Closure Care Costs				
	Subtotal				**$60,156**
	Contingency		10%		**$6,016**
	Total -- Post-Closure Care				**$66,171**
	TOTAL CLOSURE AND POST-CLOSURE CARE COSTS				
	Total Closure Costs				**$145,537**
	Total Post-Closure Costs				**$66,171**
	Total Cost				**$211,708**

6/19/2015 ST

2014 multiplier 1.014

SOLID WASTE SPECIAL SERVICE DISTRICT #1

QUANTITIES RECEIVED, CLOSING COSTS, CLOSURE FUND BALANCES

KLONDIKE LANDFILL

2008 TONS RECEIVED	8964 TONS	CLOSING COSTS	$132,160.00	PTIF CLOSURE FUND BALANCE	$187,273.67
		POST-CLOSURE	$60,051.00		
2009 TONS RECEIVED	8618 TONS	CLOSING COSTS	$134,089.00	PTIF CLOSURE FUND BALANCE	$209,697.47
		POST-CLOSURE	$60,953.00		
2010 TONS RECEIVED	8920 TONS	CLOSING COSTS	$136,111.00	PTIF CLOSURE FUND BALANCE	$234,929.69
		POST-CLOSURE	$61,873.00		
2011 TONS RECEIVED	8655 TONS	CLOSING COSTS	$138,950.00	PTIF CLOSURE FUND BALANCE	$260,130.81
		POST-CLOSURE	$63,177.00		
2012 TONS RECEIVED	8782 TONS	CLOSING COSTS	$140,476.00	PTIF CLOSURE FUND BALANCE	$286,442.62
		POST-CLOSURE	$64,284.00		
2013 TONS RECEIVED	9121 TONS	CLOSING COSTS	$143,528.00	PTIF CLOSURE FUND BALANCE	$312,040.01
		POST-CLOSURE	$65,258.00		
2014 TONS RECEIVED	9610 TONS	CLOSING COSTS		PTIF CLOSURE FUND BALANCE	$337,636.91
		POST-CLOSURE			

GRAND COUNTY COUNCIL MEMBERS
Gene Ciarus (Chair) · Joette Langianese (Vice-Chair)
Audrey Graham · Bob Greenberg · Pat Holyoak
Jerry McNeely · Jim Lewis

August 6, 2008

Mr. Dennis R. Downs, Director
Division of Solid and Hazardous Waste
Utah Department of Environmental Quality
P. O. Box 144880
Salt Lake City, Utah 84114-4880

RE: Local Government Financial Test, Annual Submittal
Klondike Landfill, Class I, Permit #9509R1
Moab Landfill, Class IV, Permit #9704R1

Dear Mr. Downs:

As allowed by the Solid Waste Permitting and Management Rules, Utah Administrative Code, Grand County is submitting Local Government Financial Test information regarding its closure and post-closure cost financial assurance for the Klondike and Moab Landfills for the period ending December 31, 2008. Please find enclosed a copy of the County's most recent audited year-end financial statement.

1. These are the current cost estimates covered by a financial test for each of the calendar years ending 2005, 2006, and 2007 for Klondike Landfill and for Moab Landfill (figures provided by the Solid Waste Management Special Service District No. 1). The assurance is shared equally between Grand County and the City of Moab.

   For calendar year 2005:
   a. Klondike Landfill--$178,816.00 total, County share $89,408.00
   b. Moab Landfill--$127,728.00 total, County share $63,864.00

   For calendar year 2006:
   c. Klondike Landfill--$188,236.00 total, County share $94,118.00
   d. Moab Landfill--$129,995.00 total, County share $64,997.50

   For calendar year 2007:
   e. Klondike Landfill--$364,779.00 total, County share $182,389.50
   f. Moab Landfill--$133,283.00 total, County share $66,641.50

2. The following information is submitted according to the requirements of Section R315-309-8(2):

   a. R315-309-8(2)(a)
      Grand County has outstanding, uninsured general obligation bonds. Its bond rating is AAA as certified by Diana Carroll, County Clerk/Auditor.

   b. R315-309-8(2)(c)
      Grand County has its financial statements prepared in conformity with Generally Accepted Accounting Principles for governmental accounting. The independent certified public accounting firm of Smuin, Rich & Marsing, 47 North 100 East, Price, Utah 84501, audits these financial statements.

   c. R315-309-8(2)(d)
      The County will place a reference to the closure and post-closure costs assured through financial test in its financial statements.

3. The following information is submitted in accordance with R315-309-8(6)(b):

   Grand County assures two environmental obligations through a financial test, the Klondike Landfill and the Moab Landfill. As certified by Smuin, Rich & Marsing, the total that may be assured under both obligations, based on current estimates of approximately $249,031.00 does not exceed 43% of the County's annual revenue.

This letter does not obligate the County to any sort of ongoing financial commitment beyond December 31, 2008 and thus maintains the independence of the County and the District from one another. If you need additional information, please do not hesitate to contact my office.

Sincerely,

Gene L. Ciarus, Chair
Grand County Council

Enclosure: 2007 Financial Statement for Grand County
County Clerk Certification
Smuin, Rich & Marsing Certification

cc: Diana Carroll, Grand County Clerk/Auditor
Thomas Edwards, Solid Waste Management SSD #1, Facility Supervisor (all enclosures)

CITY OF MOAB
217 EAST CENTER STREET
MOAB, UTAH 84532-2534
MAIN NUMBER (435) 259-5121
FAX NUMBER (435) 259-4135

MAYOR: DAVID L. SAKRISON
COUNCIL: KYLE BAILEY
JEFFREY A. DAVIS
KEITH H. BREWER
GREGG W. STUCKI
ROB SWEETEN

September 7, 2006

Dennis R. Downs, Director
Division of Solid and Hazardous Waste
Utah Department of Environmental Quality
P.O. Box 144880
Salt Lake City, Utah 84114-4880

RE: Local Government Financial Test, Annual Submittal
Klondike Landfill Class I Permit Number 9509
Moab Landfill Class IV Permit Number 9704

Dear Mr. Downs:

As required by the Solid Waste Permitting and Management Rules, Utah Administrative Code, the City of Moab is submitting information to your office pertaining to the Local Financial Test for the Moab Landfill and Klondike Landfill closure and post-closure costs. Please find enclosed a copy of the city's Independent Auditor's Report Basic Financial Statements for Fiscal Year 2004-2005.

The current cost estimates for Moab City's portion of closure are $88,027 for the Klondike Landfill and $60,720.50 for the Moab Landfill – total closure estimate of $148,747.50 for Moab City.

The following information is submitted according to the requirements of the following:

Section R315-309-3 (7) (b):

1. The City of Moab has no outstanding General Obligation Bonds.
2. Please refer to page 36 of our audited financial statement for Fiscal Year 2005-2006 which outlines our financial assurance agreement with the Grand County Solid Waste District.
3. Moab City's financial statements are prepared according to generally accepted accounting principles as applicable to governmental units and our financial statements are audited by independent certified public accountants in accordance with government auditing standards.

Section R315-309-3 (7) (f):
The estimated total that may be assured under this agreement for both obligations is $148,747.50, which does not exceed 43% of Moab City total revenue of $6,445,081[1] for Fiscal Year 2004-2005.

I hope this letter provides adequate information. A copy of this letter and the appropriate enclosures will be filed in the operating records of the Moab Landfill and the Klondike Landfill. Please contact me at the above number should you require anything further.

Sincerely,

Donna J. Metzler
City Manager

kfd

Enclosure

cc: Bruce Keeler, Grand County Solid Waste Special Service District (w/encl.)

[1] June 30, 2005 Independent Auditor's Report, p.6, Governmental Funds Total revenues plus p.12 Proprietary Funds Total operating revenues.

GRAND COUNTY COUNCIL MEMBERS
Judy Carmichael (Chair) · Joette Langianese (Vice Chair)
Al McLeod · Jerry McNeely · Jim Lewis · Nate Knight · Rex Tanner

RECEIVED
MAR 2 5 2004
04.01362
UTAH DIVISION OF
SOLID & HAZARDOUS WASTE
Moab Landfill

March 18, 2004

Mr. Dennis R. Downs, Director
Division of Solid and Hazardous Waste
Utah Department of Environmental Quality
P.O. Box 144880
Salt Lake City UT 84114 –4880

RE: Local Government Financial Test, Annual Submittal
Klondike Landfill, Class I, Permit #9509R1
Moab Landfill, Class IV, Permit #9704R1

Dear Mr. Downs:

As required by the Solid Waste Permitting and Management Rules, Utah Administrative Code, Grand County is submitting Local Government Financial Test Information regarding its closure and post-closure cost financial assurance for the Klondike and Moab Landfills. Please find enclosed a copy of the County's most recent audited year-end financial statement.

1. These are the current cost estimates covered by a financial test (figures provided by the Solid Waste Management Special Service District #1). The assurance is shared equally between Grand County and the City of Moab.

    a. Klondike Landfill -- $167,155 total, County share $83,577.50.
    b. Moab Landfill -- $114,808 total, County share $57,404.00.

2. The following information is submitted according to the requirements of Section R315-309-3(7)(b):

    a. R315-309-3(7)(b)(i)

    Grand County has outstanding, uninsured general obligation bonds. Its bond rating is AAA as certified by Fran Townsend, County Clerk/Auditor.

    b. R315-309-3(7)(b)(ii)

    Not applicable

125 E. Center Street, Moab, UT 84532 · (435) 259-1346 · (435) 259-2574 Fax · council@grand.state.ut.us

c. R315-309-3(7)(b)(iii)

Grand County has its financial statements prepared in conformity with Generally Accepted Accounting Principles for governmental accounting. The independent certified public accounting firm of Sumin, Rich & Marsing, 47 North 100 East, Price, Utah 84501, audits these financial statements.

d. R315-309-3(7)(b)(iv)

The County will place a reference to the closure and post-closure costs assured through financial test in its financial statements.

3. The following information is submitted in accordance with F315-309-3(7)(f)

Grand County assures two environmental obligations through a financial test, the Klondike Landfill and the Moab Landfill. As certified by Smuin, Rick & Marsing, the total that may be assured under both obligations, based on current estimates approximately $140,981.50, does not exceed 43% of the County's annual revenue.

If you need additional information, please do not hesitate to contact my office.

Sincerely,

Judy Carmichael
Chairman

JC:jr

Enclosure: 2002 Financial Statement for Grand County
County Clerk Certification
Smuin, Rich & Marsing Certification

cc: Fran Townsend, Grand County Clerk/Auditor
Jane S. Jones, Solid Waste Mgmt. SSD#1, District Manager (all enclosures)

Amount in PTIF Closure Fund As of Dec 31, 2006

SOLID WASTE SPECIAL SERVICE DISTRICT #1							
CASH - PTIF ANALYSIS							
AUDIT 12-31-2006							
			INTEREST	RESERVE	DEBT	CLOSURE AND	GENERAL
		TRANSACTION	INCOME	FUND	SERVICE	POST CLOSURE	ACCOUNT
UTAH PUBLIC TREAS INVEST	DATE	AMOUNT	EARNED	FROM 1707	FROM 1708	FROM 1730	FROM 2016
ACCOUNT # 4109							
BEGINNING BALANCE	01-01-06	381,667.34	0.00	24,454.60	54,315.58	78,260.82	224,636.34
DEPOSIT	01/17/06	6,419.24		376.24	2,360.00	1,666.00	2,017.00
INTEREST - JANUARY	01/31/06	1,412.00	1,412.00				
DEPOSIT	02/10/06	6,419.24		376.24	2,360.00	1,666.00	2,017.00
INTEREST - FEBRUARY	02/28/06	1,353.69	1,353.69				
DEPOSIT	03/21/06	6,419.24		376.24	2,360.00	1,666.00	2,017.00
INTEREST - MARCH	03/31/06	1,567.22	1,567.22				
DEPOSIT	04/27/06	6,419.24		376.24	2,360.00	1,666.00	2,017.00
INTEREST - APRIL	04/30/06	1,594.12	1,594.12				
DEPOSIT	05/09/06	6,419.24		376.24	2,360.00	1,666.00	2,017.00
INTEREST - MAY	05/31/06	1,748.28	1,748.28				
DEPOSIT	06/13/06	6,419.24		376.24	2,360.00	1,666.00	2,017.00
INTEREST - JUNE	06/30/06	1,774.86	1,774.86				
DEPOSIT	07/10/06	6,419.24		376.24	2,360.00	1,666.00	2,017.00
INTEREST - JULY	07/31/06	1,903.87	1,903.87				
DEPOSIT	08/08/06	6,419.24		376.24	2,360.00	1,666.00	2,017.00
INTEREST - AUGUST	08/31/06	1,972.77	1,972.77				
DEPOSIT	09/01/06	6,419.24		376.24	2,360.00	1,666.00	2,017.00
INTEREST - SEPTEMBER	09/30/06	1,955.48	1,955.48				
DEPOSIT - EXTRA	10/11/06	70,000.00				30,000.00	40,000.00
DEPOSIT	10/11/06	6,419.24		376.24	2,360.00	1,666.00	2,017.00
INTEREST - OCTOBER	10/31/06	2,271.08	2,271.08				
DEPOSIT	11/07/06	6,419.24		376.24	2,360.00	1,666.00	2,017.00
INTEREST - NOVEMBER	11/30/06	2,337.53	2,337.53				
DEPOSIT	12/12/06	6,419.24		376.24	2,360.00	1,666.00	2,017.00
TRANSFER TO CHECKING	12/21/06	(31,846.00)		(3,325.00)	(28,521.00)		
INTEREST - DECEMBER	12/31/06	2,403.19	2,403.19				
TOTAL FOR THE YEAR		137,478.97	22,294.09	1,189.88	(201.00)	49,992.00	64,204.00
ALLOCATION INTEREST EARNED			(22,294.09)	1,340.64	2,563.25	5,746.98	12,643.22
		519,146.31	0.00	26,985.12	56,677.83	133,999.80	301,483.55
FOOTS							
TRACED TO PTIF ACCOUNTS - NOTING AGREEMENT TO AMOUNT OF DEPOSITS, DATES AND TRANSACTIONS.							

Solid Waste SSD #1
Balance Sheet
As of December 31, 2006

	Dec 31, 06
ASSETS	
Current Assets	
Checking/Savings	
1101 · Zions Bank Checking	98,053.94
1103 · Petty Cash - Office	220.05
1106 · Moab Landfill till	150.00
1104 · CD - Zions	40,726.52
1137 · PTIF #4019 - Consolidated	519,146.31
Total Checking/Savings	658,296.82
Accounts Receivable	
1310 · Accts Rec	
1311 · Moab Landfill Rec.	11,427.27
1312 · Klondike Landfill Rec.	16,398.21
Total 1310 · Accts Rec	27,825.48
Total Accounts Receivable	27,825.48
Other Current Assets	
1430 · Mineral Lease Funds	59,318.32
Total Other Current Assets	59,318.32
Total Current Assets	745,440.62
Fixed Assets	
1500 · Fixed Assets	
1501 · Furniture & Fixtures	665.00
1502 · Equipment & Tools	133,674.27
1503 · Automobiles	20,179.60
1504 · Land	247,575.83
1505 · Buildings	54,309.01
1506 · Recycling	10,374.00
1530 · Improvements	11,844.50
1540 · Moab Landfill	359,011.77
1560 · Klondike Landfill	575,774.03
1520 · Accumulated Depreciation	-559,498.14
Total 1500 · Fixed Assets	853,909.87
Total Fixed Assets	853,909.87
TOTAL ASSETS	**1,599,350.49**
LIABILITIES & EQUITY	
Liabilities	
Current Liabilities	
Accounts Payable	
2111 · A/P Account	23,779.39
Total Accounts Payable	23,779.39
Other Current Liabilities	
3200 · Accrued Interest Payable	1,188.87
2200 · Payroll Liab	
2211 · State Withholding UT	929.24
2216 · Utah UC Fund	331.32
Total 2200 · Payroll Liab	1,260.56
Total Other Current Liabilities	2,449.43
Total Current Liabilities	26,228.82

Solid Waste SSD #1
Balance Sheet
As of December 31, 2006

	Dec 31, 06
Long Term Liabilities	
3500 · Long Term Liab	
3501 · PCIB Loan	466,600.00
3502 · 2004 PCIB LOAN	51,000.00
Total 3500 · Long Term Liab	517,600.00
Total Long Term Liabilities	517,600.00
Total Liabilities	543,828.82
Equity	
3900 · Retained Earnings	863,032.91
Net Income	192,488.76
Total Equity	1,055,521.67
TOTAL LIABILITIES & EQUITY	1,599,350.49

Solid Waste SSD #1
Profit & Loss
January through December 2006

	Jan - Dec 06	
Ordinary Income/Expense		
Income		
4142 · Contribution from Other governm		470.47
4010 · Landfill Fee Income		
4011 · Moab Landfill Fees	148,725.09	
4012 · Klondike Landfill Fees	264,981.07	
Total 4010 · Landfill Fee Income		413,706.16
4140 · Fed Shared Rev		287,497.08
4013 · Interest Income		23,998.74
Total Income		725,672.45
Expense		
6100 · Sal/Ben		
6110 · Gross Wages		
6502 · Bonus/Mileage	1,872.96	
6110 · Gross Wages - Other	80,161.46	
Total 6110 · Gross Wages		82,034.42
6120 · Payroll Expenses		
6122 · Utah UC Fund	2,052.53	
6123 · Workers Comp	1,353.42	
6124 · Soc Security	4,970.01	
6125 · Medicare	1,162.34	
6126 · Utah Ret	7,259.14	
Total 6120 · Payroll Expenses		16,797.44
6130 · Emp Benefits-Health/Life		18,557.37
Total 6100 · Sal/Ben		117,389.23
6200 · Oper Exp		
6201 · Admn & Nonallocated		
6201.1 · Purchase Discounts	2,628.34	
6202.1 · Donations	3,000.00	
6226 · ProfServices-Accting/Consultant	1,850.00	
6202 · Landfill Vehicle Exp	463.94	
6203 · Other Travel/Meals	695.96	
6204 · Office Supplies	2,093.24	
6205 · PostOff/Ground Delivery	258.46	
6206 · Office Utilities	2,918.67	
6207 · Cellphones Empl	1,238.06	
6209 · Training	1,278.70	
6212 · Legal	844.47	
6213 · Audit/Financial Charges	4,408.42	
6214 · Advertising	207.38	
6215 · Pub Notice/Classified	148.50	
6218 · Auto Ins	396.76	
6219 · Pub Treas Bond Ins	185.00	
6219b · DM/Chair Bond 1997A	1,126.15	
6219c · DM/Chair Bond 2004	1,313.40	
6220 · Liability Ins	10,644.00	
6221 · Property Ins	281.37	
6224 · Memberships/Subscriptions	899.00	
6227 · Shop Exp/Supplies	754.86	
6229 · Community Cleanup	11,151.91	
6299 · Shop Utilities	649.44	
Total 6201 · Admn & Nonallocated		49,436.03

Solid Waste SSD #1
Profit & Loss
January through December 2006

	Jan - Dec 06	
6230 · ML		
6231 · ML Utilities/Phone	150.59	
6232 · ML Sup/Safety/Rec'ts	4,104.15	
6233 · ML Toilet	690.00	
6235 · ML Loader fuel/sup	634.23	
6236 · ML Dozer fuel/sup	16.55	
6241 · ML Cover/Operate	125,616.82	
6243 · ML Waste Tires Exp	13,850.00	
Total 6230 · ML	145,062.34	
6250 · KL		
6251 · KL Sup/Safety/Rec'ts	5,923.18	
6255 · KL Eng/Legal	1,600.00	
6256 · KL Cover/Comp	139,607.13	
6258 · KL Gate/Litter	10,964.15	
6259 · KL Utilities	1,067.09	
Total 6250 · KL	159,161.55	
Total 6200 · Oper Exp		353,659.92
6999 · Uncategorized Expenses		0.25
Total Expense		471,049.40
Net Ordinary Income		254,623.05
Other Income/Expense		
Other Expense		
2071 · Int Exp - ML		15.00
2072 · Int Exp -- KL		15,725.07
6380 · Transfers To Other Funds		
6403 · KL - Closure Fin Assurance	0.00	
6407 · Equipment Savings	0.00	
Total 6380 · Transfers To Other Funds		0.00
6400 · Bond Payments		
6405 · KL - Debt Serv 1997A Bond	0.00	
6409 · ML - Reserve 2004 Bond	0.00	
Total 6400 · Bond Payments		0.00
6500 · Asset Expenses		
6525 · KL Scale	0.00	
6510 · Landfills		
6526 · KL-Final Cover Cell 1	0.00	
6515 · ML Road Improvement	0.00	
6529 · KL Road Improvements	0.00	
Total 6510 · Landfills	0.00	
6530 · Office Trailer	0.00	
6570 · Depreciation Expense		
6571 · Deprec - Admin	18,954.37	
6572 · Deprec - Moab Landfill	6,305.11	
6573 · Deprec - Klondike Landfill	19,320.62	
Total 6570 · Depreciation Expense	44,580.10	
Total 6500 · Asset Expenses		44,580.10
6580 · Loss on Disposal of Fixed Asset		1,814.12
Total Other Expense		62,134.29
Net Other Income		-62,134.29
Net Income		**192,488.76**

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APPENDIX F

Analytical Data-Soil Permeability

FAX TRANSMITTAL SHEET
TAHOMA COMPANIES, INC., WDBE

444 S. Main Street, Suite C-7
Cedar City, Utah
(801) 865 0131 o FAX (801) 865 0161

Date: January 10, 1995

To: Mr. Paul Baginsky, P.E.
WESTON Environmental

FAX #: (303) 980 1622

From: Gary F. Player

Subject: The following are results of permeability testing for soils at the Grand County Landfill site, near Moab, Utah.

Number of Pages (including this Header): 4

Sincerely,

Gary Farnsworth Player
Principal Geologist
Registered California Geologist No. 4984

FAX To
Damsden
406-4[illegible]
include in
App. C ~~[illegible]~~
~~[illegible]~~
APP E

Dames & Moore

PERMEABILITY TEST BY BACK PRESSURE
CONSTANT HEAD (Pbp)

Owner TARMAC COMPANIES
Job # 29261-001
Location
Boring #
Sample # GRAND COUNTY
Depth 95% MDD at +3% OMC

Deflecting Speed 0 in/Hr Min
Lateral Pressure 3 PSF PSI
Saturated ☒ Field Moisture ☐
Set-Up 12/22/94 Tested 1/6/95 (Office)
Soil Type CL

	Initial	Final	
Weight soil & dish ne			
Dry weight soil & dish			
Net loss of moisture			
Weight of dish only			
Net weight of dry soil			
Moisture, % of dry weight	17.9	24.5	
Wt. solids + moisture	W_0 452.2	475.4	gms.
$W_0 \div 454$	W_0'		lbs.
Weight solids	W_s 381.9		gms.
Wet density $W_0' - V_0'$	124.7	128.6	pcf
Dry density	105.7	103.5	pcf
Net diameter	D_0 2.416		in.
Area ($0.785\ D_0^2$)	A_0 4.582	4.640	sq. in
Height	H_0 3.00	3.027	in.
Volume (A_0H_0) – 1728	V_0'		cu. ft.
Volume (A_0H_0) x 16.4	V_0 225.44	230.33	cc
Specific gravity of solids	G_s		
Volume of solids $W_s \div G_s$	V_s		cc
$(V_0 - V_s) \div V_s$	e_i		
Initial burette reading			cc
Burette reading under pressure			cc
$(V_p - V_s) \div V_s$	e_p		

$K_{AV} = 4.64 \times 10^{-8}$ cm/s

DAMES & MOORE

SATURATION DATA

PROJECT: TAHOMA NO.: 29261-001 LOCATION: Grand Co.

Boring No.: _____ Sample: Buck Depth: _____ (ft./m.) Set up: EEL 12/22/94

σ_3 = 3 psi = _____ psf Type of Test: Pop Cell No.: _____ Dial No.: _____

DATE	TIME CLOSED	TIME OPEN	CHAMBER PRESSURE (PSI)	BACK PRESSURE (PSI)	EXTERNAL BURETTE OR DIAL RDG. (CC)/(IN.)	PORE PRESSURE (PSI)	Δ	B
12/22/94	1147	1148	0/5	0 4/4 closed	.039 / .039	0.0 / 0.3	.3/5	
	1358	1359	5/10	0 9/9 closed	— / —	4.0 / 6.5	2.5/5	
	1449	1453	10/15	0 14/14 closed	— / —	9.0 / 12.4	3.4/5	
	1513	1514	15/20	0 19/19 closed	— / —	14.0 / 17.9	3.9/5	
	1551	1552	20/25	0 24/24 closed	— / —	19.0 / 23.2	4.2/5	
	1612	1613	25/30	0 29/29 closed	— / —	24.0 / 28.4	4.4/5	
	1730		30/35	~~0 34~~ closed	— / —	29.0 / 33.9	4.9/5	
			35/37	closed	— / .045	/		
12/22	1731	0	37	0 34/34	.045 /	/		
	0721				.047 /	/		
	0722	0	37	0 34/34	/ 15.1	/		
	0910				/ 14.1	/		
	1103	113			/ 13.5	/		
	1713	370			/ 12.4	/		
12/24/94	0628	795			/ 11.6	/		
	0943	195			/ 11.5	/		
					/	/		
					/	/		
					/	/		
					/	/		
					/	/		
					/	/		
					/	/		
					/	/		
					/	/		

PERMEABILITY TEST BY BACK PRESSURE CONSTANT-HEAD

Tahoma Companies, Inc

Sample from Grand County
Remold 95 % Mdd at + 3% omc
Mdd = 111.3 pcf, Omc = 15.9 %

	Initial	Final
Wet Density pcf	124.7	128.8
Dry density pcf	105.7	103.5
% Moisture	17.9	24.5

Height Initial	3.000		450.2 Wet soil and dish
Diameter Initial	2.416		381.9 Dry soil and dish
Area Initial	4.582		0 dish only
Volume Initial	225.44		450.2 Ws Initial
Initial dial	0.333		475.4 Final Ws
Final dial	0.306		381.9 Weight solids
Initial cc/in res	0.03		
Final cc/in res.	0.047		
Height Final	3.027	7.689 cm	
Diameter Final	2.431		
Area Final	4.640	29.958 cm^2	
Volume Final	230.33		
Height change	0.027		
cc/in reser.	0.013		
Volume change	-1.30769		
Cell Change	6.2	@ 37 psi	
Net Volume Change	4.892308		
h= T/B PREss. diff	3	210.30 cm	

Standard Water .005 N CaSO4

Hydraulic Gradient
27.35

Elapsed Time minutes	cc's	K cm/sec
113.00	0.60	1.01E-07
370.00	1.10	5.63E-08
795.00	0.80	1.91E-08
195.00	0.10	9.71E-09

K Average = 4.64E-08 cm/s

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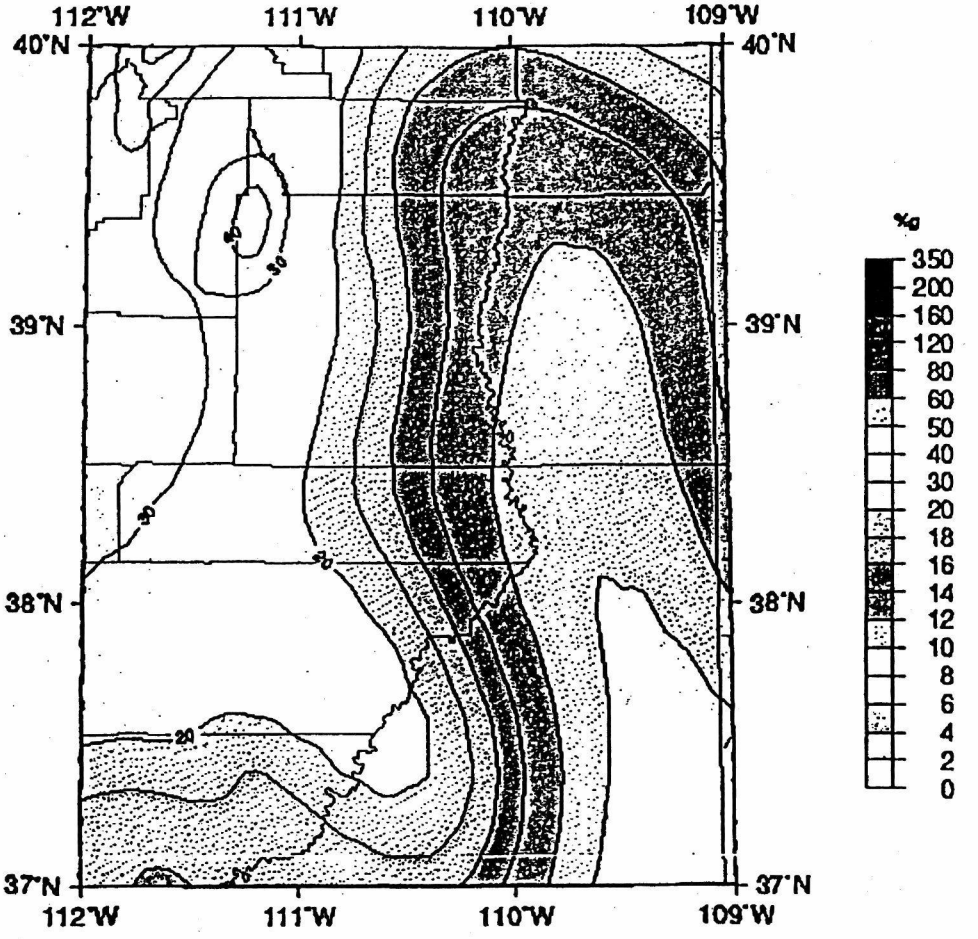
APPENDIX G

Map of Probable Horizontal Accelerations

USGS Earthquake Hazards Program - ...mic Hazard Mapping Project d

CUSTOM MAPPING OUTPUT

The map below is a greatly reduced version of the map you generated, designed to fit on a web page. If these parameters look good for your final version and you want a full size printable postscript version click below



Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years
site: NEHRP B-C boundary
U.S. Geological Survey
National Seismic Hazard Mapping Project

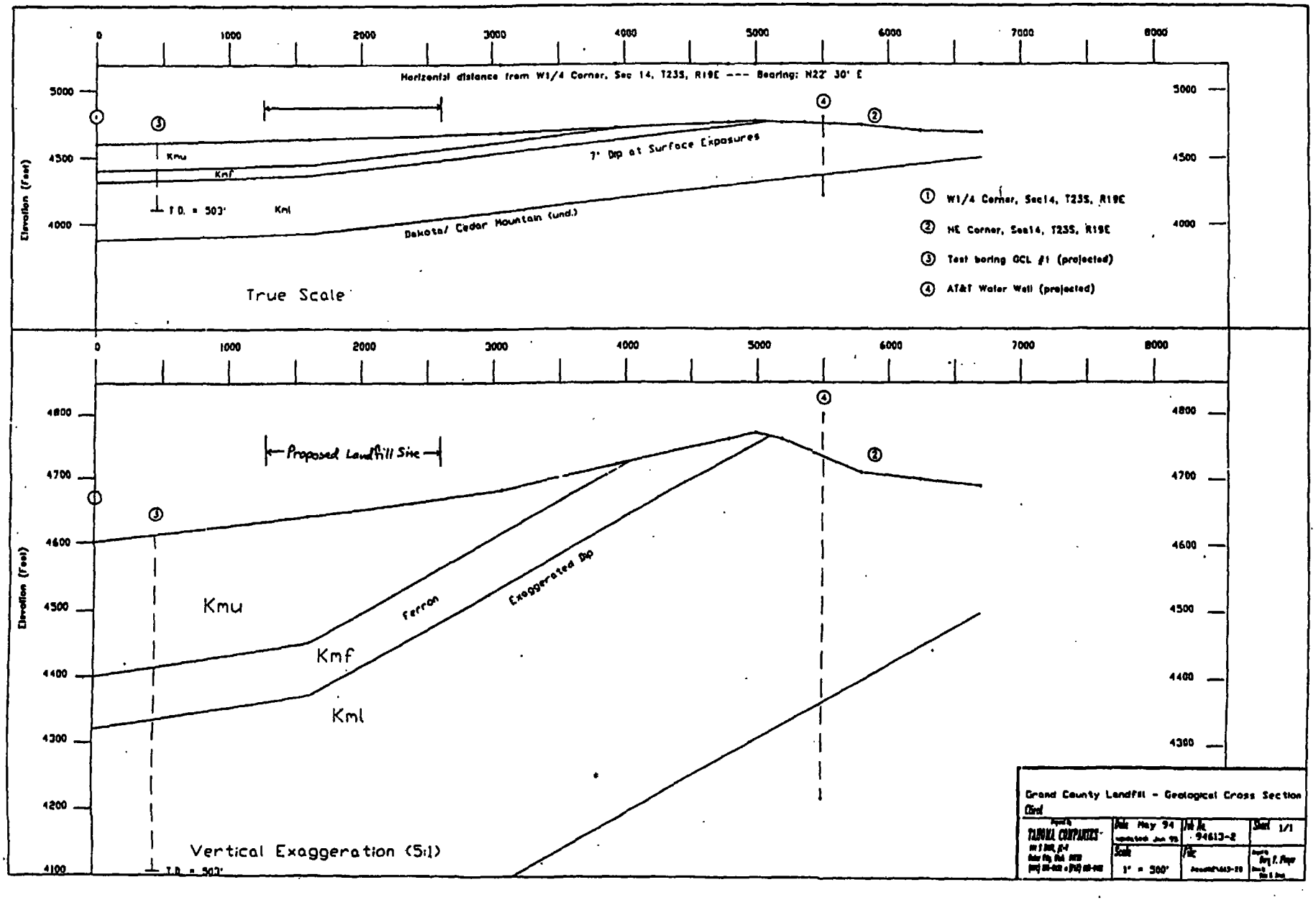
POSTSCRIPT VERSION

PROJECT INFO: Home Page
HAZARD MAPS: Custom Mapping

KLEINFELDER
Bright People. Right Solutions.

APPENDIX H

Geologic Cross Sections



Horizontal distance from W1/4 Corner, Sec 14, T23S, R19E --- Bearing: N22° 30' E
Elevation (Feet)
Kmu
Kmf
Kml
T.D. = 503'
7° Dip at Surface Exposures
Dakota/ Cedar Mountain (und.)
① W1/4 Corner, Sec14, T23S, R19E
② NE Corner, Sec14, T23S, R19E
③ Test boring GCL #1 (projected)
④ AT&T Water Well (projected)
True Scale
Proposed Landfill Site
Ferron
Exaggerated Dip
Vertical Exaggeration (5:1)
Grand County Landfill - Geological Cross Section
Client
TAHOMA COMPANIES
Date May 94
Job No. 94613-2
Sheet 1/1
Scale 1" = 500'
File

TAHOMA COMPANIES, INC.
WDBE

MEMORANDUM

TO: Mr. Paul Baginsky, WESTON

FROM: Gary F. Player

DATE: November 2, 1994

SUBJECT: RECENT GEOTECHNICAL STUDIES, GRAND COUNTY LANDFILL

We have completed the requested 37 test pits at the proposed Grand County Landfill site north of Moab. Twenty of the pits were excavated and logged on October 25, while the remainder (17) were excavated and logged on October 26, 1994.

Three basic units are present at the site.

The three units, from top down, are:

1. Silty sands (SM) at the surface and extending to depths of about 0.5' to 2.5' below ground level. The average thickness is 1 foot. This material is of alluvial (water carried) and\or eolian (wind blown) origin. The sands are loose where dry, and slightly cohesive where damp. Gypsum cement locally makes the sand friable rather than loose, but it is everywhere soft enough to excavate with a Case 580D backhoe.

2. Deeply weathered Mancos Shale that classifies as CL or SC. This material is present to depths of about five feet below ground. It has weathered in place and is soft and easily excavated.

3. Less weathered to virtually fresh Mancos "shale" bedrock. Most of this material is blocky, fractured mudstone and siltstone, with lesser amounts of weathered sandstone.

Engineering Implications

All of the materials are easily excavated, except for blocky mudstones of the Mancos Shale unit at the three most southwesterly test pits (21, 32 and 33. There the mudstones become very hard below eight feet. These three test pits are in areas slated for future expansion.

TAHOMA COMPANIES, INCORPORATED ♦ WDBE
444 South Main Street, Suite C-7
Cedar City, Utah 84720
(801) 865-0131 fax 865-0161

LOCATION: SE NW, SECTION 14, T19S, R23E, Moab, Utah

Note: Test pit locations are approximations and are for review purposes only. The perimeters of the tract and actual test pit locations should be determined by a registered land surveyor.

Log of Test Pits

Test Pit No.	Depth	Soil Description
P-1	0 - 2.5'	SM, gray, cohesive, friable Easily excavated.
	2.5'- 8.5'	Bedrock, Mudstone, blocky weathering, dark gray, fractured. Easily excavated with backhoe. Common shell molds- "Inoceramus." Thin (1-2") interbeds of site, light tan to Orange.
P-2	0 - 2'	SM, medium grained, brown, soft, cohesive, moist.
	2'- 3'	Shale, very soft, clayey, dark gray.
	3'- 10'	Shale, competent, fractured, easily excavated except for thin cemented streaks. Gray to dark gray Mancos. Microcrystalline white gypsum along fracture surfaces. fossil fragments - molluscs, hard below 9.5'.
P-3	0 - 1.5'	SM, med grained , trace coarse sand and granules, damp, cohesive, dark brown soft.
	1.5' - 3'	Shale, dark gray, soft, clayey, gypsiferous, trace orange siltstone and bentonite shale.
	3' - 11'	Shale, gray to dark gray, blocky weathering. common mollusc molds, gypsum in fractures, competent, but easily excavated with case 580D hoe. thin, fine sandy streaks (<.5") are deeply weathered, loose, tan below 8', common shell material below 10'. T.D. @ 11'.
P-4	0 - 2'	SM, med to coarse grained, tan, cohesive.
	2' - 3.5'	Clay, dark gray, sandy, soft.
	3.5' - 9'	Mancos shale, gray to dark gray, paper thin fragments in upper one foot of unit; blocky below. Common shell fragments. easily excavated. T.D. 9'.

Test Pit No.	Depth	Soil Description
P-10	0 - 2'	SM, tan, cohesive, very soft to loose. Gypsiferous and darker gray locally in lowermost 6'- no continuous gypsum cement.
	2' - 3.5'	Clay, gray to dark gray, soft, gypsiferous.
	3.5' - 9'	Mancos "shale" - actually a blocky mudstone, dark gray, cemented with gypsum and calcite. Easily excavated because of fractures, but locally breaks in large chunks (3"x 24"x 16") caves readily from fracturing T.D. 9'.
P-11	0 - .5'	SM, tan, loose.
	.5' - 10'	Mancos "shale" - mostly siltstone and limestone, dark gray, weathers blocky along fractures, common fossil molds and shell fragments. Cemented with gypsum from 1.0'-2.0' below surface. Loose fractured blocks with silt soil in fractures. Sloughs readily into hole. T.D. 10" .
P-12	0 - 1'	SM, loose.
	1' - 3.5'	Clay, gray brownish gray, soft, dry, trace gypsum cement in uppermost foot (1'-2').
	3.5' - 8'	Mancos "shale", mostly siltstone and mudstone, tan, deeply weathered, fractured. Easily excavated. Lenses of course sandstone cemented with siderite, weathered to limonite Common fossil molds and shell fragments (possible Ferron).
	8' - 10'	Mancos mudstone, dark gray, does not cave. Easily excavated. T.D. 10'.
P-13	0 - 1.5'	SM, tan, loose.
	1.5' -3.5'	Clay, dark gray, banded with gypsum.
	3.5' - 8'	Mancos "shale", blocky mudstone, fractured, caves readily, gray to dark gray, easily excavated.
P-14	0 - 1.5'	SM, tan, slightly cohesive to loose, fine to medium grained sand, cemented locally with gypsum in lower .5' (1-1.5).
	1.5' - 3'	Clay, dark gray, laminated with gypsum cemented light colored zones. soft, damp.
	3' - 10'	Mancos shale, dark gray-brown and dark gray siltstones, mudstones and shales. Fractured, blocky, common shell mold and some original shell material (calcite). Easily excavated. Lenses of orange to tan sandstone, slight bituminous odor in black shales. T.D. 10'.

Test Pit No.	Depth	Soil Description
P-21	0 - 1'	SM.
	1' - 3.5'	Clay, dark gray, banded with light gray gypsum.
	3.5'- 11.5'	Mancos "shale" 6 inch streak of sandstone from 6'-6'6", blocky, easily excavated. T.D. 11.5'.
P-22	0 - 1'	SM, gray brown, loose, dry.
	1' - 4'	Clay, dark gray-brown, gypsiferous.
	4' - 8.5'	Mancos "shale", blocky mudstone, fractured, gray to dark gray. Becomes difficult to excavate below eight feet. Backhoe refusal on hard mudstone bedrock @ 8.5'. Not many fossils, especially compared to Ferron sandstone member. T.D. 8.5'.
P-23	0 - 1'	SM, tan to brown, slightly cohesive to loose.
	1' - 3.5'	Clay, gray-brown to gray, banded with microcrystalline gypsum, soft.
	3.5' -9.5'	Mancos shale, gray to dark gray, blocky, easily excavated. Common large cephalopod fragments. T.D. 9.5'.
P-24	0 - 1'	SM, dark brown, cohesive, damp, soft.
	1' - 3.5'	Clay (CL), dark gray to dark gray-brown, banded with light gray gypsum.
	3.5' - 10'	Mancos shale, dark gray-brown to dark gray, fractured, breaks into thin shaley fragments, easily excavated, common fossil impressions.
P-25	0 - 2'	SM, tan to brown, loose, dry.
	2' - 4'	Clay, dark gray-brown, soft, deeply weathered shale.
	4' - 10'	Mancos "shale" - flaggy siltstone, light gray and blocky mudstone. Easily excavated due to common fractures. T.D. 10'.
P-26	0 - 1.5'	SM, gray-brown, cohesive, damp, soft, gypsiferous.
	1.5' - 2.5'	SC/CL, banded brown, gray and light gray, cohesive, soft.
	2.5' - 11'	Mancos shale, dark gray, papery to blocky, common shell fragments and fossil molds. Some gray-brown siltstone, fractured, easily excavated.

Test Pit No.	Depth	Soil Description
P-34	0 - 1.5'	SM, dark gray-brown, cohesive, damp.
	1.5' - 3'	SC/CL, dark gray, banded with gypsum.
	3' - 6'	Mancos shale, dark gray, fractured, easily excavated.
	6' - 7'	Mancos mudstone, hard, broke through into looser, fractured shale and siltstone below.
	7' - 10'	Mancos siltstone, fractured; gypsum coating along fractures. Easily excavated, T.D. 10'.
P-35	0 - 1'	SM, gray-brown.
	1' - 3'	SC/CL, banded gray-brown and light gray-brown, soft cohesive.
	3' - 8'	Mancos "shale", dark gray-brown siltstone with thin laminae of light gray ss., common fossil fragments, including large cephalopods to 1' in diameter. Rare siderite cemented concretions. Easily excavated.
P-36	0 - 1'	SM.
	1' - 8'	Mancos "shale", deeply weathered siltstone, gray and sandstone, fine grained, white to light gray, with black papery shale. Easily excavated. T. D. 8'.
P-37	0 - 1'	SM, brown, loose.
	1' - 3.5'	SC/CL, gray-brown, cohesive, cemented partially with gypsum, banded appearance.
	3.5' - 8'	Mancos shale, weathered, fractured, dark gray-brown siltstone and gray mudstone. Easily excavated.

FILE: TT 11-H\TESTPIT.TBL

TAHOMA COMPANIES, INCORPORATED ♦ WDBE
444 South Main Street, Suite C-7
Cedar City, Utah 84720
(801) 865-0131 fax 865-0161

October 18, 1994

Mr. Paul Baginsky
WESTON Environmental
215 Union Boulevard
Lakewood, CO 80228-1842

SUBJECT: **DRILLING RESULTS, GRAND COUNTY LANDFILL**

Dear Paul:

We successfully completed a test boring along the western edge of the proposed Grand County Landfill (GCL) on October 3, 1994. Total depth of the test boring (GCL #1) was 503 feet, measured from the Kelly Bushing, 5.5 feet above ground level. No water was encountered in the test boring.

GCL #1 was started in the upper, or Blue Gate Member of the Mancos Shale. It continued in the Blue Gate until it entered the Ferron Sandstone Member of the Mancos Shale at about 200 feet. The Ferron Sandstone Member was present from about 200 to 270 feet. Thin sandstones in the Ferron were totally cemented with calcite (calcium carbonate) and contained no water. Drilling then continued to total depth of 503 feet in gray siltstones and dark gray shales of the lower, or Tununk Member of the Mancos Shale.

The location was about 550 feet north and 250 feet east from the west quarter corner of section 14, T. 23 S., R. 19 E. The enclosed boring log shows only the approximate location of the test boring--the location will be surveyed after excavation of the test pits next week. The drillsite was within the northeastern portion of a 100' X 100' staked area that had been "cleared" for our use by the Bureau of Land Management.

Sincerely,

Gary F. Player

Gary F. Player, Principal Geologist
Tahoma Companies, Inc.
Registered California Geologist No. 4984

FILE:DOCUMENT\WESTON\GCL#1.LET

TAHOMA COMPANIES, INCORPORATED

LOG OF TEST BORING GCL–1 DATE DRILLED: OCTOBER 3, 1994

IOB NUMBER 613–2 GRAND COUNTY LANDFILL

FROM	TO	t1	t2	TIME	LITHOLOGY AND COMMENTS
0	23	11:21	11:28	18	SHALE, DARK GRAY, SLI. SILTY, TR. GYPSUM. MANCOS SHALE. WIND FROM S. AT 10 MPH CLOUDY, COOL. 8.5" SURFACE HOLE.
23	43	12:11	12:21	10	SHALE, AS ABOVE, SILTY
43	63	12:31	12:44	13	SHALE, AS ABOVE, SILTY
63	83	12:56	13:09	13	SHALE, DK. GRAY, LOCALLY FRACTURED AND WEATHERED TO LIGHT GRAY CLAY.
83	103	13:18	13:32	14	SHALE, DK. GRAY, SILTY, HARD
103	123	13:38	13:51	13	SHALE, AS ABOVE
123	143	13:58	14:11	13	SHALE, AS ABOVE
143	163	14:17	14:30	13	SHALE, AS ABOVE, TRACE SHELL FRAGMENTS
163	183	14:35	14:49	14	SHALE, DARK GRAY, SHELL FRAGMENTS
183	203	14:57	15:10	13	SHALE, AS ABOVE, BUT TRACE SAND GRAINS. SANDSTONE, WHITE, V. FINE GRAINED, CALCITE CEMENT, TIGHT, DRY, BELOW 200'
203	223	15:17	15:30	13	SHALE, DK. GRAY TO GRAY, TR. SAND
223	243	15:38	15:50	12	SHALE, DK. GRAY, NO SAND
243	263	15:57	16:11	14	SHALE, AS ABOVE. SANDY FROM 258–263: SANDSTONE V. FINE GRAINED, WHITE, DRY, TIGHT
263	283	16:17	16:29	12	SILTSTONE, LT. GRAY TO GRAY, AND SHALE
283	303	16:36	16:48	12	SILTSTONE, LIGHT BLUISH GRAY
303	323	16:54	17:07	13	SILTSTONE, LIGHT BLUISH GRAY
323	343	17:12	17:26	14	SILTSTONE, MED. TO DARK GRAY
343	363	17:31	17:43	12	SILTSTONE, TRACE DARK GRAY SHALE
363	383	17:48	18:01	13	SILTSTONE, DARK BLUISH GRAY
383	403	18:06	18:19	13	SILTSTONE, TRACE DARK GRAY SHALE
403	423	18:24	18:33	9	SILTSTONE, AS ABOVE. INCREASED RPM
423	443	18:38	18:49	11	SILTSTONE, DARK BLUISH GRAY
443	463	18:54	19:04	10	SILTSTONE, AS ABOVE
463	483	19:09	19:21	12	SILTSTONE, AS ABOVE
483	503	19:27	19:40	13	SILTSTONE, AS ABOVE

TOTAL DEPTH:	503	FEET
TOTAL DRILLING TIME:	317	MINUTES
AVE. DRILLING RATE:	0.630	MINUTES PER FOOT
AVE. DRILLING RATE:	95.20	FEET PER HOUR

TOTAL DEPTH: 503 FEET
NO WATER ENCOUNTERED

~PTHS MEASURED FROM KELLY BUSHING, 5.5 FEET ABOVE GROUND LEVEL

LOGGED BY: GARY F. PLAYER, REGISTERED GEOLOGIST

GCL #1

Sheet 1 of

date 10/3/94

From time ①	To	Time ②	Δt	Lithology / Comments
~~0~~ 11:10	23	K.B. 11:28	18	Shale, dark gray, sli silty. Trace gypsum. Mancos
(~~8 1/4~~ 8 1/2" surface hole)				Wind out of south @ 10 mph. Cloudy, cool.

Measured depths from Kelly Bushing, 5'6" above ground level.

6 1/4" bit now on bottom @ 23'

From	T①	To	T②	Δt		Rate
23	12:11	43	12:21	10	Shale, as above, silty	120 ft/hr
43	12:31	63	12:44	13	" " "	92 ft/hr
	12:56	83	13:09	13	Shale, locally fractured and weathered to light gray clay.	
83	13:18	103	13:32	14	Shale, dark gray, silty, hard	85 ft/hr
103	13:38.5	123	13:51.5	13	" " " " "	92 ft/hr
123	13:58	143	14:11	13	" " " " "	92
143	14:17.5	163	14:30.5	13	" " " " "	92
					Trace Inoceramus fragments	
163	14:35	183	14:49	14	Shale, dark gray, shell frags. (85'	
183	14:57	203	15:10	13	as above, one sand grain: Below 200', Sandstone, white, calcareous, v-f. grained, tight, dry.	
[illegible]	15:17.5	223	15:30.5	13	Shale, gray to dark gray, trace ss	
2	5:38	243	15:50	12	Shale, dk gray, no sand.	100
43	15:57.5	263	16:11	13.5	Shale: sandy from 258-263. Sandstone v.fine grained, white	

KLEINFELDER
Bright People. Right Solutions.

APPENDIX I

Location Standards Letters

FILE COPY

TAHOMA COMPANIES, INCORPORATED WDBE
444 S. MAIN STREET, SUITE C-7
CEDAR CITY, UTAH 84720
(801) 865 0131 FAX (801) 865 0161

September 20, 1994

Mrs. Mary Von Koch
U.S. Bureau of Land Management
Grand Resource Area
885 South Sand Flats Road
Moab, Utah 84532

Dear Mrs. Von Koch:

Thank you for your useful advice on wilderness issues associated with landfill licensing given in our telephone conversation this morning.

You and I briefly discussed the Grand County Landfill (GCL) near Moab, Utah. The GCL is located west of U.S. Highway 191 in section 14, T. 23 S., R. 19 E., SLB&M. The landfill site has been selected for transfer of ownership from the BLM to Grand County Special Services District No. 1, and must now be licensed under new state regulations effective September, 1993.

You informed me that the GCL is not located within a designated wilderness or wilderness study area. The landfill site is not within 1,000 feet of any national, state or county park, monument, or recreation area; designated wilderness or wilderness study area; or wild and scenic river area.

It is our opinion that the GCL will not impact wilderness or recreation areas.

Thanks again for the prompt advice from your agency. Tahoma Companies will soon be involved in license applications for several other Utah landfills. It is nice to know where we can get help on wilderness area issues so readily.

Sincerely,

Gary F. Player

Gary F. Player
Principal Geologist

File:WP51\DOCUMENTS\WESTON\USBLMLTR

TAHOMA COMPANIES, INCORPORATED
NOTES TO FILE

DATE: May 23, 1994
JOB NUMBER: 613-2
SUBJECT OR TASK: Threatened and Endangered Species at GCL

Today I spoke by telephone with Mr. Larry England of the U.S. Fish and Wildlife Service about possible T&E issues at the GCL. I mentioned two potentially problematic species: (1) Jones Cycladenia *(Cycladenia humilis, var. jonesii)* and (2) Spineless Hedgehog Cactus *(Echinocereus triglochidiatus, var. inermis)*.

Both of these are terrestrial plants.

The Spineless Hedgehog Cactus has been removed from the list of T&E species.

The Cycladenia grows only on Chinle Shale outcrops and is present north and east of Moab. This plant does not occur on Mancos shale because of the alkaline nature of residual soils.

No fish species will be effected because of the death of perennial or even intermittent streams on the GCL site.

Raptors will not be effected because there are no trees for potential nesting sites. I should explore all of the hogbacks on the property to look for nesting sites. I will also be on the lookout for nesting sites on the Ferron Sandstone outcrop when I measure the section. I will measure the section off the GCL property to the east in order to project rock types into the proposed location of one or more monitor wells.

File · TT 11\GCL NOTE1

TAHOMA COMPANIES, INCORPORATED
NOTES TO FILE

DATE: May 23, 1994
JOB NUMBER: 613-2
SUBJECT OR TASK: Threatened and Endangered Species at GCL

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File · TT 11\GCL NOTE1

FILE COPY

TAHOMA COMPANIES, INCORPORATED WDBE
444 S. MAIN STREET, SUITE C-7
CEDAR CITY, UTAH 84720
(801) 865 0131 FAX (801) 865 0161

September 20, 1994

Mr. Kyle "Jake" Jacobson
Utah Department of Agriculture
350 North Redwood Road
Salt Lake City, Utah 84116

Dear Jake:

Thanks again for another beneficial discussion of Important Farmland issues associated with landfill licensing yesterday afternoon. We briefly discussed the Grand County Landfill (GCL) near Moab, Utah. The GCL is located west of U.S. Highway 191 in section 14, T. 23 S., R. 19 E., SLB&M. It must now be licensed under new state regulations effective September, 1993.

At your suggestion, I have reviewed Utah Agricultural Experiment Station Research Report Number 76, "Important Farmlands of parts of Carbon, Emery, Grand and Sevier Counties." I have concluded that no classified "Important Farmlands" are present at the proposed Grand County Landfill.

Thanks again for your help.

Sincerely,

Gary F. Player
Principal Geologist

File:WPS1\DOCUMENTS\WESTON\UDGALTR

State of Utah

Department of Community & Economic Development
Division of State History
Utah State Historical Society

Michael O. Leavitt
Governor
Max J. Evans
Director

300 Rio Grande
Salt Lake City, Utah 84101-1182
(801) 533-3500
FAX: (801) 533-3503

September 29, 1994

OCT 03 1994

Gary F. Player
Principal Geologist
Tahoma Companies, Incorporated WDBE
444 South main Street, Suite C-7
Cedar City, Utah 84720

RE: Grand County Landfill

In Reply Please Refer to Case No. 94-0606

Dear Mr. Player:

The Utah State Historical Preservation Office received the above referenced project on September 26, 1994. After review of the material provided, the Utah Preservation Office recommends that there would be No Effect upon cultural resources by the project.

This information is provided on request to assist Grand County with its Section 106 responsibilities as specified in 36CFR800. If you have questions, please contact me at (801) 533-3555. My computer address on internet is:
internet:cedomain.cehistry.jdykman@email.state.ut.us

Sincerely,

James L. Dykmann
Compliance Archaeologist

JLD:94-0606 BLM/NP/NE

Board of State History: Marilyn C. Barker • Dale L. Berge • Boyd A. Blackner • Peter L. Goss
David D Hansen • Carol C. Madsen • Dean L. May • Christie Needham • Thomas E. Sawyer • Penny Samonne • Jerry Wo

FILE COPY

TAHOMA COMPANIES, INCORPORATED
444 S. MAIN STREET, SUITE C-7
CEDAR CITY, UTAH 84720
(801) 865 0131 FAX (801) 865 0161

September 20, 1994

Mr. Phillip Ashbaker
Director
Utah Division of Aeronautics
135 N 2400 W
Salt Lake City, Utah 84116

Dear Mr. Ashbaker:

Our company is currently applying for a license for the proposed Grand County Landfill under new Utah state regulations. I spoke on the telephone with your administrative assistant today.

She and I briefly discussed the proposed Grand County Landfill (GCL) near Moab, Utah. The GCL is located west of U.S. Highway 191 in section 14, T. 23 S., R. 19 E., SLB&M. Grand County has operated a landfill in Moab for several years, but must now license a new location under new state regulations effective September, 1993.

The following information is pertinent to the license application:

> The facility is not within ten thousand feet of any airport runway end used by turbojet aircraft or within 5,000 feet of any airport runway end used only by piston-type aircraft.

Tahoma Companies will soon be involved in license applications for several other Utah landfills. It is nice to know where we can get help on aviation issues.

Please contact us if you have any comments concerning this landfill license application.

Sincerely,

Gary F. Player

Gary Farnsworth Player
Principal Geologist
Registered California Geologist No. 4984

File:WP51\DOCUMENTS\WESTONAIR.LET

FILE COPY

TAHOMA COMPANIES, INCORPORATED WDBE
444 S. MAIN STREET, SUITE C-7
CEDAR CITY, UTAH 84720
(801) 865 0131 FAX (801) 865 0161

September 20, 1994

Mr. Jim Dykmann
Compliance Archaeologist
Utah Division of State History
300 Rio Grande
Salt Lake City, Utah 84101-1182

Dear Jim:

Thank you for your help last spring in our discussion of archaeological issues associated with landfills. At your suggestion, I am now requesting a consultation with your Division for the proposed Grand County Landfill (GCL) near Moab, Utah.

The GCL is located west of U.S. Highway 191 in section 14, T. 23 S., R. 19 E., SLB&M. The landfill site has been reviewed by archaeologists for the U.S. Bureau of Land Management preparatory to transfer of ownership from the BLM to Grand County Special Services District No. 1, and must now be licensed under new state regulations effective September, 1993.

It is my opinion that this area will not require additional field site archaeological clearances for the following reasons:

(1) The lands have been inspected by BLM archaeologists;

(2) No water courses or impoundments occur on the property; and

(3) No registered Historic Places have been identified within a mile of the landfill site.

I look forward to your comments on this site.

Sincerely,

Gary F. Player
Principal Geologist

Enclosure: Topographic Map of Emery County Landfill site.

File:MPS1\DOCUMENTS\WESTON\SKPOLETR

FILE COPY

TAHOMA COMPANIES, INCORPORATED ♦ WDBE
444 South Main Street, Suite C-7
Cedar City, Utah 84720
(801) 865-0131 fax 865-0161

November 7, 1994

Ms. Terry Nixon
Grand County Solid Waste Management Special Services District No. 1
P.O. Box 980
Moab, Utah 84532

SUBJECT: **ZONING AT PROPOSED LANDFILL SITE: NEED FOR CONDITIONAL USE PERMIT**

Dear Terry:

I have spoken by telephone with Debbie Hilger and Jeff Whitney of the Grand County Building Department. They told me the following:

1. The proposed landfill site is zoned G-1 (grazing);

2. Landfilling is not a specified use in zone G-1;

3. "All other uses" may be allowed, but only by application to the Board of Adjustment.

I told Jeff Whitney that Emery County had revised their zoning statute to specifically allow landfilling in their I-1 (industrial) zone. He suggested that application for a Conditional Use Permit within the G-1 zone would be a more appropriate option for the proposed Grand County landfill site. We recommend that the Special Services District board apply for the Conditional Use Permit soon.

Sincerely,

Gary F. Player

Gary F. Player, Principal Geologist
Tahoma Companies, Inc.
Registered California Geologist No. 4984

cc: Mr. Leo Dutilly, GGSWMSSD#1
Mr. Paul Baginsky, WESTON

FILE:C:\WP51\DOCUMENT\WESTON\ZONELET

FILE COPY

TAHOMA COMPANIES, INCORPORATED ♦ WDBE
444 South Main Street, Suite C-7
Cedar City, Utah 84720
(801) 865-0131 fax 865-0161

September 20, 1994

SUBJECT: **PROPOSED GRAND COUNTY LANDFILL**

Mr. Robert Williams
U.S. Fish and Wildlife Service
2060 Administration Building
1745 West 1700 South
Salt Lake City, Utah 84104

Dear Mr. Williams:

Please thank Mr. Clark D. Johnson for his useful advice on Threatened and Endangered Species issues associated with landfill licensing. At his suggestion, I have reviewed the USFWS list of Endangered, Threatened and Candidate Species in Utah by Latilong Block, dated September 24, 1992.

I am now informing the Service of the proposed Grand County Landfill (GCL) near Moab, Utah.

Location
The GCL is located west of U.S. Highway 191 in section 14, T. 23 S., R. 19 E., SLB&M. The landfill site has been reviewed by biologists of the U.S. Bureau of Land Management preparatory to transfer of ownership from the BLM to Grand County Special Services District No. 1, and must now be licensed under new state regulations effective September, 1993.

Critical Habitat
I have concluded that the GCL is not located within a designated Critical Habitat Zone for any terrestrial species. It is my understanding that the only critical habitat near the Grand County Landfill site is aquatic habitat identified for the Colorado River squawfish and the associated native fish community in most drainages of the Colorado, Green and San Juan river basins.

It is our opinion that the GCL will not impact aquatic habitats for the following reason:

No surface water courses or impoundments occur on the property.

Threatened and Endangered Species
At Mr. Johnson's suggestion, I also contacted Mr. Larry England and Mr. Henry Maddox of your staff for further information on endangered, threatened and candidate species in Grand County. Mr. England told me that critical habitat for listed or candidate plant species is not likely to be

present at the Grand County Landfill. He plans to review biological clearance documents prepared by the U.S. Bureau of Land Management when they are available.

Water Use Issues

Mr. Maddox explained to me USFWS concerns about consumptive ground water use in the Colorado and Green River drainage basins. He informed me that use may be restricted in aquifers physically connected to the floodplain of either or both rivers. I told him that future construction and operation of the landfill could require the use of water for dust control.

The Grand County Landfill is underlain at approximately 250 feet by low quality ground water in a fractured shale and tight sandstone aquifer. Water has a pH of 10.5 and Total Dissolved Solids (TDS) of 2600 mg/Liter. This data was obtained from a single sample of water produced from a well at the old AT&T microwave tower one half mile east of the proposed landfill site. Additional information will be obtained from a monitor well scheduled to be drilled in October of this year.

The water level in the aquifer underlying the proposed landfill site is about 500 feet above the surface elevation of the Colorado River at Moab. The water level differences, low permeability of the fractured shale and tight sandstone and the poor water quality suggest that rapid communication of ground water between the landfill site and the river floodplain is unlikely.

It is our understanding that any water used for dust control at the landfill must be obtained from sources licensed by the Utah Division of Water Rights. Surface water from the Colorado River, if utilized, will be obtained only from legally licensed points of diversion.

o O o

Thanks again for the prompt advice from your agency personnel. Tahoma Companies will soon be involved in license applications for several other Utah landfills. It is nice to know where we can get help on biological issues so readily.

Sincerely,

Gary F. Player
Principal Geologist

Enclosure: Topographic Map of Grand County Landfill site.

File:WP51\DOCUMENTS\WESTON\USFWSLTR

FILE COPY

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444 S. MAIN STREET, SUITE C-7
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(801) 865 0131 FAX (801) 865 0161

September 20, 1994

Mr. Jim Dykmann
Compliance Archaeologist
Utah Division of State History
300 Rio Grande
Salt Lake City, Utah 84101-1182

Dear Jim:

Thank you for your help last spring in our discussion of archaeological issues associated with landfills. At your suggestion, I am now requesting a consultation with your Division for the proposed Grand County Landfill (GCL) near Moab, Utah.

The GCL is located west of U.S. Highway 191 in section 14, T. 23 S., R. 19 E., SLB&M. The landfill site has been reviewed by archaeologists for the U.S. Bureau of Land Management preparatory to transfer of ownership from the BLM to Grand County Special Services District No. 1, and must now be licensed under new state regulations effective September, 1993.

It is my opinion that this area will not require additional field site archaeological clearances for the following reasons:

(1) The lands have been inspected by BLM archaeologists;

(2) No water courses or impoundments occur on the property; and

(3) No registered Historic Places have been identified within a mile of the landfill site.

I look forward to your comments on this site.

Sincerely,

Gary F. Player
Principal Geologist

Enclosure: Topographic Map of Emery County Landfill site.

File:WP51\DOCUMENTS\WESTON\SHPOLETR

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APPENDIX J

Alternative Design Justification and Exception Request
Liner, Leachate, and Cap Systems

APPENDIX J
ALTERNATIVE DESIGN JUSTIFICATION AND EXCEPTION REQUEST
LINER, LEACHATE, AND CAP SYSTEMS
KLONDIKE LANDFILL

1 INTRODUCTION

1.1 Klondike Landfill

The Klondike Landfill is located approximately 20 miles north of Moab, and approximately 1.5 miles west on U.S. Highway 191. The site is located within the Mancos shale plains, and is essentially in a desert environment. The shale formation underlying the site extends to a depth of more than 1,000 feet, with one or more sandstone members contained within the shale. The shallowest, continuous sandstone member, the Ferron sandstone, lies more than 500 feet below the western boundary of the site.

The site lies within the Mancos shale plain, in the Green River Desert and directly adjacent to the San Rafael Desert. Annual precipitation is predicted to average between 6- and 9-inches, based on nearby climatological stations, making the site essentially a desert environment. This is enhanced by the high evaporation rate that predominates on the Mancos shale plains, averaging between 50 and 70 inches per year in the vicinity of the landfill site.

The first cell of the Klondike Landfill was lined with a 6-inch thick clay liner composed of weathered Mancos shale excavated from directly above competent rock. This liner was intended to seal any vertical fissures that may have occurred in the Mancos shale host formation. Future cells will not be lined, and will be excavated directly into competent rock.

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Similarly, the first cell was provided with a leachate collection system, including a drainage layer sloping toward a gravel sump provided with a pipe and riser system. The future cells will not be provided with a leachate collection system.

Finally, the original permit application stated that the landfill cells would be closed with a traditional clay cap. Recognizing that a clay cap will likely desiccate and crack over time, a change to a capillary barrier cap is planned.

This Justification provides a rationale to allow permitting of alternative liner, leachate, and cap designs consistent with the geological and climatological setting of the landfill. The District is requesting exceptions from the standard liner, leachate, and capping system designs specified in Utah regulations.

1.2 Liner and Leachate Systems

As part of its 1996 Permit Application, the District submitted a request for exception from the liner requirements of UAC 315-303-4. The District requested approval of an alternate liner system consisting of a 6-inch thick barrier layer. This 6-inch barrier layer was intended to seal vertical fractures in the Mancos shale, causing any leachate to migrate through massive shale. The District also requested approval of an alternate leachate collection system consisting of on-site fractured shale material. Based on the information provided in the requests, both alternatives were approved by UDEQ. The District has further considered its options, and is not requesting approval of further exceptions which eliminate all liner and leachate collection system requirements.

Rationale: The request for exception from all liner and leachate system requirements is based on the following factors:

- The site is located in a remote area which received extremely low annual precipitation. The site is located approximately 20 miles north of Moab, and approximately 3.5 miles north of Canyonlands Airport. The nearest known

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neighbors, other than the airport, are located approximately 10 miles to the north of the landfill site, in Crescent Junction. The average precipitation at the landfill site is estimated at between 6.5 and 8.5 inches per year based on the data presented in Table 1 and on-site vegetation. The average evapotranspiration at the site is estimated at between 55 and 60 inches per year. This means that there is an annual water deficit at the site exceeding 45 inches per year, and that deep percolation of precipitation is insignificant except in unusual precipitation years.

- The site is underlain by a thick sequence of Mancos shale. Mineral exploration wells indicate that the total thickness of this shale is approximately 1,200 feet at the site. Local wells demonstrate that the depth to the shallowest groundwater is highly mineralized, based on sampling of a well located approximately 0.25 mile east of the site. The groundwater from this well is alkaline (i.e. pH greater than 10) and brackish (i.e. TDS greater than 2,600 mg/l). This well is screened in a low-yielding (i.e., approximately 1 gpm) sandstone member of the Mancos shale, the Ferron sandstone. The shallowest groundwater is not now or in the foreseeable future a source of drinking water.

- Migration of leachate from the alternate liner and leachate system is expected to be environmentally insignificant. Modeling of leachate migration in the massive Mancos shale predicts that it would require more than 10,000 years for leachate to reach the uppermost aquifer. This modeling used the output of the HELP model (presented in the 1996 Permit Application), using conservative assumptions, and the time needed for a wetting front to migrate through the Mancos shale to a depth of 500 feet. Table 2 summarizes these modeling calculations.

- No evidence of significant vertical fracturing was observed during construction of the first cell at the landfill site. Absence of vertical fracturing means that

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migration of leachate through the massive Mancos shale is the most probable pathway.

- The first cell is provided with a leachate collection system. The District has monitored this system quarterly during the first year of filling in the first cell, and has not detected measurable leachate in the sump. Since the HELP model predicted the greatest generation of leachate during the first year of filling (100,000 gallons), it appears questionable that the landfill will ever produce significant quantities of leachate. In any case, the leachate system in cell 1 will provide an early warning of significant leachate being produced in the landfill as a whole. In the event of unexpected volumes of leachate, the District and UDEQ could evaluate alternatives to remove this leachate.

- These factors demonstrate that exception from all linter and leachate system requirements for the Klondike Landfill is protective of the environment, and qualifies for approval as an alternate to the standard design requirements.

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APPENDIX K

Final Cover Justification

APPENDIX K
FINAL COVER JUSTIFICATION
KLONDIKE LANDFILL

UDEQ submitted a letter to the District on May 4, 1999, stating that the current alternative final cover system, the capillary barrier cap, would need closure plan revision. The letter outlined the particulars of the information necessary for a revised demonstration of equivalency of the cap. The letter also suggested the District was free to change the design of its final cover, and that either process could be accomplished by permit modification or at the time of permit renewal.

There is currently much activity throughout the regulatory and engineering communities in the Western United States, addressing final cover issues common to landfills such as the Klondike landfill that are located in the arid West. The shortcomings of the so-called "prescriptive cap" (UAR 315-303-3[4]) are well documented, but it remains as of this writing as the regulatory closure design for landfill final covers in Utah.

In analyzing its options, the District analyzed soil characteristics and compared cost estimates for several closure systems. Through this analysis, and through conversations with the UDEQ, an evapotranspiration cap is proposed as the cover design for this permit renewal period.

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PROPOSED EVAPORATIVE-TRANSPIRATION CAP
KLONDIKE FLATS LANDFILL
GRAND COUNTY, UTAH

For:

September 19, 2005

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A Report Prepared For:

Mr. Tom Edwards
Grand County Solid Waste Management
Special Service District #1
1000 E. Sand Flats P.O. Box 980
Moab, Utah 84532

PROPOSED EVAPORATIVE-TRANSPIRATION CAP
KLONDIKE FLATS LANDFILL
GRAND COUNTY, UTAH

File No.: 13590.004

Prepared By:

Brian J. Peck, R.G.
Hydrogeologist

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Senior Geologist

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September 19, 2005

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1. INTRODUCTION

The Klondike Flats Landfill is located approximately 20 miles north of the City of Moab, just west of State Route 191 (Figure 1). This landfill is a permitted Class I landfill (municipal waste) operated by the Solid Waste Special Service District #1 (the District) of Grand County, Utah. The District has proposed changing their operating permit to allow an alternative final cover that restricts infiltration by promoting evaporation of moisture from the landfill surface. The purpose of this study is to evaluate whether an alternative evaporative-transpiration (ET) cap, using on-site materials derived from the excavation of landfill cells, will meet or exceed the performance of a prescriptive cap at the Klondike Flats Landfill in Grand County.

The first cell of Klondike Flats Landfill is scheduled to be capped in the near future. The current Klondike Landfill Permit specifies that the landfill cap will be a prescriptive cap comprised of 18 inches of compacted soil that meets the Solid Waste Rules (UAC 315-303-3 (4)), overlain by 6 inches of soil that provides a suitable vegetative layer. The current permit also requires another 18 inches of soil on top of the prescriptive cap for frost protection (for a total thickness of 42 inches). UAC 315-303-3 (4) states that the saturated hydraulic conductivity (a.k.a., permeability) of the 18-inch compacted soil layer must be equal to, or less than, 10^{-7} cm/sec and must be equal to, or less than, the hydraulic conductivity of the underlying landfill liner.

To demonstrate the equivalency of an ET cap with the prescriptive cap described in the Solid Waste Rules, the Utah Division of Solid and Hazardous Waste (UDSHW) requires that modeling be performed to compare the prescriptive cap (with no frost protection) to the ET cap. To evaluate whether an alternative ET cap constructed from on-site materials at Klondike Flats Landfill meets the performance standards and satisfies the capping requirements, Kleinfelder collected soil samples from the site and performed site-specific numerical modeling in accordance with a workplan submitted to and approved by the UDSHW on May 27, 2004. Soil samples were collected on August 25, 2004, from the

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liner materials of cell 3 and from the stockpiled materials excavated during the construction of cells at Klondike Flats Landfill. Both sets of soil samples were analyzed for hydraulic conductivity by the Daniel B. Stephens and Associates, Inc., Laboratory Testing Facility in Albuquerque, New Mexico.

The HYDRUS-2D saturated/unsaturated flow model (Version 2.0; Simunek and van Genuchten, 1999) was used to assess expected long-term precipitation infiltration (seepage rates) through a prescriptive cap (composed of materials identical to the current liner) and an alternative ET cap at the Klondike Flats Landfill. Infiltration is defined as precipitation minus surface run-off, evaporation and plant transpiration. The net infiltration rate multiplied by the cap area is the net seepage volume that may contribute to formation of leachate. Infiltration rates were determined for the regulatory prescribed cap and for the alternative cap materials. The prescriptive cap simulation was based on the saturated hydraulic conductivity of the liner and the unsaturated properties of the liner soils. The resulting prescriptive cap infiltration rates are then compared to the infiltration rates modeled for the current liner and the proposed alternative ET cap.

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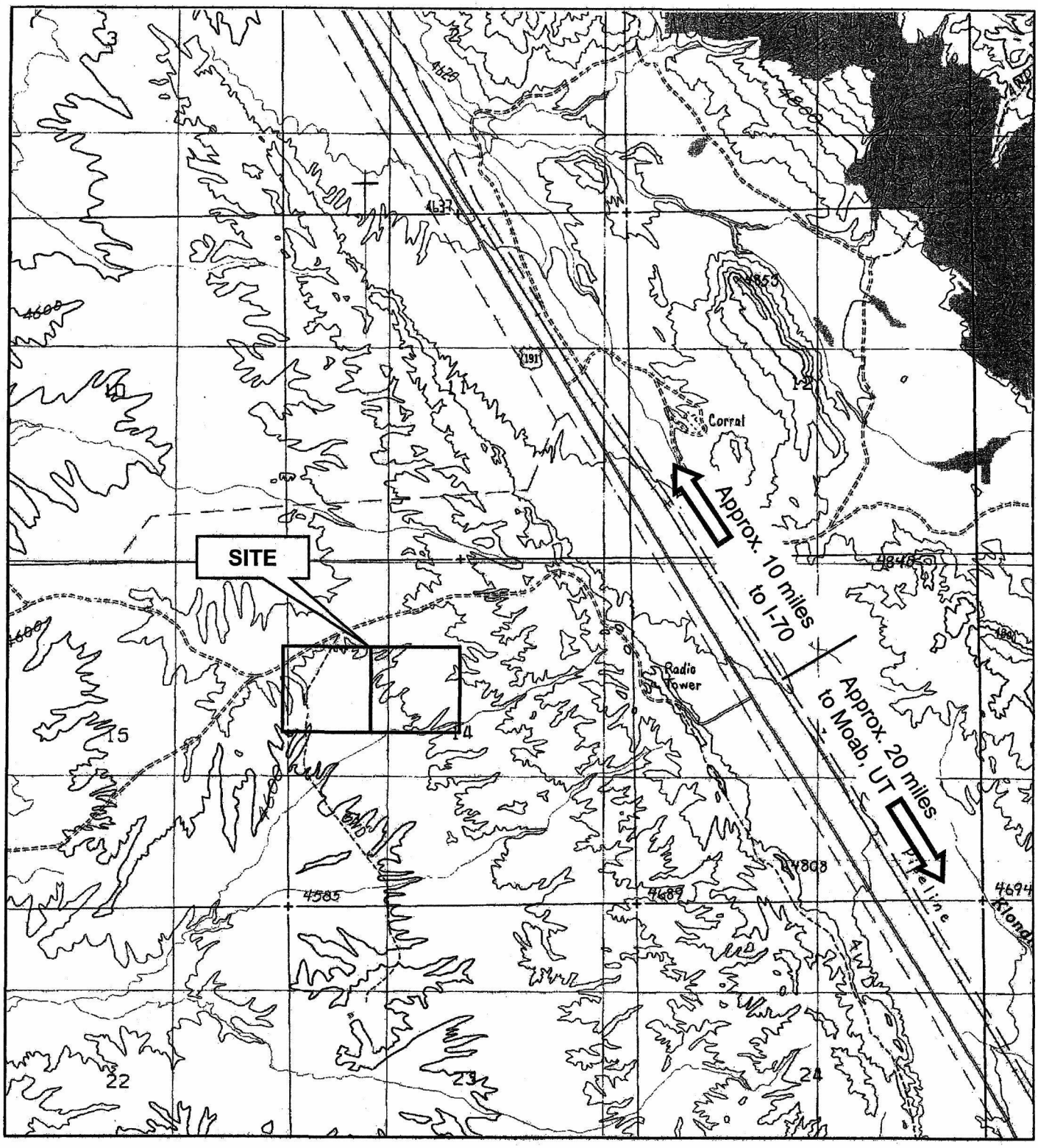
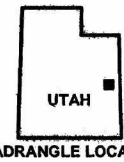


0' 1000' 2000'

SCALE 1:24,000
1" = 2000'
CONTOUR INTERVAL 40 FEET
SUPPLEMENTAL CONTOUR INTERVAL 20 FEET

BASE MAP:
VALLEY CITY UTAH
U.S.G.S. 7.5 MINUTE QUADRANGLE
PROVISIONAL EDITION 1991



QUADRANGLE LOCATION

SLC5Q014.ppt

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Date: 01/07/2005
Project Number 13590.004

Klondike Flats Landfill
Grand County Solid Waste
Management Special Service District #1
P.O. Box 980 Moab, Utah 84532

SITE VICINITY MAP

FIGURE

1

2. MODEL CODE SELECTION

The U.S. Salinity Laboratory's HYDRUS-2D unsaturated flow code was used to predict infiltration through the Klondike Flats Landfill's regulated prescriptive cap and the proposed alternative ET cap. This model is a Microsoft Windows□-based platform for running the public domain SWMS_2D finite element code published by Simunek, Vogel and van Genuchten (1992, 1994).

This model code was chosen because it incorporates the Richard's equations for groundwater flow under conditions of partial saturation and can simulate hydraulic gradients and water movement based on soil moisture retention characteristics. The code is widely used in arid regions research. A key factor of concern in arid environments is the upward capillary movement of water toward the drying atmospheric interface. The upward movement is caused by soil suction or matric potential under changing conditions of surface soil moisture that result from infrequent light precipitation events and the intervening relatively long duration desiccation periods. The EPA HELP3 model code developed for evaluation of infiltration into and leakage from landfills (Schroeder et al, 1994) only accounts for gravity drainage of rainfall and is therefore more appropriate for sites in the eastern U.S. where rainfall rates are much higher. In arid climates the HELP model tends to overestimate infiltration rates because it does not account for upward movement of soil moisture toward the land surface during drying intervals (Albright, 1997; Hart and Lassetter, 1999).

The HYDRUS-2D model reacts to heavy precipitation events by limiting surface infiltration to the maximum infiltration capacity of soil based on the unsaturated flow equations; precipitation amounts greater than this maximum rate are assumed to form runoff. The primary water budget processes that determine net infiltration rates occur in near surface materials that are transected by the evapotranspiration zone; the type and thickness of strata below the evapotranspiration depth do not significantly influence percolation rates if they are more transmissive than the near surface materials. The HELP model requires

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that the evapotranspiration depth be specified *a priori*. The HYDRUS-2D model handles evaporation by using maximum *potential* evaporation at the soil surface. The evaporation depth is implicitly computed by HYDRUS-2D during runtime according to the unsaturated flow equation. The user specifies the potential maximum evaporation rate and the simulation code computes movement of water based on saturated and/or unsaturated hydraulic gradients that depend on antecedent moisture conditions.

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2. CLIMATIC CONDITIONS

The climate data used in the Klondike Landfill HYDRUS-2D simulations is based upon actual historical daily precipitation and potential evapotranspiration data for Moab, Utah. The HYDRUS-2D model requires specification of daily rainfall and potential evaporation to simulate net infiltration. Climatic data for 100 years (1904 to 2003) were obtained from the Utah Climate Center at the University of Utah. From this selected period a total of 31 months were missing from the 1,200-month period of record used. The missing precipitation values were specified using median rainfall for the given month based on the full period of record 1893-2004 (Table 1). The monthly precipitation quantity was then applied using a typical daily precipitation pattern for that month from another year in the data set (Table 2). Through this process a 100-year atmospheric conditions input file was assembled with daily records for 36,500 days (100 years; leap year days omitted).

TABLE 1
Climate Summary for Moab, Utah (1893-2004)

	Precipitation (inches/year)	Potential Evapotranspiration (inches/year)
Average	9.01	56.02
Median	8.51	56.06
Maximum	16.42	62.45
Minimum	3.84	46.90

Note: Computed from all available monthly data (Utah Climate Center)

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TABLE 2
Summary of Monthly Precipitation and Potential Evapotranspiration in Moab, Utah (1893-2004)

MONTH	Monthly Average Precipitation (inches)	Median Precipitation (inches)	Monthly Average Potential Evapo-transpiration (inches)	Median Potential Evapo-transpiration (inches)
1	0.661	0.495	1.097	1.122
2	0.61	0.52	1.737	1.73
3	0.81	0.68	3.379	3.35
4	0.816	0.715	5.041	5.022
5	0.728	0.57	7.109	7.093
6	0.423	0.23	8.546	8.477
7	0.799	0.545	9.179	9.243
8	0.864	0.78	7.911	7.994
9	0.886	0.73	5.647	5.712
10	1.028	0.70	3.553	3.541
11	0.690	0.60	1.765	1.773
12	0.738	0.52	1.063	1.069

Note: Computed from monthly data with surrogates for missing data (Utah Climate Center)

Potential evaporation at the Klondike Flats Landfill site is a function of wind speed, relative humidity, temperature, precipitation, and insolation (solar energy). Potential transpiration, in the form of plant cover, was not quantified for this report. Plant cover was excluded from all models to obtain worst-case infiltration results. It is assumed that the addition of plants would reduce infiltration to an approximately equal degree for each cap modeled.

For modeling a worst-case rain event scenario, the DSHW suggested running the five wettest years on record in sequence. Infiltration rates during the initial five wettest year sequence were calculated by running the model for five years using typical conditions, then the five wettest years in sequence, followed by five more years under typical conditions. The typical conditions were specified by us to be the recent 1999-2003 period of record. The five wettest years were specified to occur in random order. The five wettest years in Moab were 1983, 1927, 1915, 1941, and 1918, with precipitation rates of 16.42, 15.96, 15.49, 15.42, and 15.28 inches for these years, respectively. Monthly values for each of these years are shown in Table 3.

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TABLE 3
Ranked Precipitation in Moab, Utah (1904-2003)

Rank	Year	Precipitation inches/yr	Rank	Year	Precipitation inches/yr	Rank	Year	Precipitation inches/yr
1	**1983**	**16.42**	35	1929	10.30	68	1934	7.78
2	**1927**	**15.96**	36	1939	10.23	69	2003	7.70
3	**1915**	**15.49**	37	1969	10.21	70	1977	7.60
4	**1941**	**15.42**	38	1981	10.08	71	1936	7.56
5	**1918**	**15.28**	39	1973	9.96	72	1971	7.29
6	1940	13.53	40	1949	9.78	73	1968	7.27
7	1916	13.23	41	1909	9.72	74	1992	7.09
8	1906	13.15	42	1986	9.66	75	1944	6.88
9	1997	13.10	43	1937	9.29	76	1919	6.83
10	1957	12.78	44	1907	9.27	77	1991	6.82
11	1980	12.70	45	1913	9.25	78	1994	6.76
12	1908	12.37	46	1972	9.19	79	1942	6.75
13	1965	12.15	47	1935	9.14	80	1922	6.67
14	1905	12.11	48	1910	9.06	81	1946	6.64
15	1987	12.11	49	1998	9.02	82	1952	6.63
16	1999	11.56	50	1945	8.87	83	1959	6.62
17	1985	11.40	51	1962	8.74	84	1982	6.62
18	1926	11.29	52	1943	8.55	85	1974	6.56
19	1984	11.22	53	1951	8.55	86	1976	6.14
20	1930	11.20	54	2000	8.51	87	1966	6.03
21	1911	11.10	55	1996	8.47	88	1963	6.01
22	1961	11.01	56	1953	8.40	89	1931	5.87
23	1924	10.96	57	1920	8.35	90	1950	5.80
24	1914	10.90	58	1917	8.29	91	1904	5.72
25	1912	10.87	59	1967	8.28	92	2002	5.72
26	1975	10.87	60	1938	8.18	93	1960	5.68
27	1921	10.82	61	1979	8.13	94	1970	5.66
28	1928	10.81	62	1988	8.13	95	1964	5.52
29	2001	10.81	63	1990	8.12	96	1958	5.08
30	1947	10.71	64	1932	8.09	97	1989	4.90
31	1993	10.71	65	1933	8.02	98	1955	4.84
32	1925	10.60	66	1948	7.92	99	1954	4.79
33	1978	10.46	67	1923	7.86	100	1956	3.84
34	1995	10.46						

Note: Computed from monthly data with surrogates for missing data (Utah Climate Center)

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3. SOIL HYDRAULIC PROPERTIES

4.1 GENERAL

The following paragraph explains several of the parameters used in the derivation of hydraulic flow properties. Partial saturation or unsaturated flow hydraulic properties include the effective porosity, the saturated and residual water capacity, the saturated hydraulic conductivity, and the matric potential versus water content curve that is summarized by the van Genuchten soil moisture retention parameters.

Effective porosity is the maximum amount of water that fully saturated soil can store. Matric potential is the physical property of a porous medium to attract water as a result of capillary and adsorption processes. The residual capacity of a soil is the virtually irreducible amount of water in soil that has been exposed to desiccating conditions for a long period of time; it is defined as having a matric potential of –15 bar, which is a pressure of about –153 meters of water. The negative pressure is a convention for describing conditions of partial saturation; the pressure is equal to the absolute hydraulic pressure required to drive the water from a sample. The van Genuchten parameters describe the shape of the soil matric potential (capillary suction) curve as a function of volumetric soil moisture. From this, the hydraulic conductivity versus soil moisture curve is derived using the equations of Mualem (1976).

4.2 PROPERTIES OF THE PRESCRIPTIVE CAP AND ALTERNATIVE CAP MATERIALS

Unsaturated hydraulic analyses were conducted on samples of the liner (assumed to be representative of the prescriptive cap) and samples of stockpiled soils (representative of the proposed alternative cap) collected from the Klondike Flats Landfill site. The samples of the liner were assumed to be representative of the materials for a prescriptive cap because the liner soil met the prescriptive requirement that the cap materials have a hydraulic conductivity equal to or less than the liner soils.

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On August 25, 2004, four soil samples were collected from representative locations. Two soil samples (K1 and K2) were collected from the liner of cell 3 and two soil samples (K3 and K4) were collected from the stockpile. The representative locations of the samples were selected based on the range of observed soil types at the Klondike Flats Landfill. The soil sample locations are shown on Figure 2. The general field parameters of the soil samples are shown in Table 4. The laboratory analyses assessed by Daniel B. Stephens and Associates, Inc., are presented in Table 5. The laboratory report from Daniel B. Stephens and Associates, Inc., is included in Appendix A.

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TABLE 4

General Field Parameters of Soil

Sample ID	Sample Description	Sample Depth (Inches)	Sample Location	General Compaction
K1	Silty gravel (GM), gray, dry, dense, calcium carbonate cementation, bladed coarse to fine gravel, siltstone clasts	2-8	*In-Situ* Liner East End of Cell 3	Naturally compacted, representative of liner compaction
K2	Silty gravel (GM), gray, dry, dense, calcium carbonate cementation, bladed coarse to fine gravel, siltstone clasts	3-9	*In-Situ* Liner West End of Cell 3	Naturally compacted, representative of liner compaction
K3	Gravely silt (SM), brown-gray, very stiff, bladed fine gravel, siltstone clasts	2-8	South East Corner of Soil Stockpile	Slightly compacted by equipment during placement
K4	Silt (SM), brown, very stiff, some fine gravel, siltstone clasts	2-8	Center of Soil Stockpile	Slightly compacted by equipment during placement

TABLE 5

Hydraulic Parameters for Klondike Flats Landfill Cap Samples

Sample Name	Water Content		Saturated Hydraulic Conductivity	Calculated van Genuchten Parameters	
	Saturation	Residual	(cm/sec)	Alpha (1/cm)	n
K1	0.369	0.000	1.0×10^{-7}	0.0273	1.1329
K2	0.421	0.040	2.4×10^{-3}	0.2485	1.1895
K3	0.481	0.000	1.7×10^{-7}	0.0027	1.2441
K4	0.482	0.0024	1.5×10^{-6}	0.0043	1.2304

Notes: These parameter values reported 10/7/2004 by Daniel B. Stephens and Associates, Inc.
cm/sec = centimeters per second
Alpha and n are mathematical parameters of the van Genuchten model.

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Samples representing the prescriptive cap (K1 and K2) and samples representing the ET cap (K3 and K4) have a wide range of hydraulic conductivities. Sample K2 has a much higher hydraulic conductivity than the other samples; however, laboratory analyses indicated that the sample appeared to be a tight soil, comparable to K1, but that there may have been a fissure within the sample, probably a relic of compacting the weathered shale soil into a small ring for testing. Field observations corroborate this hypothesis since numerous brass sample tubes were destroyed due to fragments of rock jamming within the tubes and disturbing the natural layering and compaction of the samples. Samples K1 and K2 (representing the prescriptive cap) have saturated hydraulic conductivities of 1.0×10^{-7} cm/sec and 2.4×10^{-3} cm/sec respectively. Samples K3 and K4 have saturated hydraulic conductivities of 1.7×10^{-7} cm/sec and 1.5×10^{-6} cm/sec respectively. Again, the higher hydraulic conductivity of sample K4 may be the result of the difficulties of compacting the soil into a small ring for testing. The unsaturated properties of sample K4 are not impacted by the presence of rock fragments – only the saturated hydraulic conductivity is expected to be affected by preferential flow paths created when breaking up the natural layering.

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4. HYDRUS-2D MODEL DESIGN

5.1 GENERAL MODEL DESIGN

The input parameters for the HYDRUS-2D finite element model remained the same for the prescriptive cap and ET cap simulations. The HYDRUS-2D finite element model was discretized in the manner of a soil column test, with one-dimensional flow from the atmospheric boundary condition at the top of the column to a seepage face drain at the bottom of the column. The height of the column was specified to be 30 inches (76.5 cm) using 156 rows and variable cell sizes from 0.1 to 1.0 centimeter (cm). Row height was specified to be 1 cm at land surface, at the lowermost free drainage boundary. Row heights were set to 0.1 cm at each side of a soil texture interface. These fine row spacings were required to handle the very low hydraulic conductivity soils sampled at the site. The uppermost boundary was specified to be an atmospheric boundary with daily records for rainfall and evaporation potential. Water leaves the model system by gravity drainage from the lower free drainage boundary. The free drainage volume was accumulated for each year and is reported as the net amount of water infiltrating through the landfill cap.

Transpiration was not included in the model due to the relatively small percentage that it constitutes relative to evaporation potential and the fact that parameters for soil moisture uptake rates for desert shrubs and grasses are poorly documented. One study reports plant transpiration contributes three percent of the total evapotranspiration potential in Jean, Nevada, and 32 percent for good grass cover on a landfill in Elko, Nevada (Albright, 1997). Excluding plant transpiration is a conservative choice that increases the predicted net infiltration rates.

The initial soil moisture pressure, an important variable influencing short term seepage rates, was specified to be in equilibrium throughout the soil column with a -100 cm pressure (matric potential) specified at the base of the model domain for all model runs.

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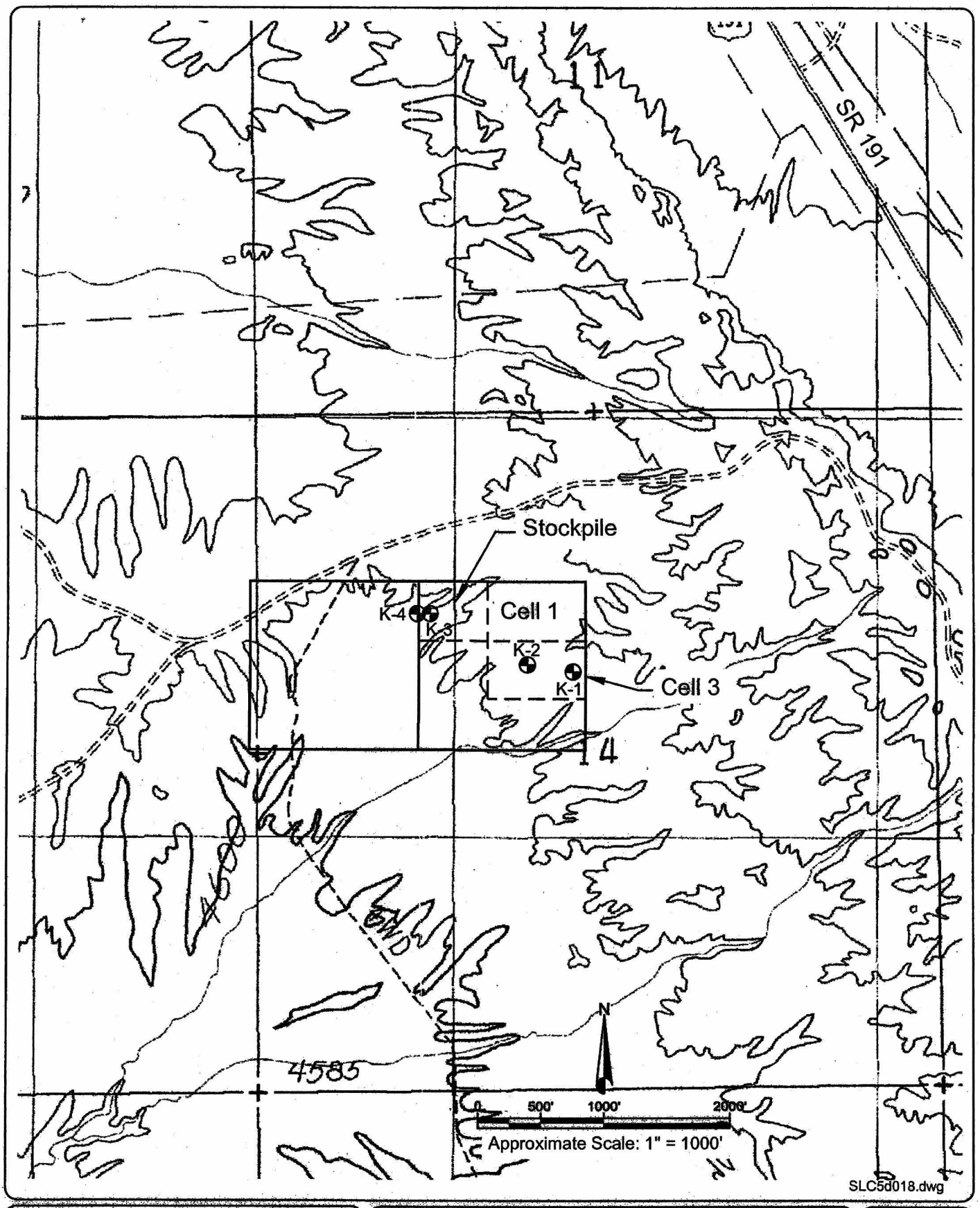

KLEINFELDER

Date: 01/07/2005
Project Number 13590.004

Klondike Flats Landfill
Grand County Solid Waste
Management Special Service District #1
P.O. Box 980 Moab, Utah 84532

SAMPLE LOCATION MAP

FIGURE

2

This pressure in the sand material represents a dry soil with a water content of 4.9 percent by volume at the base of the model. The matric potential at the surface was -170 cm, corresponding to a slightly moist initial water content of 10 percent by volume in the sandy loam topsoil. The cap has an initial matric potential of about -135 cm, which corresponds to a soil moisture of approximately 31 percent by volume, depending on the unsaturated hydraulic properties of the soil.

5.2 PRESCRIPTIVE CAP DESIGN

The prescriptive cap model was configured to have a 6-inch (16 cm) thick topsoil layer at the surface, underlain by 18 inches (45 cm) of either K1 or K2 soil, the same soil from which the liner is constructed. The base of the prescriptive cap model domain consisted of 6 inches (16 cm) of sand to simulate the top of the landfill waste material. To facilitate numerical stability, a 1-inch thick mixed soils zone was specified above and below the prescriptive cap at 5 to 6 inches depth and 18 to 19 inches depth, respectively. The properties of this zone were set to be intermediate between the prescriptive cap and the overlying topsoil and underlying sand interfaces. To improve the response time of predicted infiltration rates as a function of climate, the lower sandy layer was specified to have the same thickness as the topsoil.

Material properties for the 18-inch soil layer used in the prescriptive cap simulations are shown in Table 5 (samples K1 and K2). This 18-inch compacted soil layer is overlain by a 6-inch "top soil" layer, as required for the prescriptive cap, and underlain by "fill material" (the landfill waste). The assumed (hypothetical) properties of the overlying topsoil and underlying fill are listed in Table 6.

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TABLE 6

Hydraulic Parameters for Hypothetical Materials Used in Models
(Data from Literature)

Material Description	Soil Type	Water Content		Saturated Hydraulic Conductivity	Calculated van Genuchten Parameters	
		Saturation	Residual	(cm/sec)	Alpha (1/cm)	n
Topsoil	Sandy loam	0.41	0.065	1.2×10^{-3}	0.075	1.89
Fill Material	Sand	0.43	0.045	8.3×10^{-3}	0.145	2.68

5.3 ET CAP DESIGN

The ET model was configured to have a monolithic layer of either K3 or K4 soil representing the slightly compacted material from the onsite stockpile. A 2-inch thick topsoil layer was assumed above the cap (K3 or K4 soil). The assumed topsoil allows more infiltration to occur than would be the case if cap material was at the surface. This is a conservative assumption, but it is necessary for the numerical stability of the model.

The base of the ET cap model domain consisted of 6 inches (16-cm) of sand to simulate the landfill waste material. To facilitate numerical stability a 1-inch thick mixed soils zone was specified below the ET cap at 18 to 19 inches depth. The properties of this zone were set to be intermediate between the ET cap and the underlying sand interfaces. To improve the response time of predicted infiltration rates as a function of climate, the lower sandy layer was specified to have the same thickness as the topsoil from the prescriptive cap model domain. A summary of the material properties used in the ET cap simulations is shown in Table 5 as samples K3 and K4; assumed properties of the overlying topsoil and underlying fill are listed in Table 6.

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6. HYDRUS-2D INFILTRATION SIMULATIONS

6.1 PRESCRIPTIVE CAP RESULTS

The results of the HYDRUS-2D modeling of a prescriptive cap are shown in Table 7. Scenario H1 represents a cap having a 6-inch topsoil layer and an 18-inch thick soil layer of material K1. The average infiltration rate for the 95 years modeled is 0.019 inches per year. The model predicts an average infiltration rate of 0.039 inches per year for the five wettest years scenario.

Scenario H2 represents a cap having a 6-inch topsoil layer and an 18-inch thick soil layer of material K2. The average infiltration rate for the 95 years modeled is 0.64 inches per year. This rate is larger than that of Scenario H1 because of the larger reported hydraulic conductivity of soil K2. As noted in Section 4.2, the higher hydraulic conductivity of this sample is likely due to a fissure in the sample, a result of the difficulties of compacting the weathered shale soil into a small ring for testing.

6.2 ET CAP RESULTS

The results of the HYDRUS-2D modeling of the ET caps using soil types K3 and K4 of varying thicknessses are shown in Table 7. Scenario H3a - H3c represents an ET cap having a 2-inch topsoil layer and an 18-inch to 30-inch thick soil layer of material K3. The average infiltration rate for the 95 years modeled is 0.013 inches per year for all thicknesses of K3 soil cap material. The model predicts an average infiltration rate of 0.054 inches per year for the five wettest years scenario. The long-term modeled infiltration rate for Scenario H3a (ET cap) is less than the prescriptive cap Scenario H1, despite the higher hydraulic conductivity of soil K3 compared to K1.

Scenario H4a - H4c represents an ET cap having a 2-inch topsoil layer and an 18-inch to 30-inch thick soil layer of material K4. The average infiltration rate for the 95 years modeled is 0.22 inches per year for all thicknesses of K4 soil cap material. The model

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predicts an average infiltration rate of 0.68 inches per year for the five wettest years scenario. The infiltration rate is higher using material K4 compared to K3 because the hydraulic conductivity of material K4 is higher than K3. As with the test of sample K2, the higher hydraulic conductivity of sample K4 is likely due to a fissure in the sample, a result of the difficulties of compacting the weathered shale soil into a small ring for testing.

Comparing infiltration results of the prescriptive design and the ET cap design using the same soil cap materials, the ET cap is expected to perform generally the same as a prescriptive cap.

TABLE 7
HYDRUS-2D Unsaturated Zone Model Results

Scenario Number	Top Soil Layer Thickness (inches)	Low Permeability Layer		Average Infiltration Rate for 95 Years (inches/year)	Average Infiltration During 5 Wettest Years in Sequence (inches/year)
		Soil Type	Thickness (inches)		
Prescriptive Cap Performance					
H1	6	K1	18	0.019	0.039
H2	6	K2	18	0.64	1.8
ET Cap Performance					
H3a	2	K3	18	0.013	--
H3b	2	K3	24	0.013	--
H3c	2	K3	30	0.013	0.054
H4a	2	K4	18	0.22	--
H4b	2	K4	24	0.22	--
H4c	2	K4	30	0.22	0.68

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7. CONCLUSIONS

The proposed ET cap, constructed of stockpiled materials from Klondike Flats Landfill, appears to meet the performance of the prescriptive cap and, therefore, satisfies the requirement of the Solid Waste Rules. Additionally, the proposed ET cap is expected to out-perform a prescriptive cap in terms of long-term care and maintenance during periods of settlement and freeze-thaw.

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8. LIMITATIONS

The unsaturated groundwater model described in this report was used to predict infiltration rates based upon estimates of the regulatory prescriptive cap unsaturated hydraulic parameters and laboratory analyses of the on-site materials. The accuracy of infiltration rate estimates resulting from numerical models is entirely dependant upon the validity of the hydraulic parameters used to construct the model. The simulated infiltration rates are sensitive to the unsaturated flow parameters. These and other subsurface hydraulic parameters generally exhibit spatial heterogeneity. Therefore, simulated infiltration rates are considered to be best estimates and not precise predictions of actual field infiltration rates. No on-site hydraulic testing was performed for this project by Kleinfelder, Inc. Field tests are available which would reduce the level of uncertainty associated with estimating subsurface hydraulic properties. In some cases, the additional expense and time associated with these tests may be warranted.

This study was performed and findings obtained in substantial conformance with the engineering practice that exists within the area at the time of our investigation and includes professional opinions and judgements. We base this report on information derived from data in available literature and our knowledge of and experience in the local area. This report does not provide a warranty as to variable subsurface conditions that may exist and applies only to the specific area that was investigated. In addition, one should recognize that definition and evaluation of subsurface geologic and hydrogeologic conditions is a difficult and inexact art. Geologists and hydrogeologists must occasionally make general judgements leading to conclusions with incomplete knowledge of the geologic history, subsurface conditions and hydraulic characteristics present. No warranty, express or implied, is made.

This report may be used only by the client and only for the purposes stated within a reasonable time from its issuance, but in no event later than one year from the date of the report. Land or facility use, on and off-site conditions, regulations, or other factors

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may change over time, and additional work may be required with the passage of time. Any party other than the client who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party and client agrees to defend, indemnify, and hold harmless Kleinfelder from any claim or liability associated with such unauthorized use or non-compliance.

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Utah Division of Solid and Hazardous Waste
288 North 1460 West
P.O. Box 144880
Salt Lake City, UT 84114-4880

Attention: Mr. Phil Burns

Subject: Proposed Evaporative-Transpiration Cap Study
Klondike Landfill
Moab, Utah

Dear Mr. Burns,

Thank you for reviewing and commenting on the modeling study for the Klondike Landfill in Moab, Utah. On behalf of the Solid Waste Special Service District #1, Kleinfelder, Inc., has prepared the following responses to your questions and comments in your correspondence dated March 9, 2006. A copy of the correspondence is attached.

1) ***Clarification of the prescriptive cap model.*** The Division of Solid and Hazardous Waste (DSHW) correctly points out that the description of the prescriptive cap on page 2 of the report is confusing. The last sentence of page 2 should more accurately state: "The resulting prescriptive cap infiltration rates are then compared to the infiltration rates modeled for the proposed alternative ET cap." This paragraph attempts to summarize Kleinfelder's modeling approach, which is to create a prescriptive cap that consists of 6 inches of topsoil, underlain by 18 inches of a material that has the same saturated and unsaturated hydraulic properties as the liner. This approach is more clearly explained in detail on page 15 of the modeling study

2) ***Discussion of soil types versus initial matric potential and soil moisture.*** Kleinfelder specified that the initial soil matric potential should be in gravitational equilibrium throughout the soil column based on an arbitrary initial condition defined at the base of the modeled soil column. Kleinfelder assumed that the cap starts out in a relatively wet condition in order to get reportable infiltration results within a reasonable simulation time frame; these initial conditions do not affect the final infiltration rate resulting from the cap configuration, only how long it takes the model to achieve dynamic equilibrium. The numerical model used a specified initial matric potential (capillary suction) pressure of –100 cm at the base of the model, and the Hydrus2D code then automatically calculated the

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equilibrium matric potentials (and corresponding soil moistures) upward through the soil column, resulting in the somewhat more negative (dryer) matric potential at the surface. Clay-rich materials (such as the proposed cap) have very high soil moisture contents at the specified initial condition pressure of –100 cm. The relationship between matric potential and soil moisture content varies radically for different types of soil. At a constant matric potential (such as –100 cm), sand and clay would exhibit very different moisture contents (the sand would have a moisture content of about 22 percent, while the Mancos Shale clay would have a moisture content of about 48 percent). These equilibrium unsaturated zone pressure relationships created the effect that DSWH observed, where the clayey middle layer of our model exhibits a higher soil moisture than the sandy layers above and below it.

3) ***Discussion of initial soil moisture assumptions.*** Based on Kleinfelder's previous experience with the model in this environment (as referenced by DSHW) and subsequent comments/suggestions by DSHW and others, the initial basal boundary condition of soil moisture pressure = 0 cm (fully saturated) and a seepage face boundary at the bottom were replaced by a slightly less saturated condition (soil moisture pressure = -100 cm) and a free drainage boundary condition at the bottom of the model. The use of a free drainage boundary condition mitigated the need to fully "prime" the unsaturated system, thereby making the early time results produced by the model more meaningful and realistic. It is important to note that initial matric suction conditions of –100 cm rather than 0 cm are both very wet. For example, at a soil moisture pressure of –100 cm, our sample K3 would exhibit a soil moisture content of 48.02 percent. At 0 cm (fully saturated), our sample K3 would exhibit a soil moisture content of 48.1 percent.

4) ***Discussion of differences in laboratory methodology for saturated hydraulic conductivity tests.*** The laboratory employs different test methods for different samples depending on the performance of the sample(s) during the initial stage of the testing. All samples are started using a constant head method. For very low permeability samples, the laboratory changes to a falling head method, which allows use of a larger head ensuring more accurate test results.

5) ***Comments regarding the appropriateness of sample K2.*** Kleinfelder and the District agree with DSHW that the quantitative usefulness of sample K2 appears compromised by apparent preferential flow along a rock fragment. However, the results were included for completeness and to provide a qualitative indication that the material lining the cells (and covering the cells) will vary somewhat and should not be expected to duplicate exactly the nature or performance of K1. Based on the average infiltration rates of Scenario H1 and H3, and taking into account the expected variability as demonstrated by Scenario H2 and H4, it appears that the proposed ET cap will perform as well as a prescriptive cap in the Grand County environment.

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6 and 7) ***Discussion of cap thickness.*** The District is proposing to place a 30-inch thick ET cap to provide additional protection against infiltration, frost, or other disturbances. Therefore, the "five wettest years" scenario was only modeled for the 30-inch cap. This proposal should have been clearly spelled out in the conclusions.

8) ***Handling/screening of onsite material.*** The District is proposing that the contractor placing the cap be required to remove material greater than 2 inches in diameter during placement of the cap. This specification is consistent with the specification used at the Moab Landfill. Small (less than 2-inch) rock fragments are not expected to have significant influence within a 30-inch cap. Additionally, the District's experience with the on-site Mancos Shale material is that it rapidly disintegrates and becomes increasingly homogenous fine silt with handling. Therefore, we expect the material used to build the ET cap will be relatively homogeneous due to the minimal handling and subsequent weathering experienced by the stockpiled material. ~handling would help decomposition

We hope this information addresses the Division's questions. Kleinfelder and/or the District will be happy to answer any additional questions, or provide further clarification on the information in this letter. Please feel free to call Tom Edwards at (435) 260-9978 or Renee Zollinger of Kleinfelder at (801) 261-3336.

Sincerely,

Bruce Keeler
Vice Chairman, Administrative Control Board
Solid Waste Special Service District #1

Attachments

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State of Utah

Department of Environmental Quality

Dianne R. Nielson, Ph.D.
Executive Director

DIVISION OF SOLID AND HAZARDOUS WASTE
Dennis R. Downs
Director

JON M. HUNTSMAN, JR.
Governor

GARY HERBERT
Lieutenant Governor

COPY

September 1, 2006

Bruce Keeler, Vice Chairman
Administrative Control Board
Solid Waste Management Special Service District #1
P.O. Box 980
Moab, UT 84532

RE: Proposed Evaporative-Transpiration Cap Approval, Klondike Landfill

Dear Mr. Keeler:

We have reviewed the responses to our questions regarding the modeling study "Proposed Evaporative-Transpiration Cap, Klondike Flats Landfill, Grand County, Utah" prepared by Kleinfelder, Inc. The responses are satisfactory and will be attached to the original report.

The modeling study "Proposed Evaporative-Transpiration Cap, Klondike Flats Landfill, Grand County, Utah" along with the response to questions is complete and satisfies the requirements of Utah Administrative Code R315-303-3(4)(b) for alternative final covers. A permit modification is required to make this the approved design for the Klondike Landfill.

As part of the permit modification the Division will require a Quality Assurance Plan for construction of the final cover be submitted and approved prior to construction of the cover. The plan should include a provision for submitting a soil gradation curve for the stockpiled soil to be used as final cover material after the soil is screened to remove material greater than two inches in diameter. Of particular interest is the amount of course (3/4-inch or larger) material remaining in the soil after screening. The Plan should propose a limit on the percentage of this material, with a proportional increase in cap thickness if that limit is exceeded.

The Plan should include monitoring and testing at specified frequencies to verify cover thickness, compaction, slopes, and grading of drainage channels and erosion control materials. Revegetation procedures and seed types should also be specified.

288 North 1460 West • PO Box 144880 • Salt Lake City, UT 84114-4880 • phone (801) 538-6170 • fax (801) 538-6715
T.D.D. (801) 536-4414 • *www.deq.utah.gov*

Please submit a written request to modify the permit and incorporate the new closure design. Please indicate in the modification request that the basis for the alternative design is the study approved in this letter. A 30-day public comment period will be held on the permit modification request.

If you have questions about this review or other solid waste issues, please contact Phil Burns or Ralph Bohn at (801) 538-6170.

Sincerely,

Dennis R. Downs, Executive Secretary
Utah Solid and Hazardous Waste Control Board

DRD/PEB/kk

c: Tom Edwards, Solid Waste Management Special Service District #1
David Cunningham, B.S.N., R.N., Health Officer, Southeast Utah Dist Health Dept
David Ariotti, DEQ Southeastern District Engineer
Renee Zollinger, Kleinfelder, Inc.

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APPENDIX L

Final Cover Construction Specifications

KLEINFELDER
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KLONDIKE LANDFILL
FINAL COVER
CONSTRUCTION SPECIFICATIONS

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GENERAL CONDITIONS AND SITE WORK

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SECTION 02320	FINAL COVER
SECTION 02920	REVEGETATION

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SECTION 00700

GENERAL CONDITIONS

PART 1 - GENERAL

1.01 PARTICIPANT ROLES AND RESPONSIBILITIES

OWNER: Solid Waste Special Service District #1. Owner will issue Contract to Engineer and Contractor. Owner will be responsible for Contract administration, including payment of Engineer and Contractor.

ENGINEER: Selected by the Owner. Engineer will render technical opinions regarding issues that may arise during construction. Engineer will also conduct construction inspection and testing as the Construction Quality Assurance (CQA) Officer.

CONTRACTOR: Selected by the Owner. Contractor is responsible for construction of the project described in these specifications, as directed by Owner.

PART 2 – MATERIALS

Not used.

PART 3 – EXECUTION

Not used.

END OF SECTION

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SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.01 PROJECT DESCRIPTION

A. Work of this Contract consists of the installation of an evaporative-transpiration (ET) cap as final cover for Cell 1 at the Klondike Landfill near Moab, Utah. The Contractor shall be responsible for, but not limited, the following:

1. Transportation and placement of soil to be used for ET layer,
2. Grading and compaction of ET layer,
3. Excavation and placement of topsoil, and
4. Seeding of vegetative layer.

B. This document presents Specifications applicable to the scope of work. The general sequence of work includes the excavation of native soils, phased construction, and revegetation of the final cover. The final cover is designed as an evaporative-transpiration (ET) cap and will consist of one 30-inch thick layer of native soil overlain by a vegetative layer of 6 inches. Soils used for the ET layer will consist of on-site native silty clay material for the cover which will act as an infiltration barrier. Topsoil for the vegetative layer will come from adjoining areas on-site. The top layer will be vegetated to minimize erosion and enhance transpiration from established plants.

1.02 CONTRACT

A. Perform work under unit cost with the Owner.

PART 2 – PRODUCTS

2.01 SOIL

A. The Owner will provide the soil for the ET and vegetative layers, which will originate from native material on-site. In the case of final cover for Cell 1, previously excavated material that has been stockpiled over Cell 4 will be used. Modeling and design for the ET cap has been based on the properties of the native material.

B. In the event that off-site material is used, the material will need to be evaluated for engineering properties (i.e., hydraulic conductivity) required by the ET cap design.

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PART 3 – EXECUTION

Not used.

END OF SECTION

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SECTION 01310

PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.01 PROJECT COORDINATION

A. The Owner will identify the process and personnel for project coordination.

B. Proposed changes in design or materials must be presented to the Owner or Engineer prior to implementation. The Owner/Engineer will have five (5) working days to respond to the proposed changes in approving, disapproving, requesting further information, or suggesting modifications.

C. The Owner shall be notified in writing of any problems that develop during construction, or that are noted in the Plans or Specifications.

1.02 MEETINGS

A. A pre-construction meeting shall be held to coordinate work activities and to assist in the scheduling of CQA personnel. The Owner will set the time and date; the Contractor will be informed of the meeting time a minimum of five (5) working days prior to the meeting.

B. Daily "tailgate" meetings shall be held to review hazards during site activities. Routes to the nearest hospital shall be displayed at the site.

C. Additional meetings will be held when needed to discuss construction activities, testing deficiencies, test results, testing yet to be performed, and any other items deemed necessary by the CQA personnel, Engineer, or Owner.

PART 2 – MATERIALS

Not used.

PART 3 – EXECUTION

Not used.

END OF SECTION

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SECTION 01570

TEMPORARY CONTROLS

PART 1 – GENERAL

1.01 SCOPE

A. The Contractor shall provide dust control measures as necessary to abate fugitive dust. Dust control measures shall be implemented during excavation, transport, processing, placement, and compaction of all materials.

B. Dust control measure effectiveness shall be satisfactory to the Owner.

PART 2 – MATERIALS

2.01 WATER

A. The Contractor shall provide a water truck for the application of clean water for dust control.

B. The Contractor shall provide a means of supplying sufficient water.

PART 3 – EXECUTION

3.01 PROCEDURE

A. Dry soils shall be wetted once prior to starting work each day, and thereafter throughout the day whenever construction activities produce visible fugitive dust emissions. Water shall be applied in a manner as to avoid ponding and runoff.

END OF SECTION

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SECTION 02315

EXCAVATION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall be responsible for providing equipment and labor required to excavate and move on-site topsoil from adjoining areas to be used in the construction of the vegetative layer.

B. The Contractor shall be responsible to provide equipment and labor required to move the native soils from Cell 4 to be used in the construction of the ET layer. The ET layer material has been previously excavated and laid over Cell 4 for decomposition.

1.02 SOIL SEGREGATION

A. The Contractor shall segregate the excavated soil or topsoil under the direction and to the satisfaction of the Owner.

1.03 RELATED WORK AND REFERENCES

A. OSHA Regulations.

PART 2 – MATERIALS

2.01 SILTY CLAY

A. The on-site native silty clay soil is to be used for the ET layer.

2.02 TOP SOIL

A. Soils used as the vegetative layer shall consist of on-site topsoil removed from adjoining areas as directed by the Owner.

PART 3 – EXECUTION

3.01 TOPSOIL MATERIAL EXCAVATION

A. Native topsoil material shall be excavated from the adjoining areas for use in the construction of the vegetative layer. The borrow area is to be determined by the Owner.

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3.02 CLEANUP

A. Grade to smooth, uniformly sloping surfaces all areas disturbed by construction operations. Surfaces pre- and post- construction shall be graded to drain and precautions necessary shall be taken to minimize erosion.

B. Runoff collection system(s) will be developed as necessary by the Contractor, in coordination with the Owner, to prevent runoff from entering active cell(s).

3.03 SAFETY

A. All excavation shall be done in accordance with OSHA regulations and by local standards and accepted safe practices.

END OF SECTION

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SECTION 02320

FINAL COVER

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The Contractor shall be responsible for equipment and labor required to install the final cover.

B. The final cover will be constructed using on-site native materials. Testing for compaction characteristics, hydraulic conductivity, and Atterberg limits will be characterized before the start of construction (see CQAP). The final cover will be placed on top of the existing surface.

PART 2 – MATERIALS

2.01 EVAPORATIVE-TRANSPIRATION LAYER

A. The ET layer shall be constructed of 30 inches of native silty clay material that was stockpiled during excavation. The soil shall be free of debris or particles greater than 2 inches exceeding 10% of volume of material by weight. This soil shall come from areas on-site, as described in Section 02315.

2.02 VEGETATIVE LAYER

A. The vegetative layer shall be constructed of six (6) inches of topsoil excavated from the next active cell and seeded with vegetation suited to grow under local site conditions (see Section 02920).

PART 3 – EXECUTION

3.01 PREPARED SUBGRADE

A. Existing vegetation in the final cover area shall be stripped and stockpiled on-site at the location identified by the Owner.

3.02 MOISTURE CONDITIONING

A. The native silty clay soil shall be moisture-conditioned within a range of two (2) percentage points dry of the optimum moisture content to a maximum of the optimum moisture content as measured by ASTM D 1557.

3.03 COMPACTION

A. Acceptable compaction ranges from 80% to 85% of maximum dry density as measured by ASTM D 1557. Soil not within this range shall be rejected.

B. ET layer soil shall be placed in 1-foot deep lifts and then compacted. Vegetative layer soil can be placed in lift of less than 1-foot thick.

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C. A minimum slope of 2% shall be required on the top slope and a maximum of 3:1 (horizontal:vertical) on the side slopes. Side slopes can be flatter than 3:1 as required to match existing grades.

3.04 CORRECTIVE ACTION

A. For work or physical components that do not satisfy plans and specifications, the general actions may include:

- Removal and replacement;
- Additional compaction and moisture adjustment for soils.

B. If materials are found to deviate from specified standards, they will either be rejected or their suitability demonstrated by additional testing and analysis.

3.05 CONSTRUCTION QUALITY ASSURANCE

A. Final cover construction will be subject to CQA procedures as described in the CQA Plan which is also part of this contract.

B. Contractor shall accommodate CQA operations in the planning and execution of operations, and shall cooperate with CQA staff.

END OF SECTION

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SECTION 02920

REVEGETATION

PART 1 – GENERAL

1.01 SCOPE

A. The Contractor shall provide all material, equipment, and operations required for reseeding the final cover after completion of construction. The Contractor shall also coordinate with Owner to determine allowable time (season dependent) to reseed.

1.02 DELIVERY, STORAGE, HANDLING

A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at site.

PART 2 – MATERIALS

2.01 SEED

A. The Contractor shall drill seed for the vegetative layer. The seed mixture shall meet the following specifications and have no noxious weeds. The mixture to be used shall be as follows:

Seed	Application Rates
Indian Ricegrass:	5 lbs PLS/acre drilled
4 Wing Saltbush:	2 lbs PLS/acre broadcast

*PLS = Pure Live Seed

2.02 MULCH/TACKIFIER

A. The Contractor shall apply one of the following materials to minimize erosion of the drilled seed.

Application Materials	Application Rates
Wood fiber hydromulch	2,000 lbs/acre
Tackifier	500 lbs/acre
OR	
Weed-free straw mulch*	2,000 lbs/acre

*Enough to cover surface, straw "crimped" into the ground using a tractor-mounted straw crimper.

PART 3 – EXECUTION

3.01 GROUND PREPARATION

A. Soils that are to receive grass seed shall be properly prepared, if the soil has not already been loosened, scarify the surface to a depth not less than 3 inches. Prior to seeding, the areas shall be graded and the area shall be free of large rocks and debris.

B. Seed should be applied prior to snowfall. If seed must be applied and no snowfall is anticipated, moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting grasses. Excess water should not be applied to where it creates muddy soil conditions. After seed has been applied, lightly harrow the surface to maximum depth of 1 inch.

C. Apply sufficient hydromulch and Tackifier, or straw mulch, to cover the ground surface following seeding.

3.02 CLEANUP AND PROTECTION

A. During landscape work keep structures, fencing and other exposed facilities clean. Keep work area in an orderly condition.

B. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

END OF SECTION

re- mon. Closure

KEOGH LAND SURVEYING
REGISTERED LAND SURVEYORS
45 E. Center • P.O. Box 396
MOAB, UT 84532

(435) 259-8171
Telephone and Fax

January 29, 2003

Ms. Jane Jones
Grand County Solid Waste
P.O. Box 980
Moab, UT 84532

RE: Cover Area Cell #1

Dear Jane,

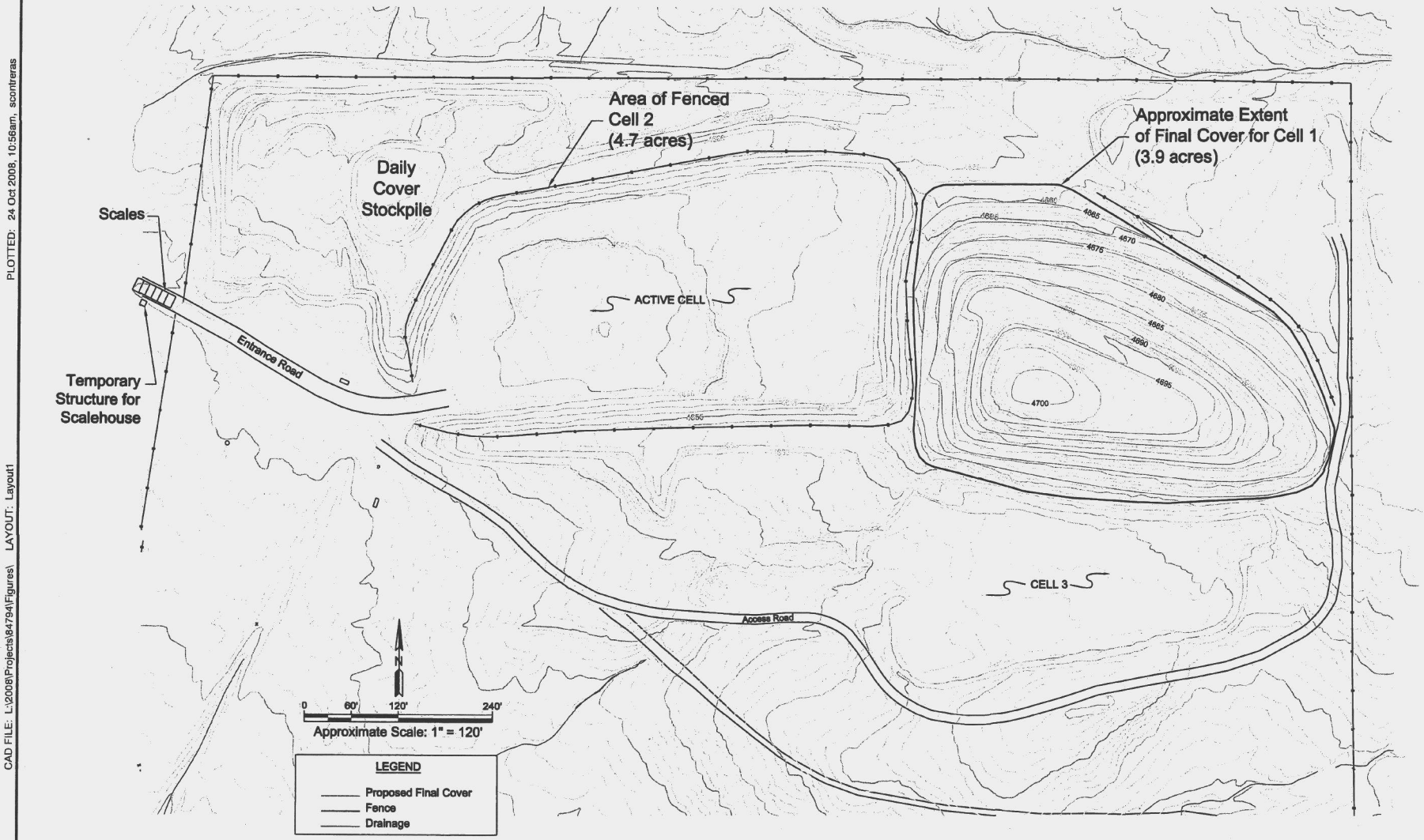
As requested, we have determined the surface area of those lands specified by Skeet Lammert to be the limits of Klondike Cell #1.

That surface area is 100,560 sq. ft. or 2.31 acres.

Thank you and call with any questions.

Sincerely Yours,

Timothy M. Keogh, P.L.S.



PLOTTED: 24 Oct 2008, 10:56am, scontreras

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SALT LAKE CITY, UT

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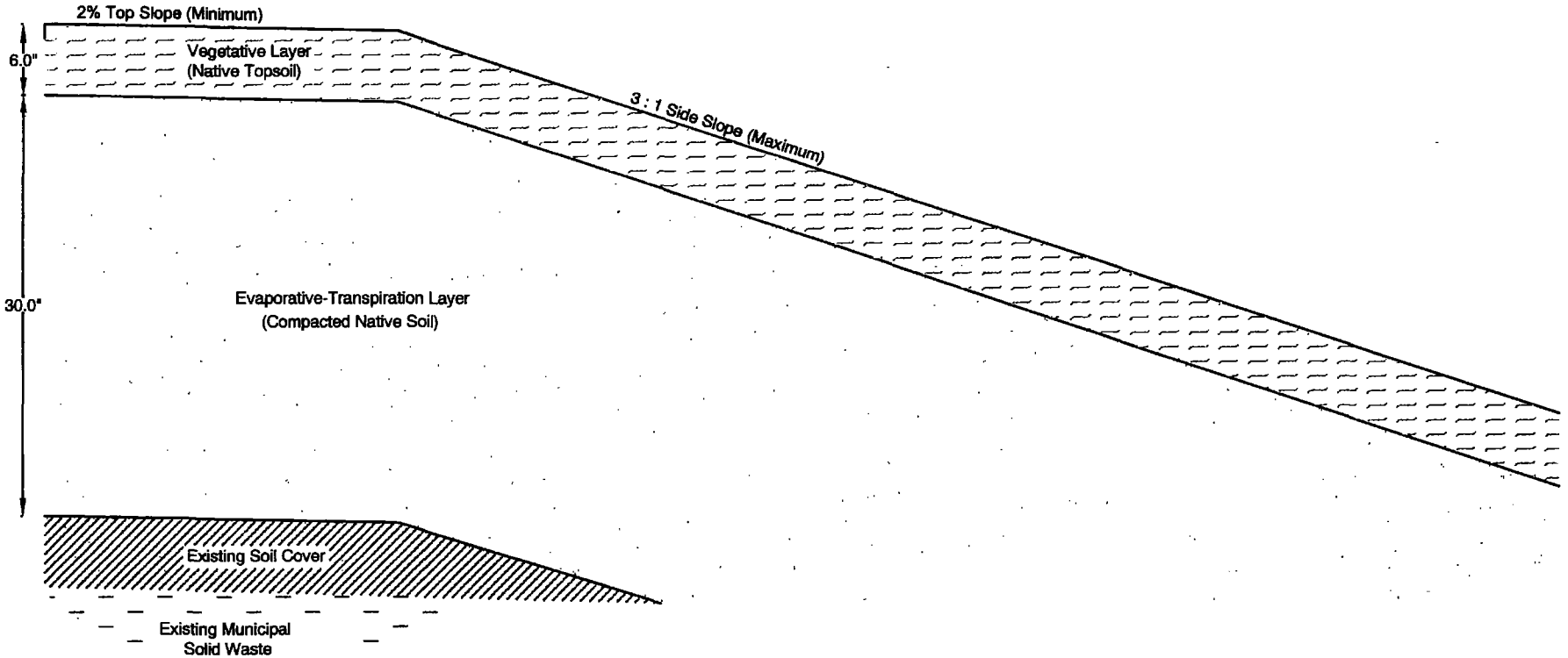
PROJECT NO.	84794.3
DRAWN:	10/24/2008
DRAWN BY:	S.C.
CHECKED BY:	A.H.
FILE NAME:	SLC8d141.dwg

CONCEPTUAL FINAL COVER DESIGN

SOLID WASTE SPECIAL SERVICE DISTRICT # 1
KLONDIKE CLASS I LANDFILL
GRAND COUNTY, UTAH

FIGURE
1

Salt Lake City, Utah CAD FILE: L:\2008\Projects\84794\Figures\ LAYOUT: Layout1 PLOTTED: 24 Oct 2008, 11:04am, scontreras



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DRAWN BY:	S.C.
CHECKED BY:	A.H.
FILE NAME:	SLC8d142.dwg

FINAL COVER SYSTEM DETAIL

SOLID WASTE SPECIAL SERVICE DISTRICT # 1
KLONDIKE CLASS I LANDFILL
GRAND COUNTY, UTAH

FIGURE
2

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APPENDIX M

Construction Quality Assurance Plan for Final Cover Construction

CONSTRUCTION QUALITY ASSURANCE PLAN

FOR

KLONDIKE LANDFILL FINAL COVER CONSTRUCTION
SOLID WASTE SPECIAL SERVICE DISTRICT #1

May 5, 2009

Prepared by

Kleinfelder West, Inc.
849 W. Levoy Drive, Suite 200
Salt Lake City, Utah 84123

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I. INTRODUCTION

A. Project Background

The Klondike Landfill (Landfill) is located 20 miles northwest of Moab, Utah and approximately 1.2 miles west of Highway 191. The site is a Class I landfill that accepts municipal waste and is regulated by the State of Utah Division of Solid and Hazardous Waste (DSHW) and managed by the Solid Waste Special Service District #1 (District) . The Landfill is currently comprised of six phases in a 25-acre disposal area in a 40-acre parcel. Additional phases will be planned in the second 40-acre parcel at a later date.

B. Purpose and Scope

This Construction Quality Assurance Plan (CQAP) is a guidance document for the Landfill final cover construction to observe, test, and document that the evaporative-transpiration (ET) cap meets or exceeds design criteria contained in the Construction Specifications (Kleinfelder, 2007) as well as the Klondike Landfill Permit, issued by DSHW. The scope of this plan includes general Construction Quality Assurance (CQA) requirements concerning roles and responsibilities of the parties involved performing Construction Quality Control (CQC) and CQA, construction meetings, and general inspection and documentation procedures.

CQC is an ongoing process of measuring and controlling the characteristics of the product in order to meet the project specifications and is the responsibility of the Contractor. CQA consists of a planned series of observations and tests to provide quantitative criteria with which to accept the final product and is the focus of this document.

The procedures described below are tailored to the Landfill site and are in part excerpted or adopted from EPA/600/R-93/182 Technical Guidance Document, *Quality Assurance and Quality Control for Waste Containment Facilities* (EPA, 1993).

C. Responsibilities

Contractor: CQC inspection by the Contractor to provide an in process measure of construction quality and conformance with the project plans and specifications, thereby allowing the Contractor to correct the construction process if the final cover does not meet the specifications and plans.

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Engineer: The CQAP will be implemented under the supervision of a registered professional engineer. The District may elect to utilize the same firm for monitoring, observation, and testing services.

CQA Officer: The District will designate or hire a registered professional engineer as CQA Officer to oversee the execution of the CQAP. Activities of the CQA officer, usually through a third-party testing firm, measure and document quality of the final cover and it's conformance with project plans and specifications. The CQA officer's responsibilities and those of the CQA officer's staff members may include:

- Communicating with the Contractor;
- Interpreting and clarifying project drawings and specifications with the designer, District and Contractor;
- Scheduling and implementation of all required inspections and tests;
- Notifying the District of construction quality problems not resolved on-site in a timely manner;
- Reviewing the Contractor's quality control recording, maintenance, summary, and interpretations of test data for accuracy and appropriateness;
- Confirming that the final cover system was constructed in accordance with approved construction plans and specifications;
- Recommending acceptance or rejection by the District of work completed by the Contractor; and
- Reporting monitoring results to the District.

Owner: The District is the Owner and will interact with Contractor, CQA Officer, and Engineer as necessary to facilitate project construction. The District will have the authority to stop work or reject work if problems or deficiencies are encountered.

II. CONSTRUCTION MEETINGS

A. Pre-construction Meeting

The CQA firm will attend a pre-construction meeting before the contractor plans to initiate significant construction activities, if possible. The meeting will include representative(s) of the District, the CQA Officer, and the Contractor. Topics to be discussed at the pre-construction meeting include, but are not limited to, the following:

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- Discuss the CQA plan and any modifications required to it;
- Review permits and other requirements of state and local regulatory agencies;
- Review the responsibilities of each party and lines of authority;
- Review procedures for documentation and reporting information;
- Establish protocol for testing and soil sample management;
- Establish protocol for handling construction deficiencies including repairs and re-testing;
- Review detailed construction time schedule and work plans;
- Review material and equipment delivery, handling, and storage areas;
- Review water management and fugitive dust control;
- Review health and safety requirements and safety protocols; and
- Project management (change orders, invoices, payment requests, etc.).

The meeting will be documented by the CQA Officer and minutes transmitted to all parties.

B. Additional Meetings

Daily "tailgate" meetings shall be held to review hazards during site activities. Routes to the nearest hospital shall be displayed at the site.

C. Additional Meetings

Additional meetings will be held when needed to discuss construction activities, testing deficiencies, test results, testing yet to be performed, and any other items deemed necessary by the CQA personnel, Engineer, or Owner. Representatives of the CQA Firm will interact and informally meet with the Contractor on a daily basis regarding construction progress, schedule, test results and deficiencies, and other items pertinent to project completion.

III. QA INSPECTIONS, SAMPLING, AND TESTING

The following is an overview of CQA activities, by major components, to be undertaken before, during, or after construction. During construction of the final

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cover, surveying techniques and visual observation will be used to evaluate the general grades and total thickness, respectively, of the soil cover.

A. ET Cap Modeling

A test pad will not be required as the *Proposed Evaporative-Transpiration Cap*[1] modeling effort demonstrated that an ET 30-inch thick cover design using the native soil meets the requirements for a maximum hydraulic conductivity of 10^{-5} cm/sec. It is assumed that the actual final cover will have a similar hydraulic conductivity, provided the actual ET cap is built of native materials and to standards that equal or exceed those used in the assumptions for the model.

B. Final Cover Construction Evaluation

The final cover system will be comprised of two soil layers consisting of one 30-inch thick ET layer with a maximum hydraulic conductivity of 10^{-5} cm/sec and one 6-inch thick vegetative layer capable of sustaining native vegetation.

The CQA of the final cover is implemented to evaluate whether construction of the system meets or exceeds all design criteria, plans, and specifications. CQA testing and test methods identified for source material shall include visual classification in accordance with ASTM D 2488. Visual classification testing is implemented to ensure that only native silty clay material is used as a source material. Additionally, visual observations should be made to check that the source material does not contain particle sizes greater than 2 inches exceeding 10% of material volume by weight; a sieve analysis should confirm these observations.

CQA testing frequencies and test methods for the construction of the final cover system are presented in Table 1.

[1] Kleinfelder, Inc. *Proposed Evaporative-Transpiration Cap, Klondike Flats Landfill, Grand County, Utah.* September, 19, 2005.

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TABLE 1
MATERIAL TESTS AND TESTING METHODS
FINAL COVER SYSTEM

Parameter	Testing Method	Minimum Testing Frequency	Requirement
Compaction (pre-field)	ASTM D 1557	2 representative samples	Not applicable
Hydraulic conductivity (pre-field)	ASTM D 5084	2 representative samples	Less than or equal to 10^{-5} cm/sec
Atterberg Limit (pre-field)	ASTM D 4318	2 representative samples	P1>10%
Visual Classification	ASTM D 2488	Continuous during construction	Native silty clay material
Compaction (field)	ASTM D 2922 (Nuclear gauge)	2 per 1-acre per lift	80 to 85% relative compaction (per ASTM D 1557
Water content (field)	ASTM D 3017 (Nuclear gauge) ASTM D 2216 (Lab oven-dried)	2 per 1-acre per lift Split samples	See specifications Section 02320
Particle size distribution	ASTM D 422	2 per 1-acre per lift	Particles greater than 2 inches not to exceed 10% volume by weight
Thickness	Field measurement	2 per 1-acre	30 inches compacted minimum

CQA testing for the final cover is implemented to inspect that similar material (native silty clay material) and soil characteristics used for the modeling are generated by construction of the final cover. CQA tests and testing methods for the final cover include visual classification, water content, compaction, gradation, thickness, and grading. Testing of water content and soil compaction will occur during material placement to verify that compaction specifications are met.

Final construction plans and specifications along with the Contractor's CQC program will address:

- Methods of controlling uniformity and grain size distribution of the soil material;
- Compactive effort (e.g., type of equipment, number of passes) to achieve required hydraulic conductivity;

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- Lift thickness and placement procedures to achieve uniformity of density throughout a lift and the absence of apparent boundary effects between lifts or between placements in the same lift;

- Test procedures for controlling the quality of construction; and

- Skill and competence of the construction team, including equipment operators and quality control specialists.

C. Surveying

Visual observation and field measurements will be used to confirm cover thickness as the placement of material will likely cause settling in the waste. Surveying will be used to confirm final grading. Measurements will be performed using excavated samples or other measuring techniques. Measurements will be performed by the Contractor to ensure the cover meets the specified grade and dimensions. The CQA representative will review measurements results to verify slope requirements are met.

At the completion of the final cover the Contractor will perform a survey to be used to develop an as-built drawing. The as-built drawing will document the configuration of the final cover as well as locations of site features such as fence lines, roads, scale, drainage structures, etc. The Contractor shall submit the as-built drawing to the District in AutoCAD format. The drawings will become part of the final construction certification report.

IV. DOCUMENTATION

Ongoing CQA is designed to confirm work has been performed per the plans and specifications, and may provide for corrective action prior to completion of an activity. The record keeping and on-site observation activities are further designed to provide documentation of compliance or non-compliance items, and corrective action. The need for corrective action should be identified during the CQC process, but may not be caught until the CQA process. Along with the final construction plans and specification, the CQC and CQA programs and personnel will identify the deficiency and its extent. They will also ultimately define the form or extent of corrective action required.

Documentation will take several forms and will be used to demonstrate the quality of materials and the condition and manner of installation. The overall documentation will include:

- Detailed plans and specifications (final design);

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- As-built drawings and Contractor QC testing results with an engineer's review;
- Records of on-site observation, via the CQA officer or the CQA officer's staff;
- Material field and laboratory test results; and
- Final Certification Report, stamped by a registered professional engineer.

The final certification report shall be prepared in accordance with DSHW requirements and shall include observations, test results, corrective measures performed, and other information required to certify that the CQAP has been carried out and that construction meets or exceeds the design criteria and specifications in the permit. The final report shall be submitted to DSHW.

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APPENDIX N

Grease and Septage Handling

file

Memorandum of Understanding
By and Between the City of Moab and the Grand County Solid Waste Management Special Service District #1 Regarding the Disposal of Septage and Grease Trap Waste

This Agreement is made and entered into this 24th day of October 2000 by and between the Grand County Solid Waste Management District #1 (hereafter "District") and the City of Moab (hereafter "City").

RECITALS

Whereas, the City of Moab owns and operates the Moab City Waste Water Treatment Plant (hereafter WWTP); and

Whereas, the District operates the Klondike Landfill; and

Whereas, the City accepts septage according to the provisions of the Moab Municipal Code, Chapter 13.26; and

Whereas, the District accepts septage on a limited and emergency basis only when the WWTP is experiencing temporary conditions which prevent its acceptance of septage, such as high Total Suspended Solids; and

Whereas, the District only accepts septage in a special handling site at the Klondike Landfill according to franchise agreements with haulers; and

Whereas, the City and the District desire to set up procedures for the temporary acceptance of septage at the Landfill during times in which the WWTP is unable to accept said septage.

AGREEMENT

The parties agree as follows:

1. Acceptance of Septage at WWTP- The City agrees to accept septage at the WWTP according to the provisions of Moab Municipal Code Chapter 13.26, the Wastewater and Septage Hauling Agreements between the City and individual haulers, and the individual Wastewater and Septage Hauling Permits issued at the WWTP.

2. Notification to District – The City agrees to notify the District in writing when the City temporarily suspends the issuance of Septage Dumping Permits at the WWTP. Said notice will state the reasons for the suspension that qualify as emergency conditions at the WWTP and the estimated duration of the emergency

suspension. The City will provide written notification to the District upon reinstatement of permit issuance.

3. Acceptance of Septage at Klondike Landfill – The District agrees to consider acceptance of septage on a case by case basis for each load of septage that qualifies under this agreement as rejected from the WWTP under the aforesaid temporary, limited, and emergency conditions, upon notification from the City of the City's suspension of the issuance of Septage Dumping Permits at the WWTP, subject to the terms of the franchise agreements between the District and individual septage haulers.

4. Effect of this Agreement – This Memorandum of Understanding is intended to outline procedures of the acceptance of septage by the parties under certain conditions. This Memorandum of Understanding is between the parties hereto only, and does not confer any rights on third parties whatsoever. Either party may withdraw from this agreement upon 10 (ten) days notice to the other party.

APPROVED AND ACCEPTED

City of Moab:

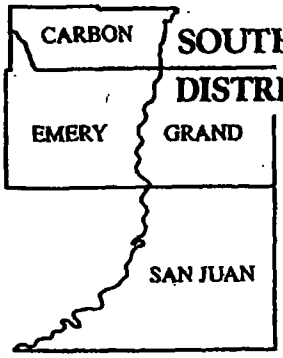
By Karla R. Hancock — 10-24-00
Mayor Karla Hancock — Date

Attest:

Rachel Ellison — 10-24-00
Rachel Ellison, City Recorder — Date

Grand County Solid Waste Management Special Service District #1:

By Dave Sakrison — Oct 13 2000
Dave Sakrison, Vice Chair — Date



SOUTHEASTERN UTAH
DISTRICT HEALTH DEPARTMENT

28 S. 100 E.
P.O. Box 800
Price, Utah 84501
(435) 637-3671
Fax (435) 637-1933

DAVE CUNNINGHAM, RN
Health Director

JOYCE PIERCE, RN
Nursing Director

CLARON BJORK, Ph.D.
Environmental Health Director

JEAN RODRIGUEZ
Budget & Accounting Officer

P.O. Box 644, Castle Dale, Utah 84513 · 381-2252
P.O. Drawer E, Moab, Utah 84532 · 259-5602
P.O. Box 127, Monticello, Utah 84535 · 587-2021
P.O. Box E, Blanding, Utah 84511 · 678-2723

RECEIVED
NOV 15 2000

November 13, 2000

Jane S. Jones, District Manager
Grand County Solid Waste Management
Special Service District # 1
P. O. Box 980
Moab, Utah 84532

Dear Ms. Jones,

An inspection of the Klondike septage area was made by Jim Adamson of the Southeastern Utah District Health Department for septage dehydration. The area is approved for accepting septage.

As needed after dehydration the septage is to be placed on the working face of the landfill and covered that same day.

If I may be of further assistance in this matter please contact the Moab office.

Sincerely,

William J. Adamson
Licensed Environmental Health Scientist

File / Septage/Haz

DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF SOLID AND HAZARDOUS WASTE

Michael O. Leavitt
Governor
Dianne R. Nielson, Ph.D.
Executive Director
Dennis R. Downs
Director

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Salt Lake City, Utah 84114-4880
(801) 538-6170
(801) 538-6715 Fax
(801) 536-4414 T.D.D.
www.deq.state.ut.us Web

RECEIVED 9/11/00

September 6, 2000

Jane S. Jones, District Manager
Grand County Solid Waste Management Special Service District #1
P.O. Box 980
Moab Utah 84532

Subject: Septage and Restaurant Grease Trap Waste Disposal at Klondike Landfill

Dear Ms. Jones:

The Division is in receipt of your letter of August 11, 2000. Your request to dispose of septage and restaurant grease trap waste at the Klondike Landfill is approved with the conditions listed below.

No liquid waste may be disposed of in an area that has received solid waste.

All waste accepted must be non-hazardous.

Waste must not be allowed to pool.

Liquids must evaporate or infiltrate within 24 hours.

Waste must be applied in a manner that spreads the waste such as spraying.

The number of loads received must be recorded in the landfill operating record.

Although the Division recognizes the need to dispose of these types of liquid wastes, the landfill is not the best place for this disposal. Every effort should be made to dispose of septage and grease trap waste in a wastewater treatment facility. The landfill disposal option, as is suggested in your letter, should only be used on a limited or emergency basis.

If you have any questions please contact Phil Burns at 801-538-6170.

Sincerely,

Dennis R. Downs, Executive Secretary
Solid and Hazardous Waste Control Board

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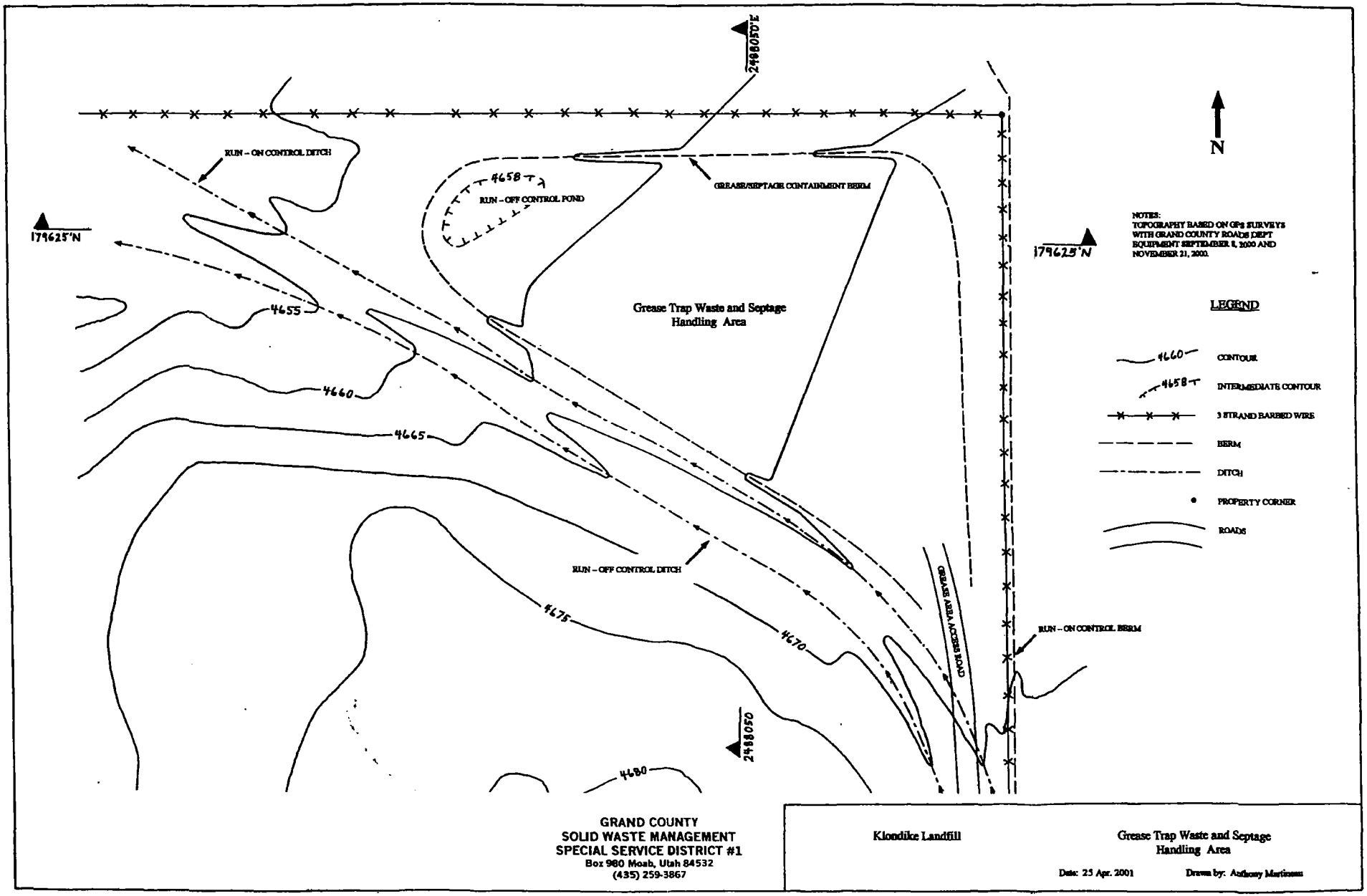
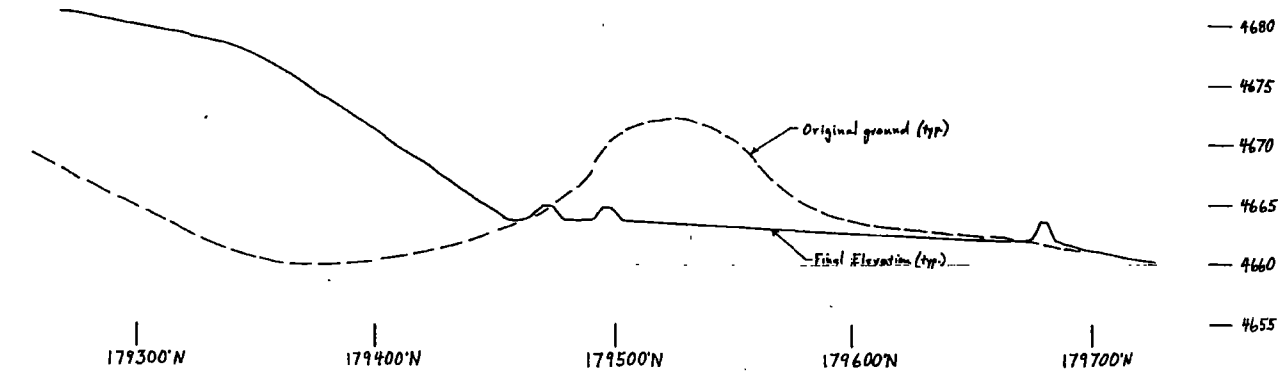
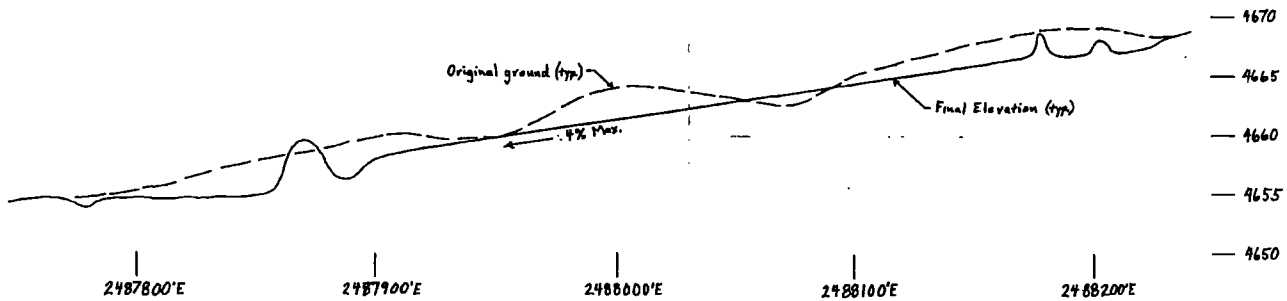
file: Grand County\Klondike Landfill


2498050'E
N
RUN – ON CONTROL DITCH
4658
RUN – OFF CONTROL POND
GREASE/SEPTAGE CONTAINMENT BERM
179625'N
179625'N
NOTES:
TOPOGRAPHY BASED ON GPS SURVEYS WITH GRAND COUNTY ROADS DEPT EQUIPMENT SEPTEMBER 8, 2000 AND NOVEMBER 21, 2000.
Grease Trap Waste and Septage Handling Area
4655
4660
4665
LEGEND
4660 CONTOUR
4658 INTERMEDIATE CONTOUR
3 STRAND BARBED WIRE
BERM
DITCH
PROPERTY CORNER
ROADS
RUN – OFF CONTROL DITCH
4675
4670
GREASE AREA ACCESS ROAD
RUN – ON CONTROL BERM
2498050
4680
GRAND COUNTY
SOLID WASTE MANAGEMENT
SPECIAL SERVICE DISTRICT #1
Box 980 Moab, Utah 84532
(435) 259-3867
Klondike Landfill
Grease Trap Waste and Septage Handling Area
Date: 25 Apr. 2001
Drawn by: Anthony Martinson





Scale: Horizontal 1" = 50'
Vertical 1" = 10'

GRAND COUNTY
SOLID WASTE MANAGEMENT
SPECIAL SERVICE DISTRICT #1
Box 980 Moab, Utah 84532
(435) 259-3867

Grease Trap Waste and Septage
Handling Area

Date: 25 Apr. 2001 Drawn by: Anthony Martinez

North – South Cross Section 2488050' E
East – West Cross Section 179625 ' N
Klondike Landfill

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TECHNICAL MEMORANDUM

TO: Tom Edwards, Grand County, Solid Waste Management SSD #1

CC:

FROM: Bruce Curtis, P.E., Ph.D., Kleinfelder

Kerry Ruebelmann, P.G., Kleinfelder

DATE: February 18, 2014

SUBJECT: **Run-On and Run-off Controls Evaluation for the Klondike Landfill Moab, Utah**

Introduction

The purpose of this investigation was to evaluate the proposed surface water run-on and run-off stormwater facilities at the Klondike Landfill, Grand County, Utah and generate calculations of our analyses. The purpose of the run-on controls is to capture and direct off-site flow away from the active portion of the landfill for the 24-hour, 25-year storm event. The run-off controls will collect and contain the water that falls on the active portion of the landfill from a 24-hour, 25-year storm event. As part of the landfill permit renewal, the Utah Department of Environmental Quality (UDEQ), Division of Solid and Hazardous Waste (DSHW) has requested that the calculations for the design and capacity of the run-on and run-off controls be provided. The landfill design was performed by others as part of the original permit application, but the calculations for these controls were not included in the original application and/or are not part of UDEQ record or the landfill files.

Included in this memorandum are a brief summary of our data acquisition process, hydrologic analyses, hydraulic analyses, and an evaluation of the adequacy of the drainage facilities.

Data Acquisition

Kleinfelder acquired topographic information from the U.S. Geological Survey (USGS) and the HDR construction drawings titled Grand County Solid Waste Management SSD No. 1, Klondike Landfill, Phase I, January 13, 1997. The construction drawings are provided in Appendix A. This information was used to define the watershed areas and ditch slopes. Soil and vegetation information was obtained U.S. Department of Agriculture (USDA) from the Natural Resource Conservation Service (NRCS) database.

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Precipitation data was obtained from National Oceanic and Atmospheric Administration (NOAA) website.

Hydrologic Analysis
Kleinfelder performed a hydrologic analysis to estimate run-on flows from off-site areas for the 24-hour, 25-year storm event and to estimate run-off flows from the landfill for the 24-hour, 25-year. This analysis provided peak flow rates so that we could evaluate whether the ditches had sufficient capacity to contain the 24-hour, 25-year flow and evaluate whether the detention basin had sufficient volume to detain the 24-hour, 25-year runoff.

Three watershed boundaries were defined for runoff flowing into Ditch A, Ditch B, and the detention basin. The watershed boundaries are shown in Figure 1. The soil and vegetation types are shown in Figure 2. The SCS method was used in the U.S. Army Corps of Engineer's (USACE) HEC-HMS hydrologic modeling program to estimate peak runoff rates and runoff volumes in each of the three watersheds. The hydrologic calculations used to provide input data to the model are supplied in Appendix B. HEC-HMS does not provide a hard copy output of the input data so only the output data is provided in Appendix C.

Hydraulic Analysis
Kleinfelder evaluated the proposed ditches' ability to convey run-on flows around the site and run-off flows to the detention facility. Manning's Equation was used to estimate the capacity of the ditches. The proposed channel cross-section for both ditches is shown in the HDR construction drawings provided in Appendix A. Because of the small amount of flow and relatively small design storm, it was assumed that the ditches would require only 0.5 feet of freeboard. The hydraulic calculations are provided in Appendix D.

Detention Basin
Kleinfelder evaluated the proposed detention basin's ability to capture and retain run-off from the landfill. Kleinfelder estimated the volume of the detention facility and the volume of runoff from the 24-hour, 25-year rainfall event. The proposed detention basin design is shown in the HDR construction drawings provided in Appendix A. The SCS method was used in the USACE HEC-HMS hydrologic modeling program. The storage capacity calculations are provided in Appendix E, and the HEC-HMS output data is provided in Appendix C

Results and Recommendation
The peak run-off flow into Ditch A during the 24-hour, 25-year rainfall event is approximately 8 cubic feet per second (cfs). Ditch A has a capacity to convey 150 cfs, so it has sufficient capacity to convey the runoff.

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The peak run-on flow into Ditch B during the 24-hour, 25-year rainfall event is approximately 26 cfs. Ditch B has a capacity to convey 143 cfs, so it also has sufficient capacity to convey the runoff.

The volume of flow into the detention basin during the 24-hour, 25-year rainfall event is approximately 1 acre-foot. The detention basin, as proposed, has a storage capacity of approximately 0.7 acre-feet, so it does not have sufficient capacity to store the runoff based on its current design.

It would take only a minor modification to the detention basin design to provide sufficient storage capacity, though. The drawings show a detention basin bottom of 4612 feet and the outlet is at an elevation of 4617 feet. The available volume is calculated from the outlet elevation and not from the detention basin volume. This assumes that a storm or storms have preceded the design storm and filled the detention basin with water up to an elevation of 4617 feet. This runoff is retained in the detention basin, because it cannot leave the detention basin except by infiltration or evaporation. It appears that if the detention basin outlet could be lowered by 1 foot to an elevation of 4616 feet, the detention basin would provide a storage volume of about 1.3 acre-feet, which would be sufficient to detain the 24-hour, 25-year rainfall event.

For bare dirt, a minimum flow velocity of 2 feet per second (fps) to 3 fps is usually considered erosive. At the design flows, the velocity in Ditch A and Ditch B are 2.7 fps and 3.8 fps, which would be slightly erosive. The ditches probably do not need to be lined with erosion-resistant materials (i.e. rock), but the ditches may require periodic maintenance to correct erosion problems.

LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of the profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. We make no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

Regulations and professional standards applicable to our engineering services are continually evolving. Techniques are, by necessity, often new and relatively untried. Different professionals may reasonably adopt different approaches to similar problems. As such, our services are intended to provide Grand County Solid Waste Management

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SSD #1 with a source of professional advice, opinions and recommendations based on a limited number of data provided, observations, and tests.

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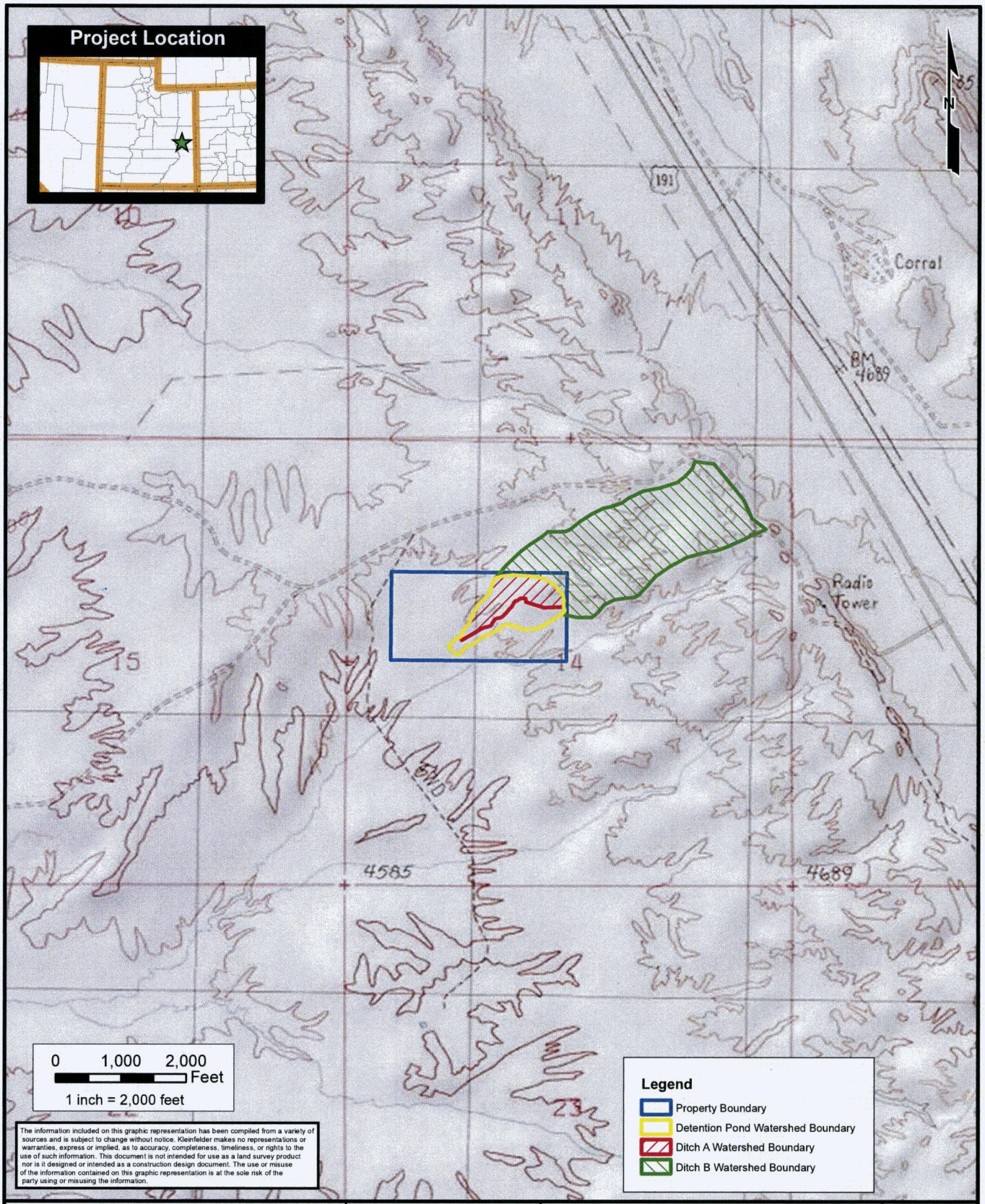
FIGURES



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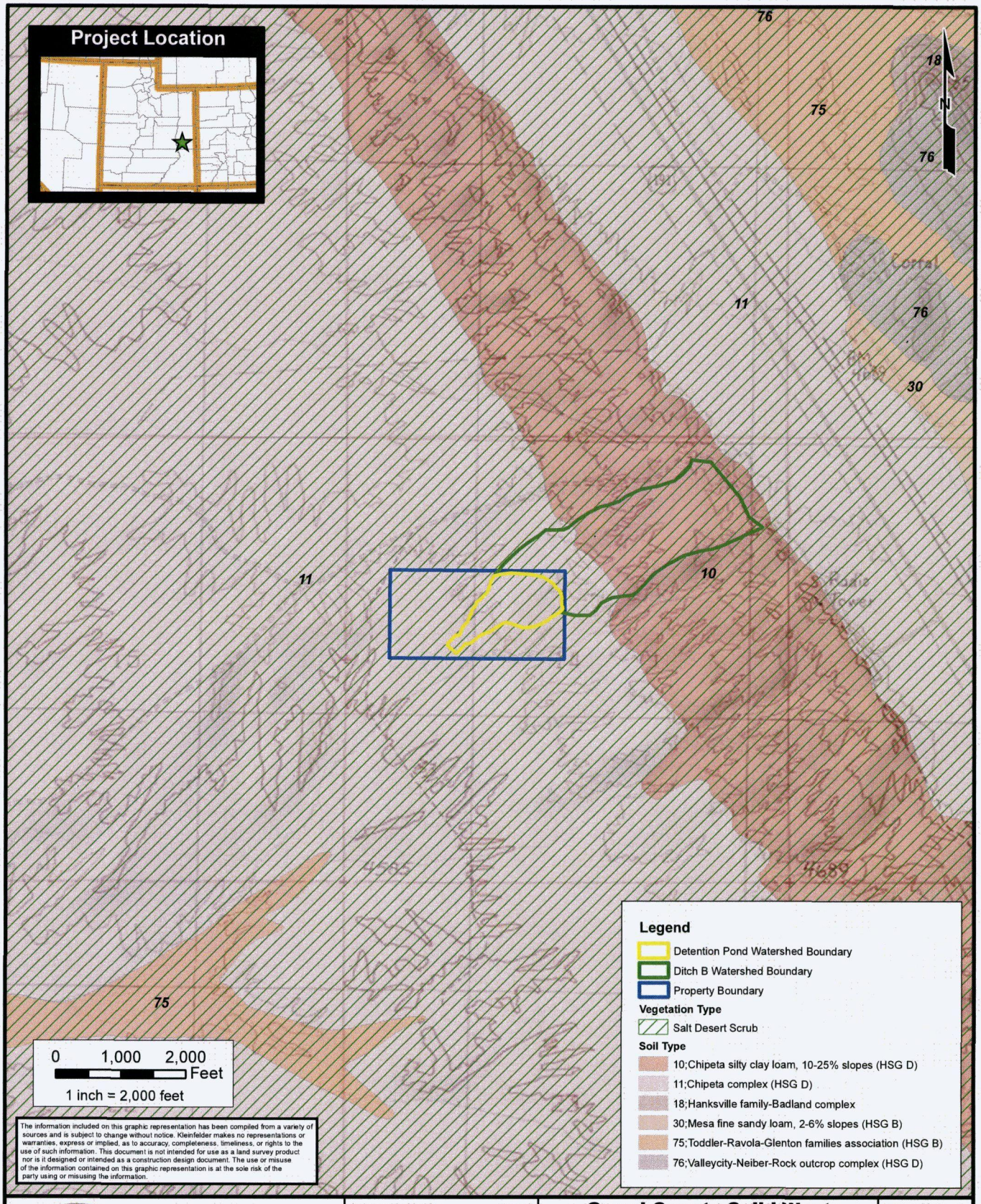
PROJECT NO.	84794
DRAWN:	2/19/2014
DRAWN BY:	L.Hockert
CHECKED BY:	B.Curtis
FILE NAME:	Fig1_Vicinity.mxd

Grand County Solid Waste Management Special Services District (SSD) #1

Watershed Boundary
Grand County, Utah

FIGURE
1



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PROJECT NO.	84794
DRAWN:	2/19/2014
DRAWN BY:	L.Hockert
CHECKED BY:	B.Curtis
FILE NAME:	Fig2_SoilsVeg.mxd

Grand County Solid Waste Management Special Services District (SSD) #1

Watershed Boundary
Grand County, Utah

FIGURE
2

APPENDIX A

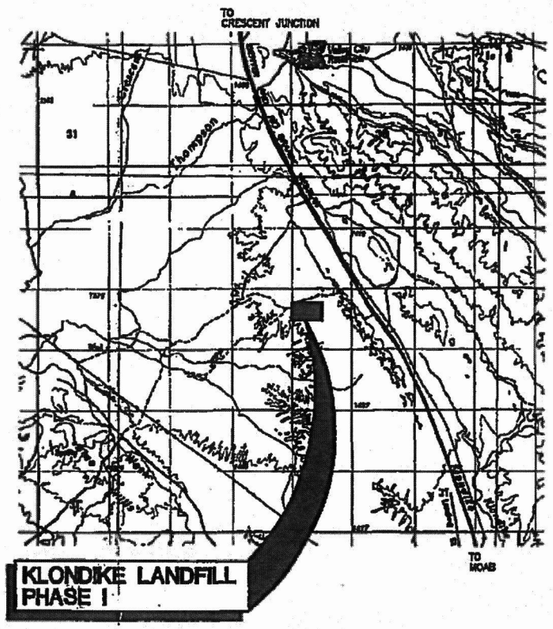
HDR Construction Drawings
Grand County Solid Waste Management SSD No. 1
Klondike Landfill, Phase I
January 13, 1997

Contract Drawings For

Grand County Solid Waste Management SSD No. 1

Klondike Landfill Phase I

January 13, 1997



VICINITY MAP
NO SCALE

INDEX

COVER	INDEX OF DRAWINGS AND VICINITY MAP
C-1	SITE PLAN
C-2	PHASE I GRADING PLAN AND DETAILS
C-3	DETENTION POND GRADING PLAN AND SITE DETAILS
C-4	SITE DETAILS

HDR

HDR Engineering Inc.

EXISTING ACCESS ROAD

PROPERTY LINE (TYP.)

APPROX. LOCATION PROPERTY CORNER (TYP.)

LEACHATE COLLECTION AND REMOVAL SYSTEM (TYP.) SEE SHT. C-2

PHASE I
SEE SHT. C-2 FOR GRADING PLAN

RUN-OFF CONTROL DITCH B. SEE SHT. C-4 FOR ALIGNMENT

RUN-OFF CONTROL DITCH A. SEE SHT. C-4 FOR ALIGNMENT

NEW 12'-0" ACCESS ROAD TO PHASE I CELL

N 8548
E 7985
STA. 0+00

SEE SHT. C-4 FOR CULVERT DETAIL

N 8569
E 8700

DETENTION POND
SEE SHT. C-3

N 7850
E 8345

N 7968
E 8505

N 8320
E 8410

N 8572
E 8585

N 8270
E 8410

N 8240
E 8360

N 8173
E 8135

N 8330
E 9000

N 8180
E 9425

N 8182
E 8900

Center Corner Section 14

N 9030
N 8500
N 8000
N 7500
E 7500
E 8000
E 8500
E 9000
E 9500
E 10000

4640 4630 4620 4610 4650 4660 4670 4680 4690

1" = 230'
.87" = 200'
1.29" = 300'

SCALE IN FEET

NOTES:
TOPOGRAPHY BASED ON AERIAL SURVEY AS OF JUNE 15, 1994 BY KLH ENGINEERING GROUP, OF GRAND JUNCTION, COLORADO.

LEGEND

- SECTION NUMBER
- DRAWING NUMBER ON WHICH SECTION IS SHOWN
- DRAWING NUMBER ON WHICH SECTION IS FIRST CUT
- DIRECTION OF SECTION
- COORDINATES
- CORNER SECTION
- PROPERTY LINE
- AGGREGATE
- LEACHATE COLLECTION MATERIAL
- RECOMPACTED CLAY LINER
- BASE GRADE

EXISTING	PROPOSED	
—4670—	—4670—	INDEX CONTOUR
		INTERMEDIATE CONTOUR
		PHASE LINE
		ROADS
		LEACHATE COLLECTION PIPE

ABBREVIATIONS

CU.FT.	CUBIC FEET
DIA	DIAMETER
DEG	DEGREE
E	EAST
EL	ELEVATION
FT	FEET
G.V.	GATE VALVE
H	HORIZONTAL
HDPE	HIGH DENSITY POLYETHYLENE
IE	INVERT ELEVATION
LCS	LEACHATE COLLECTION SYSTEM
MIN	MINIMUM
N	NORTH
PVC	POLYVINYL CHLORIDE
SHT.	SHEET
STA.	STATION
TYP	TYPICAL
V	VERTICAL
W/	WITH

HDR

HDR Engineering, Inc.

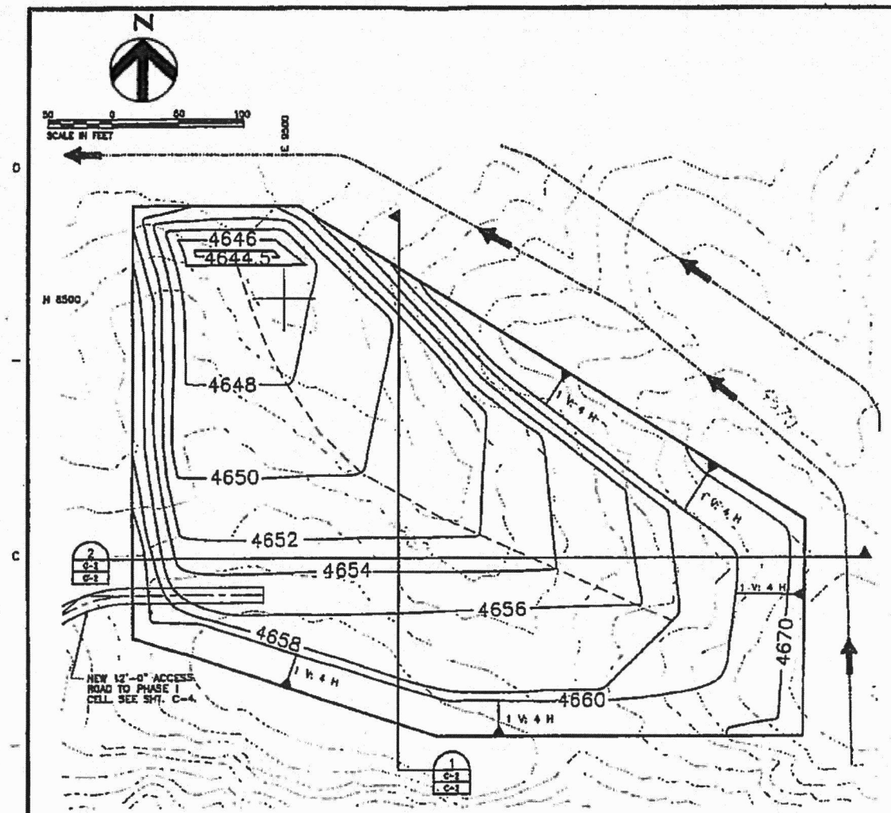
2	ISSUED FOR CONTRACT EXECUTION	1/97	MAE	RD	RB	JS
A	ISSUED FOR CLIENT REVIEW	12/96	MAE	RD	RB	JS
Rev. No.	Description	Date	Drwn.	Chkd.	Appd. Engr.	Appd. Mgr.

Project Manager: G. Savagian
Principal | Mgr./Proposals
Dept. | Coordination
Employee | Telephone
Project Engineer: R. Bandman
Drawn By: M. Dirksen

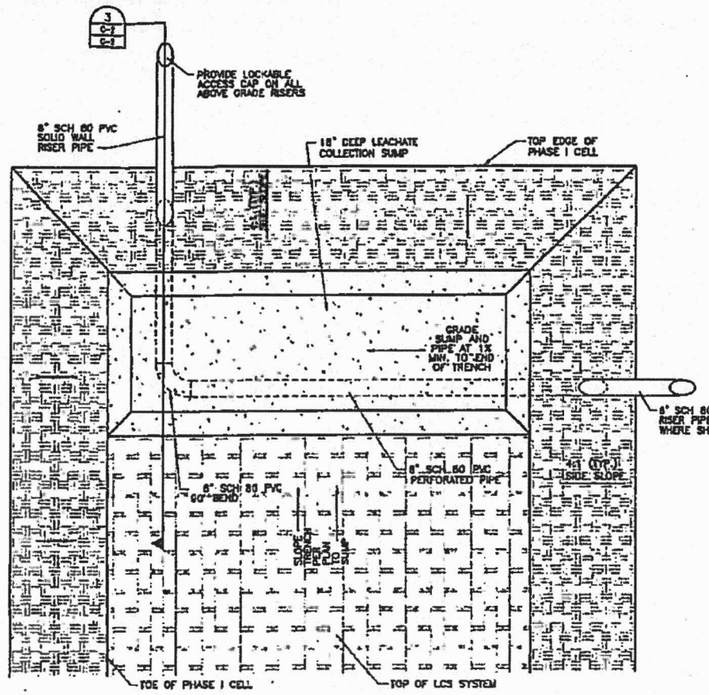
Klondike Landfill
Phase I
Grand County
Solid Waste Management SSD No. 1

Site Plan

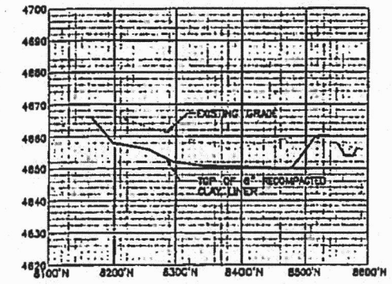
Date: January 13, 1997
Scale: 1"=100'
Project No.: 08438-021-050
File Name: C-1
Drawing No.: C-1
Rev.: B



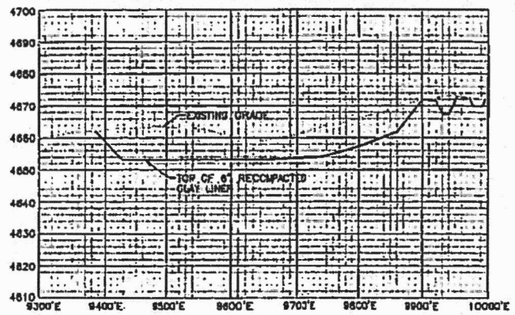
GRADING PLAN
SCALE: 1"=50'
NOTE:
GRADES ARE SHOWN TO TOP OF 6" RECOMPACTED CLAY LINER.



LEACHATE COLLECTION AND REMOVAL SYSTEM – PLAN
NO SCALE



SECTION 1
SCALE:
HORIZ. 1"=100'
VERT. 1"=10'



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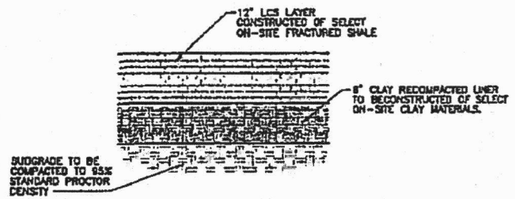

TYPICAL BASE LINER SECTION
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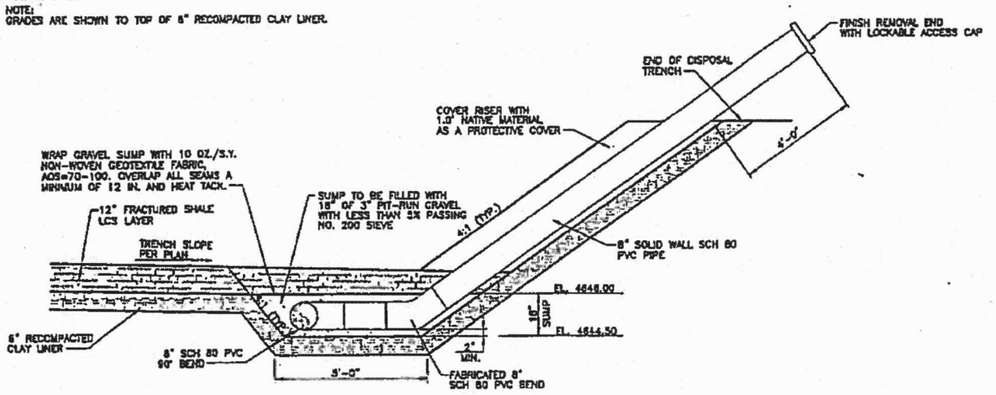


SECTION 3
NO SCALE

NOTES:
1. GRADES AREA SHOWN AT TOP OF 6" COMPACTED CLAY LINER.
2. CONSTRUCT HAUL ROAD INTO PHASE I AFTER COMPLETION OF 6" RECOMPACTED CLAY LINER IN THIS AREA. SEE SHT. C-4 FOR HAUL ROAD ALIGNMENT AND GRADE.

HDR

HDR Engineering, Inc.

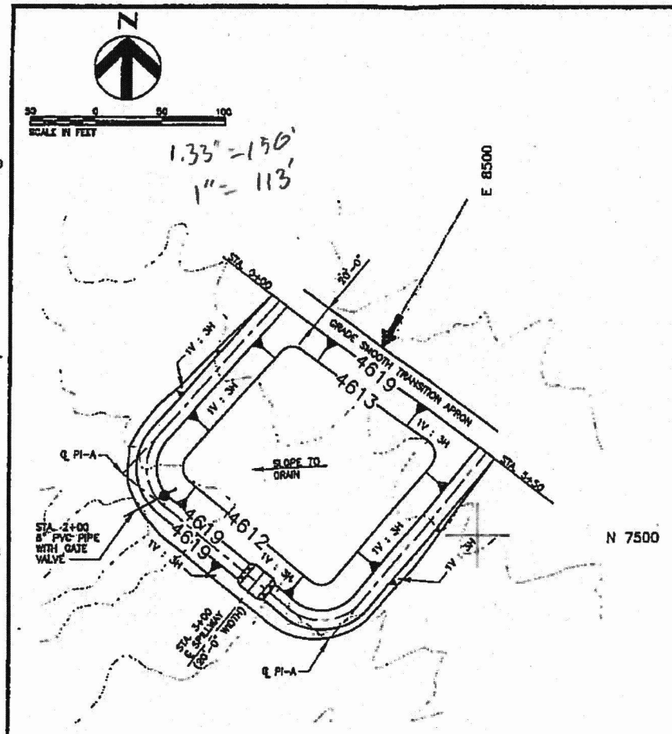
Rev. No.	Description	Date	Drwn.	Chkd.	Appr. Engr.	Proj. Mgr.
C	ISSUED FOR CONTRACT EXECUTION WITH REVISION	1/97	MAE	RO	RO	DS
B	ISSUED FOR CONTRACT EXECUTION	1/97	MAE	RO	RO	DS
A	ISSUED FOR CLIENT REVIEW	12/96	MAE	RO	RO	DS

Project Manager: B. Sprague
Project Engineer: R. Donovan
Drawn By: M. Erikson

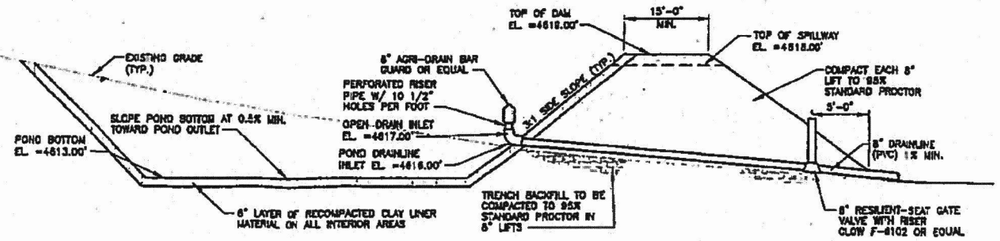
Klondike Landfill
Phase I
Grand County
Solid Waste Management SSD No. 1

Phase I Grading Plan and Details

Date: January 13, 1997
Project No.: 08456-001-050
Drawing No.: C-2
Sheet: C
Scale: As Noted
File Name: C-2



GRADING PLAN
SCALE: 1"=50'



DETENTION POND DETAIL
NO SCALE

DETENTION POND CENTERLINE DATA						
COORDINATES			CURVE DATA			
STATION	NORTHING	EASTING	DELTA (deg)	RADIUS (ft)	Lcurve (ft)	Ltan (ft)
0+00	N 7680	E 8385				
PI-A	N 7530	E 8225	90.00	47.5	74.6	47.5
PI-B	N 7430	E 8385	90.00	47.5	74.6	47.5
5+50	N 7685	E 8505				

DETENTION POND DESIGN CRITERIA	
HYDROLOGICAL DATA	
RUNOFF MODEL	SCS METHOD
RAINFALL EVENT	25 YR./24 HR.
DESIGN RAINFALL	2.5"
RUNOFF CURVE NUMBER	79
DESIGN RUNOFF	0.8"
DETENTION POND	
DRAINAGE AREA	38 ACRES
RUNOFF FROM DESIGN EVENT	107,000 CU. FT.
MAXIMUM CAPACITY	125,000 CU. FT.
MAXIMUM DEPTH	5 FT.
MAXIMUM HYDROSTATIC HEAD ON FILL	3 FT.
SIDE SLOPES	3:1
TOP WIDTH	15 FT.
POND AREA WHEN FULL	0.55 ACRES
TOP OF DAM ELEVATION	4818.0'
POND BOTTOM ELEVATION	4813.0'
SPILLWAY ELEVATION	4815.0'
SPILLWAY CAPACITY	50 CFS.
PEAK DISCHARGE	28 CFS.
DRAINLINE INLET INVERT	4816.0'
DRAINLINE TYPE	8" PVC W/ G.V.

HDR Engineering, Inc.

No.	Description	Date	Drawn	Check.	Supv. Engr.	Proj. Mgr.
B	ISSUED FOR CONTRACT EXECUTION	1/97	MAE	RD	RD	DS
A	ISSUED FOR CLIENT REVIEW	12/96	MAE	RD	RD	DS

Project Manager: D. Sprague
Approved: [illegible] | QA/Process: [illegible]
QA: [illegible] | Environment: [illegible]
Coordinator: [illegible] | Inventory: [illegible]
Project Engineer: R. Donovan | Drawn By: M. Erikson

Klondike Landfill
Phase I
Grand County
Solid Waste Management SSD No. 1

Detention Pond Grading Plan and Details

Date: January 13, 1997 | Project No.: 08456-001-050 | Drawing No.: C-3 | Issue: B
Scale: As Noted | File Name: C-3

USER: MICHAEL A. ERIKSEN 01-16-1997
DATA: Pen Table: ACAD.TBL
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Plot Rotation: 0.00 degrees
Plot Origin: 0.00, 0.00
Plot Options: Hidden Lines Removed
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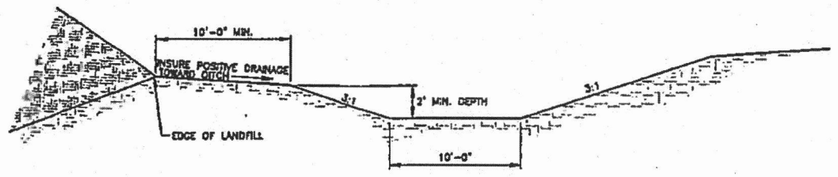
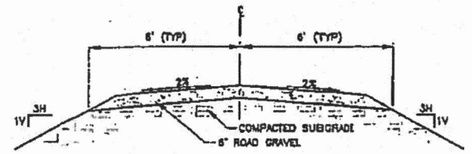


TYPICAL DITCH SECTION
NO SCALE

PERIMETER DITCH CENTERLINE DATA							
	COORDINATES		CURVE DATA				DITCH
STATION	NORTHING	EASTING	DELTA (deg)	RADIUS (ft)	Lcurve (ft)	Ltan (ft)	I.E.
RUNOFF CONTROL DITCH (Line A)							
00+00	N 81377.0	E 9738.6					4672.0
PI-A1	N 8380.8	E 9933.3	46.47	50.0	42.3	22.5	4668.0
PI-A2	N 8490.8	E 9785.4	10.75	200.0	37.5	18.8	4664.0
PI-A3	N 8511.7	E 9547.4	28.79	200.0	100.5	51.3	4652.0
PI-A4	N 8413.5	E 9140.2	8.37	200.0	32.7	16.4	4640.0
PI-A5	N 8463.4	E 8787.3	60.94	100.0	106.4	58.8	4632.0
PI-A6	N 8168.4	E 8720.2	21.28	200.0	74.3	37.6	4626.0
24+90	N 7852.7	E 8418.4					4618.0
RUNOFF CONTROL DITCH (Line B)							
00+00	N 8138.2	E 9978.4					4671.0
PI-B1	N 8372.5	E 9978.4	28.01	200.0	90.8	46.2	4668.0
PI-B2	N 8438.2	E 9951.2	28.98	200.0	101.2	51.7	4658.0
PI-B3	N 8610.2	E 9891.4	16.16	200.0	53.0	26.7	4758.0
PI-B4	N 8631.9	E 9578.7	16.84	200.0	58.8	34.6	4651.0
PI-B5	N 8946.4	E 8927.0	33.31	200.0	116.3	59.6	4638.0
17+60	N 8465.0	E 8625.0					4632.0



TYPICAL ROAD SECTION
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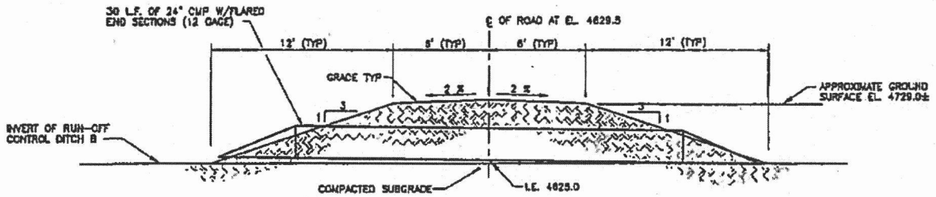
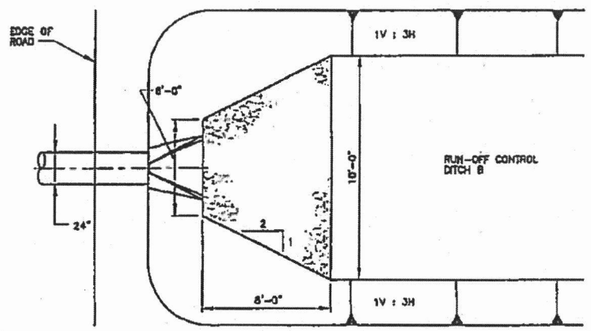
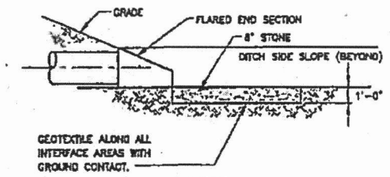


CULVERT DETAIL – STA. 7+90
NO SCALE

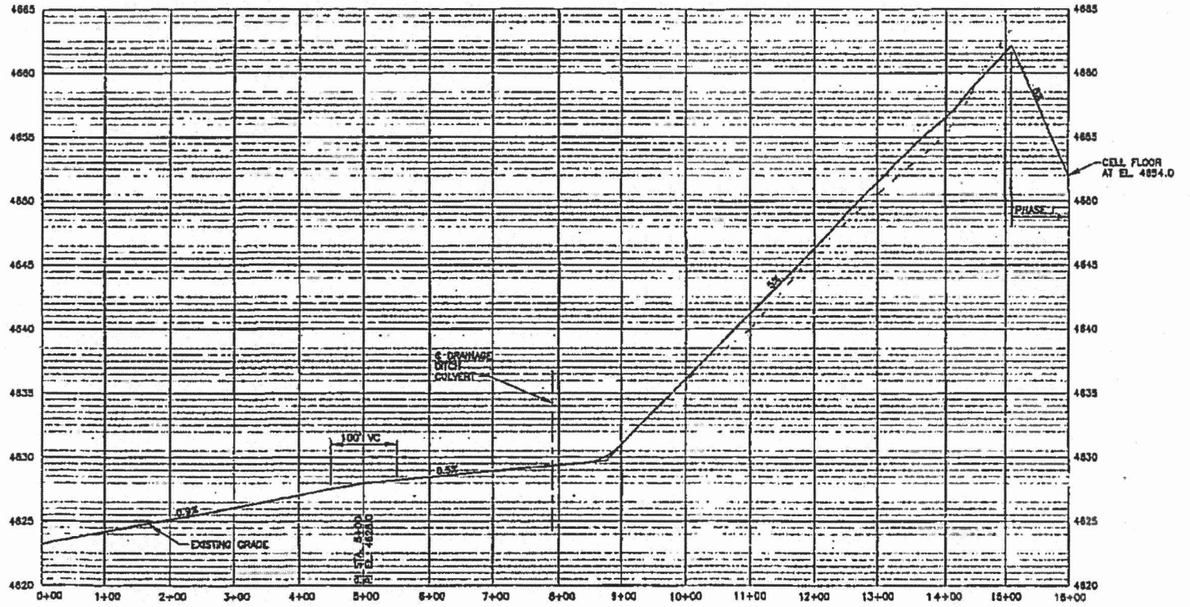


PLAN



SECTION

LINED APRON
NO SCALE



ACCESS ROAD PROFILE
PROFILE SCALE
HORIZ.: 1"=100'
VERT. : 1"=5'

HDR

HDR Engineering, Inc.

No.	Description	Date	Drawn	Check.	Proj. Engr.	Proj. Mgr.
B	ISSUED FOR CONTRACT EXECUTION	1/97	MAE	RD	RD	DS
A	ISSUED FOR CLIENT REVIEW	12/96	MAE	RD	RD	DS

Project Manager: D. Sprague
Comment | Init./Date
Chk'd | Independent
Designed | Structural
Project Engineer: R. Donovan
Drawn By: M. Dirksen

Klondike Landfill
Phase I
Grand County
Solid Waste Management SSD No. 1

Site Details

Date: January 13, 1997
Scale: As Noted
Project No.: 08458-001-050
File Name: C-4
Drawing No.: C-4
Sheet: B

WILEY, MICHAEL A. DIXON 10-15-1997
LICENSED PROFESSIONAL ENGINEER
STATE OF UTAH No. 7 2102523

APPENDIX B

HYDROLOGIC COMPUTATIONS

KLEINFELDER

PROJECT:	Grand County SWM SSD #1	PROJECT NO.:	84794		
SUBJECT:	Ditch A Lag and Time of Concentration Calc	BY:	Bruce Curtis	DATE:	2/17/14
		REVIEWED BY:		DATE:	

PURPOSE:
Perform calculations to size Ditch A for the 25-year, 24-hour storm event.

GIVEN:
1. Undeveloped Imperviousness = 2% from Urban Drainage and Flood Control District's (UDFCD) Drainage Criteria Manual (DCM)
2. Watershed area = 8.75 acres measured from USGS quad map using ArcGIS
3. Existing Land Use/Vegetation = Salt Desert Scrub from NRCS data base.
4. Site location: Lat. 38.8120°; Long. -109.7906°
5. Precipitation data obtained from NOAA website at above coordinates: http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ut
6. Precipitation depth for the 25-year, 24-hour storm event = 1.84 inches
7. The watershed soil is Chipeta Complex, which is Hydrologic Soil Group D from NRCS database.
8. Rainfall distribution is SCS Type II.

ASSUMPTIONS:
1. Runoff from the watershed flows into Ditch A.
2. It is assumed that the landfill is at full build-out when estimating the watershed area.
3. It is assumed that the landfill is not constructed when estimating the time of concentration, the time that it takes for runoff to flow off of the land fill is not included in the time of concentration calculations. This is a conservative assumption.
4. The Curve Number is assumed to be 82, based on using the Washoe County Drainage Criteria Manual for shrubland with a Hydrologic Soil Group of classification of D.
5. Because the area is undeveloped, the percent imperviousness was assumed to be 2%.

ANALYSIS:

The SCS method was used to estimate the flow in Ditch A from the 25-year, 24-hour storm event. The U.S. Corps of Engineers' HEC-HMS program was used to perform this analysis.

The flow length and slope were measured using the HDR topographic mapping. The time of concentration was calculated using the methodology provided by the UDFCD DCM. The watershed area was measured using the USGS quadrangle maps. NRCS data was used to obtain the soil and vegetation data.

General Steps:
1. Define watershed boundary and measure its area.
2. Calculate the time of concentration and lag time.
3. Estimate the Curve Number and the % imperviousness.
4. Obtain the 25-year, 24-hour precipitation from the NOAA database.
5. Enter data into HEC-HMS and run model.

The calculation sheet provides the time of concentration and lag time analyses. The HEC-HMS model is attached.

KLEINFELDER
Bright People. Right Solutions.

Sheet____ of____

PROJECT Grand County - Klondike Land Fill PROJECT NO. 84794

SUBJECT Ditch A and Detention Basin Watershed Time of Concentration BY Bruce Curtis DATE 2/17/14

REVIEWED BY _____ DATE _____

It is assumed that the Time of Concentration is based only on the ditch flow and does not include overland flow on the landfill to the ditch. This is a conservative assumption.

L = Ditch Length = 2,438'

S_w = Channel Slope = $\frac{4675 - 4620}{2438} = 2.26\%$

$C_V = 15$ from UDFCD DCM Table RO-2

$V_{channel} = (C_V)(S_w)^{.5} = (15)(0.0226)^{.5} = 2.25$ fps UDFCD DCM Eq RO-4

$T_{c_{channel}}$ = Time of Concentration in channel = $\frac{L}{V_c} = \frac{2438'}{2.25 fps} = 18.06$ min

$T_c = T_{c_{channel}} = 18.06$ min

$Lag = (0.6)(T_c) = 10.84$ min from McCuen, Richard A Guide to Hydrologic Analysis Using SCS methods, 1982. Page 19 Eq. 10

NOAA Atlas 14, Volume 1, Version 5
Location name: Utah, US*
Coordinates: 38.8120, -109.7906
Elevation: 4643 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.105 (0.092-0.123)	0.135 (0.121-0.160)	0.185 (0.163-0.218)	0.232 (0.205-0.275)	0.306 (0.266-0.365)	0.372 (0.318-0.450)	0.451 (0.380-0.557)	0.544 (0.448-0.688)	0.690 (0.550-0.906)	0.824 (0.639-1.12)
10-min	0.160 (0.139-0.187)	0.205 (0.183-0.243)	0.282 (0.248-0.331)	0.353 (0.311-0.419)	0.466 (0.404-0.556)	0.566 (0.484-0.685)	0.687 (0.578-0.848)	0.827 (0.683-1.05)	1.05 (0.837-1.38)	1.25 (0.972-1.71)
15-min	0.198 (0.173-0.232)	0.255 (0.227-0.300)	0.349 (0.308-0.410)	0.438 (0.386-0.519)	0.577 (0.501-0.690)	0.702 (0.600-0.849)	0.852 (0.717-1.05)	1.03 (0.846-1.30)	1.30 (1.04-1.71)	1.55 (1.21-2.11)
30-min	0.266 (0.233-0.313)	0.343 (0.306-0.405)	0.470 (0.414-0.552)	0.590 (0.520-0.699)	0.778 (0.674-0.928)	0.946 (0.808-1.14)	1.15 (0.965-1.42)	1.38 (1.14-1.75)	1.75 (1.40-2.30)	2.10 (1.62-2.85)
60-min	0.329 (0.288-0.387)	0.424 (0.378-0.501)	0.582 (0.513-0.684)	0.730 (0.643-0.865)	0.962 (0.835-1.15)	1.17 (1.00-1.42)	1.42 (1.20-1.75)	1.71 (1.41-2.17)	2.17 (1.73-2.85)	2.59 (2.01-3.52)
2-hr	0.406 (0.362-0.470)	0.515 (0.453-0.592)	0.694 (0.611-0.795)	0.856 (0.748-0.976)	1.13 (0.964-1.29)	1.38 (1.15-1.59)	1.68 (1.36-1.95)	2.04 (1.60-2.40)	2.62 (1.97-3.16)	3.17 (2.29-3.90)
3-hr	0.452 (0.406-0.511)	0.567 (0.506-0.645)	0.742 (0.662-0.837)	0.905 (0.799-1.02)	1.16 (1.01-1.32)	1.41 (1.20-1.60)	1.71 (1.43-1.97)	2.06 (1.68-2.42)	2.65 (2.08-3.19)	3.19 (2.42-3.93)
6-hr	0.569 (0.517-0.632)	0.708 (0.643-0.788)	0.900 (0.818-0.994)	1.07 (0.962-1.18)	1.32 (1.18-1.47)	1.54 (1.35-1.72)	1.80 (1.55-2.04)	2.16 (1.83-2.47)	2.75 (2.26-3.21)	3.30 (2.65-3.97)
12-hr	0.702 (0.639-0.772)	0.871 (0.795-0.963)	1.09 (0.990-1.20)	1.27 (1.15-1.40)	1.54 (1.38-1.70)	1.75 (1.56-1.94)	1.98 (1.74-2.21)	2.25 (1.96-2.54)	2.83 (2.40-3.23)	3.36 (2.82-4.01)
24-hr	0.862 (0.790-0.944)	1.07 (0.982-1.18)	1.33 (1.22-1.46)	1.54 (1.40-1.70)	1.84 (1.66-2.04)	2.08 (1.85-2.32)	2.33 (2.05-2.64)	2.60 (2.24-2.99)	2.97 (2.50-3.51)	3.39 (2.85-4.05)
2-day	0.943 (0.867-1.03)	1.17 (1.08-1.28)	1.45 (1.32-1.57)	1.67 (1.52-1.82)	1.99 (1.79-2.19)	2.25 (1.99-2.49)	2.52 (2.19-2.84)	2.80 (2.40-3.22)	3.21 (2.67-3.81)	3.54 (2.87-4.34)
3-day	1.01 (0.926-1.10)	1.25 (1.15-1.37)	1.55 (1.42-1.69)	1.79 (1.63-1.95)	2.13 (1.92-2.35)	2.41 (2.14-2.67)	2.70 (2.36-3.04)	3.01 (2.57-3.45)	3.44 (2.87-4.08)	3.80 (3.08-4.63)
4-day	1.07 (0.985-1.17)	1.33 (1.22-1.45)	1.65 (1.51-1.79)	1.91 (1.74-2.08)	2.28 (2.05-2.50)	2.57 (2.28-2.85)	2.88 (2.52-3.24)	3.21 (2.75-3.68)	3.68 (3.06-4.34)	4.06 (3.30-4.92)
7-day	1.20 (1.11-1.31)	1.49 (1.37-1.63)	1.84 (1.69-2.01)	2.13 (1.95-2.32)	2.53 (2.29-2.78)	2.85 (2.54-3.16)	3.18 (2.80-3.59)	3.53 (3.05-4.06)	4.03 (3.38-4.77)	4.42 (3.63-5.39)
10-day	1.33 (1.23-1.46)	1.66 (1.52-1.81)	2.05 (1.88-2.24)	2.37 (2.16-2.59)	2.81 (2.54-3.08)	3.15 (2.81-3.49)	3.51 (3.09-3.93)	3.87 (3.36-4.41)	4.40 (3.72-5.15)	4.82 (3.99-5.79)
20-day	1.65 (1.51-1.81)	2.06 (1.88-2.25)	2.55 (2.33-2.79)	2.94 (2.66-3.21)	3.46 (3.11-3.81)	3.87 (3.44-4.28)	4.28 (3.76-4.79)	4.70 (4.07-5.33)	5.26 (4.46-6.09)	5.69 (4.74-6.71)
30-day	2.00 (1.83-2.18)	2.48 (2.27-2.71)	3.05 (2.78-3.32)	3.49 (3.17-3.81)	4.07 (3.67-4.47)	4.51 (4.03-4.99)	4.96 (4.37-5.52)	5.40 (4.69-6.10)	5.99 (5.10-6.89)	6.43 (5.39-7.53)
45-day	2.36 (2.16-2.57)	2.94 (2.68-3.19)	3.60 (3.29-3.90)	4.11 (3.75-4.46)	4.78 (4.32-5.21)	5.28 (4.74-5.80)	5.78 (5.13-6.39)	6.26 (5.49-7.01)	6.89 (5.94-7.85)	7.35 (6.25-8.51)
60-day	2.74 (2.51-2.99)	3.40 (3.12-3.71)	4.16 (3.81-4.52)	4.73 (4.32-5.15)	5.48 (4.97-5.98)	6.03 (5.43-6.62)	6.57 (5.86-7.27)	7.10 (6.26-7.93)	7.77 (6.75-8.82)	8.25 (7.07-9.51)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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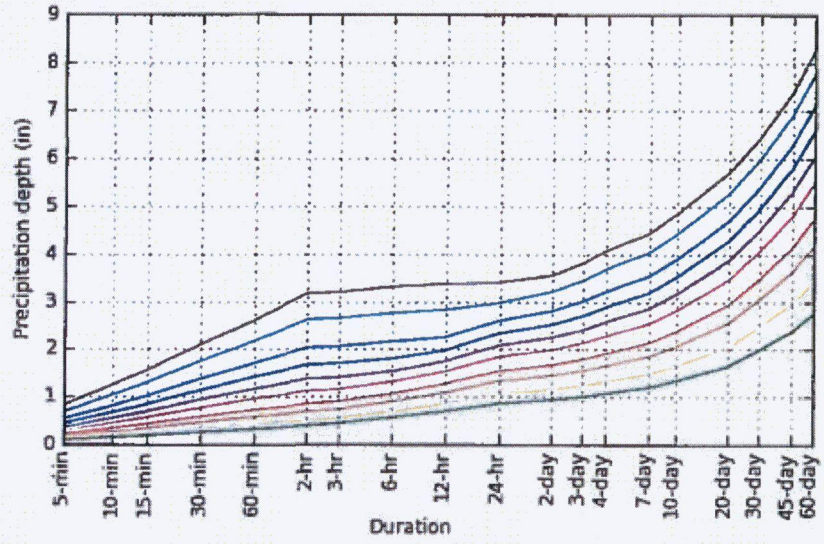
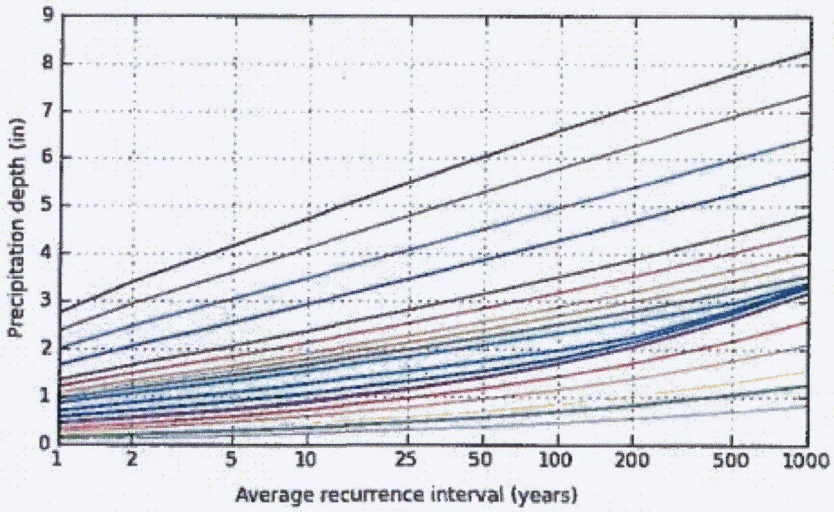
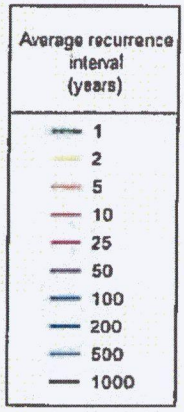
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Coordinates: 38.8120, -109.7906

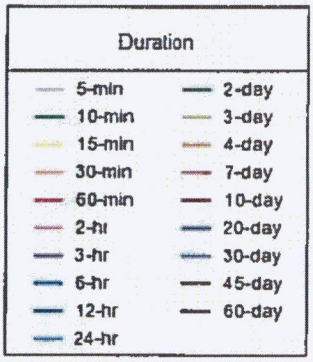






NOAA/NWS/OHD/HDSC

Created (GMT): Mon Jan 27 21:52:29 2014



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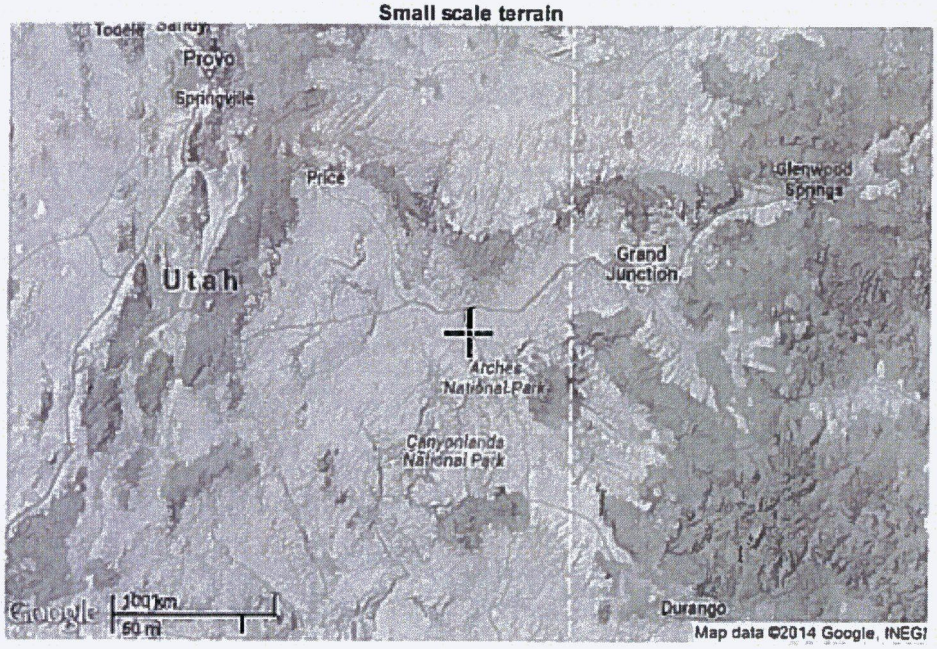
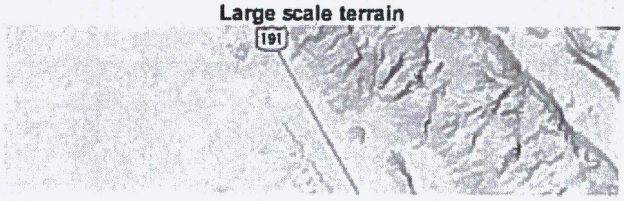
Maps & aerials

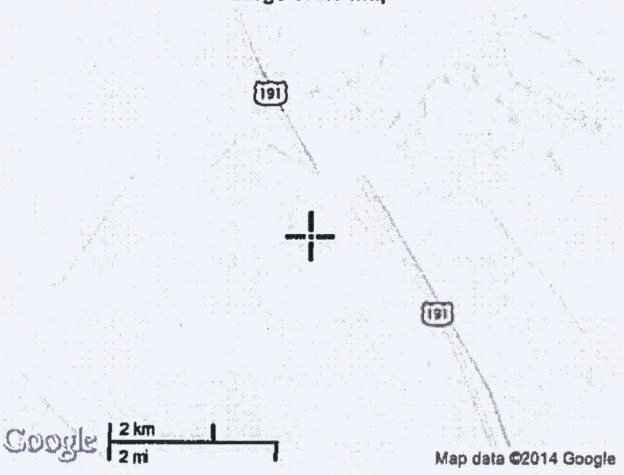
Small scale terrain



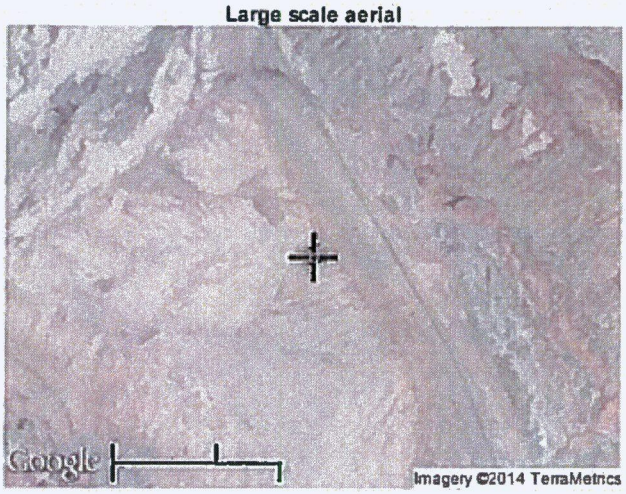
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

2.4 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations. The time of concentration relationships recommended in this *Manual* are based in part on the rainfall-runoff data collected in the Denver metropolitan area and are designed to work with the runoff coefficients also recommended in this *Manual*. As a result, these recommendations need to be used with a great deal of caution whenever working in areas that may differ significantly from the climate or topography found in the Denver region.

For urban areas, the time of concentration, t_c, consists of an initial time or overland flow time, t_i, plus the travel time, t_t, in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time, t_i, plus the time of travel in a defined form, such as a swale, channel, or drainageway. The travel portion, t_t, of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation RO-2 for both urban and non-urban areas:

$$t_c = t_i + t_t \qquad \text{(RO-2)}$$

in which:

t_c = time of concentration (minutes)

t_i = initial or overland flow time (minutes)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (minutes)

2.4.1 Initial Flow Time. The initial or overland flow time, t_i, may be calculated using equation RO-3:

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad \text{(RO-3)}$$

in which:

t_i = initial or overland flow time (minutes)

C_5 = runoff coefficient for 5-year frequency (from Table RO-5)

L = length of overland flow (500 ft maximum for non-urban land uses, 300 ft maximum for urban land uses)

S = average basin slope (ft/ft)

Equation RO-3 is adequate for distances up to 500 feet. Note that, in some urban watersheds, the overland flow time may be very small because flows quickly channelize.

2.4.2 ~~Overland~~ Channel Travel Time. For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the ~~overland~~ channel travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the ~~overland~~ channel travel time, t_t, can be estimated with the help of Figure RO-1 or the following equation (Guo 1999):

$$V = C_v S_w^{0.5} \qquad \text{(RO-4)}$$

in which:

V = velocity (ft/sec)

C_v = conveyance coefficient (from Table RO-2)

S_w = watercourse slope (ft/ft)

$t_t = \frac{L}{V}$

TABLE RO-2

Conveyance Coefficient, C_v

Type of Land Surface	Conveyance Coefficient, C_v
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

The time of concentration, t_c, is then the sum of the initial flow time, t_i, and the travel time, t_t, as per Equation RO-2. $t_c = t_t + t_i$

2.4.3 First Design Point Time of Concentration in Urban Catchments. Using this procedure, the time of concentration at the first design point (i.e., initial flow time, t_i) in an urbanized catchment should not exceed the time of concentration calculated using Equation RO-5.

$$t_c = \frac{L}{180} + 10 \qquad \text{(RO-5)}$$

TABLE RO-3

Recommended Percentage Imperviousness Values

Land Use or Surface Characteristics	Percentage Imperviousness
Business:	
Commercial areas	95
Neighborhood areas	85
Residential:	
Single-family	*
Multi-unit (detached)	60
Multi-unit (attached)	75
Half-acre lot or larger	*
Apartments	80
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	5
Playgrounds	10
Schools	50
Railroad yard areas	15
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	0
Lawns, clayey soil	0

* See Figures RO-3 through RO-5 for percentage imperviousness.

Based in part on the data collected by the District since 1969, an empirical relationship between *C* and the percentage imperviousness for various storm return periods was developed. Thus, values for *C* can be determined using the following equations (Urbonas, Guo and Tucker 1990).

$$C_A = K_A + \left(1.31i^3 - 1.44i^2 + 1.135i - 0.12\right) \text{ for } C_A \geq 0, \text{ otherwise } C_A = 0 \qquad \text{(RO-6)}$$

$$C_{CD} = K_{CD} + \left(0.858i^3 - 0.786i^2 + 0.774i + 0.04\right) \qquad \text{(RO-7)}$$

$$C_B = \left(C_A + C_{CD}\right)/2$$

in which:

i = % imperviousness/100 expressed as a decimal (see Table RO-3)

TABLE RO-5

Runoff Coefficients, *C*

Percentage Imperviousness	Type C and D NRCS Hydrologic Soil Groups					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
0%	0.04	0.15	0.25	0.37	0.44	0.50
5%	0.08	0.18	0.28	0.39	0.46	0.52
10%	0.11	0.21	0.30	0.41	0.47	0.53
15%	0.14	0.24	0.32	0.43	0.49	0.54
20%	0.17	0.26	0.34	0.44	0.50	0.55
25%	0.20	0.28	0.36	0.46	0.51	0.56
30%	0.22	0.30	0.38	0.47	0.52	0.57
35%	0.25	0.33	0.40	0.48	0.53	0.57
40%	0.28	0.35	0.42	0.50	0.54	0.58
45%	0.31	0.37	0.44	0.51	0.55	0.59
50%	0.34	0.40	0.46	0.53	0.57	0.60
55%	0.37	0.43	0.48	0.55	0.58	0.62
60%	0.41	0.46	0.51	0.57	0.60	0.63
65%	0.45	0.49	0.54	0.59	0.62	0.65
70%	0.49	0.53	0.57	0.62	0.65	0.68
75%	0.54	0.58	0.62	0.66	0.68	0.71
80%	0.60	0.63	0.66	0.70	0.72	0.74
85%	0.66	0.68	0.71	0.75	0.77	0.79
90%	0.73	0.75	0.77	0.80	0.82	0.83
95%	0.80	0.82	0.84	0.87	0.88	0.89
100%	0.89	0.90	0.92	0.94	0.95	0.96
	Type B NRCS Hydrologic Soils Group					
0%	0.02	0.08	0.15	0.25	0.30	0.35
5%	0.04	0.10	0.19	0.28	0.33	0.38
10%	0.06	0.14	0.22	0.31	0.36	0.40
15%	0.08	0.17	0.25	0.33	0.38	0.42
20%	0.12	0.20	0.27	0.35	0.40	0.44
25%	0.15	0.22	0.30	0.37	0.41	0.46
30%	0.18	0.25	0.32	0.39	0.43	0.47
35%	0.20	0.27	0.34	0.41	0.44	0.48
40%	0.23	0.30	0.36	0.42	0.46	0.50
45%	0.26	0.32	0.38	0.44	0.48	0.51
50%	0.29	0.35	0.40	0.46	0.49	0.52
55%	0.33	0.38	0.43	0.48	0.51	0.54
60%	0.37	0.41	0.46	0.51	0.54	0.56
65%	0.41	0.45	0.49	0.54	0.57	0.59
70%	0.45	0.49	0.53	0.58	0.60	0.62
75%	0.51	0.54	0.58	0.62	0.64	0.66
80%	0.57	0.59	0.63	0.66	0.68	0.70
85%	0.63	0.66	0.69	0.72	0.73	0.75
90%	0.71	0.73	0.75	0.78	0.80	0.81
95%	0.79	0.81	0.83	0.85	0.87	0.88
100%	0.89	0.90	0.92	0.94	0.95	0.96

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PROJECT:	Grand County SWM SSD #1	PROJECT NO.:	84794		
SUBJECT:	Ditch B Lag and Time of Concentration Calc	BY:	Bruce Curtis	DATE:	2/17/14
		REVIEWED BY:		DATE:	

PURPOSE:
Perform calculations to size Ditch B for the 25-year, 24-hour storm event.

GIVEN:
1. Undeveloped Imperviousness = 2% from Urban Drainage and Flood Control District's (UDFCD) Drainage Criteria Manual (DCM)
2. Watershed area = 14.4 acres measured from USGS quad map using ArcGIS
3. Existing Land Use/Vegetation = Salt Desert Scrub from NRCS data base.
4. Site location: Lat. 38.8120°; Long. -109.7906°
5. Precipitation data obtained from NOAA website at above coordinates: http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ut
6. Precipitation depth for the 25-year, 24-hour storm event = 1.84 inches
7. The watershed soil is Chipeta Complex and Chiptea Silty Clay Loam, which are Hydrologic Soil Group D from NRCS data base.
8. Rainfall distribution is SCS Type II.

ASSUMPTIONS:
1. Runoff from the watershed flows into Ditch B, which is routed around the land fill and the detention basin.
2. The Curve Number is assumed to be 82, based on using the Washoe County Drainage Criteria Manual for shrubland with a Hydrologic Soil Group of classification of D.
3. Because the area is undeveloped, the % imperviousness was assumed to be 2%.

ANALYSIS:

The SCS method was used to estimate the flow in Ditch B from the 25-year, 24-hour storm event. The U.S. Corps of Engineers' HEC-HMS program was used to perform this analysis.

The flow length and slope were measured using the USGS quad map topographic mapping except the HDR topographic mapping was used to estimate the lowest elevation point of the ditch. The time of concentration was calculated using the methodology provided by the UDFCD DCM. The watershed area was measured using the USGS quadrangle maps. NRCS data was used to obtain the soil and vegetation data.

General Steps:
1. Define watershed boundary and measure its area.
2. Calculate the time of concentration and lag time.
3. Estimate the Curve Number and the % imperviousness.
4. Obtain the 25-year, 24-hour precipitation from the NOAA database.
5. Enter data into HEC-HMS and run model.

The calculation sheet provides the time of concentration and lag time analyses. The HEC-HMS model is attached.

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Sheet ____ of ____

PROJECT Grand County - Klondike Landfill PROJECT NO. 84794

SUBJECT Ditch B Watershed BY Bruce Curtis DATE 2/17/14

Time of Concentration REVIEWED BY ____ DATE ____

Reach 1 - Overland Flow

L = Length = 500' max

S_w = Slope = $\frac{4800 - 4760}{500} = 8.00\%$

% Imperviousness = I% = 2% Assumed

Land Use - Undeveloped, scrub

Soil Type ⇒ Chipeta Silty Clay Loam Hydrologic Soil Group D

⇒ Chipeta Complex Hydrologic Soil Group D

$C_5 \approx 0.16$ for HSG = D and 2% Imp.
from Urban Drainage and Flood Control District's (UDFCD) Drainage Criteria Manual (DCM) Table RO-5

$$t_i = \frac{(0.395)(1.1 - C_5)\sqrt{L}}{S^{0.33}}$$ from UDFCD DCM Eq. RO-3

$$= \frac{(0.395)(1.1 - 0.16)(500)^{.5}}{(.08)^{.33}} = 19.1 \text{ minutes}$$

Reach 2 - Natural Channel

$L_2 = 4000'$

$S_{w_2} = \frac{4760 - 4660}{4000'} = 2.5\%$

$V_{channel_2} = C_{V_2} S_{w_2}^{.5} = (10)(0.025)^{.5} = 1.58$ fps from UDFCD DCM Eq RO-4

$C_{V_2} = 10$ Assumed Nearly Bare Ground from UDFCD DCM Table RO-2

t_{t_2} = Travel Time in Reach 2 = $\frac{L_2}{V_{c_2}} = \frac{4{,}000'}{1.58 \text{ fps}} = 42.2$ min

Reach 3 - Ditch B

$L_3 = 600'$ From Quad map from HDR drawing

$S_{v_3} = \frac{(4660) - (4632)}{600} = 4.67\%$

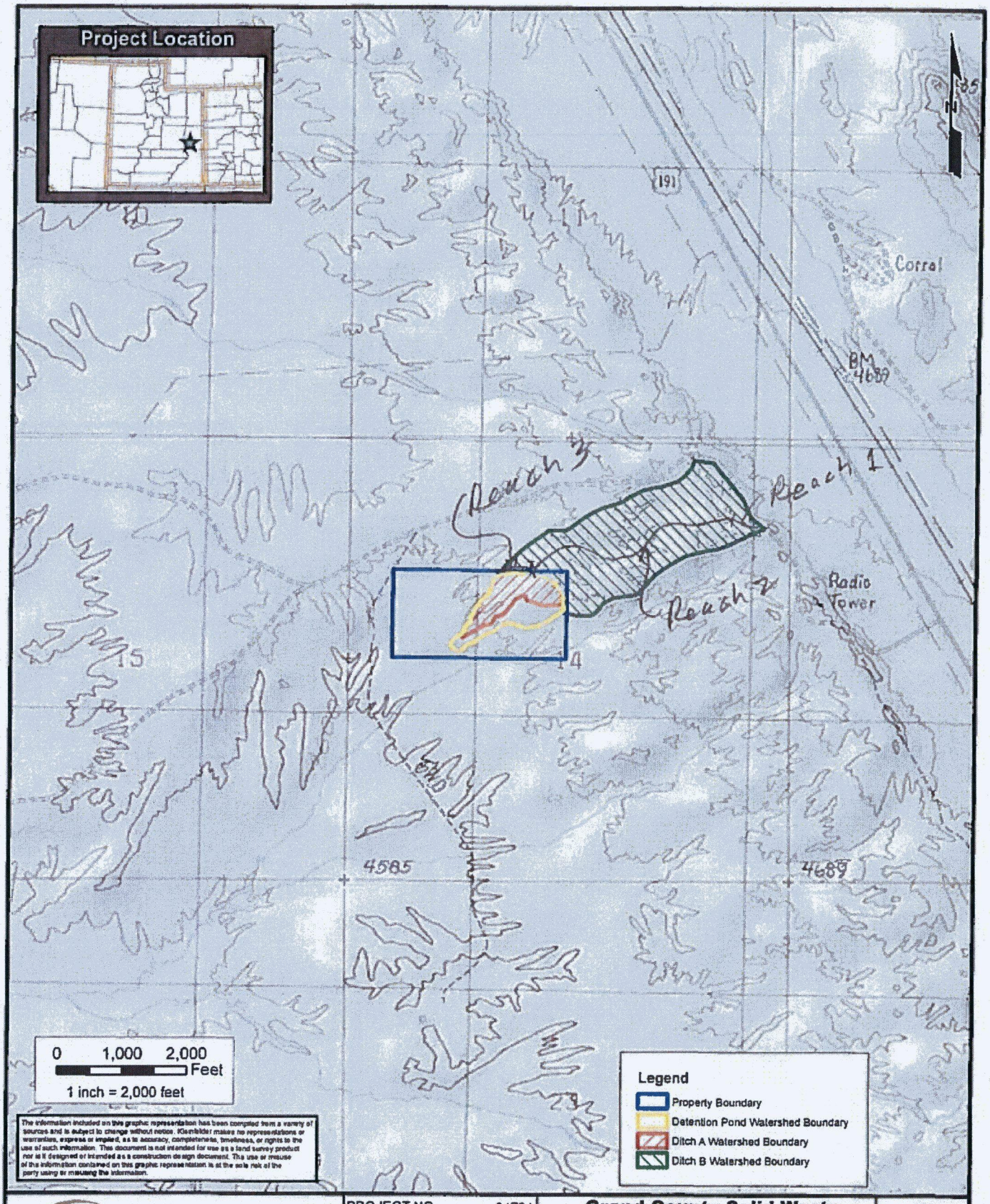
$V_{c_3} = C_{v_3} S_{v_3}^{.5} = (15)(0.0467)^{.5} = 3.24$ fps

$C_v = 15$ Assumed Halfway between Bare Ground ($C_v = 10$) and Paved channel ($C_v = 20$) from UDFCD DCM Table RO-2

$t_{t_3} = \frac{L_3}{V_{c_3}} = \frac{600}{3.24} = 3.09$ minutes

$t_c = t_i + t_{t_2} + t_{t_3} = 19.1 + 42.2 + 3.09 = 64.4$ minutes

$Lag = (.6)(64.4) = 38.6$ min



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PROJECT NO.	84794
DRAWN:	2/14/2014
DRAWN BY:	L.Hockert
CHECKED BY:	B.Curtis
FILE NAME:	VicinityMap_AL.mxd

Grand County Solid Waste Management Special Services District (SSD) #1

Watershed Boundary
Grand County, Utah

FIGURE
2

NOAA Atlas 14, Volume 1, Version 5
Location name: Utah, US*
Coordinates: 38.8120, -109.7906
Elevation: 4643 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.105 (0.092-0.123)	0.135 (0.121-0.160)	0.185 (0.163-0.218)	0.232 (0.205-0.275)	0.306 (0.266-0.365)	0.372 (0.318-0.450)	0.451 (0.380-0.557)	0.544 (0.448-0.688)	0.690 (0.550-0.906)	0.824 (0.639-1.12)
10-min	0.160 (0.139-0.187)	0.205 (0.183-0.243)	0.282 (0.248-0.331)	0.353 (0.311-0.419)	0.466 (0.404-0.556)	0.566 (0.484-0.685)	0.687 (0.578-0.848)	0.827 (0.683-1.05)	1.05 (0.837-1.38)	1.25 (0.972-1.71)
15-min	0.198 (0.173-0.232)	0.255 (0.227-0.300)	0.349 (0.308-0.410)	0.438 (0.386-0.519)	0.577 (0.501-0.690)	0.702 (0.600-0.849)	0.852 (0.717-1.05)	1.03 (0.846-1.30)	1.30 (1.04-1.71)	1.55 (1.21-2.11)
30-min	0.266 (0.233-0.313)	0.343 (0.306-0.405)	0.470 (0.414-0.552)	0.590 (0.520-0.699)	0.778 (0.674-0.928)	0.946 (0.808-1.14)	1.15 (0.965-1.42)	1.38 (1.14-1.75)	1.75 (1.40-2.30)	2.10 (1.62-2.85)
60-min	0.329 (0.288-0.387)	0.424 (0.378-0.501)	0.582 (0.513-0.684)	0.730 (0.643-0.865)	0.962 (0.835-1.15)	1.17 (1.00-1.42)	1.42 (1.20-1.75)	1.71 (1.41-2.17)	2.17 (1.73-2.85)	2.59 (2.01-3.52)
2-hr	0.406 (0.362-0.470)	0.515 (0.453-0.592)	0.694 (0.611-0.795)	0.856 (0.748-0.976)	1.13 (0.964-1.29)	1.38 (1.15-1.59)	1.68 (1.36-1.95)	2.04 (1.60-2.40)	2.62 (1.97-3.16)	3.17 (2.29-3.90)
3-hr	0.452 (0.406-0.511)	0.567 (0.506-0.645)	0.742 (0.662-0.837)	0.905 (0.799-1.02)	1.16 (1.01-1.32)	1.41 (1.20-1.60)	1.71 (1.43-1.97)	2.06 (1.68-2.42)	2.65 (2.08-3.19)	3.19 (2.42-3.93)
6-hr	0.569 (0.517-0.632)	0.708 (0.643-0.788)	0.900 (0.818-0.994)	1.07 (0.962-1.18)	1.32 (1.18-1.47)	1.54 (1.35-1.72)	1.80 (1.55-2.04)	2.16 (1.83-2.47)	2.75 (2.26-3.21)	3.30 (2.65-3.97)
12-hr	0.702 (0.639-0.772)	0.871 (0.795-0.963)	1.09 (0.990-1.20)	1.27 (1.15-1.40)	1.54 (1.38-1.70)	1.75 (1.56-1.94)	1.98 (1.74-2.21)	2.25 (1.96-2.54)	2.83 (2.40-3.23)	3.36 (2.82-4.01)
24-hr	0.862 (0.790-0.944)	1.07 (0.982-1.18)	1.33 (1.22-1.46)	1.54 (1.40-1.70)	1.84 (1.66-2.04)	2.08 (1.85-2.32)	2.33 (2.05-2.64)	2.60 (2.24-2.99)	2.97 (2.50-3.51)	3.39 (2.85-4.05)
2-day	0.943 (0.867-1.03)	1.17 (1.08-1.28)	1.45 (1.32-1.57)	1.67 (1.52-1.82)	1.99 (1.79-2.19)	2.25 (1.99-2.49)	2.52 (2.19-2.84)	2.80 (2.40-3.22)	3.21 (2.67-3.81)	3.54 (2.87-4.34)
3-day	1.01 (0.926-1.10)	1.25 (1.15-1.37)	1.55 (1.42-1.69)	1.79 (1.63-1.95)	2.13 (1.92-2.35)	2.41 (2.14-2.67)	2.70 (2.36-3.04)	3.01 (2.57-3.45)	3.44 (2.87-4.08)	3.80 (3.08-4.63)
4-day	1.07 (0.985-1.17)	1.33 (1.22-1.45)	1.65 (1.51-1.79)	1.91 (1.74-2.08)	2.28 (2.05-2.50)	2.57 (2.28-2.85)	2.88 (2.52-3.24)	3.21 (2.75-3.68)	3.68 (3.06-4.34)	4.06 (3.30-4.92)
7-day	1.20 (1.11-1.31)	1.49 (1.37-1.63)	1.84 (1.69-2.01)	2.13 (1.95-2.32)	2.53 (2.29-2.78)	2.85 (2.54-3.16)	3.18 (2.80-3.59)	3.53 (3.05-4.06)	4.03 (3.38-4.77)	4.42 (3.63-5.39)
10-day	1.33 (1.23-1.46)	1.66 (1.52-1.81)	2.05 (1.88-2.24)	2.37 (2.16-2.59)	2.81 (2.54-3.08)	3.15 (2.81-3.49)	3.51 (3.09-3.93)	3.87 (3.36-4.41)	4.40 (3.72-5.15)	4.82 (3.99-5.79)
20-day	1.65 (1.51-1.81)	2.06 (1.88-2.25)	2.55 (2.33-2.79)	2.94 (2.66-3.21)	3.46 (3.11-3.81)	3.87 (3.44-4.28)	4.28 (3.76-4.79)	4.70 (4.07-5.33)	5.26 (4.46-6.09)	5.69 (4.74-6.71)
30-day	2.00 (1.83-2.18)	2.48 (2.27-2.71)	3.05 (2.78-3.32)	3.49 (3.17-3.81)	4.07 (3.67-4.47)	4.51 (4.03-4.99)	4.96 (4.37-5.52)	5.40 (4.69-6.10)	5.99 (5.10-6.89)	6.43 (5.39-7.53)
45-day	2.36 (2.16-2.57)	2.94 (2.68-3.19)	3.60 (3.29-3.90)	4.11 (3.75-4.46)	4.78 (4.32-5.21)	5.28 (4.74-5.80)	5.78 (5.13-6.39)	6.26 (5.49-7.01)	6.89 (5.94-7.85)	7.35 (6.25-8.51)
60-day	2.74 (2.51-2.99)	3.40 (3.12-3.71)	4.16 (3.81-4.52)	4.73 (4.32-5.15)	5.48 (4.97-5.98)	6.03 (5.43-6.62)	6.57 (5.86-7.27)	7.10 (6.26-7.93)	7.77 (6.75-8.82)	8.25 (7.07-9.51)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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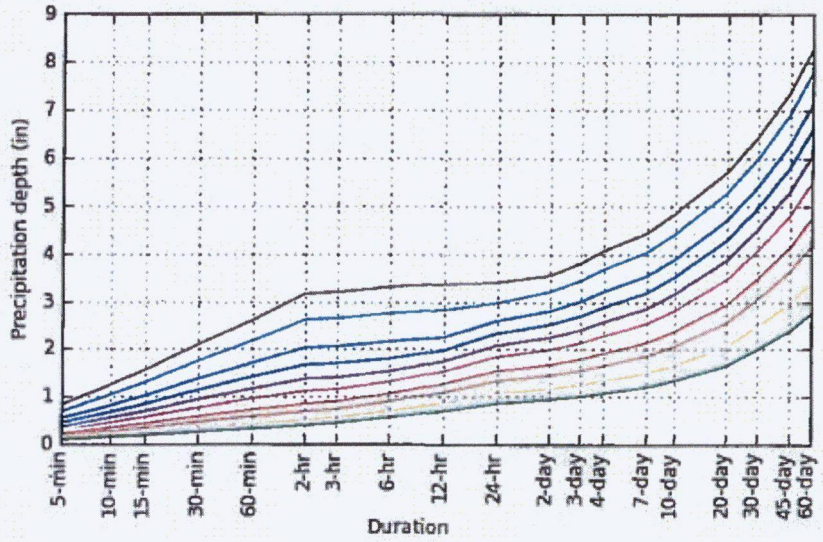
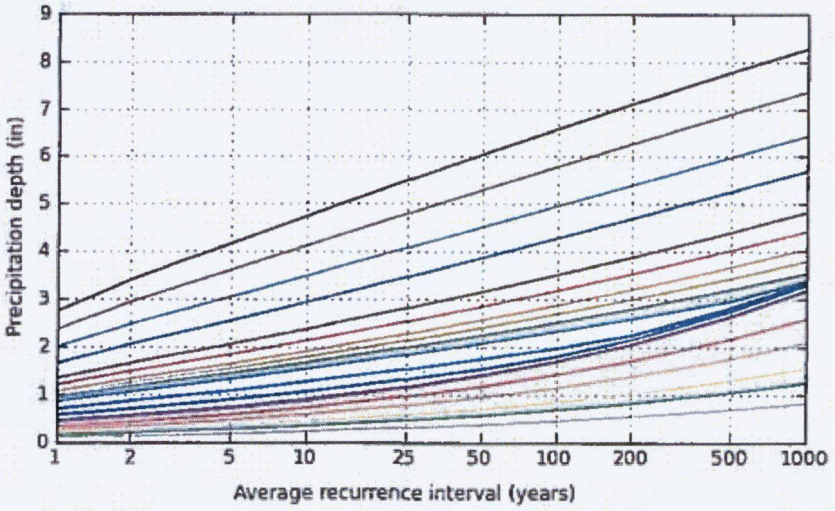
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Coordinates: 38.8120, -109.7906





Average recurrence interval (years)
1
2
5
10
25
50
100
200
500
1000

NOAA/NWS/OHD/HDSC

Created (GMT): Mon Jan 27 21:52:29 2014

Duration

5-min	2-day
10-min	3-day
15-min	4-day
30-min	7-day
60-min	10-day
2-hr	20-day
3-hr	30-day
6-hr	45-day
12-hr	60-day
24-hr	

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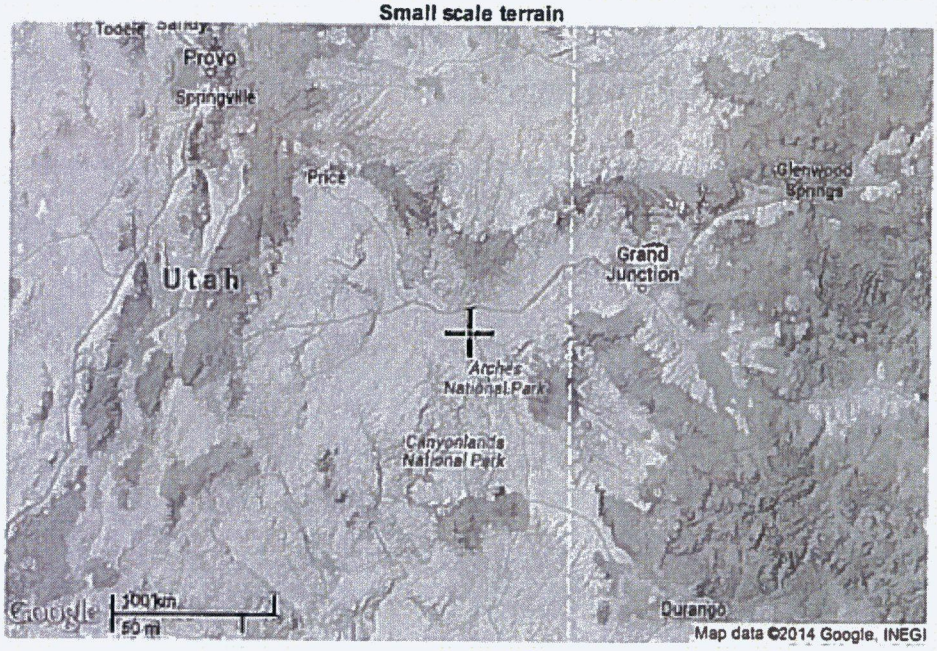
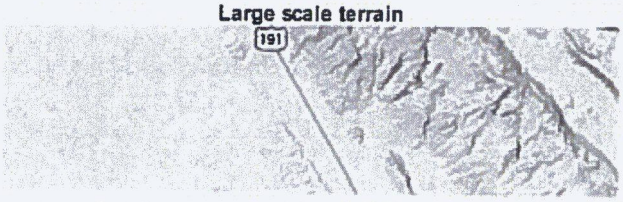
Maps & aerials

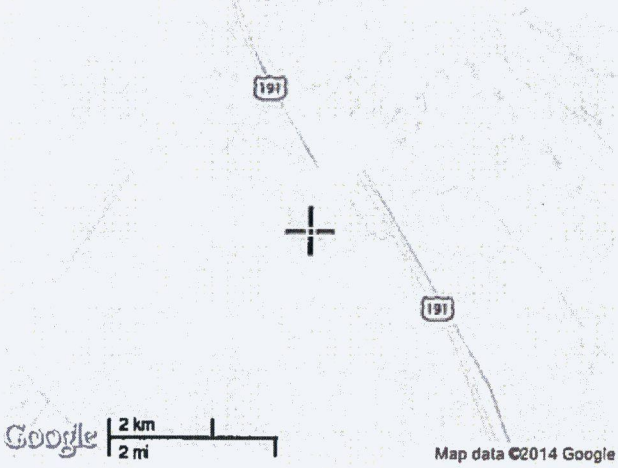
Small scale terrain



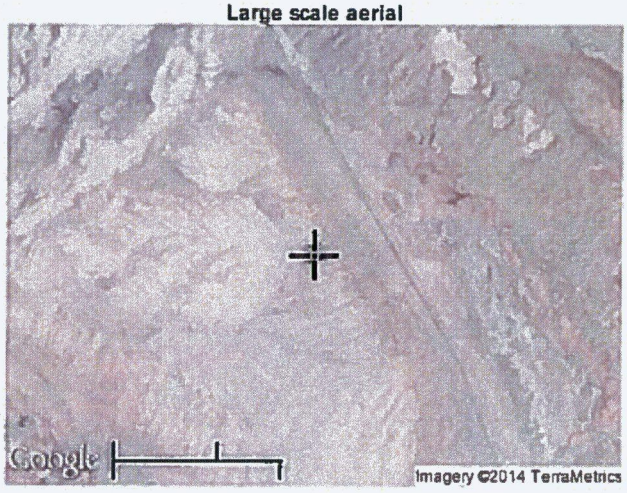
Large scale terrain



Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

2.4 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations. The time of concentration relationships recommended in this *Manual* are based in part on the rainfall-runoff data collected in the Denver metropolitan area and are designed to work with the runoff coefficients also recommended in this *Manual*. As a result, these recommendations need to be used with a great deal of caution whenever working in areas that may differ significantly from the climate or topography found in the Denver region.

For urban areas, the time of concentration, t_c, consists of an initial time or overland flow time, t_i, plus the travel time, t_t, in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time, t_i, plus the time of travel in a defined form, such as a swale, channel, or drainageway. The travel portion, t_t, of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation RO-2 for both urban and non-urban areas:

$$t_c = t_i + t_t \qquad \text{(RO-2)}$$

in which:

t_c = time of concentration (minutes)

t_i = initial or overland flow time (minutes)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (minutes)

2.4.1 Initial Flow Time. The initial or overland flow time, t_i, may be calculated using equation RO-3:

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad \text{(RO-3)}$$

in which:

t_i = initial or overland flow time (minutes)

C_5 = runoff coefficient for 5-year frequency (from Table RO-5)

L = length of overland flow (500 ft maximum for non-urban land uses, 300 ft maximum for urban land uses)

S = average basin slope (ft/ft)

Equation RO-3 is adequate for distances up to 500 feet. Note that, in some urban watersheds, the overland flow time may be very small because flows quickly channelize.

2.4.2 ~~Overland~~ Channel Travel Time. For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the ~~overland~~ channel travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the ~~overland~~ channel travel time, t_t, can be estimated with the help of Figure RO-1 or the following equation (Guo 1999):

$$V = C_v S_w^{0.5} \qquad \text{(RO-4)}$$

in which:

V = velocity (ft/sec)

C_v = conveyance coefficient (from Table RO-2)

S_w = watercourse slope (ft/ft)

$t = \frac{L}{V}$

TABLE RO-2

Conveyance Coefficient, C_v

Type of Land Surface	Conveyance Coefficient, C_v
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

The time of concentration, t_c, is then the sum of the initial flow time, t_i, and the travel time, t_t, as per Equation RO-2. $t_c = t_i + t_t$

2.4.3 First Design Point Time of Concentration in Urban Catchments. Using this procedure, the time of concentration at the first design point (i.e., initial flow time, t_i) in an urbanized catchment should not exceed the time of concentration calculated using Equation RO-5.

$$t_c = \frac{L}{180} + 10 \qquad \text{(RO-5)}$$

TABLE RO-3

Recommended Percentage Imperviousness Values

Land Use or Surface Characteristics	Percentage Imperviousness
Business:	
Commercial areas	95
Neighborhood areas	85
Residential:	
Single-family	*
Multi-unit (detached)	60
Multi-unit (attached)	75
Half-acre lot or larger	*
Apartments	80
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	5
Playgrounds	10
Schools	50
Railroad yard areas	15
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	0
Lawns, clayey soil	0

* See Figures RO-3 through RO-5 for percentage imperviousness.

Based in part on the data collected by the District since 1969, an empirical relationship between *C* and the percentage imperviousness for various storm return periods was developed. Thus, values for *C* can be determined using the following equations (Urbonas, Guo and Tucker 1990).

$$C_A = K_A + \left(1.31i^3 - 1.44i^2 + 1.135i - 0.12\right) \text{ for } C_A \geq 0, \text{ otherwise } C_A = 0 \qquad \text{(RO-6)}$$

$$C_{CD} = K_{CD} + \left(0.858i^3 - 0.786i^2 + 0.774i + 0.04\right) \qquad \text{(RO-7)}$$

$$C_B = \left(C_A + C_{CD}\right)/2$$

in which:

i = % imperviousness/100 expressed as a decimal (see Table RO-3)

TABLE RO-5

Runoff Coefficients, *C*

Percentage Imperviousness	Type C and D NRCS Hydrologic Soil Groups					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
0%	0.04	0.15	0.25	0.37	0.44	0.50
5%	0.08	0.18	0.28	0.39	0.46	0.52
10%	0.11	0.21	0.30	0.41	0.47	0.53
15%	0.14	0.24	0.32	0.43	0.49	0.54
20%	0.17	0.26	0.34	0.44	0.50	0.55
25%	0.20	0.28	0.36	0.46	0.51	0.56
30%	0.22	0.30	0.38	0.47	0.52	0.57
35%	0.25	0.33	0.40	0.48	0.53	0.57
40%	0.28	0.35	0.42	0.50	0.54	0.58
45%	0.31	0.37	0.44	0.51	0.55	0.59
50%	0.34	0.40	0.46	0.53	0.57	0.60
55%	0.37	0.43	0.48	0.55	0.58	0.62
60%	0.41	0.46	0.51	0.57	0.60	0.63
65%	0.45	0.49	0.54	0.59	0.62	0.65
70%	0.49	0.53	0.57	0.62	0.65	0.68
75%	0.54	0.58	0.62	0.66	0.68	0.71
80%	0.60	0.63	0.66	0.70	0.72	0.74
85%	0.66	0.68	0.71	0.75	0.77	0.79
90%	0.73	0.75	0.77	0.80	0.82	0.83
95%	0.80	0.82	0.84	0.87	0.88	0.89
100%	0.89	0.90	0.92	0.94	0.95	0.96
	Type B NRCS Hydrologic Soils Group					
0%	0.02	0.08	0.15	0.25	0.30	0.35
5%	0.04	0.10	0.19	0.28	0.33	0.38
10%	0.06	0.14	0.22	0.31	0.36	0.40
15%	0.08	0.17	0.25	0.33	0.38	0.42
20%	0.12	0.20	0.27	0.35	0.40	0.44
25%	0.15	0.22	0.30	0.37	0.41	0.46
30%	0.18	0.25	0.32	0.39	0.43	0.47
35%	0.20	0.27	0.34	0.41	0.44	0.48
40%	0.23	0.30	0.36	0.42	0.46	0.50
45%	0.26	0.32	0.38	0.44	0.48	0.51
50%	0.29	0.35	0.40	0.46	0.49	0.52
55%	0.33	0.38	0.43	0.48	0.51	0.54
60%	0.37	0.41	0.46	0.51	0.54	0.56
65%	0.41	0.45	0.49	0.54	0.57	0.59
70%	0.45	0.49	0.53	0.58	0.60	0.62
75%	0.51	0.54	0.58	0.62	0.64	0.66
80%	0.57	0.59	0.63	0.66	0.68	0.70
85%	0.63	0.66	0.69	0.72	0.73	0.75
90%	0.71	0.73	0.75	0.78	0.80	0.81
95%	0.79	0.81	0.83	0.85	0.87	0.88
100%	0.89	0.90	0.92	0.94	0.95	0.96

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Bright People. Right Solutions.

PROJECT:	Grand County SWM SSD #1	PROJECT NO.:	84794		
SUBJECT:	Detention Basin Lag and Time of Concentration Calcs	BY:	Bruce Curtis	DATE:	2/17/14
		REVIEWED BY:		DATE:	

PURPOSE:
Perform calculations to estimate the required volume of the detention basin to store runoff from the 25-year, 24-hour storm event.

GIVEN:
1. Undeveloped Imperviousness = 2% from Urban Drainage and Flood Control District's (UDFCD) Drainage Criteria Manual (DCM)
2. Watershed area = 59.18 acres measured from USGS quad map using ArcGIS
3. Existing Land Use/Vegetation = Salt Desert Scrub from NRCS data base.
4. Site location: Lat. 38.8120°; Long. -109.7906°
5. Precipitation data obtained from NOAA website at above coordinates: http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ut
6. Precipitation depth for the 25-year, 24-hour storm event = 1.84 inches
7. The watershed soil is Chipeta Complex and the Chipeta silty clay loam, which is Hydrologic Soil Group D from NRCS database.
8. Rainfall distribution is SCS Type II.

ASSUMPTIONS:
1. Runoff from the watershed flows into the detention basin.
2. It is assumed that the landfill is at full build-out when estimating the watershed area.
3. It is assumed that the landfill is not constructed when estimating the time of concentration, the time that it takes for runoff to flow off of the land fill is not included in the time of concentration calculations. This is a conservative assumption.
4. The Curve Number is assumed to be 82, based on using the Washoe County Drainage Criteria Manual for shrubland with a Hydrologic Soil Group of classification of D.
5. Because the area is undeveloped, the percent imperviousness was assumed to be 2%.

ANALYSIS:

The SCS method was used to estimate the flow to the detention basin from the 25-year, 24-hour storm event. The U.S. Corps of Engineers' HEC-HMS program was used to perform this analysis.

The flow length and slope were measured using the HDR topographic mapping. The time of concentration was calculated using the methodology provided by the UDFCD DCM. The watershed area was measured using the USGS quadrangle maps. NRCS data was used to obtain the soil and vegetation data.

General Steps:
1. Define watershed boundary and measure its area.
2. Calculate the time of concentration and lag time.
3. Estimate the Curve Number and the % imperviousness.
4. Obtain the 25-year, 24-hour precipitation from the NOAA database.
5. Enter data into HEC-HMS and run model.

The calculation sheet provides the time of concentration and lag time analyses. The HEC-HMS model is attached.

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Sheet _____ of _____

PROJECT Grand County - Klondike Land fill PROJECT NO. 84794

SUBJECT Ditch A and Detention Basin BY Bruce Curtis DATE 2/17/14

Watershed Time of Concentration REVIEWED BY _____ DATE _____

It is assumed that the Time of Concentration is based only on the ditch flow and does not include overland flow on the landfill to the ditch. This is a conservative assumption.

L = Ditch Length = 2,438'

S_w = Channel Slope = $\frac{4675 - 4620}{2438} = 2.26\%$

$C_V = 15$ from UDFCD DCM Table RO-2

$V_{channel} = (C_V)(S_w)^{.5} = (15)(0.0226)^{.5} = 2.25$ fps UDFCD DCM Eq RO-4

$T_{c_{channel}}$ = Time of Concentration in channel = $\frac{L}{V_c} = \frac{2438'}{2.25 fps} = 18.06$ min

$T_c = T_{c_{channel}} = 18.06$ min

$Lag = (0.6)(T_c) = 10.84$ min from McCuen, Richard A Guide to Hydrologic Analysis Using SCS methods, 1982. Page 19 Eq. 10

NOAA Atlas 14, Volume 1, Version 5
Location name: Utah, US*
Coordinates: 38.8120, -109.7906
Elevation: 4643 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.105 (0.092-0.123)	0.135 (0.121-0.160)	0.185 (0.163-0.218)	0.232 (0.205-0.275)	0.306 (0.266-0.365)	0.372 (0.318-0.450)	0.451 (0.380-0.557)	0.544 (0.448-0.688)	0.690 (0.550-0.906)	0.824 (0.639-1.12)
10-min	0.160 (0.139-0.187)	0.205 (0.183-0.243)	0.282 (0.248-0.331)	0.353 (0.311-0.419)	0.466 (0.404-0.556)	0.566 (0.484-0.685)	0.687 (0.578-0.848)	0.827 (0.683-1.05)	1.05 (0.837-1.38)	1.25 (0.972-1.71)
15-min	0.198 (0.173-0.232)	0.255 (0.227-0.300)	0.349 (0.308-0.410)	0.438 (0.386-0.519)	0.577 (0.501-0.690)	0.702 (0.600-0.849)	0.852 (0.717-1.05)	1.03 (0.846-1.30)	1.30 (1.04-1.71)	1.55 (1.21-2.11)
30-min	0.266 (0.233-0.313)	0.343 (0.306-0.405)	0.470 (0.414-0.552)	0.590 (0.520-0.699)	0.778 (0.674-0.928)	0.946 (0.808-1.14)	1.15 (0.965-1.42)	1.38 (1.14-1.75)	1.75 (1.40-2.30)	2.10 (1.62-2.85)
60-min	0.329 (0.288-0.387)	0.424 (0.378-0.501)	0.582 (0.513-0.684)	0.730 (0.643-0.865)	0.962 (0.835-1.15)	1.17 (1.00-1.42)	1.42 (1.20-1.75)	1.71 (1.41-2.17)	2.17 (1.73-2.85)	2.59 (2.01-3.52)
2-hr	0.406 (0.362-0.470)	0.515 (0.453-0.592)	0.694 (0.611-0.795)	0.856 (0.748-0.975)	1.13 (0.964-1.29)	1.38 (1.15-1.59)	1.68 (1.36-1.95)	2.04 (1.60-2.40)	2.62 (1.97-3.16)	3.17 (2.29-3.90)
3-hr	0.452 (0.406-0.511)	0.567 (0.506-0.645)	0.742 (0.662-0.837)	0.905 (0.799-1.02)	1.16 (1.01-1.32)	1.41 (1.20-1.60)	1.71 (1.43-1.97)	2.06 (1.68-2.42)	2.65 (2.08-3.19)	3.19 (2.42-3.93)
6-hr	0.569 (0.517-0.632)	0.708 (0.643-0.788)	0.900 (0.818-0.994)	1.07 (0.962-1.18)	1.32 (1.18-1.47)	1.54 (1.35-1.72)	1.80 (1.55-2.04)	2.16 (1.83-2.47)	2.75 (2.26-3.21)	3.30 (2.65-3.97)
12-hr	0.702 (0.639-0.772)	0.871 (0.795-0.963)	1.09 (0.990-1.20)	1.27 (1.15-1.40)	1.54 (1.38-1.70)	1.75 (1.56-1.94)	1.98 (1.74-2.21)	2.25 (1.96-2.54)	2.83 (2.40-3.23)	3.36 (2.82-4.01)
24-hr	0.862 (0.790-0.944)	1.07 (0.982-1.18)	1.33 (1.22-1.46)	1.54 (1.40-1.70)	1.84 (1.66-2.04)	2.08 (1.85-2.32)	2.33 (2.05-2.64)	2.60 (2.24-2.99)	2.97 (2.50-3.51)	3.39 (2.85-4.05)
2-day	0.943 (0.867-1.03)	1.17 (1.08-1.28)	1.45 (1.32-1.57)	1.67 (1.52-1.82)	1.99 (1.79-2.19)	2.25 (1.99-2.49)	2.52 (2.19-2.84)	2.80 (2.40-3.22)	3.21 (2.67-3.81)	3.54 (2.87-4.34)
3-day	1.01 (0.926-1.10)	1.25 (1.15-1.37)	1.55 (1.42-1.69)	1.79 (1.63-1.95)	2.13 (1.92-2.35)	2.41 (2.14-2.67)	2.70 (2.36-3.04)	3.01 (2.57-3.45)	3.44 (2.87-4.08)	3.80 (3.08-4.63)
4-day	1.07 (0.985-1.17)	1.33 (1.22-1.45)	1.65 (1.51-1.79)	1.91 (1.74-2.08)	2.28 (2.05-2.50)	2.57 (2.28-2.85)	2.88 (2.52-3.24)	3.21 (2.75-3.68)	3.68 (3.06-4.34)	4.06 (3.30-4.92)
7-day	1.20 (1.11-1.31)	1.49 (1.37-1.63)	1.84 (1.69-2.01)	2.13 (1.95-2.32)	2.53 (2.29-2.78)	2.85 (2.54-3.16)	3.18 (2.80-3.59)	3.53 (3.05-4.06)	4.03 (3.38-4.77)	4.42 (3.63-5.39)
10-day	1.33 (1.23-1.46)	1.66 (1.52-1.81)	2.05 (1.88-2.24)	2.37 (2.16-2.59)	2.81 (2.54-3.08)	3.15 (2.81-3.49)	3.51 (3.09-3.93)	3.87 (3.36-4.41)	4.40 (3.72-5.15)	4.82 (3.99-5.79)
20-day	1.65 (1.51-1.81)	2.06 (1.88-2.25)	2.55 (2.33-2.79)	2.94 (2.66-3.21)	3.46 (3.11-3.81)	3.87 (3.44-4.28)	4.28 (3.76-4.79)	4.70 (4.07-5.33)	5.26 (4.46-6.09)	5.69 (4.74-6.71)
30-day	2.00 (1.83-2.18)	2.48 (2.27-2.71)	3.05 (2.78-3.32)	3.49 (3.17-3.81)	4.07 (3.67-4.47)	4.51 (4.03-4.99)	4.96 (4.37-5.52)	5.40 (4.69-6.10)	5.99 (5.10-6.89)	6.43 (5.39-7.53)
45-day	2.36 (2.16-2.57)	2.94 (2.68-3.19)	3.60 (3.29-3.90)	4.11 (3.75-4.46)	4.78 (4.32-5.21)	5.28 (4.74-5.80)	5.78 (5.13-6.39)	6.26 (5.49-7.01)	6.89 (5.94-7.85)	7.35 (6.25-8.51)
60-day	2.74 (2.51-2.99)	3.40 (3.12-3.71)	4.16 (3.81-4.52)	4.73 (4.32-5.15)	5.48 (4.97-5.98)	6.03 (5.43-6.62)	6.57 (5.86-7.27)	7.10 (6.26-7.93)	7.77 (6.75-8.82)	8.25 (7.07-9.51)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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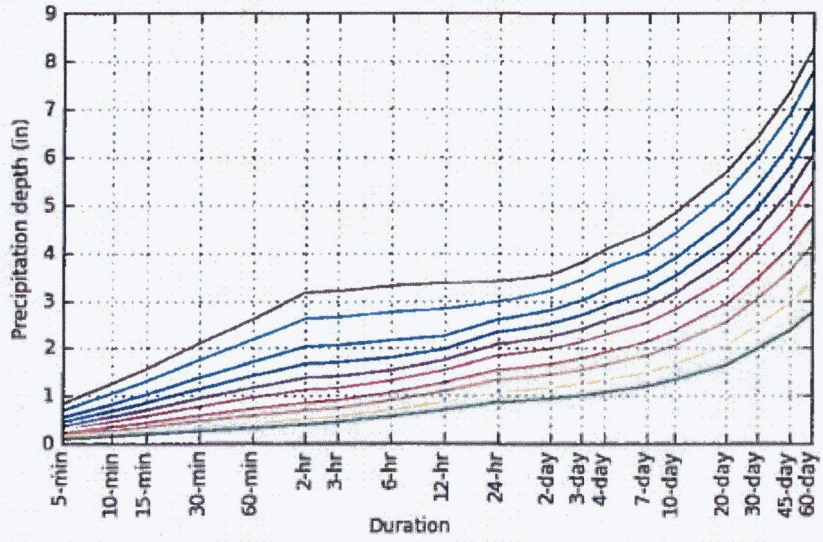
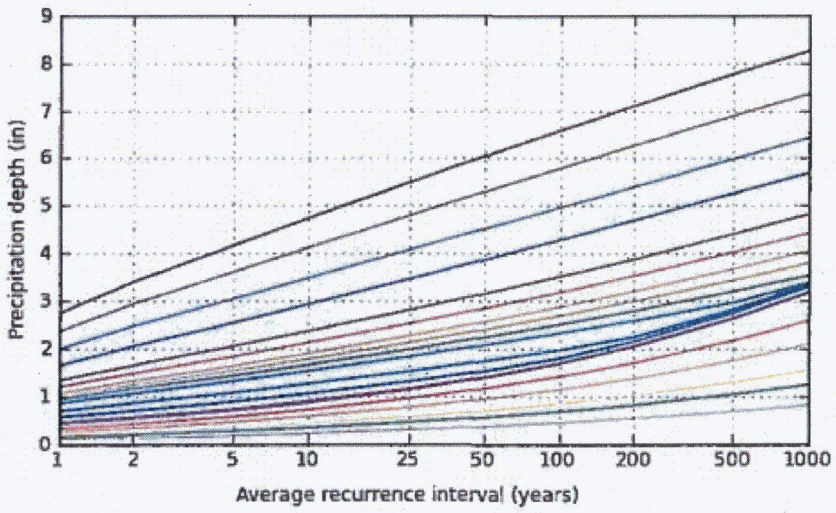
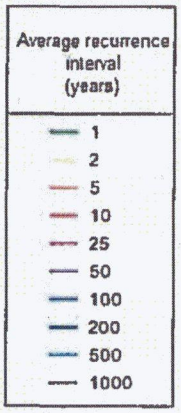
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Coordinates: 38.8120, -109.7906

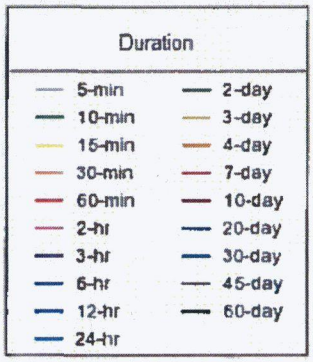






NOAA/NWS/OHD/HDSC

Created (GMT): Mon Jan 27 21:52:29 2014



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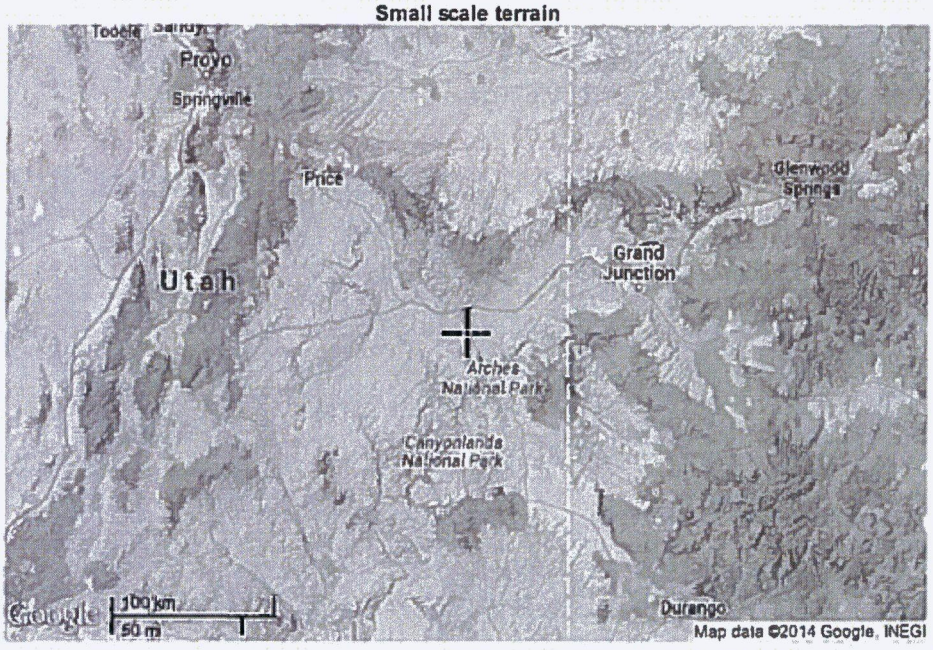
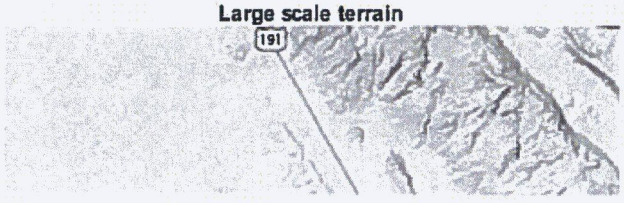
Maps & aerials

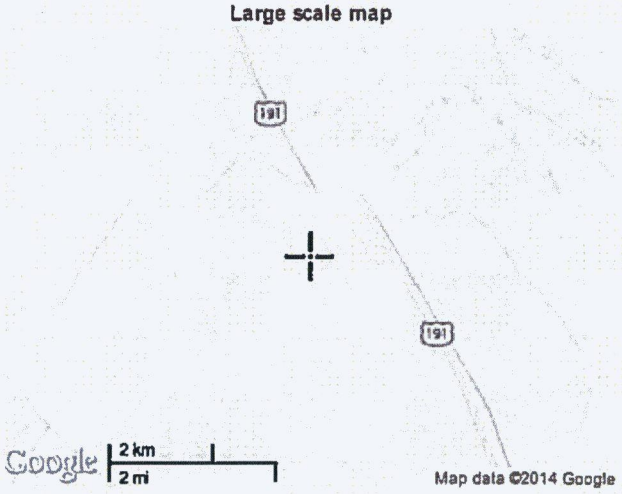
Small scale terrain



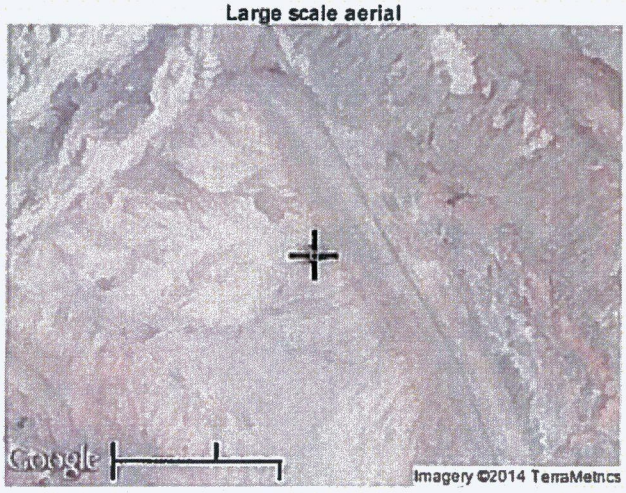
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

2.4 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations. The time of concentration relationships recommended in this *Manual* are based in part on the rainfall-runoff data collected in the Denver metropolitan area and are designed to work with the runoff coefficients also recommended in this *Manual*. As a result, these recommendations need to be used with a great deal of caution whenever working in areas that may differ significantly from the climate or topography found in the Denver region.

For urban areas, the time of concentration, t_c, consists of an initial time or overland flow time, t_i, plus the travel time, t_t, in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time, t_i, plus the time of travel in a defined form, such as a swale, channel, or drainageway. The travel portion, t_t, of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation RO-2 for both urban and non-urban areas:

$$t_c = t_i + t_t \qquad \text{(RO-2)}$$

in which:

t_c = time of concentration (minutes)

t_i = initial or overland flow time (minutes)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (minutes)

2.4.1 Initial Flow Time. The initial or overland flow time, t_i, may be calculated using equation RO-3:

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \qquad \text{(RO-3)}$$

in which:

t_i = initial or overland flow time (minutes)

C_5 = runoff coefficient for 5-year frequency (from Table RO-5)

L = length of overland flow (500 ft maximum for non-urban land uses, 300 ft maximum for urban land uses)

S = average basin slope (ft/ft)

Equation RO-3 is adequate for distances up to 500 feet. Note that, in some urban watersheds, the overland flow time may be very small because flows quickly channelize.

2.4.2 ~~Overland~~ Channel Travel Time. For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the ~~overland~~ channel travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the ~~overland~~ channel travel time, t_t, can be estimated with the help of Figure RO-1 or the following equation (Guo 1999):

$$V = C_v S_w^{0.5} \qquad \text{(RO-4)}$$

in which:

V = velocity (ft/sec)

C_v = conveyance coefficient (from Table RO-2)

S_w = watercourse slope (ft/ft)

$t_t = \frac{L}{V}$

TABLE RO-2

Conveyance Coefficient, C_v

Type of Land Surface	Conveyance Coefficient, C_v
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

The time of concentration, t_c, is then the sum of the initial flow time, t_i, and the travel time, t_t, as per Equation RO-2. $t_c = t_i + t_t$

2.4.3 First Design Point Time of Concentration in Urban Catchments. Using this procedure, the time of concentration at the first design point (i.e., initial flow time, t_i) in an urbanized catchment should not exceed the time of concentration calculated using Equation RO-5.

$$t_c = \frac{L}{180} + 10 \qquad \text{(RO-5)}$$

TABLE RO-3

Recommended Percentage Imperviousness Values

Land Use or Surface Characteristics	Percentage Imperviousness
Business:	
Commercial areas	95
Neighborhood areas	85
Residential:	
Single-family	*
Multi-unit (detached)	60
Multi-unit (attached)	75
Half-acre lot or larger	*
Apartments	80
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	5
Playgrounds	10
Schools	50
Railroad yard areas	15
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	0
Lawns, clayey soil	0

* See Figures RO-3 through RO-5 for percentage imperviousness.

Based in part on the data collected by the District since 1969, an empirical relationship between *C* and the percentage imperviousness for various storm return periods was developed. Thus, values for *C* can be determined using the following equations (Urbonas, Guo and Tucker 1990).

$$C_A = K_A + \left(1.31i^3 - 1.44i^2 + 1.135i - 0.12\right) \text{ for } C_A \geq 0, \text{ otherwise } C_A = 0 \qquad \text{(RO-6)}$$

$$C_{CD} = K_{CD} + \left(0.858i^3 - 0.786i^2 + 0.774i + 0.04\right) \qquad \text{(RO-7)}$$

$$C_B = \left(C_A + C_{CD}\right)/2$$

in which:

i = % imperviousness/100 expressed as a decimal (see Table RO-3)

TABLE RO-5

Runoff Coefficients, *C*

Percentage Imperviousness	Type C and D NRCS Hydrologic Soil Groups					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
0%	0.04	0.15	0.25	0.37	0.44	0.50
5%	0.08	0.18	0.28	0.39	0.46	0.52
10%	0.11	0.21	0.30	0.41	0.47	0.53
15%	0.14	0.24	0.32	0.43	0.49	0.54
20%	0.17	0.26	0.34	0.44	0.50	0.55
25%	0.20	0.28	0.36	0.46	0.51	0.56
30%	0.22	0.30	0.38	0.47	0.52	0.57
35%	0.25	0.33	0.40	0.48	0.53	0.57
40%	0.28	0.35	0.42	0.50	0.54	0.58
45%	0.31	0.37	0.44	0.51	0.55	0.59
50%	0.34	0.40	0.46	0.53	0.57	0.60
55%	0.37	0.43	0.48	0.55	0.58	0.62
60%	0.41	0.46	0.51	0.57	0.60	0.63
65%	0.45	0.49	0.54	0.59	0.62	0.65
70%	0.49	0.53	0.57	0.62	0.65	0.68
75%	0.54	0.58	0.62	0.66	0.68	0.71
80%	0.60	0.63	0.66	0.70	0.72	0.74
85%	0.66	0.68	0.71	0.75	0.77	0.79
90%	0.73	0.75	0.77	0.80	0.82	0.83
95%	0.80	0.82	0.84	0.87	0.88	0.89
100%	0.89	0.90	0.92	0.94	0.95	0.96
	Type B NRCS Hydrologic Soils Group					
0%	0.02	0.08	0.15	0.25	0.30	0.35
5%	0.04	0.10	0.19	0.28	0.33	0.38
10%	0.06	0.14	0.22	0.31	0.36	0.40
15%	0.08	0.17	0.25	0.33	0.38	0.42
20%	0.12	0.20	0.27	0.35	0.40	0.44
25%	0.15	0.22	0.30	0.37	0.41	0.46
30%	0.18	0.25	0.32	0.39	0.43	0.47
35%	0.20	0.27	0.34	0.41	0.44	0.48
40%	0.23	0.30	0.36	0.42	0.46	0.50
45%	0.26	0.32	0.38	0.44	0.48	0.51
50%	0.29	0.35	0.40	0.46	0.49	0.52
55%	0.33	0.38	0.43	0.48	0.51	0.54
60%	0.37	0.41	0.46	0.51	0.54	0.56
65%	0.41	0.45	0.49	0.54	0.57	0.59
70%	0.45	0.49	0.53	0.58	0.60	0.62
75%	0.51	0.54	0.58	0.62	0.64	0.66
80%	0.57	0.59	0.63	0.66	0.68	0.70
85%	0.63	0.66	0.69	0.72	0.73	0.75
90%	0.71	0.73	0.75	0.78	0.80	0.81
95%	0.79	0.81	0.83	0.85	0.87	0.88
100%	0.89	0.90	0.92	0.94	0.95	0.96

APPENDIX C

HEC-HMS OUTPUT

Project: Klondike Landfill Simulation Run: Run 1

Start of Run: 01Jan2014, 12:00 Basin Model: Basin 1
End of Run: 03Jan2014, 12:00 Meteorologic Model: Met 1
Compute Time: 19Feb2014, 10:49:20 Control Specifications: 25-year, 24-hour storm

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Detention Basin Watershed	0.0225	13.5	02Jan2014, 00:04	1.0
Ditch B Watershed	0.0925	25.6	02Jan2014, 00:32	4.2
Ditch A Watershed	0.0137	8.2	02Jan2014, 00:04	0.6

APPENDIX D

HYDRAULIC COMPUTATIONS

KLEINFELDER
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PROJECT:	Grand County SWM SSD #1	PROJECT NO.:	84794		
SUBJECT:	Ditch A and B Flow Capacity Calculations	BY:	Bruce Curtis	DATE:	2/17/14
		REVIEWED BY:		DATE:	

PURPOSE:
Perform calculations to estimate the flow capacity of Ditch A and Ditch B and estimate whether they have the capacity to convey the 25-year, 24-hour storm event.

GIVEN:
1. Ditch cross-section from HDR construction drawings titled Grand County Solid Waste Management SSD No. 1, Klondike Landfill, Phase I, January 13, 1997.

ASSUMPTIONS:
1. It is assumed that the channels are earth-lined with some gravel so the Manning's n will be 0.035.
2. An average slope will be used to estimate flow capacity for the entire channel.
3. Assume that the ditch has 0.5 feet of freeboard.

ANALYSIS:

Manning's equation was used to estimate the flow velocity and capacity in Ditch A and Ditch B. The capacity was compared to the estimate flow entering the ditches during the 25-year, 24-hour storm event. The SCS method was used to estimate the flow in Ditch A from the 25-year, 24-hour storm event. The U.S. Corps of Engineers' HEC-HMS program was used to perform this analysis. The slope was measured using the HDR topographic mapping. .

General Steps:
1. Calculate the flow velocity in each ditch when it is flowing full.
2. Calculate the flow capacity of each ditch.
3. Compare the ditch capacity to the runoff entering it during the 25-year, 24-hour storm.

The calculation sheet provides the time of concentration and lag time analyses.

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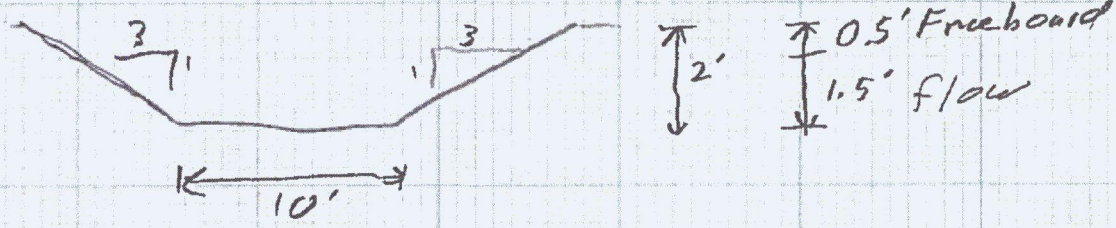
PROJECT Grand County - Klondike Landfill PROJECT NO. 84794

SUBJECT Ditch A and B Capacity BY Bruce Curtis DATE 2/18/14

REVIEWED BY _____ DATE _____

Typical Channel



Manning's Equation

$$V = \frac{1.49}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Assume channel is lined with bare-dirt and some gravel, so $n = 0.035$

$$R = \frac{A}{WP} = \frac{(10 \times 1.5) + (2)\left(\frac{1}{2}\right)(1.5 \times 4.5)}{10 + (2)(1.5^2 + 4.5^2)^{.5}} = \frac{21.75}{19.49} = 1.12'$$

$$A = (10 \times 1.5) + (2)\left(\frac{1}{2}\right)(1.5 \times 4.5) = 21.75 \text{ ft}^2$$

Ditch A

$$\text{Slope}_A = \frac{4675 - 4620}{2438} = 2.26\%$$

$$V_A = \left(\frac{1.49}{.035}\right)(1.12)^{\frac{2}{3}}(0.0226)^{0.5} = 6.90$$

$$Q_{A\,\text{capacity}} = V_A A_A = (6.90)(21.75) = 150 \text{ CFS}$$

PROJECT _____ PROJECT NO. _____

SUBJECT _____ BY _____ DATE _____

_____ REVIEWED BY _____ DATE _____

$Q_{A_{Cap}} >> Q_{A_{Req}}$

150 cfs >> 8.2 cfs

So Ditch A has sufficient capacity to convey runoff.

at 8.2 cfs, the channel will have a depth of flow of about 0.3'

$V_{Avg} = \left(\frac{1.49}{.035}\right)\left(\frac{10(.3)+(2)(\frac{1}{2})(.3\times.9)}{(10+(2)(.3^2+.9^2)^{.5})}\right)^{.67}(0.0266)^{.5} = 2.7$ fps

$Q \leq 8.8$ cfs

Ditch B

Slope B = $\frac{4668-4832}{1750} = 2.06\%$

$V_B = \left(\frac{1.49}{.035}\right)(1.12)^{0.66}(0.0206)^{.5} = 6.59$ fps

$Q_{b\ capacity} = (6.59)(21.75) = 143$ cfs

$Q_{B_{Cap}} >> Q_{B_{Req}}$

143 cfs >> 25.6 cfs

So Ditch B has sufficient capacity to convey runoff.

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PROJECT _____ PROJECT NO. _____

SUBJECT _____ BY _____ DATE _____

_____ REVIEWED BY _____ DATE _____

at 25.6 cfs, Depth ≈ 0.57'

$$V = \left(\frac{1.49}{.035}\right)\left(\frac{10 \times .57 + (2)(\tfrac{1}{2})(.57 \times 1.71)}{10 + (2)(.57^2 + 1.71^2)^{.5}}\right)^{.67}(.0206)^{.5} = 3.8 \text{ fps}$$

APPENDIX E

DETENTION BASIN STORAGE COMPUTATIONS

KLEINFELDER
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PROJECT:	Grand County SWM SSD #1	PROJECT NO.:	84794		
SUBJECT:	Detention Basin Capacity Calculations	BY:	Bruce Curtis	DATE:	2/17/14
		REVIEWED BY:		DATE:	

PURPOSE:
Perform calculations to size the storage volume of the detention basin and compare to estimate whether it has the capacity to store the 25-year, 24-hour storm event.

GIVEN:
1. Detention basin design was obtained from HDR construction drawings titled Grand County Solid Waste Management SSD No. 1, Klondike Landfill, Phase I, January 13, 1997.

ASSUMPTIONS:
1. Industry standard is that the detention basin volume is calculated from the invert of the low flow outlet, which is at an elevation of 4617 feet, while the bottom of the detention basin is at an elevation of 4612 feet. The elevation below 4617 feet is assumed to be filled with water from a previous storm event because the only way that it can leave the detention basin is from infiltration or evaporation.
2. The maximum water surface elevation is assumed to be 4618 feet, which is the invert of the emergency spillway which leaves a freeboard of 1 foot.
3. The 10 - ½" diameter holes does not have sufficient flow capacity to release water at a rate that will affect the required storage volume.

ANALYSIS:

The average end method was used to estimate storage volume.

General Steps:
1. Estimate storage volume.
2. Compare storage volume to required storage volume.

The calculation sheet provides the estimated storage volume.

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Sheet 1 of 1

PROJECT Grand County Klondike Landfill PROJECT NO. 84794

SUBJECT Storage Capacity in Detention Basin BY Bruce Curtis DATE 2/18/14

REVIEWED BY _____ DATE _____

Area of Detention Basin at Elevation 4617'

$A_{17} = L \times W = 176' * 161' = 28,336\ ft^2 = 0.65$ acres

$A_{18} = 182 * 173 = 31,486\ ft^2 = 0.72$ acres

Storage Capacity $= \left(\frac{0.65+0.72}{2}\right)(4618-4617) = .69\ AF$

Storage Capacity < Required storage

.69 AF < 1.0 AF

The detention Basin does not have sufficient storage capacity to Retain the 25-Yr, 24-hour storm