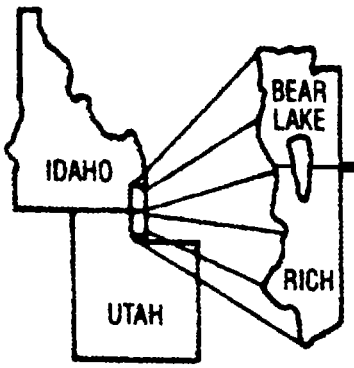

Bear Lake Regional Commission

69 N. Paradise Parkway, P.O. Box 472, Garden City UT 84028 • (435) 946-2198 • Fax (435) 946-2205

Established 1973

SW 124
Division of
Solid and Hazardous Waste

JAN 0 8 2013
2012-012067

Phil Burns
Utah Department of Environmental Quality
Division of Solid and Hazardous Waste
P.O. Box 144880
Salt Lake City, UT 84114-4880

Monday, December 31, 2012

RE: Rich County Landfill

Dear Mr. Burns,

It is with great excitement that we submit on behalf of Rich County the Class II Landfill permit application for Rich County.

This application has been worked on by individuals from the Bear Lake Regional Commission and Bear River Association of Governments and has been in various stages of completion for several years. The principle barriers to completion were the lack of satisfactory financial guarantee and QA/QC plan for the final cover. Both of these items have been completed and are included in the document.

It has been a pleasure working with the division of Solid and Hazardous Waste. Please don't hesitate to contact me with any questions or comments you may have regarding the application.

Sincerely,

Mitch Poulsen
Executive Director
Bear Lake Regional Commission

Division of
Solid and Hazardous Waste

JAN 0 8 2013
2012-012067

Rich County Class II Landfill Permit Application 2013

Organized by:

Mitch Poulsen
Executive Director
Bear Lake Regional Commission

Technical services provided by:

Bear River Association of Governments

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
195 North 1950 West
Salt Lake City, Utah 84116

Phone (801) 536-0200
Fax (801) 536-0222
www.deq.utah.gov

APPLICATION FOR A PERMIT TO OPERATE A CLASS II LANDFILL

Please read the instructions that are found in the document, INSTRUCTIONS FOR APPLICATION FOR A PERMIT TO OPERATE A CLASS II LANDFILL. This application form shall be used for all Class II 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. Part II is provided to assist in preparation and review of a permit application, it is not rule. The text of the rule governs all permit application contents and should be consulted when questions arise.

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) 536-0200 to determine if this form is still current. When completed, please return this form and support documents, forms, drawings, and maps to:

Scott T. Anderson, 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)

Division of
Solid and Hazardous Waste

JAN 0 8 2013
2012-012067

Utah Class II Landfill Permit Application Form

Part I General Information APPLICANT: PLEASE COMPLETE ALL SECTIONS.

I. Landfill Type	II. Application Type	
[X] Class II	[ ] New Application [X] Renewal Application	[ ] Facility Expansion [ ] Modification

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

III. Facility Name and Location

Legal Name of Facility: Rich County

Site Address (street or directions to site): The landfill is approximately one mile west of Sage Creek jct. on the north of sr 30

County: Rich

City: Randolph | Zip Code: 84064 | Telephone: 435-793-2415

Township: 12N | Range: 7E | Section(s): 15 and 16 | Quarter/Quarter Section | Quarter Section

Main Gate Latitude: 41 degrees 46 minutes 11.95 seconds | Longitude: 111 degrees 09 minutes 02.30 seconds

IV. Facility Owner(s) Information

Legal Name of Facility Owner: Rich County Corporation

Address (mailing): P.O. Box 218

City: Randolph | State: UT | Zip Code: 84064 | Telephone: 435-793-2415

V. Facility Operator(s) Information

Legal Name of Facility Operator: Rich County Corporation

Address (mailing): P.O. Box 218

City: Randolph | State: UT | Zip Code: 84064 | Telephone: 435-793-2415

VI. Property Owner(s) Information

Legal Name of Property Owner: Rich County Corporation

Address (mailing): P.O. Box 218

City: Randolph | State: | Zip Code: 84064 | Telephone: 435-793-2415

VII. Contact Information

Owner Contact: Becky Peart | Title: County Clerk

Address (mailing): P.O. Box 218

City: Randolph | State: Ut | Zip Code: 84064 | Telephone: 435-793-2415

Email Address: bpeart@richcountyut.org | Alternative Telephone (cell or other):

Operator Contact: Scott Jacobson | Title: Sanitation Dept. Head

Address (mailing): P.O. Box 218

City: Randolph | State: Ut | Zip Code: 84064 | Telephone: 435-881-9700

Email Address: rcsanitation@allwest.net | Alternative Telephone (cell or other):

Property Owner Contact: N.A. | Title:

Address (mailing):

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

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

Utah Class II Landfill Permit Application Form

Part I General Information (continued)

VIII. Waste Types (check all that apply)

☒ All non-hazardous solid waste **OR** the following specific waste types:

Waste Type	Combined Disposal Unit	Monofill Unit
☐ Municipal Waste	☐	☐
☐ Construction & Demolition	☐	☐
☐ Industrial	☐	☐
☐ Incinerator Ash	☐	☐
☐ Animals	☐	☐
☐ Asbestos	☐	☐
☐ Other _____	☐	☐

IX. Facility Area

Facility Area	125	acres
Disposal Area	20	acres
Design Capacity		
Years	67	
Cubic Yards	2,964,144	
Tons	741,035	

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

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

Signature of Authorized Owner Representative William E. Cox Name typed or printed	Title Commissioner	Date 8/22/13
	Address 20 South Main Randolph, Utah 84064	
Signature of Authorized Land Owner Representative (if applicable) Name typed or printed	Title	Date
	Address	
Signature of Authorized Operator Representative (if applicable) Name typed or printed	Title	Date
	Address	

Utah Class II Landfill 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, operated, and closed in compliance with 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 801-536-0200. 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
Ia. General Information - All Facilities	
Completed Part I General information form above	
General description of the facility (R315-310-3(1)(b))	page 1
Legal description of property (R315-310-3(1)(c))	page 2
Proof of ownership, lease agreement, or other mechanism (R315-310-3(1)(c))	Appendix A
Area served by the facility including population (R315-310-3(1)(d))	page 2
A demonstration that the landfill is not a commercial facility	
Waste type and anticipated daily volume (R315-310-3(1)(d))	page 2
Ib. Information Required - All New Or Laterally Expanding Facilities	
Intended schedule of construction (R315-302-2(2)(a))	page 3
Name and address of all property owners within 1000 feet of the facility boundary (R315-310-3(2)(i))	Appendix A
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))	N/A

Utah Class II Landfill Permit Application Checklist

I. **Facility General Information**	
Description of Item	Location In Document
Name of the local government with jurisdiction over the facility site (R315-310-3(2)(iii))	page 2
Ic. Location Standards - All New And Expanding Facilities	
Documentation that the facility has meet the historical survey requirement of R315-302-1(2)(f)	N/A
Land use compatibility (R315-302-1(2)(a))	page 17
Maps showing the existing land use, topography, residences, parks, monuments, recreation areas or wilderness areas within 1000 feet of the site boundary	N/A
Certifications that no ecologically or scientifically significant areas or endangered species are present in site area	N/A
List of airports within five miles of facility and distance to each	N/A
Geology (R315-302-1(2)(b))	page 13
Geologic maps showing significant geologic features, faults, and unstable areas	N/A
Maps showing site soils	figure 3e
Surface water (R315-302-1(2)(c))	page 14
Magnitude of 24 hour 25 year and 100 year storm events	page 18
Average annual rainfall	page 13
Maximum elevation of flood waters proximate to the facility	page 18
Maximum elevation of flood water from 100 year flood for waters proximate to the facility	page 18
Wetlands (R315-302-1(2)(d))	page 18
Ground water (R315-302-1(2)(e))	page 14
Id. Plan of Operations – All Facilities (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))	page 3/Appendix B
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 B
Contingency plans in the event of a fire or explosion (R315-302-2(2)(d))	page 5
Corrective action programs to be initiated if ground water is contaminated (R315-302-2(2)(e))	page 5
Contingency plans for other releases, e.g. explosive gases or failure of run-off collection system (R315-302-2(2)(f))	page 5

Utah Class II Landfill Permit Application Checklist

I. **Facility General Information**	
Description of Item	Location In Document
Plan to control fugitive dust generated from roads, construction, general operations, and covering the waste (R315-302-2(2)(g))	page 8
Plan for litter control and collection (R315-302-2(2)(h))	page 20
Description of maintenance of installed equipment (R315-302-2(2)(i))	page 6
Procedures for excluding the receipt of prohibited hazardous or PCB containing wastes (R315-302-2(2)(j))	page 4
Procedures for controlling disease vectors (R315-302-2(2)(k))	page 6
A plan for alternative waste handling (R315-302-2(2)(l))	page 6
A general training plan for site operations (R315-302-2(2)(o))	page 6
Any recycling programs planned at the facility (R315-303-4(6))	page 6
Closure and post-closure care Plan (R315-302-2(2)(m))	page 7
Procedures for the handling of special wastes (R315-315)	page 5
Plans and operation procedures to minimize liquids (R315-303-3(1))	N/A
Plans and procedures to address the requirements of R315-303-3(7)(c) through (i) and R315-303-4	page 8
Any other site specific information pertaining to the plan of operation required by the Executive Secretary (R315-302-2(2)(p))	

II **Facility Technical Information**	
Description of Item	Location In Document
IIa. Maps – All Facilities	
Topographic map drawn to the required scale with contours showing the boundaries of the landfill unit, gas monitoring points, and the borrow and fill areas (R315-310-4(2)(a)(i))	figure 3b
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))	figure 2a
IIb. Geohydrological Assessment - All Facilities (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))	page 13
Evaluation of bedrock and soil types and properties including permeability rates (R315-310-4(2)(b)(ii))	page 14
Depth to ground water (R315-310-4(2)(b)(iii))	page 14
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))	figure 3b

II **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))	Appendix F
Identification and description of all surface waters on-site and within one mile of the facility boundary (R315-310-4(2)(b)(vii))	page 14
For an existing facility, identification of impacts upon the ground water and surface water from leachate discharges (R315-310-4(2)(b)(viii))	page 16
Calculation of site water balance (R315-310-4(2)(b)(ix))	page 15
IIc. Engineering Report - Plans, Specifications, And Calculations – All Facilities	
Documentation that the facility will meet all of the performance standards of R315-303-2	pages 5,14,16,18
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))	page 17
Anticipated facility life and the basis for calculating the facility's life (R315-310-4(2)(c)(ii))	page 8
Unit design to include cover design; fill methods; and elevation of final cover including plans and drawings signed and sealed by a professional engineer registered in the State of Utah, when required (R315-303-3(3), R315-303-3(6) and (7)(a), R315-310-3(1)(b) and R315-310-4(2)(c)(iii))	page 20
Equipment requirements and availability (R315-310-4(2)(c)(iii))	page 7,19
Identification of borrow sources for daily and final cover and for soil liners (R315-310-4(2)(c)(iv))	page 19
Run-On and run-off diversion designs (R315-303-3(1)(c), (d) and (e))	page 6
Landfill gas monitoring and control plan that meets the requirements of Subsection R315-303-3(5) (R315-310-4(2)(c)(vii))	page 4
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))	page 17
Design and location of run-on and run-off control systems (R315-310-4(2)(c)(viii))	page 5
IId. Closure Plan – All Facilities (R315-310-3(1)(h))	
Closure Plan (R315-302-3(2) and (3))	page 7
Closure schedule (R315-310-4(2)(d)(i))	page 8
Design of final cover (R315-310-4(2)(c)(iii))	pages 9,10
Capacity of site in volume and tonnage (R315-310-4(2)(d)(ii))	page 7
Final inspection by regulatory agencies (R315-310-4(2)(d)(iii))	
IIe. Post-Closure Care Plan – All Facilities (R315-310-3(1)(h))	
Post-Closure Plan (R315-302-3(5) and (6))	page 9
Site monitoring of landfill gases, and surface water, if required (R315-310-4(2)(e)(i))	page 9

II **Facility Technical Information**	
Description of Item	Location In Document
Changes to record of title, land use, and zoning restrictions (R315-310-4(2)(e)(v))	N/A
Maintenance activities to maintain cover and run-on/run-off control systems (R315-310-4(2)(e)(iii))	page 5
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))	page 1
IIf. Financial Assurance – All Facilities (R315-310-3(1)(j))	
Identification of closure costs including cost calculations (R315-310-4(2)(d)(iv))	page 11
Identification of post-closure care costs including cost calculations (R315-310-4(2)(e)(iv))	page 12
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))	page 9

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PART II – GENERAL REPORTS

GENERAL BACKGROUND

Rich County's landfill is an existing landfill seeking a permit to continue operation with lateral expansion. The landfill site has been receiving waste since 1982. The landfill's extent was initially 40 acres operated under a lease agreement with the Bureau of Land Management (BLM). In 1994, Rich County secured ownership of the original 40 acres with additional acreage totaling 125 acres.

Location

The Rich County landfill is located approximately one and one-half miles west of Sage Creek Junction and one-half mile north of Utah Highway 30. Access to the site is restricted by a locked gate located at the intersection of Highway 30 and the landfill road. The BLM is the sole landowner for all lands surrounding the Landfill site. The general location is shown in **Figure II-A.**

Current Status

In 1999, the original fenced in 15 acres (see **Figure III-L**) stopped receiving waste and the area was permanently closed. Consistent with closure requirements, 18 inches of final cover was applied over each trench. Soil that remained from excavation of the trench cell was spread over the capped trenches. At least four feet of consistent cover was added over the final cover. Natural processes eliminated the need for manual vegetative re-seeding. Native vegetation has adequately re-established itself on the closed portion of the landfill. Since closure of the area in 1999, none of the trench cell's cover material has been compromised in terms of functional integrity. The site has very little rain and given the topography very little run-off potential.

As specified in Rich County's original permit, a waste tire pile is located in the closed 15 acre portion of the landfill. This pile now numbers over 1000. The county is waiting for the tires to be picked up as part of the State of Utah's Waste Tire Recycling Program. No more than four tires at a time may be accepted for disposal.

Commencement of land filling operation in the portion of the landfill identified as Current Phase (see **Figure III-L**) began in 1999. This is consistent with the operation plan included in the original permit application submitted in 1997. Movement to this new area has required very little in terms of site improvement. The dirt road servicing this area already existed and needed only minor improvement. The county plans to move the fence that currently encloses the original 15 acre portion and install it around the active portion of the landfill (**Figure III-L**).

Waste disposal has always been accomplished and will continue to use the trenching method. Trenches are excavated to a depth of about 15 to 20 feet and are about 15 feet wide. The length of the trenches is extended as needed and takes place in phases. Daily cover consists of approximately six to ten inches of cover material with a final cover of eighteen inches and a

frost/vegetable layer of 50 inches install according to the Construction Quality Assurance Plan found in appendix H.

Landfill Service Area

The Rich County Landfill serves the total area of Rich County. Rich County is responsible for the collection and disposal of all solid waste generated within the County. This includes the four incorporated municipalities of Garden City, Laketown, Randolph and Woodruff and also all unincorporated areas within the County. A number of recreation sites and campgrounds are also included in the service area. The population of Rich County as of the 2010 Census was 2,264.

Types of Waste Received

The Rich County Landfill does not receive and plans to continue to receive municipal solid waste (which includes household waste), and wastes generated by commercial enterprises. In 2001, the landfill received an estimated 2989 tons of solid waste (8.2 tons per day averaged annually). A large portion (about 14%) of the total annual solid waste generated in the county originates from seasonal tourism related sites. Due to the relative lack of industry in Rich County, wastes generated from manufacturing operations do not pose a significant problem. The amount of waste accepted that is classified as "special wastes" will be limited to that generated by households and agricultural operations.

Relationship with Rich County Solid Waste Management Plan

This permit application supports the recommended solid waste strategy as proposed in the Rich County Solid Waste Management Plan (April 1993). The preferred alternative identifies continued use of the existing site with lateral expansion.

Legal Description

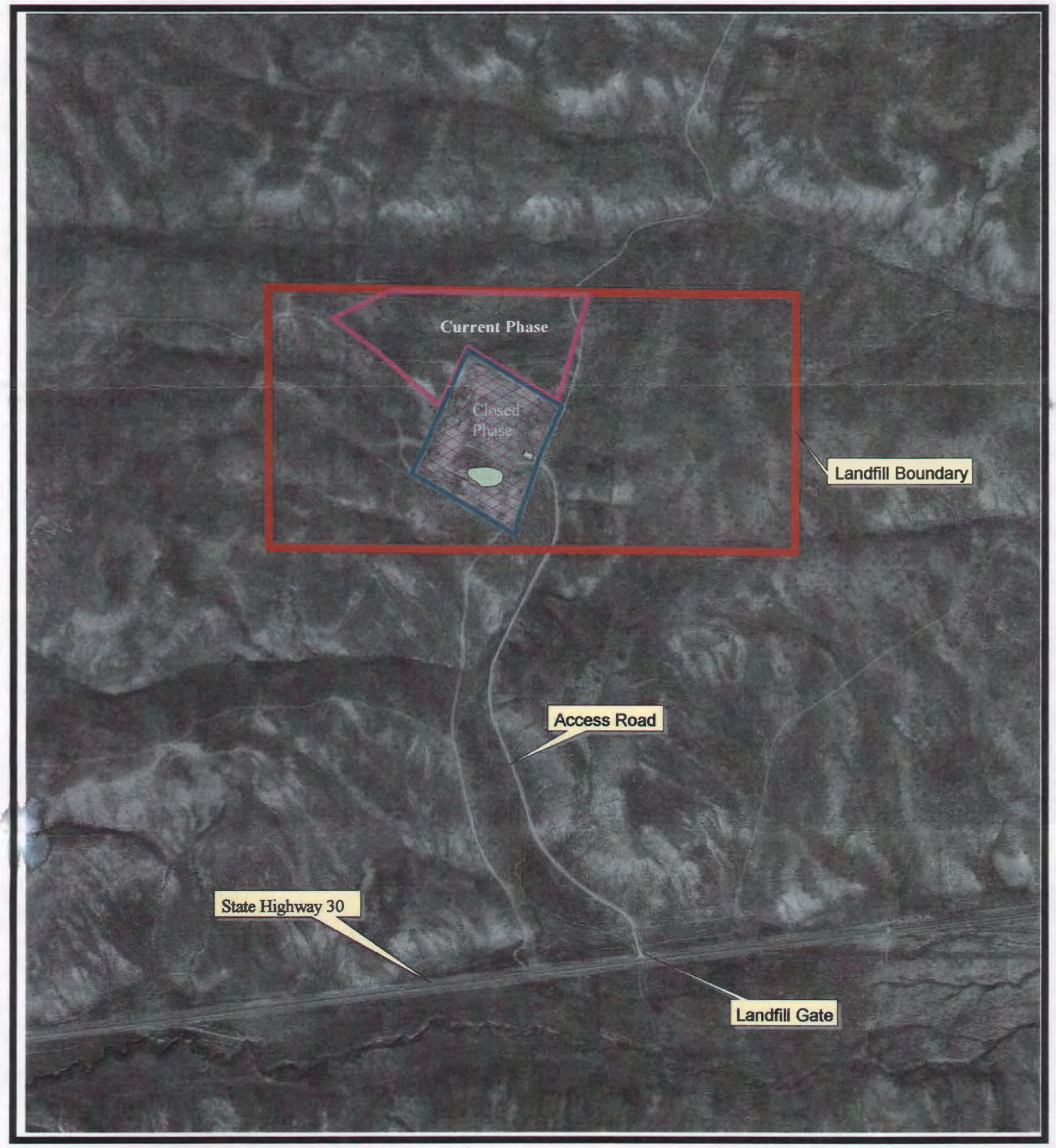
The following table identifies the limits of ownership and landfilling operations for the Rich County Landfill:

MERIDIAN	TOWNSHIP	RANGE	SECTION	SUBDIVISION	ACRES
SL	12 N.	7 E.	15	S1/2 SW1/4 SW1/4, W1/2 SW1/4 SW/14	25
SL	12 N.	7 E.	16	S1/2 S1/2 N1/2 SE1/4, S1/2 SE1/4	100

Table II-A Landfill limits of operations and ownership.

Proof of Ownership

Appendix A provides a copy of the U. S Land Patent issued by the Bureau of Land Management to Rich County Corporation of November 13, 1993 for the 125-acre site.



Rich County Landfill

Solid Waste Permit Application

2002 Update

Figure II-A

USGS 7.5 Min Quad Map
Sage Creek, Utah
Photorevised 1986

200 0 200 400 600 800 Feet

N

Map prepared March 2002 by:

BRAG
Bear River Association of Governments
Box Elder
Cache
Rich

PLAN OF OPERATION

Construction Schedule

Most of the facilities necessary to support landfilling operations in the foreseeable future for the Rich County Landfill are in place. These improvements include a storage shed, gate, access roads, and fencing. A new water well was drilled a few years ago to provide water for cleaning landfill equipment. The only construction activities planned for the next five years are extension of the access road to follow active landfill trench area and movement of existing fence currently around the original 15 acre site to the active landfill portion of "current phase" area (see **Figure III-L**).

On-site Solid Waste Handling Procedures

Incoming loads will be evaluated and documented according to the form labeled "Landfill Log" located in Appendix B. Landfill users will then be directed (by on-site personnel and signage) to the active trench where they will deposit their solid waste. Periodically (when needed), the waste will be spread and compacted in the trench. This will be done with the Kawasaki Front-End Loader and Komatsu trackhoe located on-site. At the end of each day that the landfill is open (or accepting waste), the waste will again be spread and compacted and then covered with a minimum of 6 inches of suitable material. The final cover will consist of 18 inches of compacted soil with a permeability of 1×10^{-7} cm/sec or less. An additional 50 inches of excess soil excavated from the trench will be placed over the trench in a mound (this includes the 6 inches of previously segregated top soil). The final cover will be installed according to the "Construction Quality Assurance Plan" found in Appendix H.

Acceptable Types of Wastes

The following type of waste will be accepted at the Rich County Landfill.

- **Household Wastes:** Discarded animal and vegetable wastes, trash and non-liquid sanitary wastes in septic tanks derived from single and multiple residences, hotels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic grounds, and day-use recreation areas.

- **Commercial Wastes:** All types of wastes generated by stores, offices, restaurants, warehouses, and other non-manufacturing activities.

- **Waste Tires:** Will be accepted. They will either be segregated into piles of 1000 and stored for pick up with the States Waste Tire Recycling Program or they will be land filled in the bottom of the trench cell. This will depend on the responsiveness of the Waste Tire Recycling Program pickup. No more than 4 tires will be accepted in any load.

- **Dead Animals:** Will be accepted and placed at lower depths of the trenches and immediately covered.

- **Common Household Hazardous Wastes:** Efforts will be made to minimize acceptance of these types of wastes.

- **Furniture and Appliances:** These items will be compacted, where possible, before they are placed at lower depths of the trench.

In accordance with Rule R315-301-2(31), all of the wastes listed above are restricted to containers of "household size." This means containers for a material or product that is normally and reasonably associated with households or household activities. All other types of wastes not listed will be excluded from the landfill.

Procedures for the Exclusion of Unacceptable Types of Wastes

All incoming landfill users will be asked to identify the types of wastes included in their load and also any types of waste that may require special handling. In addition, inspections of incoming loads of wastes will be done on a random basis (one load will be inspected every week). The landfill receives approximately 20-30 loads a week at the peak season. The loads will be visually inspected before discharge and after discharge while the landfill user is still present. With hand tools, a breakdown of the waste will be performed looking for indications of the presence of hazardous types of waste or suspicious containers. This routine inspection will be conducted by trained landfill operation personnel and be documented as per "Waste Inspection Form" located in Appendix B. Upon identification of potentially hazardous materials, the landfill will be closed immediately and the proper officials will be notified.

Monitoring and Self Inspection

Due to the low potential for ground water contamination from the landfill (see **Part III**), no ground water monitoring wells or facilities are proposed for the site. Nor is any leachate collection or monitoring system proposed for the site.

A waiver from the requirement to test for methane gas is requested for the landfill itself as well as the on-site landfill shed for the following reasons. The site receives very little annual rainfall, the trench method distributes the waste in relatively small cells with earthen separators and the landfill portion of site is a fair distance away from the landfill shed.

Daily routine inspections will be done by landfill personnel on-site for such things as litter, unauthorized burning, and disease vectors. A more intensive inspection will be carried out quarterly by the County's Public Works Director. This inspection will access the integrity of the cover materials, status of the vegetable cover and any other impacts related to erosion, as well as the condition of any run-on control systems. These inspections will be documented with the form labeled "Landfill Inspection Form" located in Appendix B. In addition, a comprehensive annual inspection will be conducted to confirm compliance with all permit requirements. The results of this inspection will be documented and submitted to the Executive Secretary of the Utah Solid and Hazardous Waste Department by March 1st of each year. The format for this report will be as follows:

- Name and address of the facility
- Calendar year covered by the report
- Annual quantity, in tons or volume of waste received
- Results of monitoring programs
- Training programs or procedures completed

Contingency Plans

The following actions will be taken in case of ground water contamination, fire, explosions, or discharge of hazardous materials.

Ground Water Contamination

Due to the low potential for ground water contamination, no monitoring system is proposed. However, if significant levels of ground water contaminate are detected in down gradient locations and the problem can be directly linked to landfilling operations, corrective actions will be taken in accordance with Rules R315-308-2(12) and R315-308-3(1).

Fire Control

Due to the size of the active cell and the landfilling methods used, fire hazard does not pose a significant threat. However, efforts will be made by landfill supervisory personnel to discourage waste and debris fires started on purpose or accidentally. In the event of the landfill fire, the proper officials will be notified and the fire will be extinguished by the placement of additional cover materials. If needed, landfilling operations will be relocated to a designated backup area of the landfill. At present a sign is posted at the current phase entrance prohibiting fires. Controlled burns or vegetative yard waste made periodically be done on an "as-needed" basis during the county designated "burn window." This will be coordinated with the county Fire Marshal and will be done outside the active trench cell. Fire extinguishers have been placed on site in the event of fire. Communication with emergency personnel is through cellular phone use as there is no existing land line to the office. Emergency services phone numbers are posted and readily available.

Explosion

In the event of an explosion, the landfill will be properly secured and then County Fire Officials will be notified. Landfilling operations will be relocated to the designated backup area until the situation is under control.

Explosive Gases

If gas monitoring suggests that the levels of explosive gases are 25 percent of the lower explosive limit in the building or 100 percent of the lower explosive limit at the property boundary, all landfilling operations will be halted and the proper officials will be notified. Corrective actions would include an engineering evaluation and possible implementation of a gas collection facility (if deemed necessary).

Run-off System Failure

Failure of any of the run-off containment systems would require immediate remedial action. All of the berms or ditches would be repaired and would be reinforced to prevent future failures.

Any displaced waste materials would be collected and disposed of appropriately. Maintenance of run-on and run-off systems will be conducted on an "as needed" basis. Routine evaluations will be conducted by solid waste staff on these systems and areas needing attention will be addressed immediately.

Alternative Waste Handling Procedures

Given the simplicity of landfilling methods (and the speed in which a new trench can be readied to accept waste), in the case of an emergency or landfill closure a new trench will be started in the area designated in **Part III** as a "backup area." The landfill boundaries are large enough to accommodate alternative access given most types of events that would render part of the landfill inaccessible. Another alternative, on a short term basis, would be to negotiate with a landfill operator within close proximity and transport the waste. Maintenance of run on and run off will include regular evaluations of existing catch basins to control stormwater run off and adding culverts where necessary.

Maintenance of Installed Equipment

Other than landfilling machinery, no other equipment exists or is proposed for the site that would require maintenance.

Disease Vector Control

Because of the remoteness of the landfill site, it is not likely that problems will arise with disease vectors. However, if problems do arise, remedial actions will be taken in the form of rodent trapping or other extermination measures. Prompt cover of waste, especially dead animals, should prevent any potential problems with scavenging vermin.

Recycling Program

The county intends to segregate and collect waste tires and haul to a commercial shredder. No other recycling programs are proposed for the Rich County Landfill. In the future, recycling alternatives will be considered by the county as market conditions change for the region.

Training

Landfill operators will be required to review the contents of this operation plan. Training will have emphasis on conforming to operating guidelines and the identification of hazardous waste. All landfill workers will be required to review the contents of Appendix C dealing with the identification of hazardous types of waste. All training will be conducted and certified by Rich County's Public Works Director. A new landfill supervisor was hired in 2011 to take over operations of the landfill. He will be attending future trainings as notified.

Access Control

On-site personnel staffed by Rich County Public Works Department will be present during times in which the landfill is accepting waste from the public or county collection vehicles. Rich County collection vehicles will be allowed to use the landfill when the landfill is not open to the general public. These hours are posted at the landfill gate. A new sign will be added identifying acceptable and unacceptable types of wastes.

During times the landfill is not open to the public, the landfill will be kept locked. The gate is located on the intersection of the landfill access road and Highway 30. The placement of the access gate immediately on the turnoff with Highway 30 rather than on the landfill boundary is to discourage illegal dumping (during closed periods, landfill users are less likely to dump their waste illegally next to the relatively busy Highway 30 than they would be next to a secluded gate nearest to the landfill).

Access roads are developed to facilitate safe passage during all weather conditions. Snow removal during the winter as part of regular maintenance allows for safe operation. Road grades and widths are maintained to accommodate safe passage during all types of weather conditions encountered during the year. Dust control is maintained by establishing slow speed limits within the landfill boundaries.

Traffic patterns

Traffic entering the facility are directed where to go and what locations are accepting waste. Signage posted at strategic locations directs the flow of traffic. Unloading locations are placed to facilitate smooth ingress, egress and unloading to minimize confusion.

CLOSURE PLAN

In accordance with Rule 315-302-3(3), this closure plan seeks to close the facility such as to minimize the need for further maintenance and minimize or eliminate the threat to human health and the environment.

Phase	Area FT^2	Cubic Yards	Tons
Current	874,844	680,433	170,108
Phase II	2,139,082	1,663,730	415,932
Phase III	797,119	619,981	154,995
TOTAL	3,811,045	2,964,144	741,035

Table II-B: Estimated area, volume and tonnage of waste broken down by phase for the Rich County Landfill.

Capacity of the Site

Assuming that the proposed methods/density of landfilling continues, the site's landfilling capacity is an estimated 741,035 tons (2,964,144 Cubic Yards) of solid waste. This figure was derived by estimating the volume of waste each trench cell can hold and multiplying this number by the number of trench cells the site can accommodate (absent areas not suitable for landfilling). Volume estimates are based on the assumption that 9.7 feet of the 15 foot trench depth is compacted waste. Tonnage was estimated based on the assumption that one cubic yard of compacted waste weights 500 pounds. **Table II-B** shows the estimates broken down by phase.

Ongoing Closure Activities

Future Activities

As specified in **Part III** of this document, proper closure of each landfilling cell will be done soon after the cell is full. This modular approach to closure helps to minimize the effort and costs associated with closure (it also spreads the costs over the life of the landfill rather than being due at one time). In addition, this approach also minimizes the risk of ground water contamination and the escape of other solid waste constituents because each cell is left absent its final cover for only a short time. Application of the final cover for full trench cells will occur in the fall of each year. Trenches that reach capacity other times of the year will receive an interim cover of 6 inches installed consistent with the daily cover. Construction of the final cover once a year will minimize construction and testing expenses. The installation of the final cover will be done according to the "Construction Quality Assurance Plan" found in Appendix H. Closure activities will include:

1) Placement of 18 inches of compacted cover material with hydraulic conductivity of 1 x 10^{-7} cm/sec or less over the trench cell (this material has been physically segregated upon excavation of trench cell).

2) Placement of 50 inches of on-site soil to prevent frost desiccation of the final cover layer.

3) Replacement of top 6 inches of top soil to act as an erosional layer and to facilitate natural re-vegetation processes (re-seeding is not required because size of the trench and the abundance of plant materials around the trench cells that will naturally reestablish).

After completion of each phase of the landfill (see **Part III**), a comprehensive review and site assessment will be conducted to determine if the phase has been properly closed.

Past Activities

Past landfilling operations on the original 15 acres fenced-in area have been properly closed.

Closure Projections

Although closure activities will be ongoing, efforts will be made to insure that each individual phase of the landfill is properly closed before moving on to the next phase. Using past usage of landfill space (since 1982) as a basis for estimation, **Table II-C** show the projected life of each phase. In the calculations, yearly usage rates are estimated to increase 5% with each new phase. Projection accuracy depends on the accuracy of this growth factor as well as the assumption that future landfilling space will be used at the same level of efficiency as in the past (landfill usage will likely become more efficient).

Phase	Remaining Area FT^7	Rate	Years Remaining	Projected Year
Current	745,314	44,697 ft^2/year	16.6	2018
Phase II	2,139,082	46,931 ft^2/year	45.5	2063
Phase III	797,119	49,277 ft^2/year	16	2079
TOTAL	3,681,415		78	

Table II-C: Closure projections based on current usage of landfill space adjusted by 5% growth rate.

Final Closure Schedule

The following schedule will be followed at least every three years for closed portions of the landfill (ongoing closure) as well as after the receipt of the final volume of solid waste for the Rich County Landfill:

1) Sixty days prior to closure the Executive Secretary of the Utah Solid and Hazardous Waste Control Board will be notified of the intent to complete the closure plan.

2) Within thirty days of closure, an inspection will be conducted by a qualified engineer to establish the adequacy of past closure activities and make recommendations that will minimize or eliminate the post-closure escape of solid waste constituents. Any "as-built" changes to closure construction specified in the closure plan will be documented and submitted.

3) Implementation of any recommendations and final inspection.

4) Within 180 days of final closure a formal certification of closure will be submitted by Rich County and a professional engineer to the Executive Secretary of the Utah Solid and Hazardous Waste Department.

POST-CLOSURE PLAN

Post-closure care of the landfill will consist mostly of on-going monitoring and reactive maintenance and repairs. These activities will conclude only when the Executive Secretary of the Utah Solid and Hazardous Waste Department considers the site to have "stabilized."

Monitoring

Due to the low potential for contamination from solid waste constituents, post-closure monitoring of ground water, surface water or leachate is not proposed for the Rich County Landfill site.

A waiver from the requirement to test for methane gas is requested for the landfill itself as well as the on-site landfill shed for the following reasons. The site receives very little annual rainfall, the trench method distributes the waste in relatively small cells with earthen separators and the landfill portion of site is a fair distance away from the landfill shed.

An on-site inspection will be conducted quarterly according to Utah Administrative Code R315-310-4(2)(e)(ii)(A). These inspections will access the integrity of the cover materials, status of the vegetative cover and any other impacts related to erosion, as well as the condition of any run-on control systems. An annual report will be submitted to the Executive Secretary of the Utah

- Name and address of the facility
- Calendar year covered by the report
- Results of monitoring programs
- Training programs or procedures completed

FINANCIAL ASSURANCE PLAN

This permit application proposes the establishment of an account with the Public Treasurers Investment Fund to meet the financial assurance mechanism required by UAC R315-309.

Cost Estimates

What follows are the cost estimates for landfill closure and post-closure. The costs reflected are based on a third party doing all of the specified tasks. Using the resources available internally to Rich County, costs will most likely be considerably lower. It should be noted that the construction cost for landfill closure are lower in this permit renewal application as compared to the original permit application. The cost estimates in the original permit application included closure cost for the entire 15 acre area that had not been adequately closed. This is no longer the case. The only area requiring closure construction are the active trench cells located in the "current phase."

Construction Closure Requirements

The following descriptions and item numbers correspond to **Table II-E** (items described in **Table II-D** require no further explanation).

Item 2.2.1 Infiltration Layer

The last active cell will require re-grading of the final cover material as per guidelines provided in **Part III**.

Item 2.3 Erosion Layer

The last active cell, after receiving its final cover, will require a six-inch erosion layer of replaced top soil.

Item 2.5 Re-grading

Application of the appropriate cover material and re-grading to 50 inch mounds over trench cells.

ENGINEERING COSTS				
ITEM	UNIT MEASURE	COST/UNIT	NO. UNITS	TOTAL COST
1.2 Boundary Survey for Affidavit	Lump Sum			$2500
1.3 Site Evaluation	Hours	$145	5	$725
1.6 Administrative Costs for The Certification of Final Cover and Affidavit to Public	Hours	$65	4	$260
Subtotal				$3,485
10% Contingency				$349
Engineering Total				$3,834

Table II-D: Closure cost estimates for the Rich County Landfill.

CONSTRUCTION COSTS				
ITEM	UNIT MEASURE	COST/UNIT	NO. UNITS	TOTAL COST
6" Leveling Layer**	Cubic Yard	$4.00	425	$1,700
18" Final Cover Layer**	Cubic Yard	$2.80	1,670	$6,680
2.5 Site Grading and Drainage	Cubic Yard	$2.00	500	$1,000
Subtotal				$9,380
10% Contingency				$938
Construction Total				$10,318

Table II-E: Construction closure cost estimates for the Rich County Landfill.
*Units based on 75' wide by 400' long cell
**Depths from IGES, Inc. evaluation of soil cover letter to Rich County-Date 5/26/2010

SUBTOTAL:	$14,152
Legal Fees (25%):	$3,538
TOTAL CLOSURE COSTS:	**$17,690**

Post-Closure Requirements
The following item description numbers correspond to **Table II-F**.

Item 1.2 Site Inspection & Record Keeping
This item represents the cost of a quarterly comprehensive inspection that will access the integrity of the cover materials, status of the vegetative cover and any other impacts related to erosion, as well as the condition of any run-on control systems. In addition, costs associated with the documentation and submittal of the findings of this inspection along with the results of monitoring programs are also included. The length of time for post-closure care will follow the generally accepted span of 30 years.

Item 1.4 Site Monitoring
No ongoing monitoring is proposed in this application.

Item 2.0 Construction Costs
This is the estimated annual cost of maintenance and repair of cover materials, access roads and run-on control systems. In addition, this line item also includes any costs associated with the upgrade or repair of fencing and security control systems.

POST-CLOSURE COSTS				
ITEM	UNIT MEASURE	COST/UNIT	NO. UNITS	TOTAL COST
1.1 Post-Closure Plan	Lump Sum			$1,300
1.2 Site Inspection & Record Keeping (quarterly)	Hours	$145	20	$2,900
2.0 Construction Costs (annual maintenance & repair)	Lump Sum			$1,000
Subtotal				$5,200
10% Contingency				$520
Engineering Total				$5,720

Table II-F: Closure cost estimates for the Rich County Landfill.

Total Post-Closure Costs
First Year Post-Closure Costs: $5,720 ($4,620 in engineering fees)
Subsequent Years Annual Post-Closure Costs: $4,420 ($3,190 in engineering fees)
30 Year Post Closure Costs-Present Worth (30*$4,420) $132,600
*associated mileage is included in the above prices

PART III – TECHNICAL INFORMATION

GEOHYDROLOGICAL ASSESSMENT

General Description

The landfill site is in an area of gently rolling hills on the Bear River Plateau near the western edge of the upper Bear River Valley. The sub region is characterized by some nearly level uplands and fairly steep foothills. Many small drainages dissect the region. The closest precipitation monitoring station (located in Laketown) has recorded an average annual precipitation of 11.22 inches. This is based on 85 years of historical data (see Appendix D).

Geologic Assessment

The following geological summary was taken from a Bureau of Land Management "Mineral Potential Report" (BLM, 1993) prepared for the land ownership transfer and a field investigation conducted for the site by the Utah Geological survey (Solomon, 1993).

Regional Geology

The area in which the landfill site is located is situated in the overthrust belt of the Middle Rocky Mountain physiographic province. The area is characterized by thick sequences of Paleozoic and Mesozoic sedimentary rocks. The apparent thickness of the sedimentary section is greater than the true thickness because of extensive thrust faulting which has repeated the section in most of the region. During the late 1970's and early 1980's the "Wyoming" overthrust belt, in which the landfill site can be included, was one of the most productive oil and gas prospect areas in the lower forty eight states. Appendix E contains geologic cross-sections for the region.

Local Geology

The surface geology of the landfill site is mapped as Tertiary Wasatch Formation and Quarternary Hill Wash. The Wasatch formation of Eocene age is a nearly horizontal formation composed of continentally derived sediments. This formation unconformably overlies an erosion surface cut into structurally complex Mesozoic and Paleozoic sedimentary rocks. None of these older rocks are exposed on the landfill site. The unit mapped as Quaternary Hill wash is basically a soil that is derived from the Wasatch Formation.

The subsurface geology is unrelated to the surface geology. A cross section of the Hogback gas field suggests that it is situated on the Allocthonous plate of the Crawford thrust. It is likely that the subsurface geology of the landfill is very similar of the Hogback gas field which is about five miles north of the landfill (see Appendix E). The cross-section documents the presence of source rocks and host rocks for petroleum. It is also interesting to note the absence of the Preuss Formation in the cross-section. The Preuss formation is the source of the salt that was used to justify the prospectively valuable classification for sodium.

Hydrologic Assessment

Surface Water

Regionally, the landfill site is located in the upper Bear River Drainage Area. The headwaters of the Bear River begin on the north slope of the Uinta Mountains in Summit County. The river enters Rich County on the east from Wyoming and flows northward through the Bear River Valley. Many small tributaries flow into the Bear River. Among the most important of these drainages in Rich County are the Saleratus, Woodruff, Randolph and Big Creeks. About 12 miles north of Randolph, the Bear River flows back into Wyoming and then into Idaho.

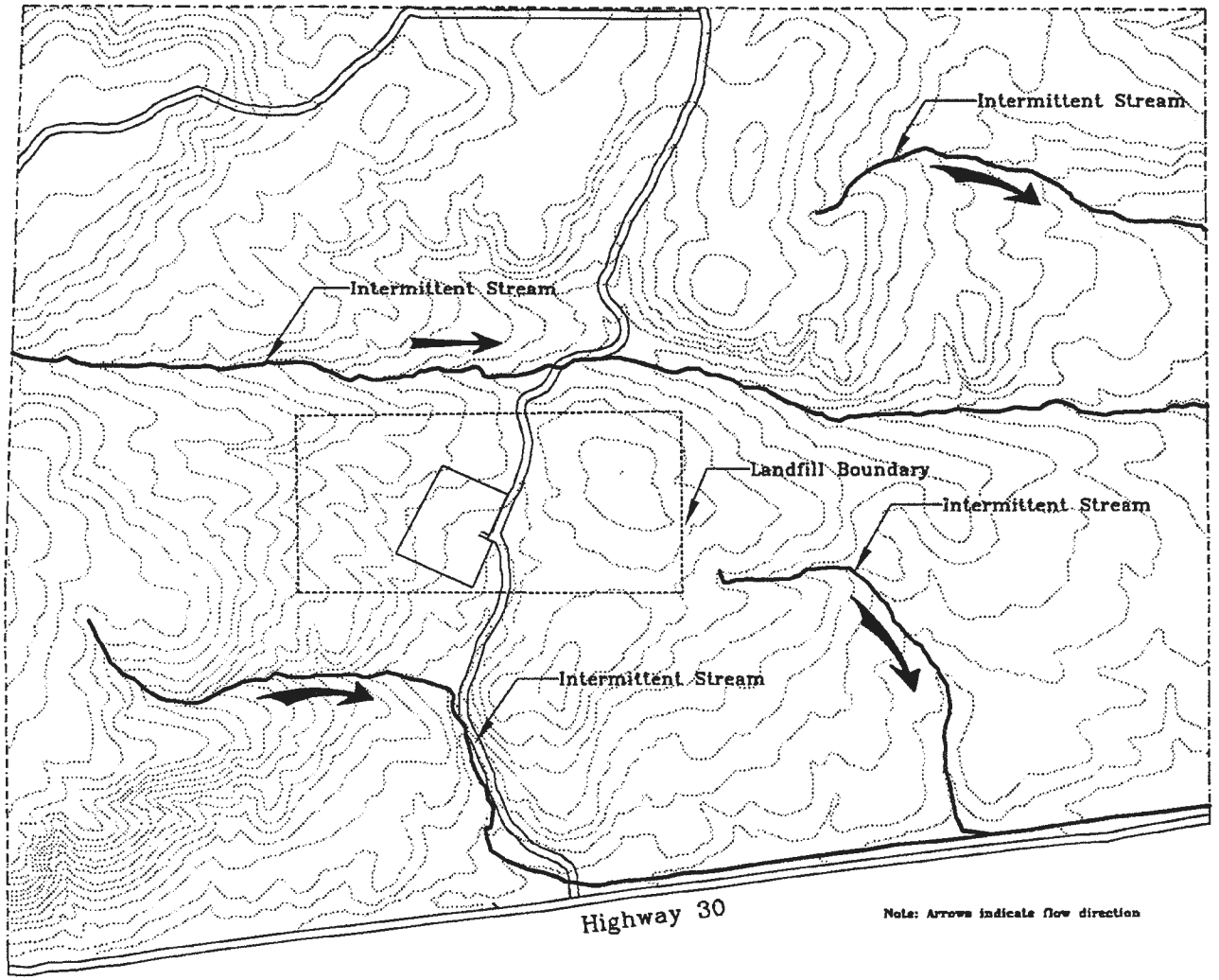
Near the Rich County Landfill, surface water is present in a number of unnamed intermittent streams (none of the intermittent streams flow through the landfill site). The closest surface water feature is an intermittent stream that flows about 800 feet from the northernmost edge of the landfill site **(see Figure III-A)**. Given the physiographic characteristics of the site, it is estimated that only about 15-20% of the landfill's runoff would naturally flow to this drainage. An estimated 80 to 85% of the site would flow to the south and southeastern drainages from the site. Most of the surface drainage flows from the site into these intermittent streams and eventually reaches Sage Creek and finally the Bear River.

Groundwater

A single test boring was conducted on the landfill site. The location designated at W-1 in **Figure III-B** was intended to determine the depth to groundwater and the geologic stratigraphy below the landfill site.

Groundwater was encountered at 97 feet below the surface. The test boring stratigraphy can be seen in **Figure III-C**. Samples were collected from the borings at depths of 10, 20, 22, 30, 38, 40, 45, 60, 70, 80 and 90 feet in depth. Selected samples are plotted in **Figure III-D**. The samples collected from 60-90 feet (immediately above the water level) were compacted clay loams with nine to 23 percent of the material passing a 0.063 mm screen. Twenty to 41 percent of the sample passed a 0.125 mm screen which would classify these samples as fine sands, silts and clays. Because of the fine texture and compacted nature of these samples, the permeability would be in the range of 4×10^{-4} m/day. In addition, several other extensive clay layers were encountered above the 60 foot depth. One layer (20-35 feet below the surface) had over 50 percent of the sample passing through the 0.125 mm screen.

The landfill is exempt from groundwater monitoring and thus the direction and flow rate of groundwater was not determined.



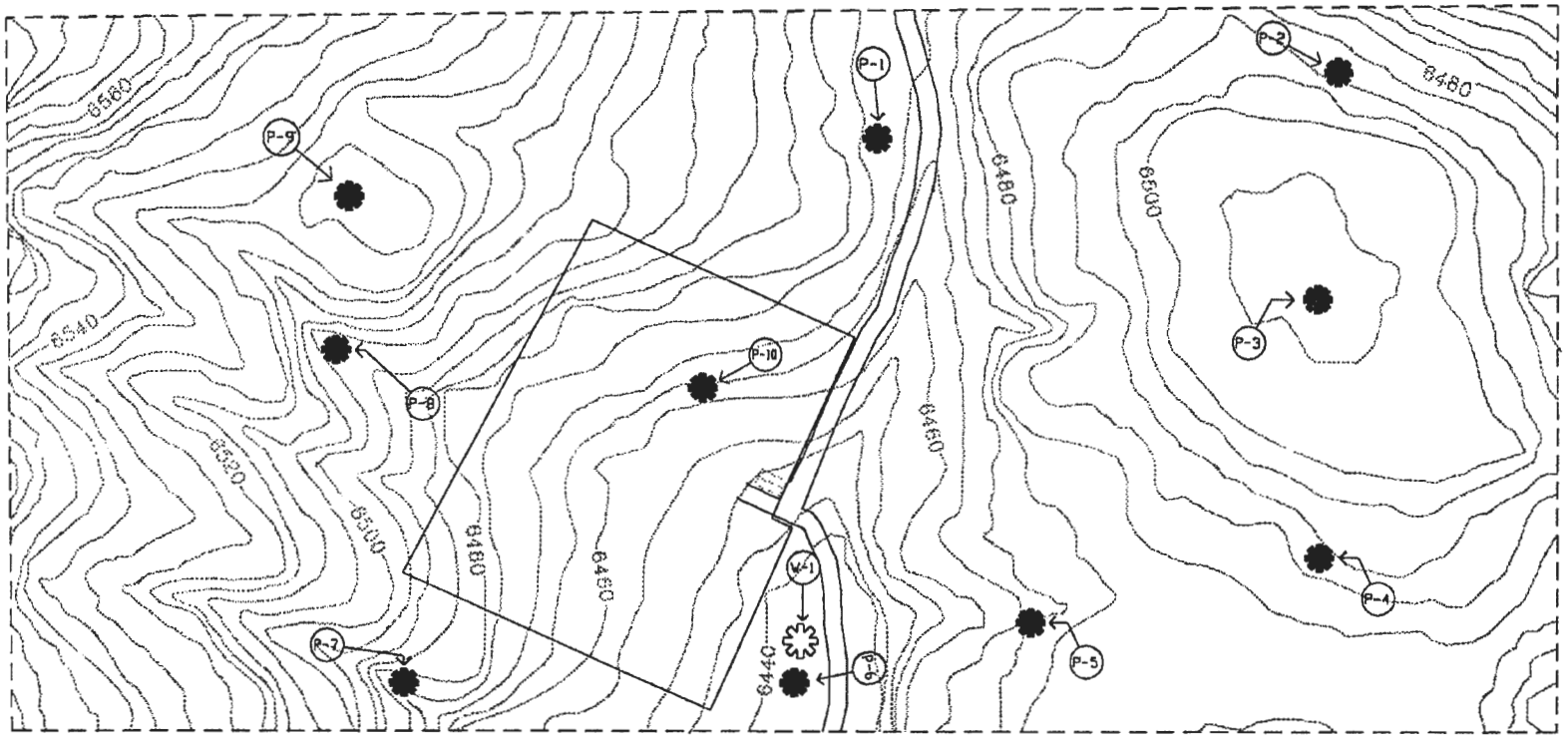
Rich County Landfill
Solid Waste Permit Application

Figure III-A

Produced By: Bear River Association of Governments in conjunction with Rich County

Drawn By: Jeff Gilbert

SCALE (in feet)
0 250 750 1500



LEGEND

Test Pit Location

Test Drilling Location

NOTE: Symbol label corresponds to tabular soil data contained in this report.

5' Contors were field interpolated.

Rich County Landfill

Solid Waste Permit Application

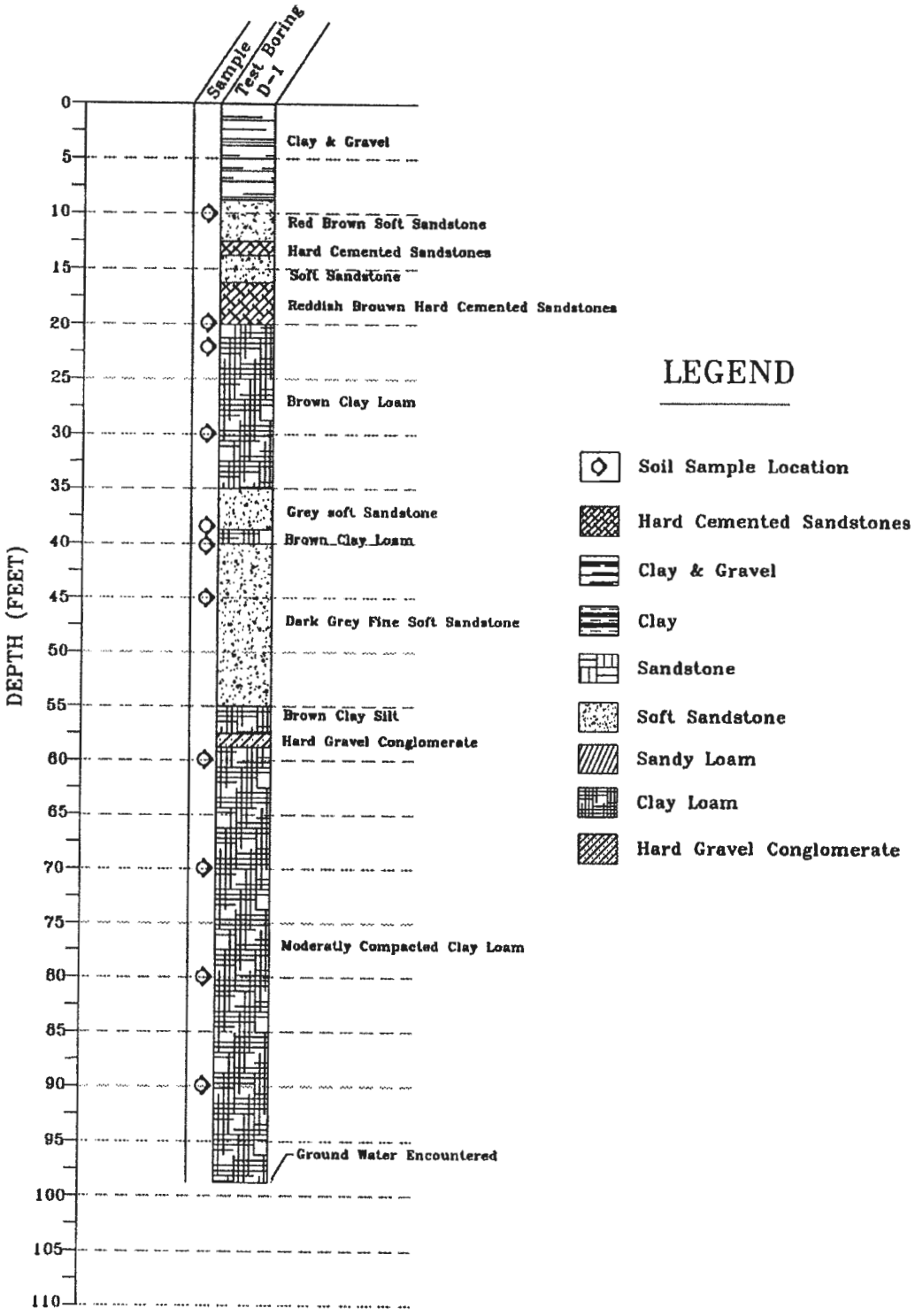
Figure III-B

Produced By: Bear River Association of Governments in conjunction with Rich County

Drawn By: Jeff Gilbert

SCALE (in feet)

0 100 200 500



Rich County Landfill
Solid Waste Permit Application
March 1995

Test Drilling By SlimTec, Evanston WY

Produced By: Bear River Association of Governments in conjunction with Rich County
Drawn By: Jeff Gilbert

Figure III-C

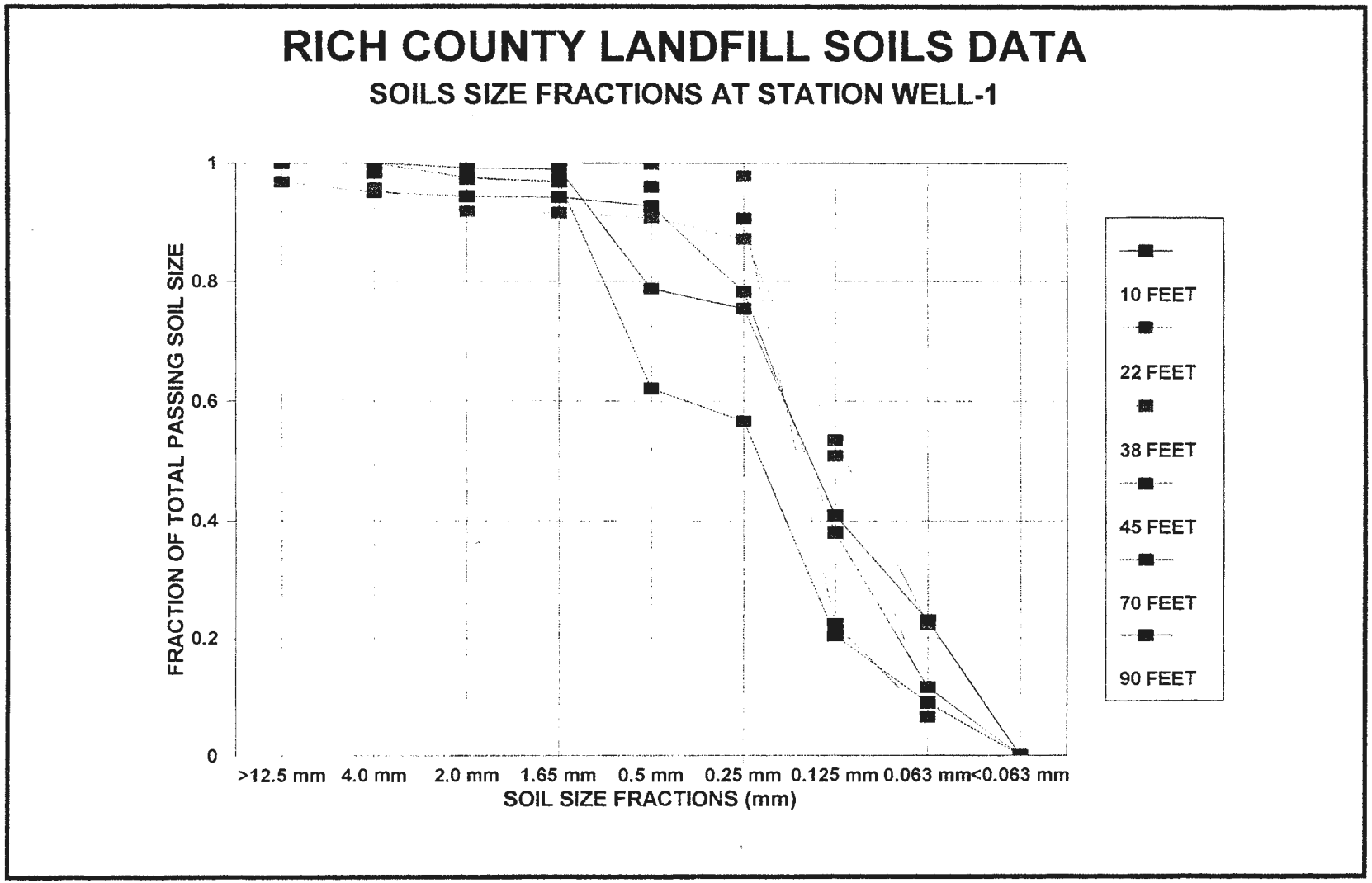


Figure III-D The size distribution of soils collected at selected depths from the test borings at the Rich County Landfill.

Water Balance

The total average annual precipitation at the site was calculated to be 37.3 million gallons of water, of which evapo-transpiration utilizes 31.7 million gallons (85%). The remaining 15 percent or 5.6 million gallons is stored in the soils on site or leaves the landfill properties via the three intermittent streams (**Figure III-A**). Because most of the annual precipitation occurs as snowfall, the majority of surface runoff is associated with the brief spring melt period. Typically summer and fall precipitation does not yield surface flows.

Water Rights

Appendix F contains a list of all water rights maintained by the Utah Division of Water Rights for a 2-mile radius around the landfill site. No public or private wells exist on the site or within a 2,000-foot radius of the site.

Soil Types and Properties

Soil Description

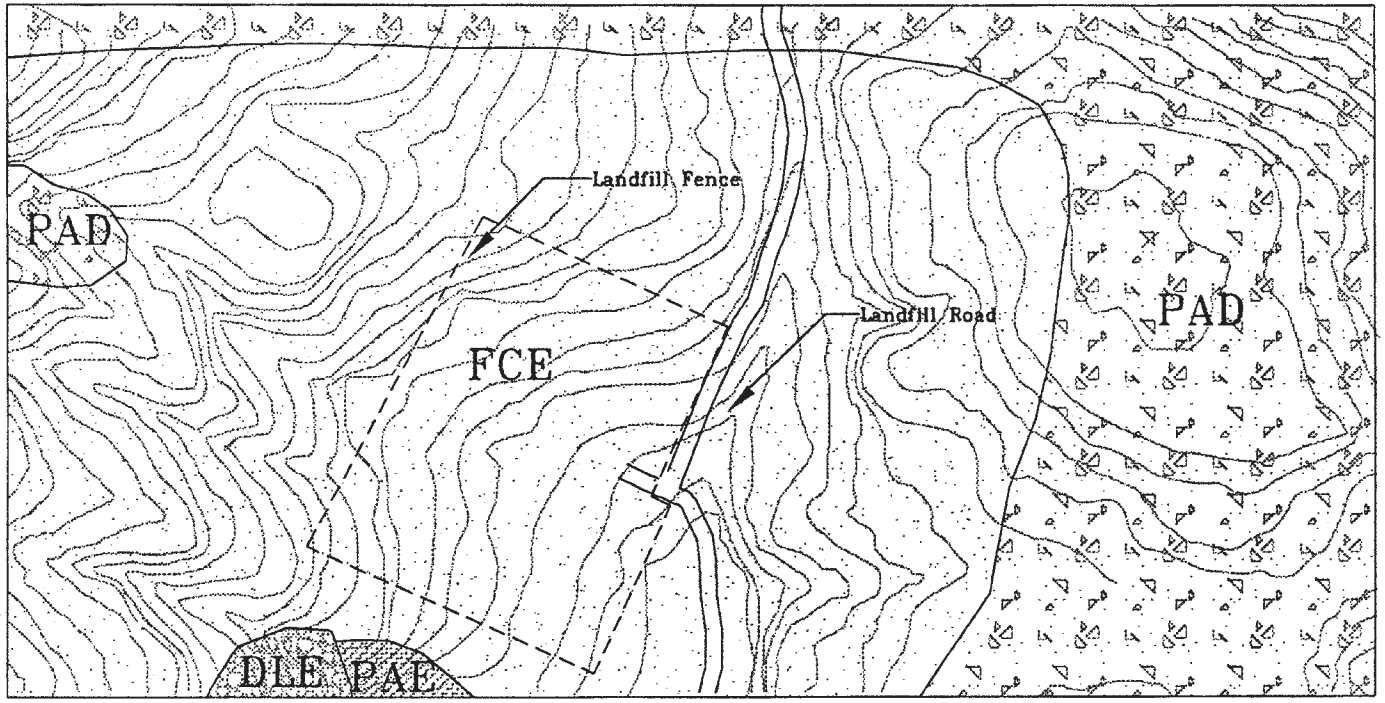
The following soil descriptions as given by the Soil Conservation Service (SCS, 1993) correspond to the soil type delineations presented in **Figure III-E** for the landfill site:

DLE-Duckree gravelly silt loam: Very deep, somewhat excessively drained soil that is formed in colluvium derived dominantly from a conglomerate composed of sandstone and quartzite. Typically the surface layer is yellowish brown gravelly silt loam 6 inches thick. The subsoil is light brown very gravelly loam 9 inches thick. The upper 13 inches of the substratum is light brown very gravelly loam, and the lower part to a depth of 60 inches or more is extremely gravelly loamy sand. A layer of carbonate accumulation is at a depth of about 15 inches. Permeability of this duckree soil is moderately rapid.

FCE-Falula Kearl complete: The Falula Kearl soil is shallow and somewhat excessively drained. It formed in residuum derived dominantly from sandstone and conglomerate. Typically, the surface layer is dark reddish brown gravelly loam about 10 inches thick. The underlying material is red extremely gravelly loam about 8 inches thick. Fractured sandstone is at a depth of 18 inches. Permeability of the Falula soil is moderate.

PAD-Pancheri silt loam, cool, 5 to 10% slopes: This soil is very deep, well drained soil that is formed in loess deposits derived from mixed parent material. Typically the surface layer is yellowish brown silt loam about 6 inches thick. The subsoil is brown silt loam about 16 inches thick. The substratum to a depth of 60 inches or more is light brown silt loam. A layer of carbonate accumulation is at a depth of about 22 inches. Permeability of the Pancheri soil is moderate.

PAE-Pancheri silt loam, cool, 10 to 25% slopes: This soil is well drained and is formed in loess deposits derived from mixed parent material. The surface layer is yellowish brown silt loam about 6 inches thick. The subsoil is yellowish brown silt loam about 11 inches thick. The substratum to a depth of 60 inches or more is



LEGEND

- PAD Pancheri silt loam 1-5% slope
- Falula-Kearl complex
- DLE Duckree gravelly silt loam
- PAE Pancheri silt loam 10-25% slope

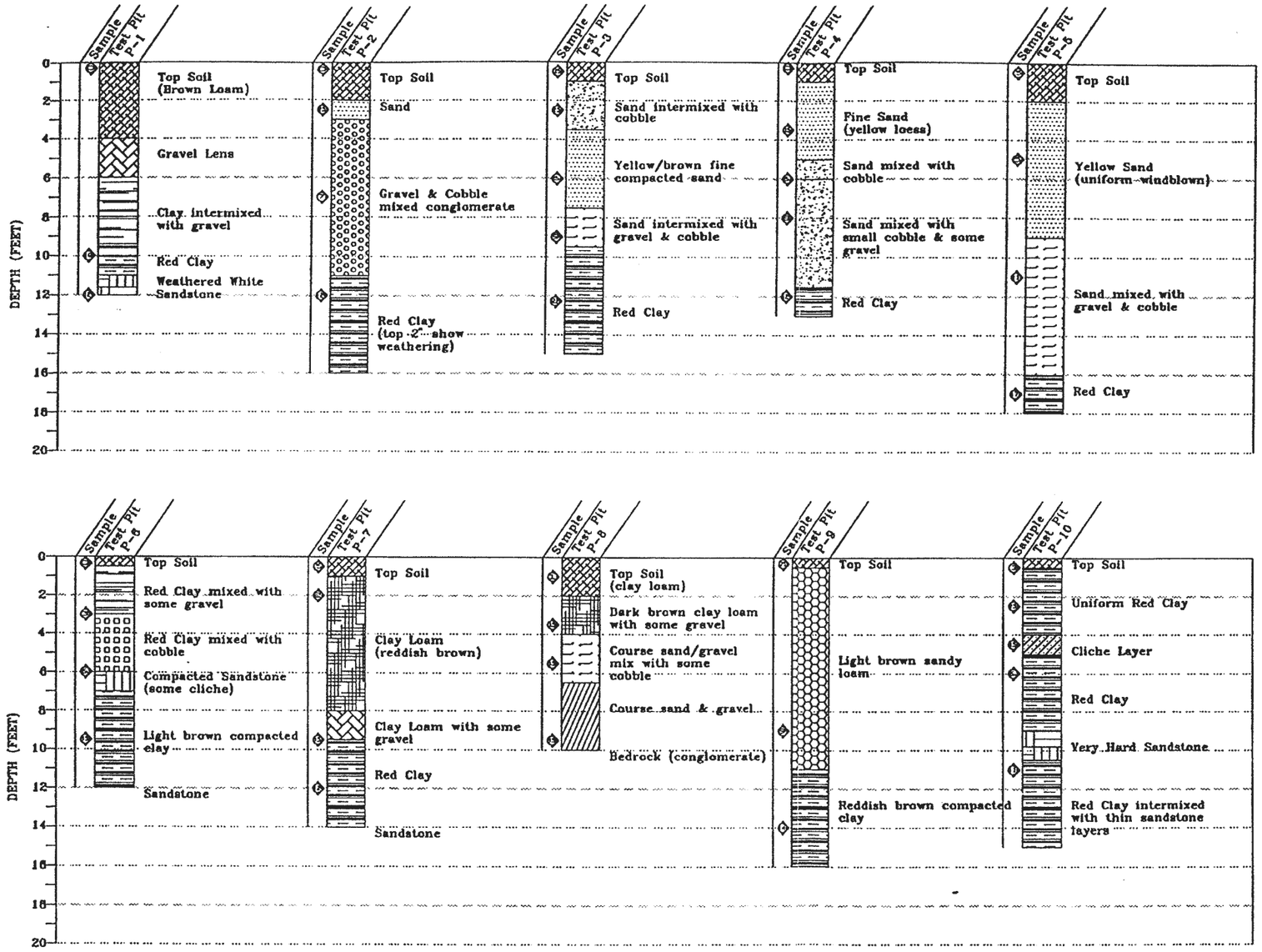
Rich County Landfill
Solid Waste Permit Application

Figure III-E

Produced By: Bear River Association of Governments in conjunction with Rich County

Drawn By: Jeff Gilbert

SCALE (in feet)
0 100 200 500



LEGEND

- Soil Sample Location
- Top Soil
- Clay & Gravel
- Gravel Lens
- Sandstone
- Sand & Cobble
- Clay
- Sand & Gravel
- Sand, Gravel & Cobble
- Sand
- Gravel & Cobble
- Sandy Loam
- Clay Loam
- Cliche Layer
- Bedrock
- Clay & Cobble

Rich County Landfill

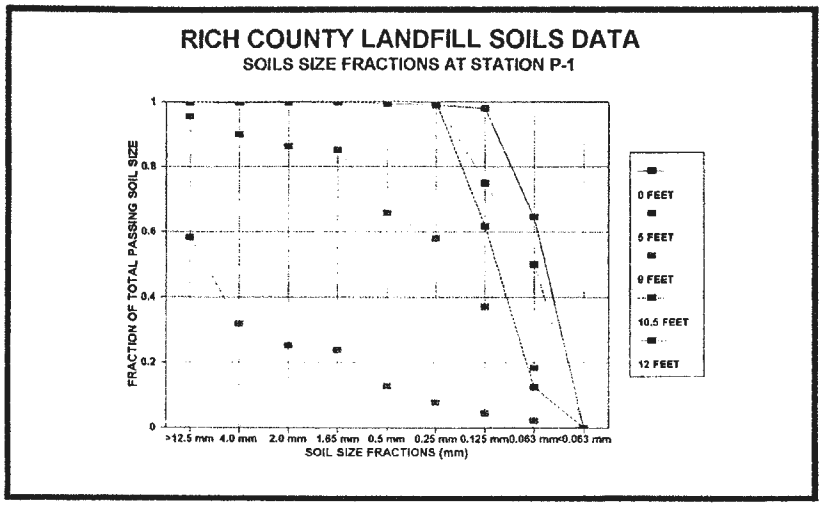
Solid Waste Permit Application

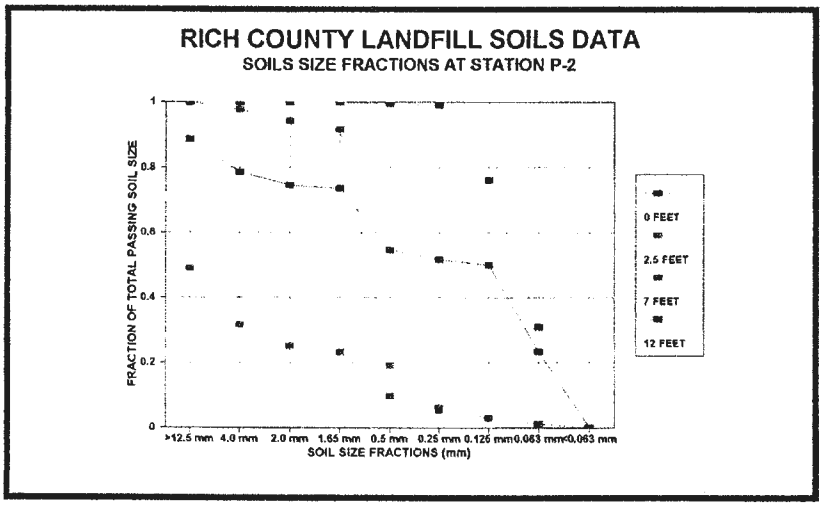
Soil field investigation conducted by Ecosystems Research Institute, Logan UT

Produced By: Bear River Association of Governments in conjunction with Rich County

Drawn By: Jeff Gilbert

Figure III-F





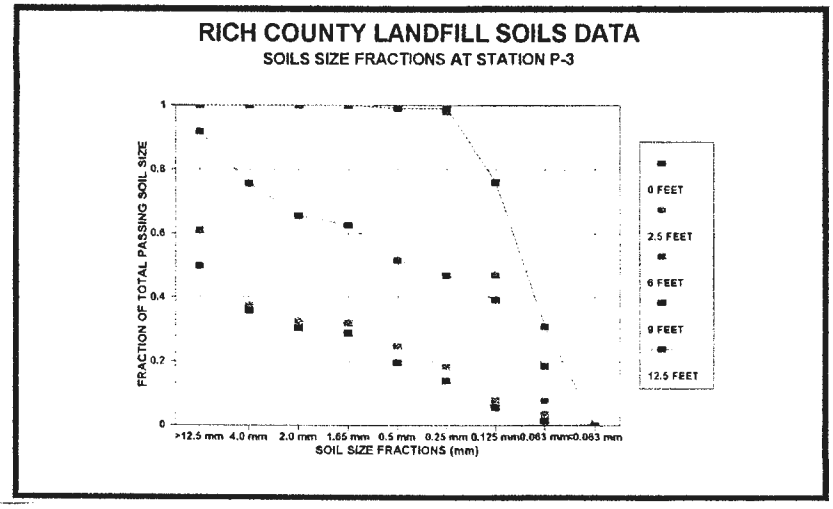


Figure III-G The soil size fractions for selected depths in pits P-1, P-2 and P-3.

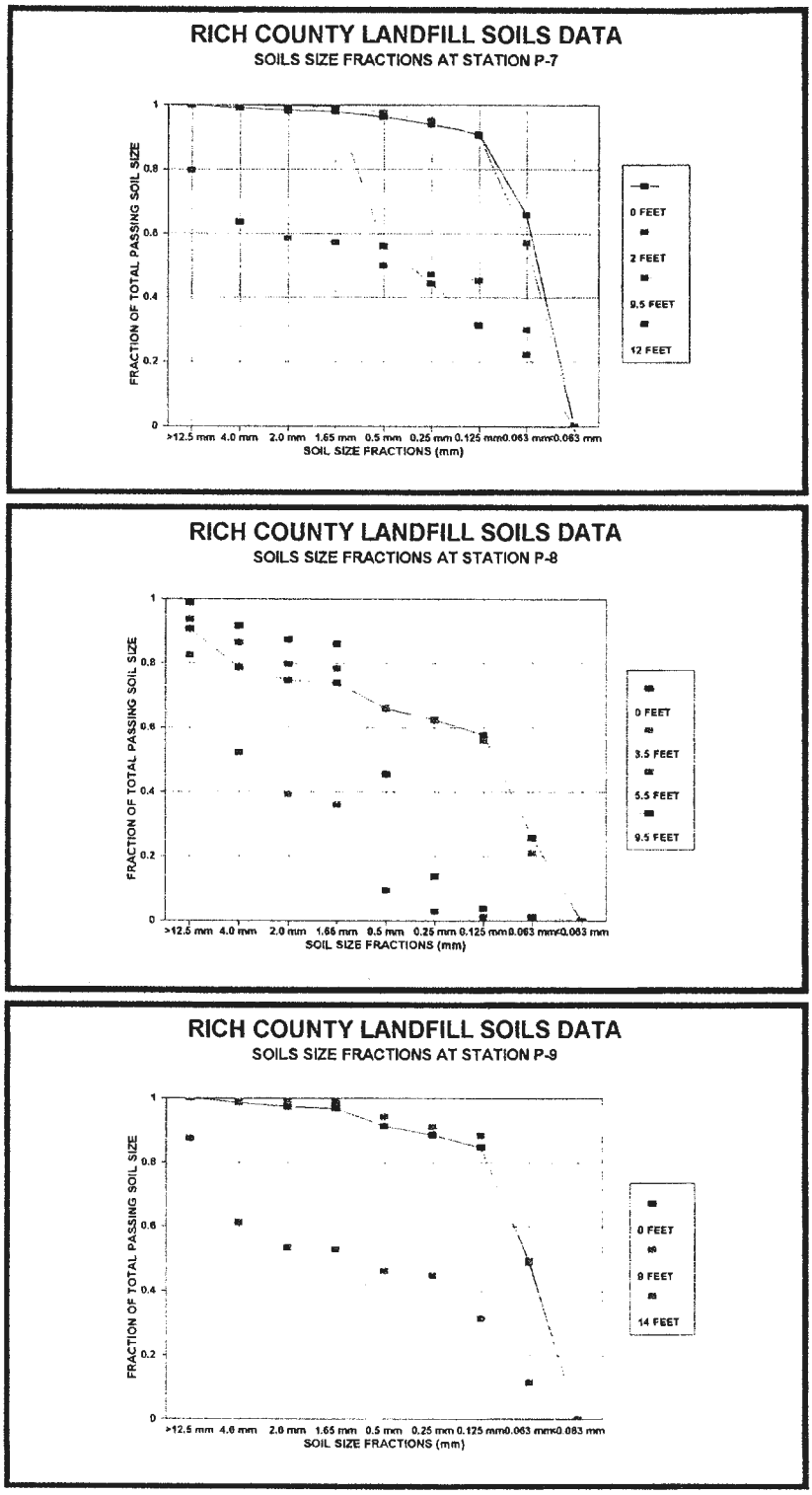
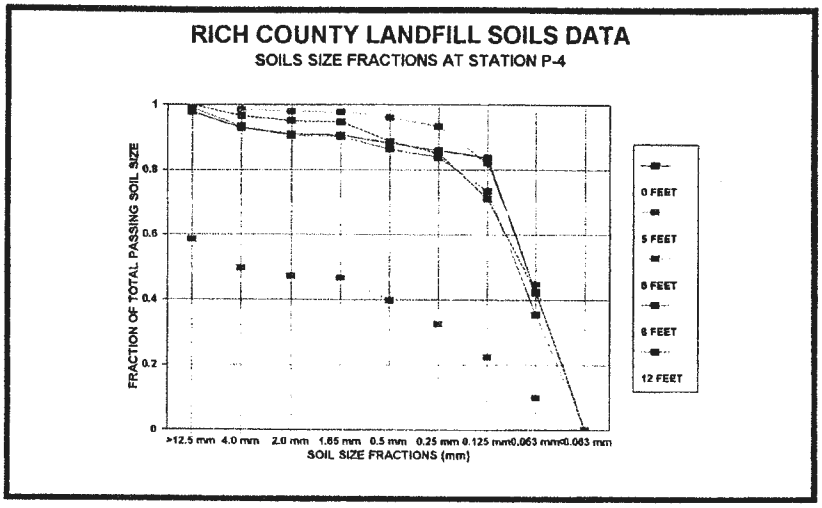
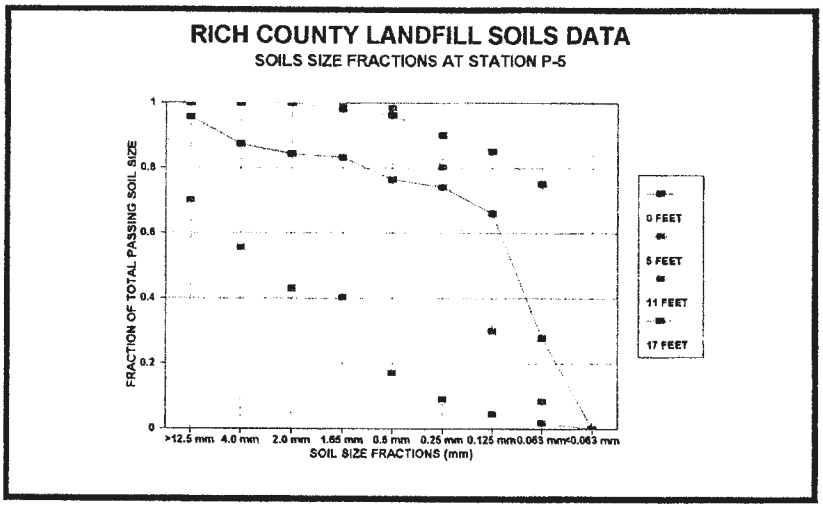


Figure III-H The soil size fractions for selected depths in pits P-7, P-8 and P-9.





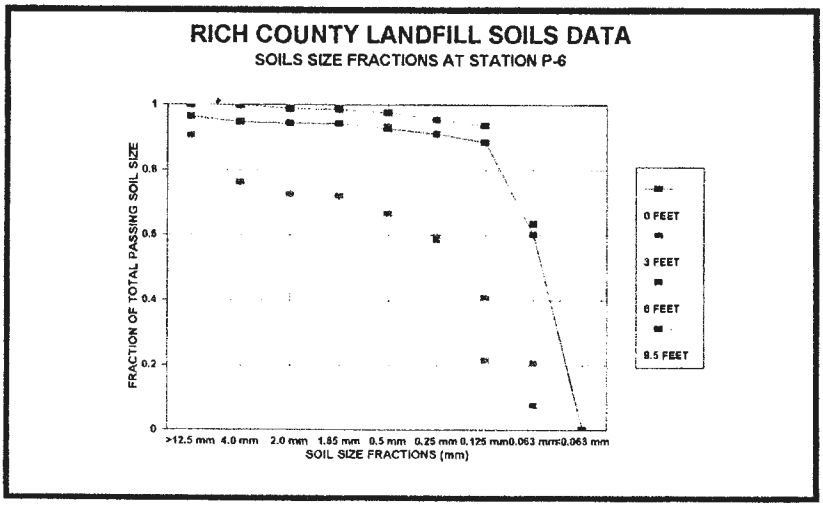


Figure III-I The soil size fractions for selected depths in pits P-4, P-5 and P-6.

light brown and very pale brown silt loam. A layer of carbonate accumulation is at a depth of about 17 inches. Permeability of this soil is moderate.

Soil Field Investigations

The identification of site specific soil characteristics within the working zone of the Rich County Landfill (10-15) feet was determined by the excavation of ten uniformly placed sample pits. The location of the soil sample sites can be seen in **Figure III-B**. These pits were dug as deep as possible. The depths ranged from nine to 17 feet. The shallow pits encountered bedrock. **Figures III-C** and **III-F** contain the field classifications for the soil pits and the deep test borings at site W-1. In addition to field classifications, samples were collected at various locations within the soil stratigraphy in order to characterize the soils within each major feature. An inspection of **Figures III-G, III-H and III-I** indicates a wide range of soil textures encountered in this investigation. The commonality throughout all the test pits was: 1) at lease one gravel layer was encountered which varied in location and thickness, and 2) all of the excavated pits had a strongly compacted red clay or bedrock. The test borings (**Figure III-C**) indicated that bedrock and compacted clays extend down at least 95 feet from the surface. Soils analysis of the bottom layer indicated that the material was heavily dominated by fine sands and silt/clays (50% or more passing 0.125 mm screen). The exception to this observation occurred in sites P-7, P-8 and P-9. As noted in **Figure III-I**, the bottom layer at these sites was found to contain coarser material (50% or greater passing a 0.50 mm screen). Even though this material is coarser than the bottom material found at the other pits, it still represents a medium sand. It is believed that these samples represent the surface of a weathered bedrock layer found at a dept of 14 feet below the surface.

The surface materials excavated at the site (0-5) would all be considered extremely fine sands or silts and clays (50% or more passing a 0.125 mm screen). The exception was pit P-2, which has some surface gravels.

Evaluation of Potential Water Quality Impacts

Given the physical, geologic and climatic characteristics of the site, the potential for ground water contaminations from landfill leachate discharge is minimal and does not justify the need for groundwater monitoring. The type and arrangement of soils underlying the landfill coupled with the depth to ground water make the migration of groundwater contaminates very unlikely. As evidenced by the test boring and test pits, underlying the active area of landfilling are layers of alluvial soils including staggered layers of very hard, compacted sandstones. The thickest of these sandstone layers is nearly 4 ½ feet deep and is found about 17-20 feet below the surface (5-7 feet below the active face of landfilling) and is found throughout the landfill site (this layer often halted the digging of test pits). In addition, alluvium layers of clays, compacted clays and clay loam were found. The test boring found a 15 foot layer of a brown clay loam with 38% of the sample passing a 0.125 mm screen. In addition, another layer beginning at 20 feet with 87% passing 0.125 mm was found. The largest clay layer started at 58 feet and extending to the margin of groundwater also was composed of compacted fine material. These intermittent layers of clay will reduce the downward migration of water and dissolved material. The lack of permeability of the soils underlying the landfill is evidenced by the time it takes water to drain from the currently active excavated pits. Landfill operators report that, in the past, a pit dug to the depth of 15 feet has filled with a few feet of water from snow melt. The water took 2-3

months to disappear through normal evaporation. In addition, the climatic context of the landfill site minimizes the production of significant amounts of landfill leachate. The landfill receives less than 11 inches of precipitation per year. A high evapo-transpiration rate means that most of the moisture never passes the active vegetation zone. Landfilling methods also minimize the potential for leachate migration. The trenches are not left absent their final cover for any extended period of time.

Groundwater Monitoring

The Rich County Landfill meets the requirements that qualify for an exemption from groundwater monitoring.

LANDFILL DESIGN

Locational Standards

As per Rule 315-302-1(1-3), the following discussion considers only those factors applicable to an existing landfill seeking lateral expansion.

Land Use Compatibility

Conflicts related to incompatible surrounding land uses have yet to arise and are not likely to be a problem during the life of the landfill. The remoteness of the site minimizes the potential for land use conflicts. The BLM retains ownership of all the land that surrounds the landfill and the continued operation of the Rich County Landfill is consistent with the BLM's Land Use Plan for the region (BLM, EA).

Fault and Seismic Zones

An investigation conducted by the Utah Geological Survey (UGS, 1993), concluded that the Rich County Landfill site "satisfies the performance standard related to Holocene faulting and further work to consider these faults is not necessary." The State Geologist's conclusions are based on two lines of evidence that were investigated related to the potential for Holocene faulting for the landfill site. Eocene faults on the site were inspected for evidence of Holocene faulting, and faults to the south were inspected to find out if faulting had offset Holocene material. Some seismic risk exists for the site. However, Cook (1970) suggests that the risk is less than that within Salt Lake and Tooele Counties. Site impacts related to seismic events are minimal given the landfilling methods proposed. The use of small, well distributed trenches coupled with the lack of containment systems (subject to failure), suggests that no mitigation measures are necessary. The landfill site is not located on or adjacent to any geologic feature that could compromise the structural integrity of the facility.

Unstable Areas

Given the on-site soil conditions of the landfill and also the physiographic characteristics of the site, subsidence, slumping or any other unstable landform movement does not pose a significant problem. No erosional evidence of past subsidence of landform movement events is present on the site. This suggests the area's susceptibility to mass movement is minimal.

Surface Water

No intermittent or perennial streams flow through the site. The closest surface water feature to the site is an intermittent drainage located about on-quarter mile north of the landfill. Sage Creek is the closest perennial stream. It is located about three-fourths of a mile to the south of the landfill on the opposite side of Highway 30.

Wetlands

None of the factors that suggest the presence of wetlands on the site are present. The characteristics investigated on the site included the presence of: 1) hydrophytic vegetation, 2) hydric soils, and 3) wetland type hydrology. The obvious absence of any of these factors negates the need for any future consideration related to wetlands on the site.

Floodplains

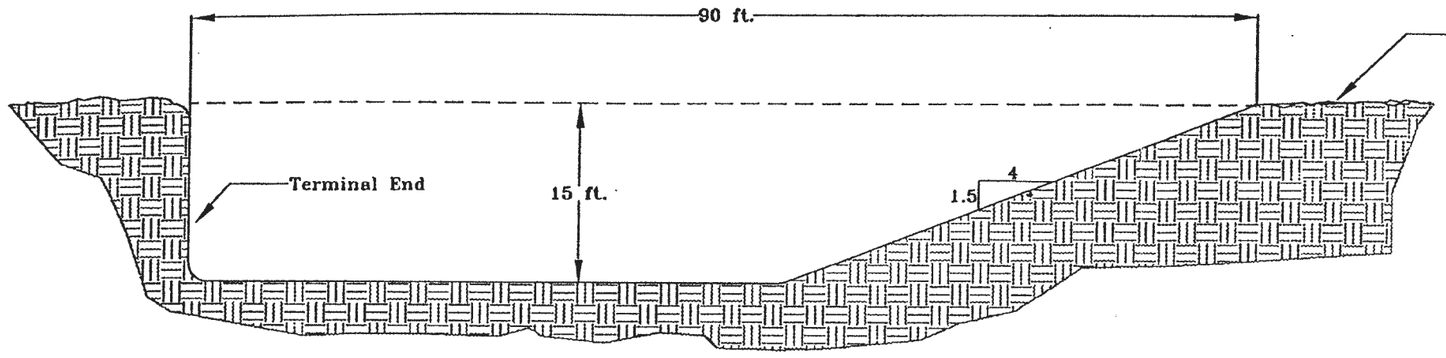
The absence of any surface water features near the site coupled with the topographic characteristics of the site suggests that threat from a 100-year flood event is not an issue. The BLM's investigation also concluded that the site is not located within a floodplain (BLM: EA, 1993). In addition, the site is not located within the "10 year" flood areas as delineated in the Rich County Natural Resource Inventory.

Public Water Systems

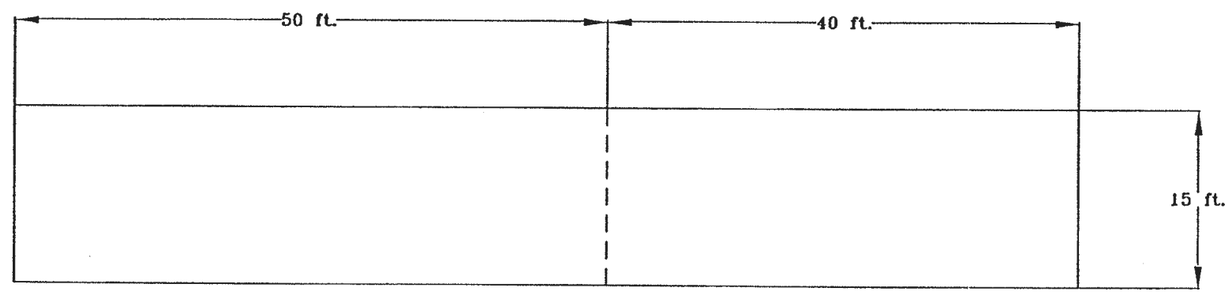
According to the State's Office of Drinking Water Protection, the Rich County Landfill site is not within any "Municipal Drinking Water Source Protection Areas." The nearest water source used for municipal drinking water purposes is a well located about 9 miles to the south of landfill site used for the town of Randolph.

Small Landfill Design Criterion Documentation

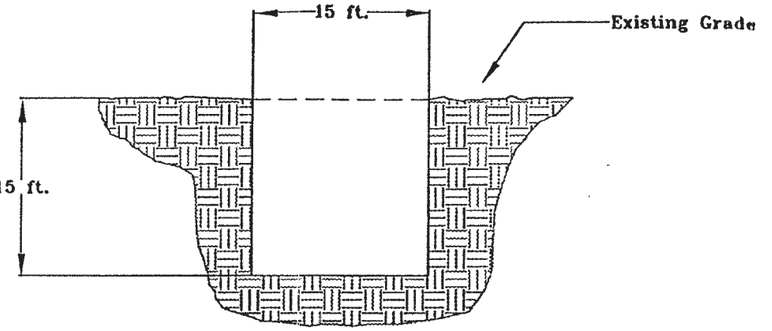
The Rich County Landfill currently receives an estimated 6.84 tons of waste per day (averaged annually). This is well below the 20 tons per day (averaged annually) that is allowable to qualify for "small landfill" status. This figure is consistent with the accepted waste calculated from the past five years annual reports (average 6.36 tons per day). The formulas are updated with current population figures and the results are shown in **Table III-A**.



Trench Cell (Front View)



Trench Cell (Plan View)



Trench Cell (Side View)

Rich County Landfill

Solid Waste Permit Application

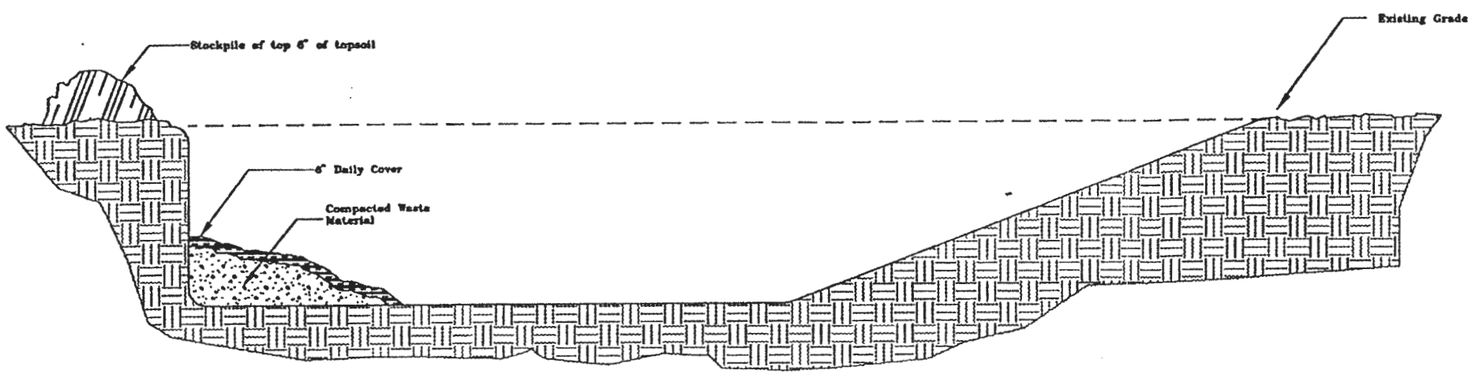
SCALE (in feet)

0 5 10 25

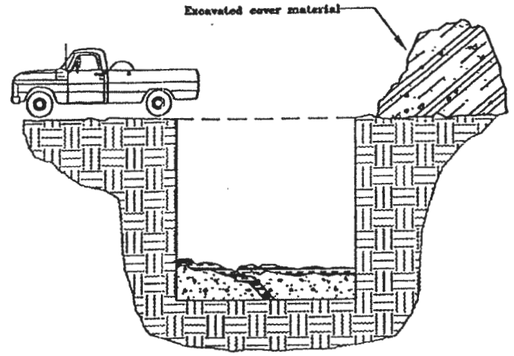
Produced By: Bear River Association of Governments in conjunction with Rich County

Drawn By: Jeff Gilbert

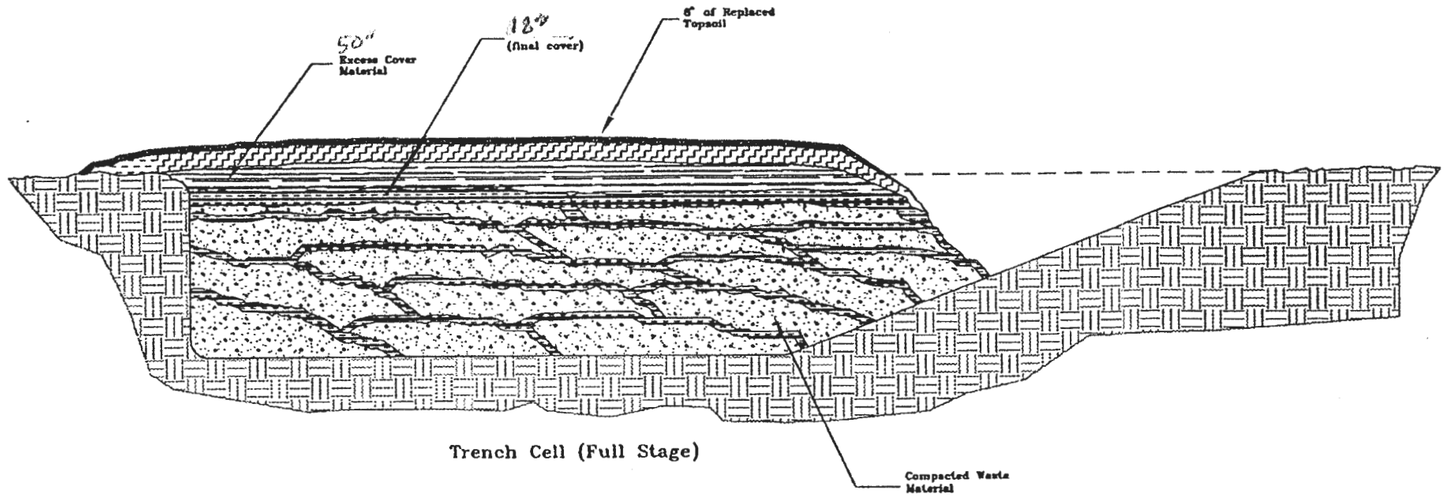
Figure III-J



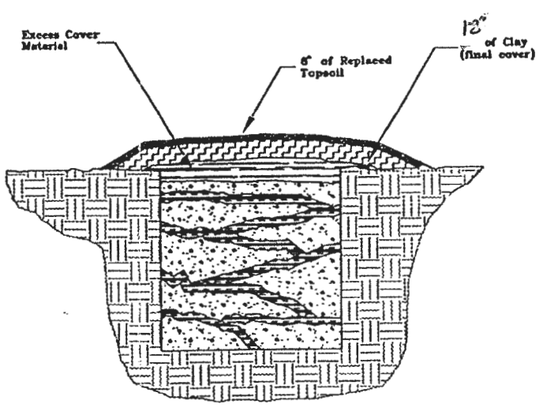
Trench Cell (Active Stage)



Side View



Trench Cell (Full Stage)



Side View

Rich County Landfill

Solid Waste Permit Application

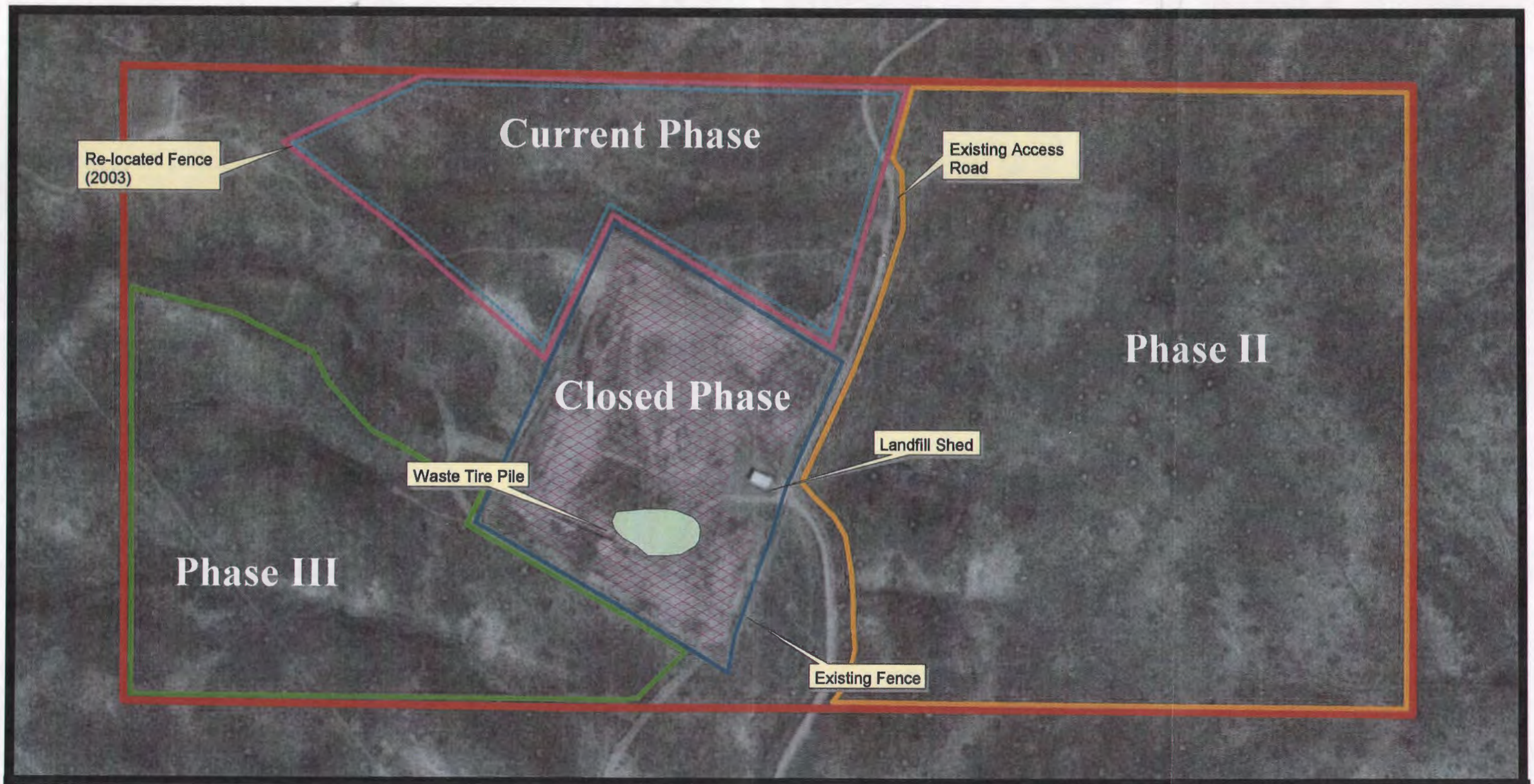
SCALE (in feet)

0 5 10 25

Produced By: Bear River Association of Governments in conjunction with Rich County

Drawn By: Jeff Gilbert

Figure III-K



Rich County Landfill

Solid Waste Permit Application
Class II 2002 Update

100 0 100 200 Feet

- Current Phase (est cloursure date 2018)
- Phase II Area (est. clousure date 2063)
- Phase III (est. clousure date 2079)
- Closed Phase
- Waste Tire Pile
- Relocated Fence Line
- Landfill Boundary

N

Figure III-L

BRAG

Service Area	2000 Population	Formula	Tons Per Year	Tons Per Day Avg.
Woodruff	194	x 4 lbs/day x 365 days / 2000	141.0	0.38
Randolph	453	x 4 lbs/day x 365 days / 2000	330.7	0.90
Laketown	188	x 4 lbs/day x 365 days / 2000	137.2	0.37
Garden City	357	x 4 lbs/day x 365 days / 2000	260.6	0.71
Unincorporated	739	x 4 lbs/day x 365 days / 2000	539.4	1.47
Commercial & Tourist Estimates			1,100.0	3.01
COUNTY TOTAL			2,508.9	6.84

Table III-A: Current estimated waste generated by the Rich County Landfill service area for 2000

Unit Design

This permit application proposes the continued use of the trenching landfilling methods for the Rich County Landfill. This method provides for enhanced cell performance related to erosion, stability, and settlement as well as reducing the visual impact of landfilling operations. Unit schematic drawings **Figure III-J** and **Figure III-K** show the trench cell design and proposed landfilling methods.

The trenching excavation takes place on an "as needed" basis and is designed such that only one trench cell is accepting waste at any given time. As the trench's linear progression takes the place the previous cell receives its final cover.

Trench cell excavation begins by scraping the first 6" of top soil to the terminal end of the trench where it is kept segregated from other excavated materials. The trench cell is then excavated to the indicated specifications and the fill material is placed on the East side of the trench cell (opposite side of prevailing wind). This fill material will be used as the source for daily cover and final cover. As cell excavation takes place, enough of this clay material will be physically segregated from the other fill material to provide the 18-inch final cover. The trench cell should be filled to just over 18 inches short of grade (compacted). The remainder of the trench will be filled with the final cover and compacted to grade. An additional 50 inches of excess cover material will be placed over the trench cell once the cell is filled to form an earthen mound over the trench. This includes the 6" of previously segregated top soil which will facilitate re-vegetation. This cover will mitigate the effects of root desiccation and frost.

The earthen mound, at its highest point with final cover applied, will not exceed a 5-foot grade increase above existing grade. The earthen mound will facilitate run-off from the cell's surface and also take care of excess fill material. Using this method a permeability of 1.51 x 10-7 cm/sec was achieved (See soil lab analysis results found in Appendix H). This low permeability of the surface cover material minimizes the potential for water accumulation in the trench.

The final cover of replacement top soil will always be staggered one row behind. This is so the activities associated with staging of the excavated material for the active cell will not disturb the final layer of top soil. The final cover will be installed according to the "Construction Quality Assurance Plan" found in Appendix H.

Site Design

The landfill design for the Rich County Landfill is presented in **Figure III-L**. The site design is left conceptual for two main reasons: 1) the size of the landfill site (125 acres) and 2) the relatively simple cell design methods used. Thus, some flexibility is required to adapt the design to the site specific conditions encountered on the site.

The plan excludes from landfilling areas of the site that have prohibitively steep slopes and surface drainage features. Excessively steep slopes pose a problem for operational activities and also make it difficult to maintain the integrity of the final cover from erosion. Drainage features are excluded because of the risk of washout from storm events and because of operational difficulties (test pits dug in drainages indicate the presence of large rocks and boulders that make landfilling operations difficult). The plan is broken down into three spatial and sequential phases that begin with the current area.

Common to all phases is the orientation and progression of trenching. The prevailing wind is north easterly and easterly in direction. Thus, to minimize litter scatter, the trenches are orientated perpendicular to the prevailing wind direction. An additional safeguard from litter scatter (it has already proven effective), is to situate the excavated cover material on the leeward side of the trench to collect blowing trash. This method requires that trench progression proceeds from East to West so that trench access does not require travel over previously landfilled trenches. The size of the landfill and the relatively complex access schemes will require strict control and signage to prohibit alternate access "short-cuts" from developing in undesirable areas such as over previously landfilled areas.

Works Cited

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BRAG, "Rich County Solid Waste Management Plan." Bear River Association of Governments, Unpublished Report, Logan, Utah, April 1993.

Cook, Kenneth L., "Earthquake Hazards in Utah", in: Governor's Conference on Geologic Hazards in Utah, December 14, 1968, Utah Geological and Mineral Survey, Special Studies 32, May 1970, 22-28.

Richardson, G.B., "Geology and Mineral Resources of the Randolph Quadrangle, Utah-Wyoming", U.S. Geological Survey Bulletin 923, Washington, D.C., 1941.

SCS, "Soil Survey of Rich County Utah", United States Department of Agriculture, Soil Conservation Service, Washington, D.C., 1980.

Solomon, Barry J., "Investigation of faults near Sage Creek Junction Solid Waste disposal site, Rich County, Utah", Utah Geological Survey: Dept. of Natural Resources, Unpublished Report, July 1993.

Walker, Jerome P., "Hogback Ridge Field, Rich County, Utah: Thrust Belt Anomaly or Harbinger of Further Discoveries?, in: Geologic Studies of the Cordilleran Thrust Belt, Richard Blake Power, ed., Rocky Mountain Association of Geologists, Denver, Colorado, 1982, 581-590.

Appendix A

Form 1860-9
(January 1988)

The United States of America

To all to whom these presents shall come, Greeting:

Serial: UTU-48889

WHEREAS,

County of Rich, State of Utah

is entitled to a land patent pursuant to the Recreation and Public Purposes Act of June 14, 1926 (44 Stat. 741), as amended and supplemented (43 U.S.C. 869; et. seq.), for the following described land:

Salt Lake Meridian, Utah

T. 12 N., R. 7 E.,
sec. 15, S½SW¼NW¼SW¼, W½SW¼SW¼;
sec. 16, S½S½N½SE¼, S½SE¼.

containing 125.00 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 County of Rich, State of Utah, the land above described for use as a solid waste 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 County of Rich, State of Utah, forever; and

EXCEPTING AND RESERVING TO THE UNITED STATES:

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

2. All mineral deposits in the lands so patented, and the right of the United States, or persons authorized by the United States, to prospect for. mine, and remove such deposits from the same under applicable laws and regulations as the Secretary of the Interior may prescribe; and

The County of Rich, State of Utah, its successors or assigns, assumes all liability for and shall defend, indemnify, and save harmless the United States and its officers, agents, representatives, and employees, 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.

Recorded DEC 0 2 1993 Filing No. 44812
At 11:25 AM/PM In Book 76 Page 183
Fee No fee Debra L. Ames, Rich County Recorder
Requested By Rich County

Patent Number 43-94-0003

183

Serial: UTU-48889

If, at any time, the patentee transfers to another party ownership of any portion of the land not used for the purposes specified in the application and approved plan of development, 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.

The above described land has been conveyed for utilization as a solid waste sanitary landfill. Upon closure, the sites 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 liner or final cover of the landfill unless excavation is conducted subject to applicable State and Federal requirements.

Patent Number 43-94-0003

Form 1860-10
(April 1988)
Serial: UTU-48889

43-84-0003

Patent Number _____

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 thirtieth day of November
in the year of our Lord one thousand nine hundred and ninety-three
and of the Independence of the
United States the two hundred and eighteenth.

By _____
Chief, Branch of Lands and Minerals
Operations

Appendix B

WASTE INSPECTION FORM
Rich County Landfill

To be completed on a random basis (once a week) **or when a suspicious load is encountered.**

Inspected by _____ Date_____

Vehicle License Number _____ Drivers Name _____

Drivers Address:

_____ _____ _____ _____
Street City State Zip

Drivers Description of the Types of Waste Contained in the Load

Source of the waste (according to driver) _____

_____

Types of waste (according to driver) _____

_____

Inspectors Analysis of Waste Material
Segregate and break-down the load in the presence of the landfill user and indicate existence and relative volume of the following types of waste contained in the load:

Infectious Waste _____ Asbestos _____ Liquids _____

Radio Active _____ Animals _____ Furniture _____

Automobiles _____ Ag. waste _____ Sludge _____

Ash _____ Tires _____

Other Types of Hazardous Wastes (describe) _____

_____

Action Taken _____

LANDFILL INSPECTION FORM

Rich County Landfill

On-site landfill inspections must be completed on a quarterly basis. Inspectors should consider each of the factors listed and record the findings in narrative on this form. As well, the location of any problem areas should be marked on a landfill site map and referred to in the narrative.

Inspector's Name _____ Title_____

Inspection Date_____ Inspection Time_____

Inspection Categories

Conformity with Landfill Design Scheme & Methods: Make note of any variation from design guidelines or landfilling methods.

Integrity of Run-on Control Berms and Ditches: Note any undue erosion or failures of current systems and specify any needed expansion or upgrades.

Evaluate the Adequacy of Daily Cover for Active Cells: Inspect to ensure daily cover conforms to operating plan.

Inspect the Integrity of Cells that have Already Received Final Cover: Note the status of vegetative cover that has established, any erosional impacts, and any evidence of subsidence.

Inspect for Litter, Disease Vectors, Evidence of Burning, and also the adequacy of the access gate, fencing and signage.

Update with a description of any remedial action taken to rectify or repair any problems encountered in the inspection and indicate the date the corrective action was taken.

Inspector's Signature_____

Appendix C

Chapter 2

BACKGROUND FOR DEFINING HAZARDOUS WASTES

There are two major methodologies presently in use to identify wastes as hazardous—a list approach and a criteria approach. Both approaches are difficult to implement. The criteria approach addresses the problem more directly. It identifies those properties of waste that cause hazardous effects to the environment and then recommends methods and procedures to measure these properties (or effects). The list approach, on the other hand, is more indirect. The waste is analyzed for certain prescribed species, and depending upon the presence of these species (and possibly their concentration), a hazard judgement is made. The following discussion will address methods presently available to implement a criteria approach.

Since some aspects of the safe management of hazardous waste are identical to safe management of other regulated substances, some of the methods mentioned herein are those recommended by other agencies for the testing of these other regulated substances. Waste materials, however, do possess certain peculiarities of form and function for which existing criteria may not be adequate or appropriate to characterize a waste's hazardousness. In these cases, the differences are mentioned and the problems addressed. The criteria that will be discussed are: flammability, corrosiveness, and reactivity. These criteria can be viewed as properties of the waste as disposed and can be measured by directly testing the waste.

There are other criteria, such as waste toxicity, etiologic activity, genetic activity, and tendency to bioconcentrate, which must be considered in the context of their routes of exposure. A waste containing a contaminant conforming to these criteria can only be a hazard if there exists a vector (exposure route) by which this contaminant can be made available to the environment under disposal conditions. In order to measure these criteria in a meaningful way, the measurement must be done on the exposure vector, be it eluent from the waste, vapor due to waste evaporation and sublimation, or air float particles from waste particulates. For example, a waste may contain a toxic constituent, but if this toxicant is bound up in the waste matrix in such a way that it cannot leach (elute), vaporize, air-float particulate, or sublimate under disposal conditions, the waste does not present a toxicity hazard. Therefore, any testing done to identify wastes that would conform to the above criteria should ideally be done on these vectors. Testing of this sort is complex and still under development in both the public and private sectors. This chapter will not deal with these criteria further.

FLAMMABILITY

Flammability is one criterion for defining a waste as hazardous. Flammable wastes may cause damage directly, from heat and smoke production, or indirectly, either by providing a vector by which other hazardous wastes could be dispersed (such as convection currents carrying toxic particulates or dust), or could cause otherwise benign wastes to become hazardous (such as plastics which, when ignited, undergo condensation reactions or depolymerize to emit toxic fumes). For these reasons, it is desirable to identify wastes that are flammable, so they can receive proper handling.

One method by which the degree of flammability

TAKEN FROM "STATE DECISION-MAKERS GUIDE FOR HAZARDOUS WASTE MANAGEMENT" U.S. E.P.A. 1977 #10320

of a material can be defined is by the flashpoint (FP) of the substance. This is the lowest temperature at which evaporation produces sufficient vapor to form an ignitable mixture with the air, near the surface of the liquid, or within the vessel used. (By "ignitable mixture" is meant a mixture that, when ignited, is capable of the initiation and propagation of flame away from the source of ignition. By "propagation of flame" is meant the spread of flame from layer to layer independently of the source of ignition.)

The initiation of flame is always the result of the progressive auto-acceleration of reaction, which becomes possible only under definite thermal conditions brought about by an external source (for example, spark discharge, hot walls of a vessel, etc.) Most combustion reactions are exothermic (heat producing), and as they proceed they raise the temperature of the surroundings. Since reaction rate is a function of temperature (a measure of available energy), these reactions accelerate themselves by the thermal energy they release in reaction. (The reaction here is oxidation, that is, the exhaustive combination of the vapors with the elemental oxygen in the atmosphere.)

In defining flammability, only the flash point need be considered since direct vigorous oxidation of a substance not in the gaseous state is very rare at normal temperatures. While all agencies and organizations that define flammability use flash points as their limiting criteria there is no consensus as to what that limit should be (for example, Department of Transportation F.P. $< 100^{\circ}$F, California F.P. $< 80^{\circ}$F). In landfill situations, there are many available external sources of energy which could provide the impetus for combustion—electrical energy resulting from sparks generated by bulldozers, thermal energy resulting from the heat of neutralization when wastes of differ-pH's are mixed, biologically initiated thermal energy from the decomposition of organic wastes, etc. These sources could raise the temperature at the landfill surface above the ambient temperature. Data should be gathered on the temperature and energy sources at landfills to help address the question of what flashpoint limit should be chosen to avoid conflagrations due to these external sources.

Another source of concern is the fact that disposal sites often contain wastes that are not hazardous by themselves, but when burned become hazardous (for example, certain plastics give off noxious fumes when burning, beryllium dust may leave the site by a vector supplied by the fire, etc.) For this reason, it may be desirable not only to require that flammable wastes be placed in a hazardous waste facility, but also combustible wastes. Combustible wastes can be managed in a safe manner at these facilities by being segregated from those wastes which become hazardous upon burning.

The established tests for flammability take the physical state of the substance into consideration, since the state will affect the vapor pressure and consequently change the flash point. Therefore, flammability will be examined for the four following physical states of wastes: (1) pure liquid; (2) solution; (3) sludge; (4) solid. The testing modifications that must be made for each state, and a short discussion of each state follow:

I. Pure Liquids

The vapor, as measured by the vapor pressure, produced by a pure substance is directly proportional to the ambient temperature. (The reference is primarily to liquids, although there are certain solids, e.g., camphor, that sublime, that is, change from a solid to a vapor, at ordinary temperatures, and that have a meaningful vapor pressure.) The "ideal vapor pressure" of a substance is defined as the sum of the vapor pressure of each constituent multiplied by its mole fraction. Temperature is a manifestation of molecular motion, which in turn is a physical consequence of the kinetic energy of the molecules themselves. At any given temperature, the molecules in a sample will have a "spread" of kinetic energies that can be statistically described as a Boltzman distribution.

A molecule must possess a certain minimum threshold energy in order to overcome the attractive forces of its neighboring molecules in the close-packed liquid state. As the temperature is raised, the entire curve shifts toward higher kinetic energy and more molecules now possess the prerequisite energy to escape into the gaseous state.

It has been suggested that flash points be standardized to a particular atmospheric pressure, since barometric pressure does vary with different locations, and with time at the same location. The reason for

this suggestion is as follows: Atmospheric pressure is the measure of the amount of air available at any given point. Thus, as the atmospheric pressure drops, less vapor (that is, lower vapor pressure) is necessary to attain that concentration which defines an ignitable mixture, and the temperature which produces this lower vapor pressure (that is, the flash point) is also lower. One might assume then that if the barometer drops appreciably after a flash-point determination is made, what was tested as a nonflammable substance at the higher reading may be flammable at the new pressure. However, this seems to be an unrealistic concern since according to the National Oceanic and Atmospheric Administration (NOAA), the largest barometric deviation in a single day (excluding hurricanes and tornadoes) *is less than 20 mm Hg*, and this would change a flash point of 80°C by less than 3°C.

There are several common methods of determining the flash point of a liquid. The methods vary only slightly with the apparatus used, and these apparatus are of two types—open cup testers and closed cup testers. The method is basically as follows: the sample is placed in the sample cup and heated at a slow but constant rate. A small test flame is passed across the cup at regular, specified intervals. The flash point is taken as the lowest temperature at which application of the test flame causes the vapor at the surface of the liquid to flash.

The apparatus on the market differ in four ways: (1) sample cup type; (2) cup insulation type; (3) heating mechanisms; (4) agitation.

The most important of these is the type of sample cup. Open cup testers as a class give higher flash points than closed cup testers, and are normally used for determinations on liquids with relatively high flash points. These higher determinations result from the fact that the design of the top of the sample cup in an open cup tester allows the sample to be in greater contact with the atmosphere, preventing any quantitative buildup of vapors over the liquid as it is heated. Closed cup testers have smaller openings above the sample cup; this keeps the vapor from quickly dissipating and results in a mixture richer in vapor. Thus, closed cup testers would be representative of the worst, or most dangerous situation.

There are two types of cup insulators (temperature baths): liquid bath and air bath. Since the purpose of these temperature baths is to ensure a uniform temperature around the entire sample, a liquid bath is superior to an air bath, due to the better thermal transport properties of liquids as compared to air.

As far as temperature control mechanisms are concerned, it makes no difference whether the apparatus has a gas or electric burner. Both are equally accurate at the low temperature of concern, and the choice becomes one of convenience (electric) versus economy (gas).

The final choice that must be made is whether or not to include a method of sample agitation in the apparatus. If the sample to be tested is very viscous, tends to skin over, or contains suspended solids, a stirrer should be incorporated into the apparatus to agitate the sample and prevent local temperature variations. Since a pure nonviscous liquid can also be run on such an apparatus without a stirrer, it is recommended that a stirrer be incorporated into the apparatus.

There are a number of different flash-point testers offered by the vendors, Fischer and Sargent to name two, with various combinations of the above features (Table 1).

The following is a short discussion on three types of physical state deviations from a pure liquid and and how they should be handled.

II. Solution

A solution is the least complex deviation from a pure liquid, and the procedures for ascertaining flash points of solutions have also been developed. The vapor pressure of solutions will vary either positively or negatively from the ideal vapor pressure (where the "ideal vapor pressure" is defined as the sum of the vapor pressure of each constituent multiplied by its mole fraction). Solutions can be tested in the same manner as pure liquids with the following procedural change. If the flash point is determined to be 6.6°C (20°F) or higher, a sample of the liquid evaporated to 90 percent of its original volume should be tested. The lower value of the two tests can then be used as the flash point of the material. The purpose of this procedure is as follows: Since the different components in the mixture have different volatilites,

TABLE 1

FLASH-POINT TESTERS

Type	Sample Cup	Stirrer	Bath	Type of Temp. Control	Cost (1974)
Pensky-Martens (Fischer)	Closed	No	Air	Electric	$395
Pensky-Martens (Fischer)	Closed	Yes	Air	Electric	$470
Tagliague (Fischer)	Open	No	Liquid	Electric	$200
Tagliague (Fischer)	Closed	No	Liquid	Electric	$300
Cleveland (Fischer)	Open	No	None	Gas	$265
Cleveland (Sargent)	Open	No	None	Gas	$120
Cleveland (Sargent)	Open	No	None	Electric	$240
Pensky-Martens (Fischer)	Closed	No	Air	Gas	$330
Pensky-Martens (Fischer)	Closed	Yes	Air	Gas	$400

the composition of the liquid phase changes, which produces a change in the composition of the resultant vapor phase, which in turn will affect the flash point. The evaporation of 10 percent of the more volatile composition ascertains whether this change in composition will produce a flammable mixture.

III. Sludges

Sludges, including slurries, colloids, etc., pose a much more difficult testing problem. Following is a short discussion of some of the physical peculiarities of sludges which might affect flash-point testing. If the sludge is stratified, which is likely due to the differing densities of most substances, then the upper layers will inhibit evaporation of the lower layers. The evaporation of the lower layers will occur at the normal rate only when they are in direct contact with the atmosphere at either thermally or mechanically produced holes. This problem can be overcome by taking two testing samples, representing the two extreme situations, these situations being: (1) no mechanical or thermal agitation present so that only the least dense (top) layer is in contact with the atmosphere and able to evaporate; (2) the vigorous agitation so that all components of the sample come into contact with the atmosphere and can evaporate.

If two samples representing these extremes are taken and tested (a sample of just the top layer, and a sample of the waste when agitated) and neither results in a flammable solution, then any linear combination of the two situations should also be nonflammable.

The theoretical rationale for this evaporation inhibiting effect of layer stratification is as follows: at any given temperature the molecular motion, which is simply a manifestation of the kinetic energy of a sample, can be statistically described in terms of a Boltzman distribution. Only those molecules with a kinetic energy above a certain level have enough energy to escape the attractive forces of the other molecules in the liquid phase and can escape into the gas phase. Obviously, those molecules far below the surface have a very small chance of reaching the surface with this minimum kinetic energy intact, since they are constantly being involved in inelastic collisions (collisions where momentum, and hence kinetic energy, is exchanged) and will, on the average, lose energy in these exchanges since they are themselves above the mean in energy.

IV. Solids

The final situation is one in which the sample to be tested is a solid. In the burning of most substances, the actual combustion takes place only after the substance has been vaporized or decomposed by heat to produce a gas. Most solids have lower vapor pressures than liquids, due usually to the stronger intermolecular forces existing in solids. For this reason, they are less likely to be flammable since it takes more energy, that is, a higher "temperature," to volatilize them. It is rare for a solid to have a flash or fire point in the normal temperature range except for those solids having a meaningful vapor pressure, like napthol. Because of this fact, there is less danger of fire from solids. Since solids can exist in many different "states" (granular, amorphous, rigid, etc.), the flammability testing procedures must be very general with few of the specific details one has come to expect in standards.

Also tests which measure the ignition or flame

point of solids tend to give results which are highly dependent upon the conditions of heating. Solids, as a rule, do not conduct heat as well as liquids, for this reason localized hot and cold spots can develop when testing a solid, and give rise to an observed ignition point which may be different than the actual ignition temperatures. Therefore, presently available testing methods measuring such properties as the auto-ignition point of solids do not seem to be useable in a regulatory system, due to the inconsistency of the available test methods, and the problems associated with obtaining representative samples for testing. What can be used in place of a testing method could be a prose definition similar to that used by the State of California: "A flammable solid is a solid which may cause fire through friction or which may be ignited readily and when ignited burns so vigorously and persistently as to create a hazard . . ."

CORROSIVENESS

Corrosive wastes are of two-fold concern. The primary concern is for the safety of the waste handlers (haulers and disposers). Wastes capable of damaging tissue by corrosive action must be identified, and then properly labeled to insure that they receive cautious handling. The second concern is that if wastes which are to be stored for a period in a container are corrosive, they may corrode the container, leak out, and cause damage. There are standard methods available to judge if a specific waste might be cause for either concern. The Food and Drug Administration (FDA), the Department of Commerce, the Occupational Safety and Health Administration (OSHA), and the Department of Transportation (DOT) all reference a test which can be used to determine how corrosive a particular waste would be to mammalian tissue (Title 21, CFR 191.10, .11). The test specificies use of an albino rabbit, and there is good correlation that substances corrosive to the skin of an albino rabbit would also be corrosive to human tissue. Unfortunately, this test is very expensive and time-consuming when run on a regular basis, that is, for each batch of waste.

The second area of concern, the corrosion of the container holding a hazardous waste, can be addressed by a standard test described by the National Association of Corrosion Engineers. This test determines how corrosive a sample is to certain metal alloys. This is necessary if: (1) the waste is hazardous and is to be stored in a metal container; and (2) the waste will come into contact with metal containers which contain hazardous wastes. This test is described in the National Association of Corrosion Engineers Standard (TM-01-69). The test consists of placing a sample of metal of known surface area into the suspected corrosive waste and measuring the weight loss due to corrosion after specified time intervals. This weight loss is then manipulated by algebraic equations to give such information as mils of metal corroded per year (perpendicular to the metal surface).

It is important to realize that this standard was written for the primary purpose of determining the ability of a particular metal to withstand corrosion, whereas our interest is in whether a particular "solution" (sludge, slurry, etc.) is itself corrosive. This difference in philosophy, however, does not affect the validity of the test, and seems to necessitate only minor procedural changes.

In the test as it was originally devised, the exhaustion of the corrosive constituents of the sample solution was avoided by the addition of more corrosive constituents, or by changing the solution during the test. For waste identification purposes this is unnecessary, for while the test was designed to determine the corrosion rate of a material which is being constantly assaulted by fresh solution, our metal containers are only in contact with a very limited, specific amount of solution. As long as the ratio of the surface of test alloy to the amount of test solution is smaller than the ratio of the inside surface of the container to the total amount of solution in the container, any error will be on the safe side. Obviously, the alloy tested should be the one of which the container is made.

This protocol would not be foolproof. Pitting, galvanic, intergranular and other types of corrosion can cause leakage within a time period within which the test results would indicate that no leakage would occur. A decision would have to be made as to what time period a waste might be allowed to remain drummed before it would have to be tested.

Another alternative to specifying a corrosiveness testing protocol is to specify container standards. The container lining and drum gauges could be specified

for wastes which are to be stored for stipulated periods of time.

REACTIVITY

There are presently no recognized standard general testing methods for reactivity. The present regulatory method of describing "reactive" materials is to publish a list of such, and then give a catch-all definition. These definitions do not, however, indicate a positive test for reactivity, but rather describe the physical peculiarities of these reactive materials, for example, "a strong oxidizer" or "a self-polymerizer." This ambiguity results from the fact that while "highly reactive" substances are found to belong to specific classes or chemicals (for example, peroxides, etc.), there is no particular structure of chemical composition that can be used as an *a priori* indicator of "reactivity." This is because reactivity is solely a function of the thermodynamic description of the initial, transition, and final states of the reaction components.

These highly reactive hazardous substances are substances which:

I. Autopolymerize
II. React vigorously with air or water
III. Are unstable with respect to heat or shock
IV. Are strong oxidizing agents
V. React readily to give off toxic fumes
VI. Are explosive

These categories are not discrete, but overlap. For instance some peroxides would fit four of the above categories.

All these categories (except IV) usually require an external impetus to precipitate the reaction either in the form of energy as a "shock" or the addition of an initiating agent.

One common link among highly reactive substances, and an important reason for their hazardousness, is that their reactions can cause the formation of steep temperature or pressure gradients with time. There are standard methods of testing for and measuring these effects. Differential Thermal Analysis DTA (ASTM E475) is one procedure that can be used to identify wastes which give off large amounts of heat when reacting. The procedure consists of confining the sample in a specially designed vessel equipped with a shielded thermal-couple.

The test assembly is put into a temperature bath and then heated at a constant temperature increment rate. The differential temperature (sample temperature minus bath temperature) is recorded versus bath temperature or versus a thermally inert control material. The differential temperature curve (that is, sample temperature, due to reaction exothermicity versus bath temperature, due to constant thermal input), is graphically analyzed to determine the threshold temperature for initiation of measurable reaction.

Likewise, wastes which react to form high pressure gradients can be identified by use of a reaction vessel equipped with a pressure transducer. This can then be heated and the pressure increase with time analyzed graphically.

The problem with these two methods lies in the fact that the results must be analyzed and a judgment made. The results can be ambiguous and not readily interpretable. For example, the pressure transducer only reads the pressure increase, but gives no indication as to the nature of the vapor being formed.

There are standardized testing methods available to identify those materials which are pressure sensitive, or can be detonated by shock, such as the Picatinny Arsenal test.

A test method which could be used to identify strong oxidizers would be use of a redox electrode. Oxidation can be thought of as the loss of electrons: a redox electrode measures the potential difference between the test solution and a standard electrode. From this potential, a test solution can be judged as either oxidizing or reducing, and to what extent. This test method can only be used on a liquid waste, and specific protocols are not presently available to use this method for determining the redox potential of wastes.

The tests mentioned above are all specialized testing procedures which should only be run on a small percentage of wastes. An alternative method of handling the identification of highly reactive wastes would be to develop prose definitions of the effects of these reactive wastes similar to the National Fire Protection Association categories for reactive substances or oxidizers, with a sample listing for each.

SUMMARY

As the foregoing discussion illustrates, the definition of a hazardous waste (as required by Section 3001 of the Resource Conservation and Recovery Act) promises to be both scientifically, and in a policy sense, a very complex task. The variety of options for definition of these simpler, physical parameters will compound greatly when the acute and chronic toxicity factors are addressed.

Identifying Hazardous Waste

Hazardous Wastes

A *hazardous waste* is a waste which poses a threat to life and property. It can contaminate the environment by virtue of being toxic, radioactive, explosive, or flammable, as well as nonbiodegradable and bioaccumulative. When a hazardous chemical used in the workplace or the lab is contaminated, or no longer useful, the material is a potential threat if disposal is not carried out properly.

The fundamental fact about these hazardous wastes is that they are a menace to human health and the environment. They can poison, burn, maim, blind, and kill people and other living organisms. They may snuff out life immediately when inhaled, swallowed, or brought in contact with the skin. They may wreak their havoc slowly over time, affecting the nervous system, causing cancers, or spawning birth defects. Some are nondegradable and persist in nature indefinitely. Some may accumulate in living things. Some may work their way into the food chain.

Hazardous wastes are found in a wide variety of solid, liquid, or gaseous forms. They may be packaged in small jars, bags, drums, cylinders, cans, and aerosol containers. **Table 1 provides a partial list of commonly encountered sources of hazardous waste.**

As yet, the U.S. Environmental Protection Agency (EPA) has not formally defined what is a hazardous waste although several Federal regulations deal with hazardous properties of chemicals, transportation of these chemicals, or certain commercial products which may contain hazardous components. Several States do maintain lists or criteria for hazardous wastes which makes those agencies an excellent source of information for determining what is hazardous.

All *pesticides* are regulated under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended (FIFRA), and disposal must be in accordance with label directions or with regulations and procedures published pursuant to Section 19 of the Act. Published guidelines (40 CFR 165) provide for the disposal of single containers of household pesticide products that are securely wrapped in several layers of paper in regular municipal solid waste disposal facilities.

Information Sources

Detailed information on the hazardous characteristics of laboratory chemicals and the most commonly used commercial and household products can be obtained from the manufacturers/suppliers, open literature, and by contacting appropriate governmental agencies.

Most chemicals used in the laboratories or products used in the household or in small commercial and business establishments carry warning labels as to the hazards involved if they contain hazardous substances or if they may be hazardous under certain conditions of use. Thus, if the original label still remains on the container, it should be read very carefully as a first step toward waste identification (and for safe handling and disposal). If the name of the manufacturer or distributator of a product is known, the manufacturer or distributor can be contacted for information on hazardous characteristics of the product and on proper handling and disposal procedures.

There are five reference manuals, available in many public libraries and in most chemical laboratories, which can be consulted on properties, uses, and hazardous characteristics of laboratory chemicals and many consumer products (Table 2). Generally, descriptions of the material's hazardous nature will be in terms of its toxicity, flammability, reactivity, explosiveness, or corrosive nature. The reference manuals noted describe the hazardous nature of the material in these terms, and some may give a relative rating of its danger. Some of these references also tell whether or not these materials are potentially carcinogenic (cancer-causing).

Local, State, and Federal agencies can also be contacted for assistance in the identification of hazardous material. A list and brief description of these agencies are presented in Appendices A, B, and C.

Table 1. Commonly Encountered Hazardous Materials and Products Found in Small Batches of Waste

TYPICAL WASTE SOURCES	HAZARDOUS MATERIALS
1. ACIDS	
Pickling Liquor Battery Acid Acidic Chemical Cleaners Spent Acid Plating Operations Laboratory Glassware Acid Baths Glass Etching Solutions	Chromic-sulfuric acid mixture, hydrobromic acid, hydrochloric acid, hydrofluoric acid, nitric acid, perchloric acid, sulfuric acid
2. ALKALIES	
Miscellaneous Caustic Products Alkaline Battery Fluid Caustic Wastewater Cleaning Solutions Lye	Ammonia, lime (calcium oxide), potassium hydroxide, sodium hydroxide, sodium silicate
3. ORGANICS *(Mainly Non-Halogenated)*	
Capacitor Fluids Chemical Cleaners and Solvents Chemical Toilet Wastes Electrical Transformer Fluids Furniture and Wood Polishes Laboratory Chemicals Paint Removers Silver Cleaning Agents Shoe Polish	Aromatic compounds, organic amides, organic mercaptans, organonitriles, nitrobenzene, phosgene, thioureas
4. HALOGENATED ORGANICS	
Cleaning Solvents Laboratory Chemicals Paint and Varnish Removers Dry Cleaning Solutions Capacitors and Transformers Containing PCB	Carbon tetrachloride, chloroform, methylene chloride, polychlorinated biphenyls (PCB)
5. INORGANICS	
Catalysts Chemical Toilet Wastes Laboratory Chemical Wastes Paint Sludge Plating Solutions Fluorescent Lamps Germicidal and "Disinfectant" Solutions Paints Fluxes Aluminum Cleaning Agents	Ammonium fluoride, ammonium silicofluoride, antimony salts, arsenic salts, asbestos products and fibers, beryllium compounds, barium salts, borane compounds, cadmium salts, chromium salts, cyanide compounds, inorganic halides (potassium bromide, sodium iodide), lead compounds, mercury salts, selenium salts, sodium silicofluoride, vanadium compounds, zinc chloride

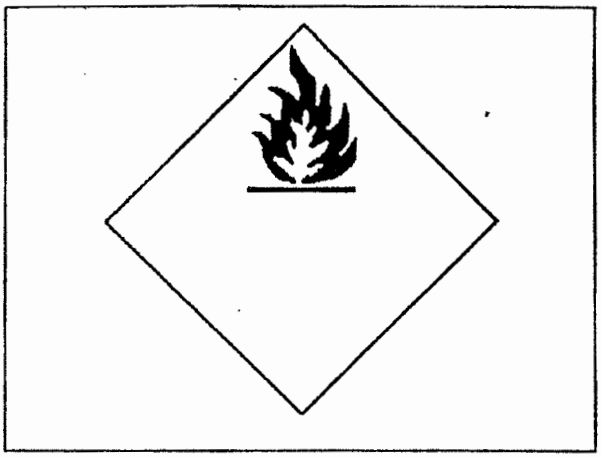
Table 1. Commonly Encountered Hazardous Materials and Products Found in Small Batches of Waste (Continued)

TYPICAL WASTE SOURCES	HAZARDOUS MATERIALS
6. EXPLOSIVES	
Illegal Explosive "Firecrackers" Laboratory Wastes Obsolete Explosives Track Torpedoes Blasting Caps Detonators Commercial Pyrotechnics for Private Use	Ammonium nitrate, ammonium nitrate-fuel oil mixtures (ANFO), dynamite, mercury fulminate, nitroglycerin, 2,4,6-trinitrotoluene (TNT), water-gel explosives
7. PESTICIDES	
Waste Pesticides House and Garden Discarded Pesticide Cans Waste Water from Cleaning of Pesticide Containers Containers and Pesticide Application Equipment	Chlorinated hydrocarbon pesticides, organophosphate pesticides, phosphorothioate pesticides, organic carbamates, organic thiocarbamates
8. GASES	
Welding Gases Laboratory Gas Cylinders Local Anesthetic "Aerosol" Cans Medical Oxygen Cylinders	Acetylene, ammonia, carbon monoxide, chlorine, ethyl chloride, hydrogen, hydrogen sulfide, methyl chloride, nitrogen dioxide, oxygen, other gases under high pressure
9. BANNED PRODUCTS	
Banned Pesticides Banned Hair Sprays Banned Aerosol Bathroom Cleaners Waste Lead-Base Paints	Aerosol products containing vinyl chloride as propellant, aldrin products, lead-based paints containing 0.5 percent lead or greater

Table 2. Reference Manuals on Hazardous Properties of Laboratory Chemicals and Commercial/Industrial Products

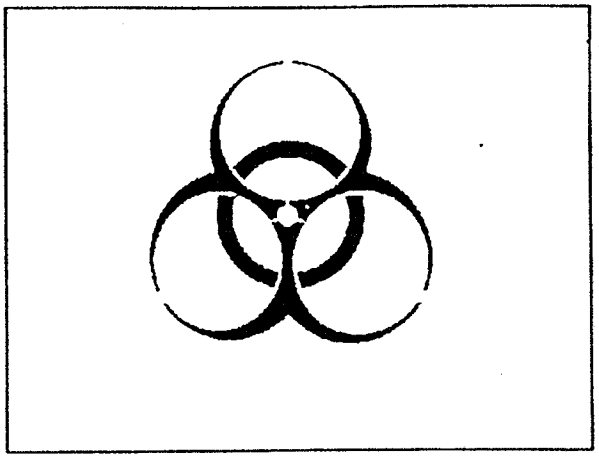
REFERENCE	CONTENTS
Gleason, Marion N., et al. *Clinical toxicology of commercial products; acute poisoning.* 3d ed. Baltimore, The Williams & Wilkins Co., 1969. various pagings.	Contains alphabetical compilation of 3,000 major chemical substances (ingredients) found in widely used commercial products, and gives toxicity information and a toxicity rating for each ingredient. In addition, the manual contains a trade name index for 17,000 products, identifies the manufacturers and lists the ingredients for each product and identifies the toxic components.
Stecher, P.G., et al. *The Merck index; an encyclopedia of chemicals and drugs.* 8th ed. Rahway, N.J., Merck & Co., Inc., 1968. 1713 p.	Describes 10,000 individual substances, provides data on their toxic effects on humans and test animals, and lists common uses for selected entries. In addition, the index lists poison control centers and first aid procedures. A cross-index of chemical names and formulas is also given.
Sax, N.I., et al. *Dangerous properties of industrial materials.* New York, Reinhold Publishing Corporation, 1957. 1467 p.	Lists 9,000 general chemicals and products; gives descriptions of physical properties and toxicity, explosion, fire, and radiation hazard ratings. For each chemical, pertinent data are provided on personal hygiene, ventilation, disaster control, shipping regulations, and storage/handling procedures.
Weast, R.C. *Handbook of chemistry and physics.* 56th ed. Cleveland, CRC Press, 1975-1976. various pagings.	Identifies physical and chemical properties of most organic and inorganic chemicals. The handbook gives toxicity of select chemicals, and general information on chemical hazards, fire precautions and first aid.
Christensen, H.E., Luginbyhl, T.T., and B.S. Carroll. *Registry of toxic effects of chemical substances; 1975 edition.* Washington, U.S. Government Printing Office, June 1975. 1296 p.	Identifies toxicity (to man, animals, and aquatic life) of most known organic and inorganic chemicals and identifies carcinogenic, teratogenic, and mutagenic nature, if any.

FLAMMABLE SYMBOL



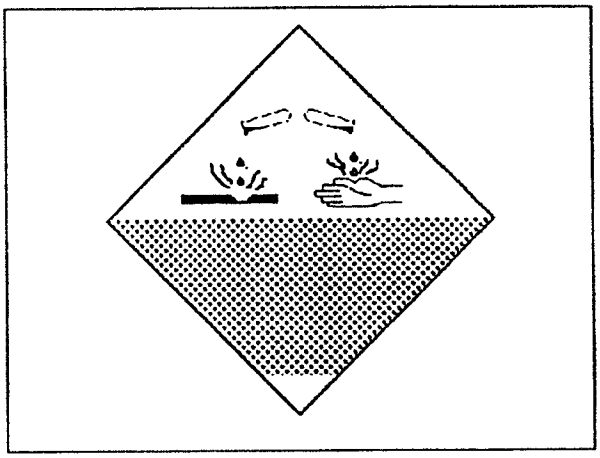
Category	Message	Symbol	Background (shape/color)
Flammable Liquid	Flammable Liquid (black/white	Flame (black/white)	(diamond) (red)
Flammable Solid	Flammable Solid (black)	Flame (black)	(diamond) (red/white strip)
Spontaneously Combustible	Spontaneously Combustible (black)	Flame (black)	(diamond) (white top) (red bottom)
Dangerous When Wet	Dangerous When Wet (black/white)	Flame (black/white)	(diamond) (blue)

BIOMEDICAL SYMBOL



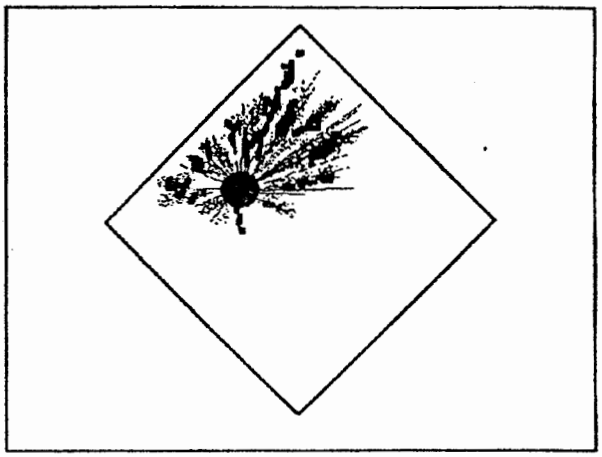
Category	Message	Symbol	Background (shape/color)
Biomedical	Biomedical Material Etiologic Agents (black/white)	(special symbol) (black)	(rectangle) (black/white)

CORROSIVE SYMBOL



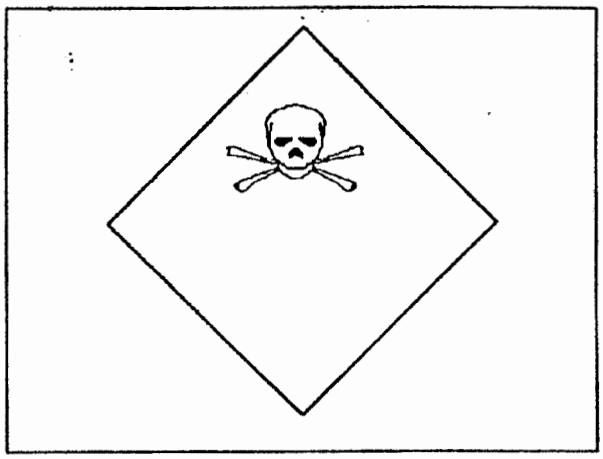
Category	Message	Symbol	Background (shape/color)
Corrosive	Corrosive (black/white)	(special symbol) (black/white)	(diamond) (white top) (black bottom)

EXPLOSIVE SYMBOL



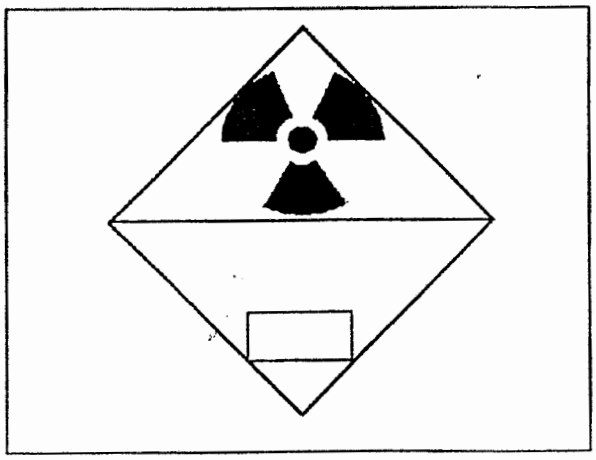
Category	Message	Symbol	Background (shape/color)
Explosives	Explosive A (black)	Exploding Ball (black)	(diamond) (orange)
	Explosive B (black)	Exploding Ball (black)	(diamond) (orange)
	Explosive C (black)	Exploding Ball (black)	(diamond) (orange)
	Blasting Agent (black)	(none) (black)	(diamond) (orange)

POISON AND IRRITANT SYMBOL



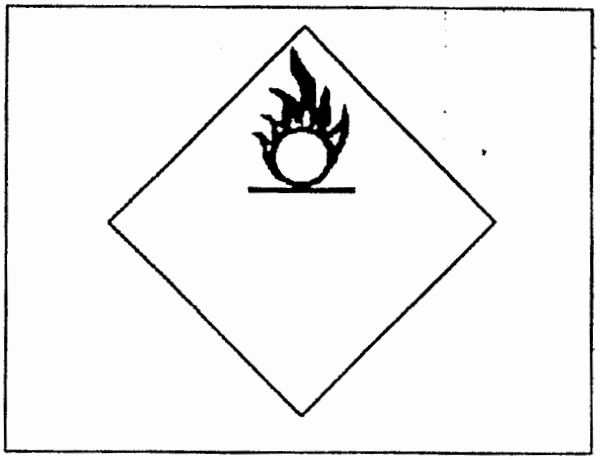
Category	Message	Symbol	Background (shape/color)
Poison	Poison (black)	Skull/X Bones (black)	(diamond) (white)
Poison Gas	Poison Gas (black)	Skull/X Bones (black)	(diamond) (white)
Irritant	Irritant (red)	(none) (none)	(diamond) (white)
	Irritant (black)	Skull/X Bones (black)	(diamond) (white)

RADIOACTIVE SYMBOL



Category	Message	Symbol	Background (shape/color)
Radioactive	Radioactive (black/red)	(special symbol) (black)	(diamond) (white or yellow or yellow/white)

OXIDIZER SYMBOL



Category	Message	Symbol	Background (shape/color)
Oxidizer	Oxidizer (black)	Flaming Circle (black)	(diamond) (yellow)
Organic Peroxide	Organic Peroxide (black)	Flaming Circle (black)	(diamond) (yellow)

Appendix D

LAKETOWN

Monthly total precipitation

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1910	1.50	0.75	0.53	1.10	0.00	0.00	0.50	0.15	0.45	1.35	0.75	1.15	8.23
1911	3.81	0.83	1.40	1.55	1.15	1.18	0.20	0.00	1.11	1.35	0.80	0.05	13.43
1912	0.60	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90
1913	-	-	-	-	-	-	-	-	-	-	-	-	-
1914	-	-	-	-	-	-	-	-	-	-	-	-	-
1915	-	-	-	-	-	-	-	-	-	-	-	-	-
1916	-	-	-	-	-	-	-	-	-	-	-	-	-
1917	-	-	-	-	-	-	-	-	-	-	-	-	-
1918	0.77	1.18	1.39	0.44	1.44	0.30	1.95	0.10	1.16	2.40	0.74 M	0.04	11.91 M
1919	-	0.84	0.62	1.35	0.80	0.00	0.70	0.20	1.89	3.81	0.72	0.84	-
1920	0.95	0.92	1.12	1.59	1.28	0.50	0.35	1.17	0.65	3.43	0.32	0.52	12.80
1921	0.92	0.73	0.83	1.95	0.79	0.37	0.36	1.52	0.15	1.21	0.78	2.01	11.62
1922	0.53	1.64	0.27	0.82	0.27	0.25	0.30	1.45	0.35	1.11	0.31	0.64	7.94
1923	1.24	0.05	0.52	2.70	2.00	1.21	0.73	0.90	2.05	2.88	0.03	1.14	15.45
1924	0.31	0.31	0.93	0.28	0.49	0.08	0.44	0.04	0.81	1.82	0.89	1.13	7.53
1925	0.10	0.45	0.89	1.11	1.76	0.80	0.34	0.83	1.68	1.57	0.63	0.22	10.38
1926	0.38	0.91	0.61	1.50	1.46	0.30	1.56	1.07	1.18	0.52	1.32	0.10	10.91
1927	0.55	1.11	0.78	1.37	1.05	0.66	0.45	0.26	2.03	1.39	1.24	0.51	11.40
1928	0.21	0.57	1.32	0.88	0.48	1.07	0.65	0.02	0.20	1.40	1.45	0.85	9.10
1929	1.13	0.36	1.59	1.44	0.14	0.38	0.13	1.06	1.98	1.10	0.24	0.44	9.99
1930	1.25	0.73	0.64	1.30	1.80	0.97	0.16	2.74	2.09	0.99	0.41	0.02	13.10
1931	0.06	0.27	0.93	0.28	1.45	0.06	1.11	0.61	0.68	1.15	0.66	0.97	8.23
1932	1.51	0.65	1.41	0.54	0.25	0.51	1.09	1.45	0.04	1.31	0.03	0.81	9.60
1933	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48
1934	0.34	1.07	0.44	0.46	0.41	0.44	0.47	0.71	0.28	0.50	0.88	0.52	6.52
1935	0.82	0.62	0.65	1.96	1.64	0.14	0.00	0.50	0.26	0.26	0.55	0.12	7.52
1936	1.50	3.04	1.33	0.37	0.56	1.27	1.93	2.06	0.83	2.08	0.35	0.60	15.92
1937	0.77	1.45	0.33	1.32	1.00	1.59	0.49	0.19	1.20	0.91	0.72	1.02	10.99
1938	0.41	0.45	2.54	1.46	1.82	0.52	0.37	0.43	0.50	0.77	0.91	0.78	10.96
1939	0.74	0.47	0.41	0.29	1.93	0.76	0.29	0.05	1.06	0.64	0.00	0.07	6.71
1940	0.63	0.84	0.54	0.71	0.48	0.33	0.37	1.04	1.93	0.99	1.05	0.60	9.51
1941	0.13	0.73	0.56	1.20	0.95	1.66	1.65	1.09	1.31	2.15	0.96	0.94	13.33
1942	0.72	0.72	0.46	1.00	0.79	0.39	0.11	0.60	0.80	1.53	1.58	0.42	9.12
1943	1.23	0.55	1.24	1.08	0.46	1.65	0.42	1.35	0.30	1.06	0.06	0.45	9.85
1944	0.61	0.33	1.52	2.31	0.66	2.23	0.26	0.00	0.69	0.12	1.09	0.36	10.18
1945	0.13	0.84	0.64	0.66	2.34	2.35	0.59	1.99	1.33	1.40	2.83	1.02	16.12
1946	0.08	0.38	2.09	0.91	1.26	0.24	0.38	1.23	0.71	3.15	0.72	1.14	12.29
1947	0.56	0.46	0.99	1.06	2.41	2.97	0.11	2.11	1.69	1.03	0.69	0.11	14.19
1948	0.71	0.85	0.76	2.42	0.24	1.16	0.07	0.11	0.37	0.64	1.53	0.98	9.84
1949	1.27	0.57	0.28	0.59	1.65	2.25	0.75	0.60	0.49	2.94	0.35	0.88	12.62
1950	3.34	0.50	0.87	1.24	2.32	1.03	0.85	0.10	1.34	0.80	0.90	0.97	14.26
1951	0.95	0.95	1.23	1.92	1.08	0.80	0.51	1.15	0.27	1.24	1.58	1.01	12.69
1952	0.78	1.18	1.06	0.31	1.18	1.31	0.30	0.86	0.27	0.00	0.41	0.40	8.06
1953	1.47	1.60	0.60	1.44	2.03	0.74	0.29	1.07	0.05	0.17	0.86	0.47	10.79
1954	1.64	0.35	0.78	0.13	0.84	0.98	0.20	0.41	0.70	1.14	1.19	1.32	9.68
1955	0.93	1.54	0.81	0.94	1.07	0.82	0.76	1.22	1.27	0.37	1.31	2.59	13.63
1956	1.46	0.44	0.20	0.48	1.91	0.49	0.35	0.43	0.03	0.57	0.07	1.30	7.73
1957	1.16	0.58	0.88	2.18	1.02	0.94	0.33	0.58	0.34	0.39	1.01	0.68	10.09
1958	0.44	0.84	1.05	0.36	1.32	0.96	0.30	1.40	0.43	0.05	2.44	1.10	10.69
1959	0.51	0.89	0.74	1.62	1.48	0.47	0.14	1.37	2.07	0.23	0.05	0.53	10.10
1960	1.10	1.43	0.82	0.45	0.15	0.61	0.19	0.22	1.38	1.91	1.21	0.31	9.78
1961	0.05	0.45	0.73	0.32	0.33	0.47	0.49	1.03	1.60	1.19	0.35	0.93	7.94
1962	0.68	1.87	1.50	1.76	1.47	0.82	0.83	0.24	0.40	1.25	0.67	0.49	11.98
1963	0.89	1.25	0.65	1.43	0.12	2.28	0.24	0.53	1.03	1.83	1.12	0.05	11.42
1964	0.42	0.10	0.80	2.01	1.21	2.14	0.38	0.03	0.41	0.07	1.46	5.36	14.39
1965	1.70	1.44	0.37	1.37	1.56	2.40	0.63	2.00	2.89	0.03	3.30	1.38	19.07
1966	0.58	0.49	0.40	0.68	0.62	0.30	0.09	0.20	0.99	0.34	0.59	1.49	6.77
1967	0.91	0.76	2.28	2.56	2.18	2.46	0.16	0.34	0.25	1.10	0.32	1.39	14.71
1968	0.46	0.86	0.71	1.06	1.63	1.38	0.76	1.81	0.13	0.58	0.63	1.24	11.25
1969	1.74	1.37	0.29	0.82	0.15	2.89	0.96	0.44	0.63	1.25	0.00	0.93	11.47
1970	0.99	0.26	0.63	0.94	1.18	0.89	0.04	0.04	1.22	1.71	3.60	1.32	12.82
1971	2.59	1.01	1.08	1.86	1.25	1.01	0.80	0.22	1.09	2.28	1.03	1.26	15.48
1972	2.31	0.45	0.83	2.74	0.00	2.03	0.34	0.42	0.55	1.69	0.80	1.26	13.42

continued on next page

LAKETOWN

Monthly total precipitation

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
						continued from previous page							
1973	0.35	0.33	1.51	0.80	0.57	0.46	1.58	0.68	2.88	0.56	1.22	1.69	12.63
1974	1.29	0.74	0.99	1.22	0.47	0.30	0.92	0.16	0.03	2.05	0.44	0.66	9.27
1975	1.11	0.52	1.49	0.54	0.87	2.76	0.79	0.20	0.08	2.24	1.01	0.63	12.24
1976	0.54	1.96	1.70	0.86	1.01	0.59	1.21	1.08	0.53	0.09	0.00	0.00	9.57
1977	0.31	0.39	0.91	0.00	2.20	0.88	0.85	3.36	0.61	0.64	1.12	1.74	13.01
1978	0.45	0.97	0.31	1.02	0.91	0.44	0.35	0.73	1.80	0.00	1.04	2.10	10.12
1979	1.49	0.45	0.52	0.00	0.86	0.11	0.16	1.42	0.11	1.78	0.47	0.19	7.56
1980	3.58	0.85	0.84	1.55	3.16	1.73	1.00	0.70	1.09	1.37	1.00	0.80	17.67
1981	0.37	0.16	0.79	0.32	1.11	0.65	0.79	0.16	0.55	2.77	0.93	1.67	10.27
1982	1.37	1.01	1.33	1.25	1.46	0.31	1.83	0.98	4.65	0.37	1.10	0.44	16.10
1983	0.15	0.40	0.93	1.65	2.66	0.59	1.36	5.13	2.71	1.76	-	2.60	-
1984	0.18	0.14	0.34	1.12	0.41	0.91	1.15	0.31	2.56	0.88 M	1.56	1.05	10.61 M
1985	0.28	0.63 M	1.53	0.25	0.85	0.30	1.24	0.00	1.81	0.95	2.23	1.06	11.13 M
1986	0.59	4.25	1.93	2.55	1.22	0.60	0.67	0.38	2.11	1.44	0.41	0.00	16.15
1987	0.88	0.42	1.34	0.00	3.08	0.52	1.28	1.15	0.18	1.60	1.17	0.89	12.51
1988	0.41	0.15	0.54	1.01	0.55	0.66	0.00	0.14	0.26	0.00	1.26	0.13	5.11
1989	0.41	1.15	1.66	1.38	1.43	1.10	0.17	0.40	0.97	0.63	0.51	0.73	10.54
1990	0.89	0.53	0.39	1.32	0.90	1.23	0.19	0.38	1.11	0.76	1.51	0.67	9.88
1991	0.22	0.00	0.95	1.35	2.76	2.31	0.94	1.07	1.81	1.83	1.88	0.28	15.40
1992	0.69	0.26	0.25	0.94	0.99	0.63	1.16	0.67	0.44	1.80	0.98	1.12	9.93
1993	1.56	0.87	1.19	2.12	1.77	1.25	2.22	1.16	0.15	1.50	0.88	0.53	15.20
1994	0.53	1.23	2.08	1.32	0.69	0.00	0.03	0.58	0.61	2.03	2.48	0.98	12.56
Average*	0.91	0.80 M	0.92	1.11	1.14	0.94	0.61	0.81	0.98	1.20 M	0.93 M	0.86	11.22 M

M For monthly values, superscript M indicates 1 to 9 daily observations are missing and a monthly value is calculated from available data. For annual values, superscript M indicates 1 or more months during the year had 1 to 9 missing observations and an annual value is calculated from available data.

– For monthy values, a hyphen indicates 10 or more daily observations are missing and a monthly value is not calculated. For annual values, a hyphen indicates that one or more months during the year had a missing monthly value and no annual value is calculated.

* The last row of the table gives average monthly values. Each value is calculated using data from all years that have values printed in the table (i.e., all years with 9 or less missing observation during the month). To eliminate bias caused by missing observations, averages are obtained from daily observation rather than by averaging monthly values. The average annual value is obtained from the 12 monthly average values.

County: RICH Elevation: 5980 feet Latitude: 41.816667 Longitude: -111.316667

Appendix E

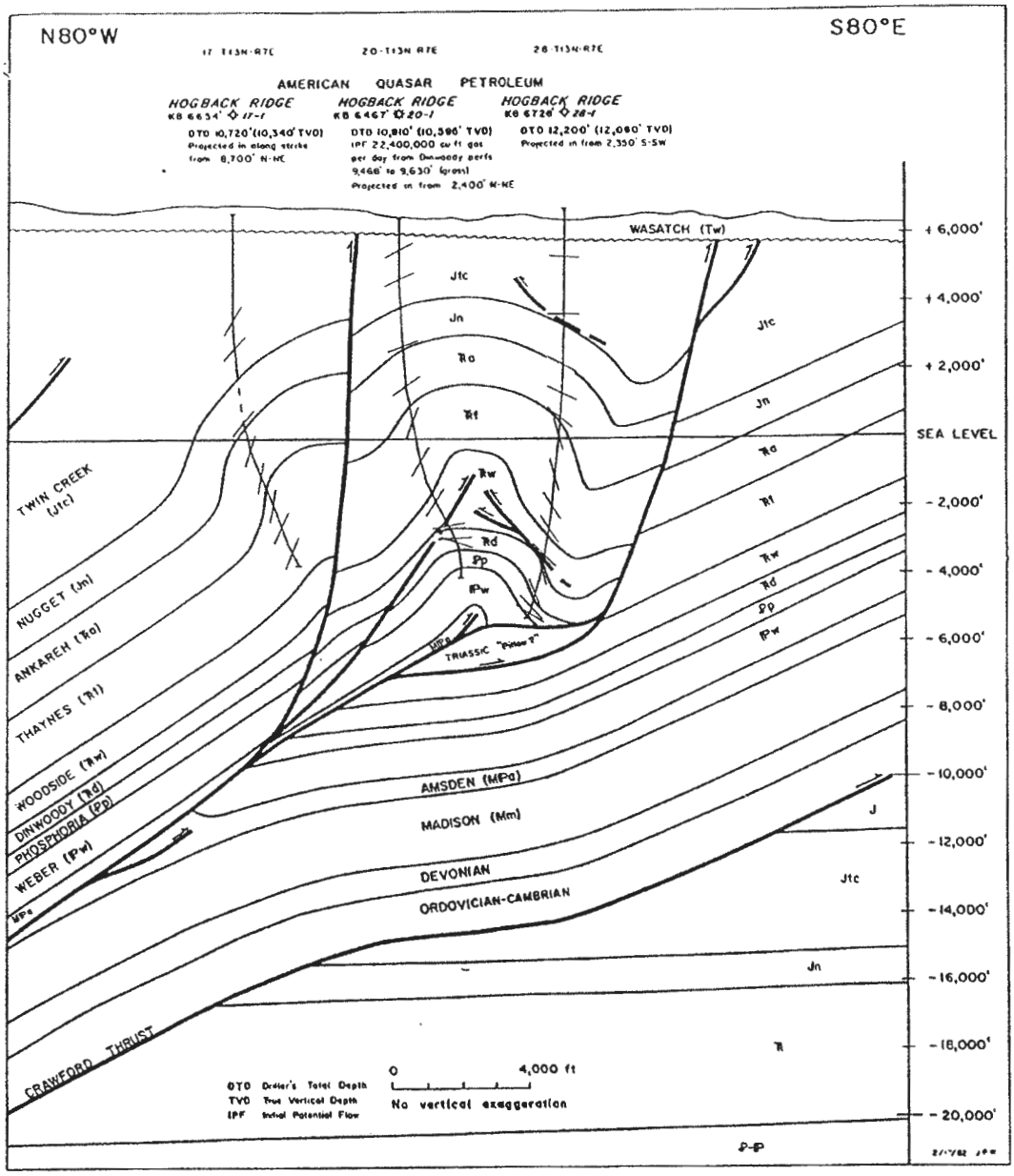


Figure 2. Structure section through Hogback Ridge field. Line of section shown on figures 5 and 6. Section is oriented so as to show true geometrical relationship of the wells and true dips.

ROCKY MOUNTAIN ASSOCIATION OF GEOLOGISTS

TAKEN FROM:

Walker, Jerome P. "Hogback Ridge Field, Rich County, Utah: Thrust-belt Anomaly or Harbinger of Further Discoveries?" In: Geologic Studies of the Cordilleran Thrust Belt. Ed. Richard Powers, Rocky Mountain Association of Geologists, Denver, ColorADO, 1982. 581-590.

TAKEN FROM:

Richardson, G. B., 1941, Geology and Mineral Resources of the Randolph Quadrangle, Utah-Wyoming USGS Bulletin 923, Washington, D.C., 52.

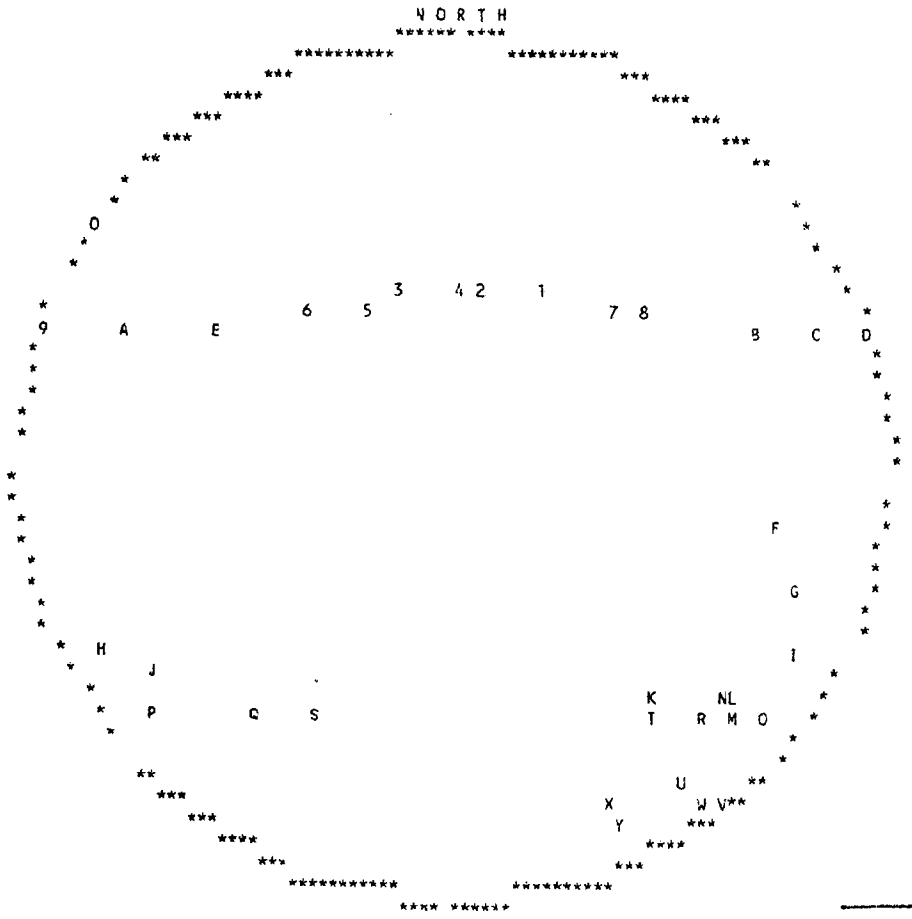
System	Series	Formation	Section	Approximate thickness (feet)	Character of rocks
Tertiary.	Eocene.	Wasatch formation.		1,000+	Varicolored conglomerate and sandstone with subordinate shale, limestone, and tuff.
Cretaceous.	Upper.	Bear River formation.		Complete section not exposed.	Fissile dark clay and carbonaceous shale with interbedded thin gray limestone and buff sandstone.
Cretaceous (?).					
Jurassic.	Upper.	Beckwith formation.		Complete section not exposed.	Gray and buff sandstone and shale overlying varicolored shale and sandstone.
		Twin Creek limestone.		Complete section not exposed.	Thick- and thin-bedded gray limestone; weathers in splintery fragments.
	Middle (?).	Nugget sandstone.		Complete section not exposed.	Thick-bedded, fine-textured red and white sandstone.
Triassic (?).		Ankareh shale.		600	Variegated red and drab sandy and clayey shale, red and gray calcareous sandstone and thin limestone.
Triassic.	Lower.	Thaynes limestone.		Complete section not exposed.	Limestone and calcareous sandstone, locally shaly.
		Woodside shale.		1,000	Varicolored red and green shale, subordinate sandstone and limestone.
Carboniferous.	Permian.	Rex chert member, Phosphoria formation.		400	Chert and limestone, Rex chert member, overlying clayey shale and oolitic phosphate rock.
	Pennsylvanian.	Wells formation.		1,000	Thick-bedded quartzite, calcareous sandstone, and sandy limestone.
	Mississippian.	Brazer limestone.		1,100	Massive gray siliceous limestone and sandstone; in places chorty, lower part thin-bedded and shaly, locally phosphatic.
		Madison limestone.		1,000	Medium- to thin-bedded dark limestone.
Devonian.	Upper.	Three Forks limestone.		200	Thin-bedded limestone, weathers red.
	Middle.	Jefferson dolomite.		1,200	Massive dark dolomite; weathers a characteristic brown tint.
Silurian.		Lakeetown dolomite.		1,000	Massive light-gray dolomite of Niagaran age.

Appendix F

UTAH DIVISION OF WATER RIGHTS
WATER RIGHT POINT OF DIVERSION PLOT CREATED WED, MAR 8, 1995, 10:52 AM
PLOT SHOWS LOCATION OF 36 POINTS OF DIVERSION

PLOT OF AN AREA WITH A RADIUS OF 10560 FEET FROM A POINT
S 2640 FEET, FEET OF THE NE CORNER,
SECTION 16 TOWNSHIP 12N RANGE 7E SL BASE AND MERIDIAN

PLOT SCALE IS APPROXIMATELY 1 INCH = 4000 FEET



Attn: Jeff Gilbert

801-752-6962

4 pages total

Jeff - It does not appear that we have any recent Publications for Rich Co. Any other questions (technical ones) you may want to contact Bob Fotheringham - he is the Regional Engineer for Rich Co. his # is 801-752-8755 - thanks Judy

UTAH DIVISION OF WATER RIGHTS
NWPLAT POINT OF DIVERSION LOCATION PROGRAM

MAP CHAR	WATER RIGHT	QUANTITY CFS	QUANTITY AND/OR AC-FT	SOURCE DESCRIPTION or WELL INFO DIAMETER	DEPTH	YEAR LOG	POINT OF DIVERSION DESCRIPTION NORTH	EAST	CNR	SEC	TWN	RNG	B&M	U N	A P	P E	T E	S U	U G	P R	R E	D
D	23 3356	.0024	.00	Hidden Spring			N 3060	W 660	S4	8	12W	7E	SL		X		X					
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1869												
	USA Bureau of Land Management				P.O. Box 45155					Salt Lake City			UT 84145									
1	23 2989	.0000	.00	Duck Creek											X		X				X	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1885												
	J. W. Ranching, (Incorporated)									Laketown			UT									
2	23 2994	.0000	.00	Duck Creek											X		X				X	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1870												
	USA Bureau of Land Management				P.O. Box 45155					Salt Lake City			UT 84145									
3	23 3200	.0110	.00	Unnamed Spring											X		X				X	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1870												
	USA Bureau of Land Management				P.O. Box 45155					Salt Lake City			UT 84145									
4	23 2990	.0010	.00	Unnamed Spring											X		X				X	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1885												
	USA Bureau of Land Management				P.O. Box 45155					Salt Lake City			UT 84145									
5	23 2991	.0010	.00	Unnamed Spring											X		X				X	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1870												
	USA Bureau of Land Management				P.O. Box 45155					Salt Lake City			UT 84145									
6	23 2992	.0010	.00	Unnamed Spring											X		X				X	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1870												
	USA Bureau of Land Management				P.O. Box 45155					Salt Lake City			UT 84145									
7	23 3031	.0200	.00	Hatch Spring											X		X				X	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1885												
	J. W. Ranching (Incorporated)									Laketown			UT									
8	23 600	2.0000	.00	Duck Creek			N 1125	W 840	SE	10	12W	7E	SL		X		X					
	WATER USE(S): IRRIGATION STOCKWATERING									PRIORITY DATE: 00/00/1876												
	Peart, G. Willard									Randolph			UT 84064									
9	23 3198	.0110	.00	Unnamed Spring											X		X				X	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1870												
	USA Bureau of Land Management				P.O. Box 45155					Salt Lake City			UT 84145									
A	23 2993	.0010	.00	Unnamed Spring											X		X				X	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1870												
	USA Bureau of Land Management				P.O. Box 45155					Salt Lake City			UT 84145									
B	23 2989	.0000	.00	Duck Creek											X		X				X	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1885												
	J. W. Ranching, (Incorporated)									Laketown			UT									
C	23 2987	.0000	.00	Duck Creek											X		X				X	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1876												
	Rich County Land & Grazing Company									Laketown			UT 84038									
D	23 2987	.0000	.00	Duck Creek											X		X				X	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1876												
	Rich County Land & Grazing Company									Laketown			UT 84038									
E	23 3199	.0110	.00	Unnamed Spring											X		X				X	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1870												
	USA Bureau of Land Management				P.O. Box 45155					Salt Lake City			UT 84145									
F	23 146	.0110	.00	Jensen Spring											X		Y				Y	
	WATER USE(S): STOCKWATERING									PRIORITY DATE: 00/00/1885												
	Hatch, Rulon J. & Sarah									Randolph			UT 84064									

UTAH DIVISION OF WATER RIGHTS
NWPLAT POINT OF DIVERSION LOCATION PROGRAM

MAP CHAR	WATER RIGHT	QUANTITY CFS	AND/OR AC-FT	SOURCE DESCRIPTION or WELL INFO DIAMETER	DEPTH	YEAR LOG	POINT OF DIVERSION DESCRIPTION NORTH	EAST	CNR SEC TWN RNG B&M	U N	A P	T E	S U	U G	P R	R E D
G	23 147	.0450	.00	6	88	1986 Y	S 410	E 330	N4 23 12N 7E SL		X				X	
	WATER USE(S): IRRIGATION DOMESTIC STOCKWATERING								PRIORITY DATE: 00/00/1929							
	J. W. Ranching Incorporated								Randolph UT 84064							
H	23 1941	.0100	.00	Unnamed Spring							X		X		X	
	WATER USE(S): STOCKWATERING								PRIORITY DATE: 00/00/1870							
	USA Bureau of Land Management			P.O. Box 45155					Salt Lake City UT 84145							
I	23 3420	.0600	.00	8	154		S 1790	W 2530	NE 23 12N 7E SL		X				X	
	WATER USE(S): STOCKWATERING								PRIORITY DATE: 10/29/1974							
	J. W. Ranching, (Incorporated)								Laketown UT 84038							
J	23 3012	.2200	.00	North Fork Sage Creek			N 3123	W 1779	SE 20 12N 7E SL		X		X			
	WATER USE(S): STOCKWATERING OTHER								PRIORITY DATE: 00/00/1870							
	USA Bureau of Land Management			P.O. Box 45155					Salt Lake City UT 84145							
K	23 148	1.7500	.00	Sage Creek			S 270	W 430	E4 22 12N 7E SL		X		X			
	WATER USE(S): IRRIGATION STOCKWATERING								PRIORITY DATE: 00/00/1885							
	Hatch, Rulon J. & Sarah								Randolph UT 84064							
L	23 73	1.7500	.00	Sage Creek			S 295	E 1510	W4 23 12N 7E SL		X		X			
	WATER USE(S): IRRIGATION STOCKWATERING								PRIORITY DATE: 00/00/1885							
	Schenck, Guy L.								Randolph UT 84064							
M	23 1440	.0150	.00	Underground Water Well			N 1825	E 1445	SW 23 12N 7E SL		X		X			
	WATER USE(S): DOMESTIC STOCKWATERING								PRIORITY DATE: 12/29/1951							
	Schenck, Guy L.								Randolph UT 84064							
N	23 3512	.0150	.00	6	160		S 350	E 1170	W4 23 12N 7E SL		X		X			
	WATER USE(S): IRRIGATION DOMESTIC STOCKWATERING								PRIORITY DATE: 03/23/1978							
	Hatch, Scott								Randolph UT 84064							
O	23 67	.0220	.00	Underground Water Well			S 410	E 2030	W4 23 12N 7E SL		X		X			
	WATER USE(S): DOMESTIC STOCKWATERING								PRIORITY DATE: 00/00/1886							
	Schenck, Guy L.								Randolph UT 84064							
P	23 1477	.0000	.00	Sage Creek							X		X		X	
	WATER USE(S): STOCKWATERING								PRIORITY DATE: 00/00/1870							
	USA Bureau of Land Management			P.O. Box 45155					Salt Lake City UT 84145							
Q	23 1477	.0000	.00	Sage Creek							X		X		X	
	WATER USE(S): STOCKWATERING								PRIORITY DATE: 00/00/1870							
	USA Bureau of Land Management			P.O. Box 45155					Salt Lake City UT 84145							
R	23 1143	.0000	.00	Sage Creek							X		X		X	
	WATER USE(S): STOCKWATERING								PRIORITY DATE: 00/00/1870							
	J. W. Ranching, (Incorporated)								Laketown UT							
R	23 1143	.0000	.00	Sage Creek							X		X		X	
	WATER USE(S): STOCKWATERING								PRIORITY DATE: 00/00/1870							
	J. W. Ranching, (Incorporated)								Laketown UT							
S	23 2126	.0000	.00	Sage Creek							X		X		X	
	WATER USE(S): STOCKWATERING								PRIORITY DATE: 00/00/1890							
	Cook, Howard J. and Lois								Randolph UT 84064							
T	23 2126	.0000	.00	Sage Creek							X		X		X	
	WATER USE(S): STOCKWATERING								PRIORITY DATE: 00/00/1890							
	Cook, Howard J. and Lois								Randolph UT 84064							
U	23 3552	.0150	.00	6	118		N 320	E 150	SW 23 12N 7E SL		X				X	
	WATER USE(S): IRRIGATION DOMESTIC STOCKWATERING								PRIORITY DATE: 10/10/1979							
	Richau, Robert L. & Peggy K.			90 East Sterling Lane					Randolph UT 84064							

UTAH DIVISION OF WATER RIGHTS
NWPLAT POINT OF DIVERSION LOCATION PROGRAM

U = UNAPPROVED
A = APPROVED
P = PERFECTED
T = TERMINATED
S = SURFACE
U = UNDERGROUND
P = POINT TO POINT
R = [illegible]

MAP CHAR	WATER RIGHT	QUANTITY CFS	QUANTITY AND/OR AC-FT	SOURCE DESCRIPTION or WELL INFO DIAMETER	DEPTH	YEAR LOG	NORTH	EAST	POINT OF DIVERSION DESCRIPTION CNR SEC	TWN	RNG	B&M	U N	A P	P E	T E	S U	U G	P R	R E D
V	23 54	.0110	.00	Underground Water Well			N 110	E 1155	SW 23	12N	7E	SL			X			X		
	WATER USE(S): DOMESTIC								PRIORITY DATE: 00/00/1928											
	J. W. Ranching, (Incorporated)								Laketown			UT								
W	23 1443	.0150	.00	Underground Water Well			S 100	E 670	NW 26	12N	7E	SL			X			X		
	WATER USE(S): IRRIGATION DOMESTIC								PRIORITY DATE: 08/27/1952											
	Hoffman, Kennth L. & Helen C.			385 East Sterling					Randolph			UT	84							
	Hoffman, Richard W. & Charmaine M.			385 East Sterling					Randolph			UT	84							
X	23 220	.0020	.00	Spring Hollow Spring											X		X		X	
	WATER USE(S): STOCKWATERING								PRIORITY DATE: 00/00/1885											
	Rich County Land & Grazing Company								Randolph			UT	84064							
Y	23 3638	.0150	.00	6	235		S 340	W 1180	NE 27	12N	7E	SL			X			X		
	WATER USE(S): IRRIGATION DOMESTIC STOCKWATERING								PRIORITY DATE: 01/26/1982											
	Kunz, Darcy			Box 68					Randolph			UT	84064							

Appendix G

RICH COUNTY LANDFILL SEDIMENTS PERCENT PASSING EACH SCREEN SIZE

DATE	LOG#	ID	DEPTH (ft)	>12.5mm	>4.0mm	>2.0mm	>1.65mm	>0.5mm	>0.25mm	>0.125mm	>0.063mm	<0.063mm
04/28	766-5246	P-1	0	1.00	1.00	1.00	1.00	0.99	0.99	0.98	0.65	0.00
04/28	766-5247	P-1	5	0.58	0.32	0.25	0.24	0.13	0.08	0.05	0.02	0.00
04/28	766-5248	P-1	9	0.96	0.90	0.86	0.85	0.66	0.58	0.37	0.18	0.00
04/28	766-5249	P-1	10.5	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.50	0.00
04/28	766-5250	P-1	12	1.00	1.00	1.00	1.00	1.00	1.00	0.62	0.13	0.00
04/28	767-5251	P-2	0	0.89	0.79	0.75	0.74	0.55	0.52	0.50	0.23	0.00
04/28	767-5252	P-2	2.5	1.00	0.98	0.94	0.92	0.19	0.06	0.03	0.01	0.00
04/28	767-5253	P-2	7	0.49	0.32	0.25	0.23	0.10	0.05	0.03	0.01	0.00
04/28	767-5254	P-2	12	1.00	1.00	1.00	1.00	0.99	0.99	0.76	0.31	0.00
04/28	768-5255	P-3	0.25	0.92	0.75	0.66	0.63	0.52	0.47	0.39	0.18	0.00
04/28	768-5256	P-3	2.5	0.61	0.37	0.33	0.32	0.25	0.18	0.08	0.04	0.00
04/28	768-5257	P-3	6	1.00	1.00	1.00	1.00	1.00	0.98	0.47	0.08	0.00
04/28	768-5258	P-3	9	0.50	0.36	0.30	0.29	0.20	0.14	0.06	0.01	0.00
04/28	768-5259	P-3	12.25	1.00	1.00	1.00	1.00	0.99	0.99	0.76	0.31	0.00
04/28	769-5260	P-4	0	0.98	0.93	0.91	0.91	0.88	0.86	0.84	0.42	0.00
04/28	769-5261	P-4	5	1.00	0.98	0.98	0.98	0.96	0.93	0.82	0.45	0.00
04/28	769-5262	P-4	6	0.59	0.50	0.47	0.47	0.40	0.32	0.22	0.10	0.00
04/28	769-5263	P-4	8	0.99	0.93	0.90	0.90	0.86	0.84	0.73	0.35	0.00
04/28	769-5264	P-4	12	1.00	0.97	0.95	0.95	0.89	0.85	0.71	0.42	0.00
04/28	770-5265	P-5	0.5	0.96	0.87	0.84	0.83	0.76	0.74	0.66	0.28	0.00
04/28	770-5266	P-5	5	1.00	1.00	1.00	1.00	0.98	0.80	0.30	0.08	0.00
04/28	770-5267	P-5	11	0.70	0.56	0.43	0.40	0.17	0.09	0.04	0.02	0.00
04/28	770-5268	P-5	17	1.00	1.00	1.00	0.98	0.96	0.90	0.85	0.75	0.00
04/28	771-5269	P-6	0	0.96	0.95	0.94	0.94	0.93	0.91	0.88	0.60	0.00
04/28	771-5270	P-6	3	0.91	0.76	0.73	0.72	0.67	0.59	0.41	0.21	0.00
04/28	771-5271	P-6	6	1.00	1.00	0.99	0.99	0.93	0.59	0.22	0.07	0.00
04/28	771-5272	P-6	9.5	1.00	1.00	0.99	0.99	0.98	0.95	0.94	0.64	0.00
04/28	772-5273	P-7	0.5	1.00	0.99	0.98	0.98	0.96	0.94	0.91	0.66	0.00
04/28	772-5274	P-7	2	1.00	1.00	1.00	1.00	0.98	0.95	0.90	0.57	0.00
04/28	772-5275	P-7	9.5	0.80	0.64	0.58	0.57	0.50	0.47	0.45	0.30	0.00
04/28	772-5276	P-7	12	1.00	1.00	1.00	0.99	0.56	0.44	0.31	0.22	0.00
04/28	773-5277	P-8	1	0.91	0.79	0.75	0.74	0.66	0.62	0.58	0.26	0.00
04/28	773-5278	P-8	3.5	0.94	0.86	0.80	0.78	0.66	0.62	0.56	0.21	0.00
04/28	773-5279	P-8	5.5	0.83	0.52	0.39	0.36	0.09	0.03	0.01	0.00	0.00
04/28	773-5280	P-8	9.5	0.99	0.92	0.87	0.86	0.45	0.14	0.04	0.01	0.00
04/28	774-5281	P-9	0.25	1.00	0.99	0.97	0.97	0.91	0.89	0.85	0.49	0.00
04/28	774-5282	P-9	9	1.00	0.99	0.99	0.99	0.94	0.91	0.88	0.50	0.00
04/28	774-5283	P-9	14	0.87	0.61	0.54	0.53	0.46	0.45	0.32	0.12	0.00
04/28	775-5284	P-1	2.5	1.00	0.96	0.78	0.75	0.56	0.55	0.42	0.15	0.00
04/28	775-5285	P-1	4	0.91	0.67	0.39	0.34	0.14	0.12	0.09	0.04	0.00
04/28	775-5286	P-1	4.5	1.00	1.00	0.99	0.99	0.98	0.95	0.94	0.64	0.00
04/28	775-5287	P-1	6	1.00	1.00	1.00	1.00	1.00	0.99	0.78	0.50	0.00
04/28	775-5288	P-1	11	1.00	1.00	0.99	0.97	0.90	0.89	0.80	0.75	0.00
	776-5289	W-1	10	0.97	0.95	0.94	0.94	0.93	0.78	0.38	0.12	0.00
	776-5290	W-1	20	1.00	0.93	0.85	0.84	0.78	0.70	0.56	0.25	0.00
	776-5291	W-1	22	1.00	0.96	0.92	0.92	0.91	0.87	0.54	0.22	0.00
	776-5292	W-1	30	1.00	1.00	1.00	1.00	1.00	0.97	0.87	0.21	0.00
	776-5293	W-1	38	1.00	1.00	1.00	1.00	1.00	0.98	0.51	0.09	0.00
	776-5294	W-1	40	1.00	0.99	0.99	0.99	0.98	0.97	0.71	0.24	0.00
	776-5295	W-1	45	1.00	0.98	0.97	0.97	0.96	0.91	0.22	0.06	0.00
	776-5296	W-1	60	1.00	1.00	0.94	0.93	0.76	0.65	0.37	0.10	0.00
	776-5297	W-1	70	1.00	1.00	0.98	0.97	0.62	0.57	0.20	0.09	0.00
	776-5298	W-1	80	1.00	1.00	0.87	0.84	0.53	0.42	0.26	0.16	0.00
	776-5299	W-1	90	1.00	1.00	0.99	0.99	0.79	0.75	0.41	0.23	0.00

Soils Investigation Report
for the Rich County Landfill
Rich County, Utah
June 18, 1996

On June 3, 1996, Jeff Gilbert and I traveled to the Rich County Landfill site about 8 miles east of Laketown, Utah. We met the landfill operator and discussed the methods used in excavating trenches for new waste disposal, and also, the method for covering over used trenches and compaction of the surface soil. It was decided that we would sample two locations. The first sampling, # B-1, was done on the surface after the soil was compacted in a routine fashion. The second sample, # B-3, would come from a completed trench at approximately 16' before waste was added. This second sample would be in undisturbed soil.

The sampling device used was a Dames and Moore tube sampler. The stainless steel tube sampler (2.40" in diameter) is pounded into the soil, withdrawn, and the filled tube is removed from the device, capped, and placed in a plastic bag for transport and storage.

As was stated above, soil samples were taken from the compacted surface over a used trench (filled with waste), # B-1. # B-3 was taken in the bottom of a trench; the soil was undisturbed. Falling head permeability tests and USDA soil classification were done on both samples. Soil classification requires that mechanical or sieve analysis, Atterburg limits, hydrometer, and gradation curve be done. The results of these tests are included with this report.

The results are as follows: The surface sample, #B-1, has a permeability or Kav = 1.51×10^{-7} cm/sec. and the USDA classification is a silty clay loam (1% gravel, 6% sand, 61% silt, and 32% clay). The undisturbed bottom of a trench sample, # B-3, has a permeability or Kav=6.02×10^{-8} cm/sec., and a USDA classification of silty clay loam (7% sand, 55% silt, and 38% clay).

These permeabilities are very low and typical of tight clays. Basically, these two soil samples, can be considered impervious. It is our opinion, that the methods and soil used by the landfill operator at this site are effective in limiting the amount of vertical water movement.

Lee Camp, E.I.T.

Lee Camp
6-20-96.

OWNER/LOCATION Knighton-CROW JOB NO.

BORING NO. B-1 DATE 6/6/96

DEPTH Surface TESTED LAF

SAMPLE NO. 1 LAB SOIL DESCRIPTION fill

INITIAL HEIGHT 2.00" FINAL HEIGHT

DENSITY	BEFORE TEST	AFTER TEST
WT. SOIL & RINGS	389.9	
WT. RINGS	90.6	
WT. SOIL	299.3	304.1
WET DENSITY	124.3	126.2
DRY DENSITY	102.9	102.9
MAX. DRY DENSITY		
PERCENT COMPACTION		

MOISTURE	BEFORE TEST	AFTER TEST
WT. WET SOIL & PAN		514.0
WT. DRY SOIL & PAN		458.5
WT. WATER		
WT. OF PAN NO. #9732		210.7
WT. DRY SOIL		
WATER CONTENT	20.8	22.7

SETUP NO. 5 INITIAL DIAL .729

SURCHARGE 1000 PSF FINAL DIAL .730

$K = \frac{aL}{A\Delta t} \text{ in } \frac{h_1}{h_2}$

$H_0 = 3'5" \rightarrow 41.0"$

DATE	TIME	ELAPSED TIME (Δt)	DIAL	BURETTE READING h_1 (CC)	BURETTE READING h_2(CC)	PERCOLATION RATE FT/YEAR	PERCOLATION RATE CM/SEC
6/6/96	1400		.722	0.4			
6/7	0718		.721	12.6			
	1722		.721	16.5			
6/8/96	1251		.721	22.9			
	1632		.723	23.9			
6/9/96	0853		.723	28.4			
6/10/96	1010		.726	34.7			
	1705		.728	36.3			
6/11/96	0636	811	.728	39.4			1.21×10^{-7}
	1616	820	.728	41.7			9.03×10^{-8}
6/12	1638	742	.730	47.7			2.68×10^{-7}
6/13	0632	834	.730	51.0			1.36×10^{-7}
	1316	404	.730	52.6			1.39×10^{-7}

$K_{AV} = 1.51 \times 10^{-7}$ cm/s

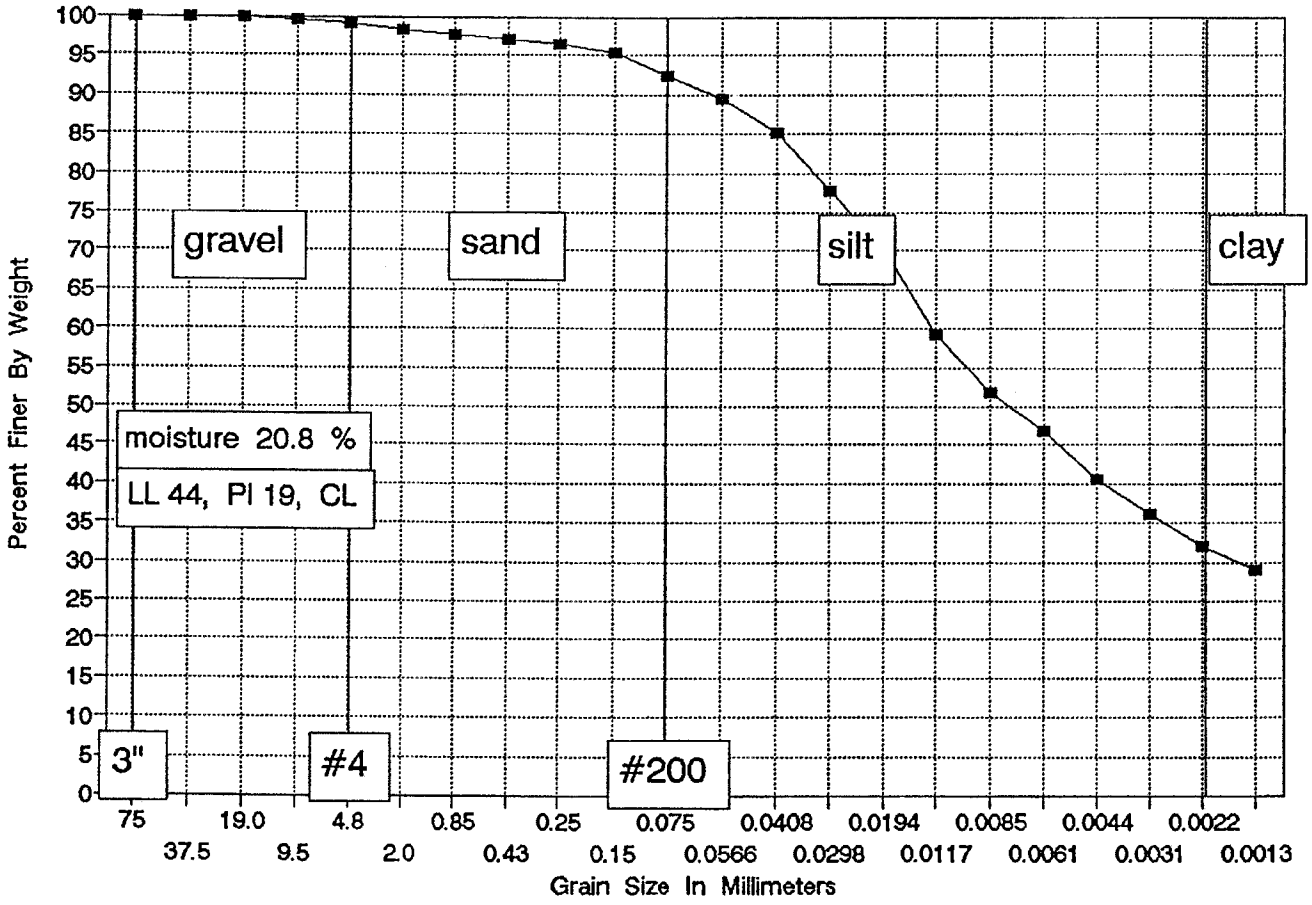
DATE 6/14/96 CHECKED BY DATE BY

PERCOLATION TEST - FALLING HEAD

Dames & Moore

GRADATION CURVE

Boring B-1, Sample 1 at Surface



ATTERBERG LIMITS TEST DATA

FIELD CLASSIFICATION _____

LABORATORY CLASSIFICATION _____

JOB NO. _____

CLIENT/OWNER Knighton Woods

LOCATION _____

BORING B1 SAMPLE 1 DEPTH SURFACE

FIELD DENSITY BY _____

DETERMINATION	1	2
NUMBER OF RINGS		
WT OF RINGS + WET SOIL		
WT OF RINGS	———	———
WT OF WET SOIL		
FIELD DENSITY		
DRY DENSITY		

THIS IS AN 1/8-INCH THREAD

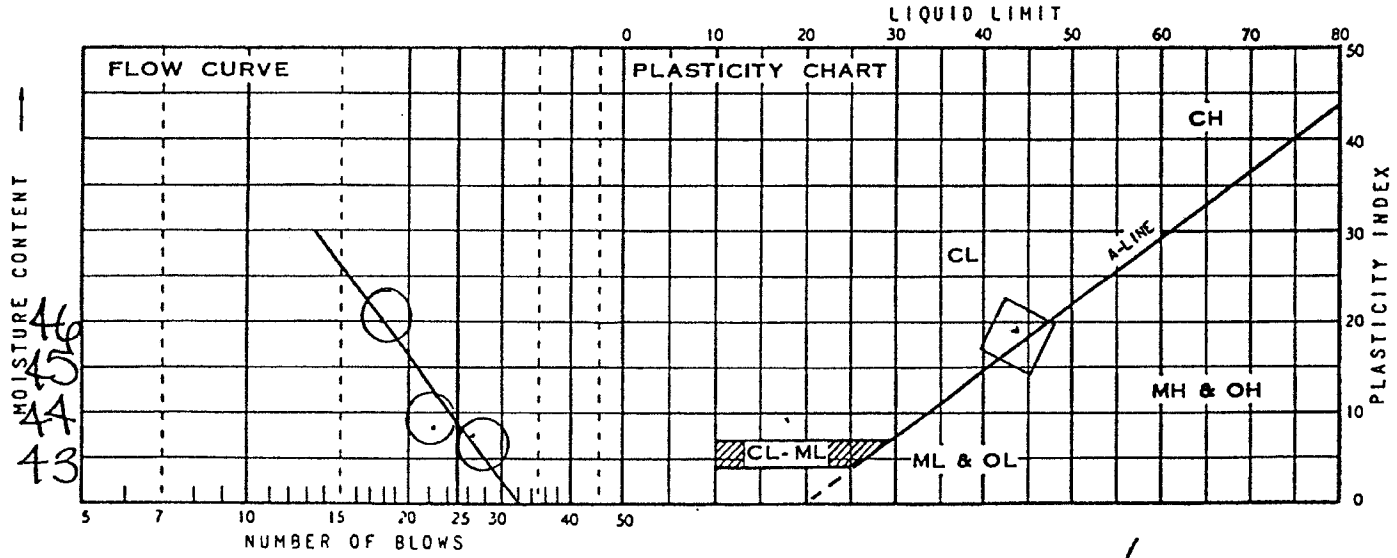
DETERMINATION	1	2
DISH		
WT OF DISH + WET SOIL		
WT OF DISH + DRY SOIL	———	———
WT OF MOISTURE		
WT OF DISH	———	———
WT OF DRY SOIL		
FIELD MOISTURE CONTENT		

PLASTIC LIMIT BY CKH 6.9.96

DETERMINATION	1	2	3	4	5	6
DISH	T8	35				
WT OF DISH + WET SOIL	9.45	10.25				
WT OF DISH + DRY SOIL	8.33	9.01	———	———	———	———
WT OF MOISTURE						
WT OF DISH	1.34	1.38	———	———	———	———
WT OF DRY SOIL						
MOISTURE CONTENT	16.09	16.25	AV = 25			

LIQUID LIMIT

DETERMINATION	1	2	3	4	5	6
DISH	8	72	82			
NUMBER OF BLOWS	34	23	18			
WT OF DISH + WET SOIL	12.05	11.71	12.00			
WT OF DISH + DRY SOIL	8.82	8.57	8.65	———	———	———
WT OF MOISTURE						
WT OF DISH	1.41	1.37	1.38	———	———	———
WT OF DRY SOIL						
MOISTURE CONTENT	43.59	43.61	46.08			



SUMMARY

FG1

DRY DENSITY	MOISTURE CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	IDENTIFICATION	
		44	25	19	CL	

DAMES & MOORE

MECHANICAL ANALYSIS (AL)

SA ☒ HA ☒ BLK SA ☐ -#200 ☐

OWNER/CLIENT Knighton-Crow JOB NUMBER

LOCATION/PROJECT Rich County Landfill DATE 6/6/96

BORING B-1 SAMPLE 1 DEPTH Surface BY LAF

DENSITY		MOISTURE ANALYSIS	M.C.	+#10	-#10	3A
HEIGHT= DIAMETER=		PAN	A-3	A-2	E-6	
NUMBER OF RINGS	Calc	WT. OF PAN & WET SOIL	55.3	89.22	96.80	
WT. OF RINGS & WET SOIL	Pf	WT. OF PAN & DRY SOIL	136.3	87.55	85.36	
WT. OF RINGS		WT. OF MOISTURE				
WT. OF WET SOIL		WT. OF PAN	43.6	43.60	43.7A	
FIELD DENSITY		WT. OF DRY SOIL				
DRY DENSITY		MOISTURE CONTENT %				

WET SAMPLE		4A	
WT. OF WET SAMPLE & PAN		445.4	
WT. OF PAN		52.1	
WT. OF WET SOIL			
WT. OF SAMPLE/ OVEN DRIED			

FIELD SAMPLE CONTAINER	
DRY SIEVE	WASH SIEVE

SAMPLE SPLIT ☐

PAN NUMBER	PAN WEIGHT	SIEVE NUMBER	WEIGHT RETAINED	ACCUMULATIVE WEIGHT RETAINED	ACCUMULATIVE PERCENT PARTIAL RETAINED	ACCUMULATIVE PERCENT PARTIAL FINER	ACCUMULATIVE PERCENT TOTAL FINER
		3"					
		1-1/2".					
		3/4"		0			
		3/8"		1.34			
		#4		2.75			
		#10		5.28			
ST39		#20		.36			
		#40		.57			
		#60		.83			
		#100		1.39			
		#200		2.76			

NOTE:

Dames & Moore

HYDROMETER ANALYSIS

DATE 6/7/96

OWNER KNIGHTON-CROWE JOB NO.

BORING NO. B-1 #1 SURFACE

SAMPLE SPECIMEN NO. CLASSIFICATION

DISH NO. 34 GRADUATE NO. 13 HYDROMETER NO. 152H

DISPERSING AGENT USED SODIUM HEXA META PHOSPHATE ; QUANITY 5.00 GRAMS

DISPERSING AGENT CORRECTION, C_D 5 ; MENISCUS CORRECTION, C_M = 1

TIME	ELAPSED TIME	TEMP °C	HYDRO READING (R')	CORRECTED READING $R+C_M-C_D$	HEIGHT Z_R	PARTICLE DIA. (MM)	PERCENT FINER PARTIAL	PERCENT FINER TOTAL
0911								
	.5	21°	42					
	1	21°	40					
	2.	21°	42.5					
	5.	21°	39					
	15.	21°	33.0					
	30.	21°	30.3					
	60.	21°	28					
1111	120.	21°	25'					
1321	250	21°	23					
1731	500	21°	21					
0840		21°	19.6					

WEIGHT IN GRAMS

DISH PLUS DRY SOIL		
DISH		
DRY SOIL	W_O	

SPECIFIC GRAVITY OF SOLIDS, G_S =

CORRECTED HYDROMETER READING (R) = HYDROMETER READING (R')+C_M

6661.98 6014.15

THE PARTICLE DIAMETER (D) IS CALCULATED FROM STOKE'S EQUATION USING CORRECTED HYDROMETER READING. USE NOMOGRAPHIC CHART FOR SOLUTION OF STOKE'S EQUATION.

HYDROMETER GRADUATED IN SPECIFIC GRAVITY

PARTIAL PERCENT FINER = $\frac{G_S}{G_S-1} \times \frac{100}{W_O}(R-C_D+M)$

HYDROMETER GRADUATED IN GRAMS PER LITER

PARTIAL PERCENT FINER = $\frac{100}{W_O}(R-C_D+M)$

W_S = TOTAL OVEN-DRY WT. OF SAMPLE USED FOR COMBINED ANALYSIS

W_O = OVEN-DRY WT. IN GRAMS OF SOIL USED FOR HYDROMETER ANALYSIS

W_1 = OVEN-DRY WT OF SAMPLE RETAINED ON NO. 200 SIEVE

TOTAL PERCENT FINER = PARTIAL PERCENT FINER $\times \frac{W_S-W_1}{W_S}$

REMARKS

TECHNICIAN RJH COMPUTED BY CHECKED BY

URAQT FORM 1040-A
2-31-73

Knighton-Crow
Rich County Landfill

			field
Boring B-1, Sample 1 at Surface		Wt soil and dish	155.3
		Dry soil & dish	136.3
		dish	43.6
Moisture Content =	20.50 %	H	0
Wet Density =	ERR PCF	A	4.582
Dry Density =	ERR PCF	Ws	0
		total for HA	393.3

SIEVE & HYDROMETER ANALYSIS

SIEVE PORTION

Dry weight of TOTAL sample= 326.4
sample split -#10 sieve = 46.23

Sieve #	Weight Retained	Total Percent Finer
1.5 inch		100.00%
3/4 inch	0	100.00%
3/8 inch	1.34	99.59%
# 4	2.75	99.16%
# 10	5.28	98.38%
# 20	0.36	97.62%
# 40	0.57	97.17%
# 60	0.83	96.62%
# 100	1.39	95.42%
# 200	2.76	92.51%

Constants this test
Gs= 2.75 20c=.01365 21c=.01348 22c=.01332
18c=.01399 19c=.01382
When 5 grams of Sodium
Hexametaphosphate used correction
= 6

HYDROMETER ANALYSIS

Elapsed time	Tc	R'	Zr	Particle Dia. mm	Percent Partial	Total Percent Finer
0.5	21	48	8.38	0.0566	90.85	89.38
1	21	46	8.71	0.0408	86.52	85.12
2	21	42.5	9.29	0.0298	78.95	77.68
5	21	39	9.87	0.0194	71.38	70.23
15	21	33.8	10.72	0.0117	60.13	59.16
30	21	30.3	11.30	0.0085	52.56	51.71
60	21	28	11.68	0.0061	47.59	46.82
120	21	25.1	12.16	0.0044	41.31	40.65
250	21	23	12.51	0.0031	36.77	36.18
500	21	21	12.84	0.0022	32.45	31.92
1409	21	19.6	13.07	0.0013	29.42	28.94

OWNER/LOCATION Knighton-CROW JOB NO.

BORING NO. B-3 DATE 6/6/96

DEPTH 16' - TESTED LaF

SAMPLE NO. 3 LAB SOIL DESCRIPTION Natural

INITIAL HEIGHT 2.00" FINAL HEIGHT 1.988

DENSITY	BEFORE TEST	AFTER TEST
WT. SOIL & RINGS	402.3	
WT. RINGS	90.7	
WT. SOIL	311.6	*315.9
WET DENSITY	129.4	132.0
DRY DENSITY	109.9	110.6
MAX. DRY DENSITY		
PERCENT COMPACTION		

MOISTURE	BEFORE TEST	AFTER TEST
WT. WET SOIL & PAN		537.3
WT. DRY SOIL & PAN		486.2
WT. WATER	#ST-37	
WT. OF PAN NO.		222.5
WT. DRY SOIL		
WATER CONTENT	17.8	19.4

SETUP NO. 6

SURCHARGE 1000 PSF

INITIAL DIAL .755

FINAL DIAL

$K = \frac{aL}{A\Delta t} \text{ in } \frac{h_1}{h_2}$

$H_0 = 3'6\frac{3}{4}" \rightarrow 42.75"$

* 629.1 - 222.5 - 90.7

DATE	TIME	ELAPSED TIME (Δt)	DIAL	BURETTE READING h_1 (CC)	BURETTE READING h_2 (CC)	PERCOLATION RATE FT/~~YEAR~~	PERCOLATION RATE CM/SEC
6/6/96	1336		.742	0.2			
6/7	0718		.744	7.1			
	1722		.744	10.9			
6/8/96	1251		.744	17.2			
	1632		.744	17.8			
6/9/96	0853		.744	20.7			
6/10/96	1010		.743+	24.4			
	1705		.743	25.2			
6/11/96	0636	811	.743	26.8			5.45×10^{-8}
	1616	820	.743	27.9			3.74×10^{-8}
6/12	1638	742		30.6			1.03×10^{-7}
6/13	0632	834		32.1			5.14×10^{-8}
	1329	417	.743	32.9			5.52×10^{-8}

$K_{AV} = 6.02 \times 10^{-8}$ cm/s

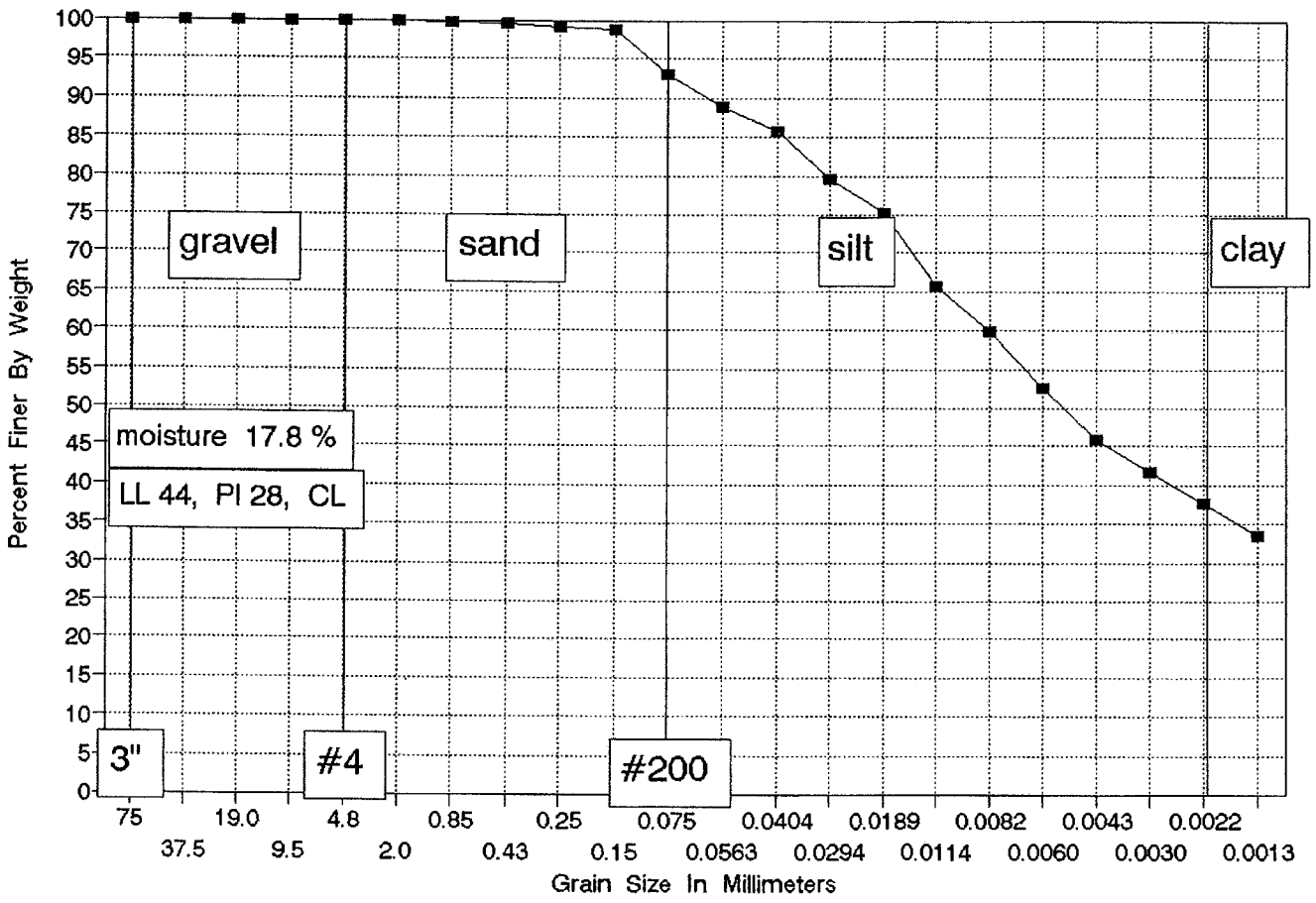
PERCOLATION TEST - FALLING HEAD

Dames & Moore

DATE 6/14/96 CHECKED BY DATE BY

GRADATION CURVE

Boring B-3, Sample 3 at 16 feet



Knighton-Crow
Rich County Landfill

			field
Boring B-3, Sample 3 at 16 feet		Wt soil and dish	146.9
		Dry soil & dish	130.1
		dish	43.6
Moisture Content =	19.42 %	H	0
Wet Density =	ERR PCF	A	4.582
Dry Density =	ERR PCF	Ws	0
		total for HA	349.1

SIEVE & HYDROMETER ANALYSIS

SIEVE PORTION

Dry weight of TOTAL sample= 292.3
sample split -#10 sieve = 47.80

Sieve #	Weight Retained	Total Percent Finer
1.5 inch		100.00%
3/4 inch	0	100.00%
3/8 inch	0	100.00%
# 4	0	100.00%
# 10	0	100.00%
# 20	0.15	99.69%
# 40	0.26	99.46%
# 60	0.36	99.25%
# 100	0.62	98.70%
# 200	3.31	93.08%

Constants this test
Gs= 2.75 20c=.01365 21c=.01348 22c=.01332
18c=.01399 19c=.01382
When 5 grams of Sodium
Hexametaphosphate used correction
= 6

HYDROMETER ANALYSIS

Elapsed time	Tc	R'	Zr	Particle Dia. mm	Percent Partial	Total Percent Finer
0.5	21	48.5	8.30	0.0563	88.91	88.91
1	21	47	8.55	0.0404	85.77	85.77
2	21	44	9.04	0.0294	79.49	79.49
5	21	42	9.37	0.0189	75.31	75.31
15	21	37.4	10.13	0.0114	65.69	65.69
30	21	34.6	10.59	0.0082	59.83	59.83
60	21	31.1	11.17	0.0060	52.51	52.51
120	21	27.9	11.70	0.0043	45.81	45.81
250	21	25.9	12.03	0.0030	41.63	41.63
500	21	24	12.34	0.0022	37.65	37.65
1409	21	22	12.67	0.0013	33.47	33.47

HYDROMETER ANALYSIS

DATE 6/7/96

OWNER KNIGHTON CROWN JOB NO. _____

BORING NO. B-3 #3 16'

SAMPLE SPECIMEN NO. | CLASSIFICATION

DISH NO. L-1 | GRADUATE NO. 6 | HYDROMETER NO. 152H

DISPERSING AGENT USED SODIUM HEXA META PHOSPHATE ; QUANITY 5.00 GRAMS

DISPERSING AGENT CORRECTION, C_D 5 ; MENISCUS CORRECTION, C_M = 1

TIME	ELAPSED TIME	TEMP °C	HYDRO READING (R')	CORRECTED READING $R+C_M-C_D$	HEIGHT Z_R	PARTICLE DIA. (MM)	PERCENT FINER PARTIAL	PERCENT FINER TOTAL
0912								
	.5	21°	48.5					
	1.	21°	47					
	2.	21°	44					
	5.	21°	42					
	15.	21°	37.4					
	30.	21°	34.6					
	60	21°	31.1					
	120.	21°	27.9					
	250.	21°	25.9					
	500.	21°	24					
0841		21°	22					

WEIGHT IN GRAMS

DISH PLUS DRY SOIL		
DISH		
DRY SOIL	W_O	

SPECIFIC GRAVITY OF SOLIDS, G_S =

CORRECTED HYDROMETER READING (R) = HYDROMETER READING (R')+C_M

658.90 - 609.36

THE PARTICLE DIAMETER (D) IS CALCULATED FROM STOKE'S EQUATION USING CORRECTED HYDROMETER READING. USE NOMOGRAPHIC CHART FOR SOLUTION OF STOKE'S EQUATION.

HYDROMETER GRADUATED IN SPECIFIC GRAVITY

$$\text{PARTIAL PERCENT FINER} = \frac{G_S}{G_S - 1} \times \frac{100}{W_O}(R - C_D + M)$$

HYDROMETER GRADUATED IN GRAMS PER LITER

$$\text{PARTIAL PERCENT FINER} = \frac{100}{W_O}(R - C_D + M)$$

W_S = TOTAL OVEN-DRY WT. OF SAMPLE USED FOR COMBINED ANALYSIS

W_O = OVEN-DRY WT. IN GRAMS OF SOIL USED FOR HYDROMETER ANALYSIS

W_1 = OVEN-DRY WT OF SAMPLE RETAINED ON NO. 200 SIEVE

$$\text{TOTAL PERCENT FINER} = \text{PARTIAL PERCENT FINER} \times \frac{W_S - W_1}{W_S}$$

REMARKS _____

TECHNICIAN RJH COMPUTED BY _____ CHECKED BY EGL

URAQT FORM 1040-A
2-31-75

MECHANICAL ANALYSIS

SA ☒ HA ☒ BLK SA ☐ -#200 ☐ (AL)

OWNER /CLIENT Knighton-Crow JOB NUMBER

LOCATION/PROJECT Rich County Landfill DATE 6/6/96

BORING B-3 SAMPLE 3 DEPTH 16' BY LaF

DENSITY		MOISTURE ANALYSIS	M.C.	#10	#10	L-1
HEIGHT= DIAMETER=		PAN	L-8	H22	A-4	
NUMBER OF RINGS	See Pf	WT. OF PAN & WET SOIL	146.9	81.56	100.75	
WT. OF RINGS & WET SOIL		WT. OF PAN & DRY SOIL	130.1	80.11	98.74	
WT. OF RINGS		WT. OF MOISTURE				
WT. OF WET SOIL		WT. OF PAN	43.6	43.51	43.41	
FIELD DENSITY		WT. OF DRY SOIL				
DRY DENSITY		MOISTURE CONTENT %				

WET SAMPLE		Right	
WT. OF WET SAMPLE & PAN		395.9	
WT. OF PAN		46.7	
WT. OF WET SOIL			
WT. OF SAMPLE/ OVEN DRIED			

FIELD SAMPLE CONTAINER	

DRY SIEVE	WASH SIEVE

SAMPLE SPLIT

PAN NUMBER	PAN WEIGHT	SIEVE NUMBER	WEIGHT RETAINED	ACCUMULATIVE WEIGHT RETAINED	ACCUMULATIVE PERCENT		
					PARTIAL		TOTAL
					RETAINED	FINER	FINER
		3"					
		1-1/2".					
		3/4"					
		3/8"					
		#4					
		#10		0			
ST-2		#20		.15			
		#40		.26			
		#60		.36			
		#100		.62			
		#200		3.31			

NOTE:

Dames & Moore

ATTERBERG LIMITS TEST DATA

FIELD CLASSIFICATION _____

LABORATORY CLASSIFICATION _____

JOB NO. _____

CLIENT/OWNER Knighton Crow

LOCATION _____

BORING B3 SAMPLE 3 DEPTH 11.6'

FIELD DENSITY BY _____

DETERMINATION	1	2
NUMBER OF RINGS		
WT OF RINGS + WET SOIL		
WT OF RINGS	—	—
WT OF WET SOIL		
FIELD DENSITY		
DRY DENSITY		

THIS IS AN 1/8-INCH THREAD

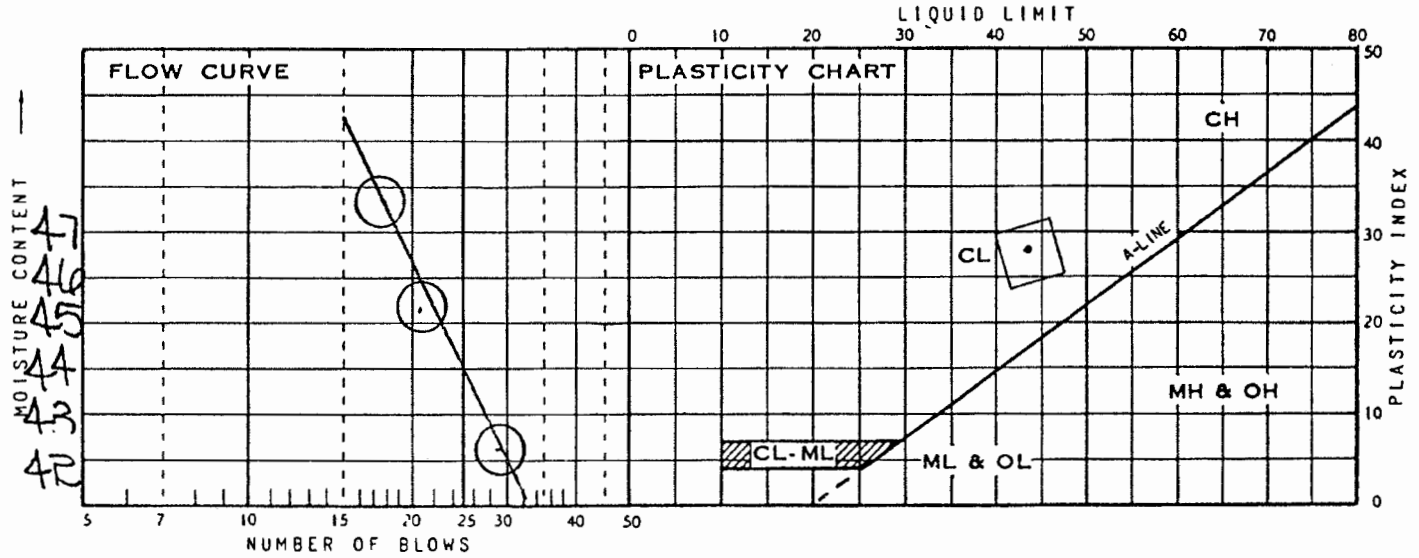
DETERMINATION	1	2
DISH		
WT OF DISH + WET SOIL		
WT OF DISH + DRY SOIL	—	—
WT OF MOISTURE		
WT OF DISH	—	—
WT OF DRY SOIL		
FIELD MOISTURE CONTENT		

PLASTIC LIMIT BY CKH 6/9/16

DETERMINATION	1	2	3	4	5	6
DISH	91	54				
WT OF DISH + WET SOIL	10.46	10.41				
WT OF DISH + DRY SOIL	9.22	9.19	—	—	—	—
WT OF MOISTURE						
WT OF DISH	1.37	1.33	—	—	—	—
WT OF DRY SOIL						
MOISTURE CONTENT	15.80	15.52	AV = 16			

LIQUID LIMIT

DETERMINATION	1	2	3	4	5	6
DISH	60	40	66			
NUMBER OF BLOWS	29	21	10			
WT OF DISH + WET SOIL	11.22	11.87	11.50			
WT OF DISH + DRY SOIL	8.30	8.60	8.23	—	—	—
WT OF MOISTURE						
WT OF DISH	1.38	1.37	1.38	—	—	—
WT OF DRY SOIL						
MOISTURE CONTENT	42.20	45.23	47.74			



SUMMARY

EH

DRY DENSITY	MOISTURE CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	IDENTIFICATION	
		44	16	28	CL	

DAMES & MOORE

Appendix H

Rich County Class II Landfill

EVAPOTRANSPIRATION FINAL COVER
CONSTRUCTION QUALITY ASSURANCE PLAN

PREPARED FOR

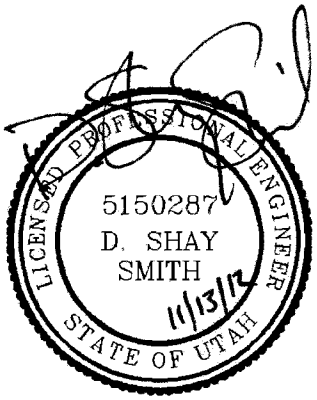
RICH COUNTY COMMISSIONERS
20 S. Main
Randolph, UT 84640

2012

FORSGREN Associates Inc.

Rich County Class II Landfill

EVAPOTRANSPIRATION FINAL COVER
CONSTRUCTION QUALITY ASSURANCE PLAN



2012

OWNER: *Rich County*
20 S. Main
Randolph, UT 84064
Phone: 435-793-2415

ENGINEER: *Forsgren Associates, Inc.*
849 Front St. #201
Evanston, WY 82930
Phone: 307.789.6735
Fax: 307.789.6746

FORSGREN Associates Inc.

1. INTRODUCTION

The purpose of this document is to make sure Rich County Landfill's alternate closure and construction activities are consistent with the Solid & Hazardous Waste Regulation of the State of Utah. This construction quality assurance plan is based on IGES's evaluation of an ET final cover at the Rich County Landfill as presented to Mr. Justin Gurr on May 26th, 2010.

2. ORGANIZATION/RESPONSIBILITIES

The County Engineer will oversee quality assurance of trench cell final cover. He will report directly to the County Commission. He will be responsible for construction quality control and acceptance testing. The County Engineer will be on-site during final cover installation. The County Engineer will inform the County Commission of any problems or issues that arise in the installation of the final cover.

The County Engineer is to make certain tests related to the final cover are conducted appropriately and within the parameters established in this document. He will oversee and supervise the earthwork done by the Landfill Manager.

The County Engineer is responsible for taking field notes and documenting the results of final cover construction activities and testing.

3. QUALIFICATIONS

The following key personnel must meet the following minimum qualifications:

Project Engineer

*Civil or Environmental Engineering Degree
*Licensed Professional Engineer in the State of Utah
*Five years experience on earthwork projects

Landfill Manager

*Five years earthwork experience
*Trained in the operation and construction plans of the Rich County Landfill Permit Application.

4. INSPECTION ACTIVITIES

Evapotranspiration Final Cover

The existing soil at the Rich County landfill has been tested and is likely to perform well as an ET final cover. The site soils should consist primarily of clay type materials with a plasticity index of 18%. The ET cover will consist of two layers of soil. The first layer will be a 6 inch preparation layer to account for site grading anomalies. The second layer or final cover will be 18 inches in thickness for a total soil thickness of 24 inches.

The soil should be placed in lifts not to exceed 8 inches in depth over the preparation layer. The final cover of material should be placed/compacted such that the material will be stabilized but not over compacted as to prohibit the growth of vegetation.

During the placement of the final cover material samples will be taken for every 1000 c.y. of cover material installed. The samples taken will be tested for grain size distribution, liquid limit, plastic limit, plasticity index, and soil moisture characteristics. The Wilting Point and Field Capacity of samples will be determined using the Capillary-Moisture Relationship by Pressure-Membrane Apparatus (ASTM D3152) to insure that the material placed will act as an effective ET final cover.

Once the 18 inches final cover is installed, 6 inches will be the previously staged top soil layer that will be returned to facilitate re-vegetation. Because the area disturbed is relatively small the natural re-vegetation process will negate the need for re-seeding. This has proved to be sufficient on other parts of the landfill. If it is determined that the natural re-vegetation process is not adequate drill seeding with native rangeland vegetation should be implemented.

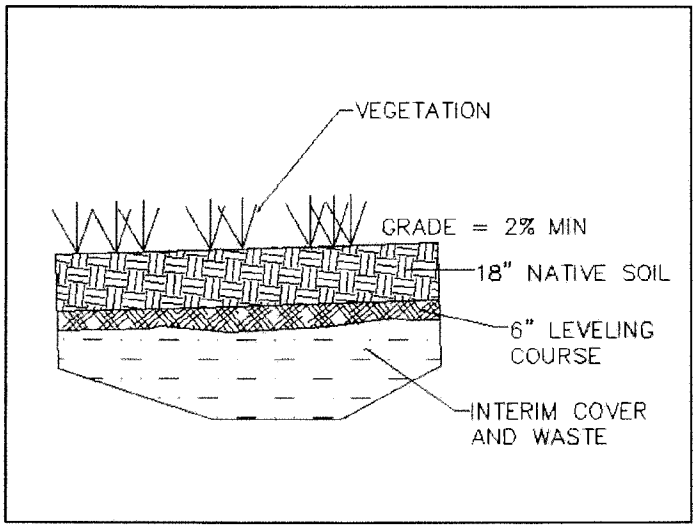


Figure 1 - SOIL PROFILE FOR ET COVER

Application of the final cover for full trench cells will occur in the fall of each year. Trenches that reach capacity other times of the year will receive an interim cover of 6 inches installed consistent with the daily cover. Construction of the final cover once a year will minimize construction and testing expenses.

5. DOCUMENTATION

The County Engineer will document final cover construction activities and testing results and submit a report to the County Commission within 30 days of cell closure.