Revised 01/05

CORRES. CONTROL
INCOMING LTR NO.

00193_RF05

DUE DATE

ACTION

DIST.	LTR	ENC
BERARDINI, J.H.	X	X
BOGNAR, E.S.	X	X
BROOKS, L.	X	X
CARPENTER, M.	X	X
CIUCCI, J.A.		
CROCKETT, G. A.	X	X
DECK, C. A.	X	X
DEGENHART, K. R.	X	X
DEL VECCHIO, D.		
~~DIETER, T. J.~~		
FERRERA, D. W.	X	X
GIACOMINI, J. J.		
GILPIN, H.		
LINDSAY, D. C.		
LONG, J. W.		
MARTINEZ, L. A.	X	X
NAGEL, R. E.	X	X
NESTA, S.		
~~NORTH, K.~~		
SHELTON, D. C.	X	X
SPEARS, M. S.		
TUOR, N. R.		
WIEMELT, K.	X	X
WILLIAMS, J. L.		
ZAHM, C.	X	X
Ward, D	X	X
Davis, B	X	X

COR. CONTROL	X	X
ADMIN. RECORD	X	X
PATS		

Reviewed for Addressee
Corres. Control RFP

4/6/05 (Date) — By: [initials]

Ref. Ltr. #

DOE ORDER #
5400.1

RECEIVED

2005 APR -6 P 3:18

CORRESPONDENCE CONTROL

Department of Energy
ROCKY FLATS PROJECT OFFICE
10808 HIGHWAY 93, UNIT A
GOLDEN, COLORADO 80403-8200

05-DOE-00198

APR 0 4 2005

Ms. Pat Smith
U.S. Environmental Protection Agency, Region VIII
999 18th Street, Suite 300
Denver, Colorado 80202-2466

Mr. Carl Spreng
Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

Dear Ms. Smith and Mr. Spreng:

Enclosed please find:

1. Revised Specification 02221 to include language about gradation testing the 2-inch and 22-inch soil layers. The revision is Part 3, 3.08, 6
2. Revised QA/QC Plan Table 4.2 to include the post placement testing of the 2-inch and 22-inch layers
3. Revised Section of the Design Analysis Report to include vegetation text

These enclosures complete the commitments made by the Department of Energy (DOE) to your respective agencies in the March 24, 2005, correspondence from Mr. Joseph Legare to Mr. Steve Gunderson and Mr. Mark Aguilar. Together with actions already completed, these enclosures satisfy the seven items set by the Environmental Protection Agency in the March 14, 2005, correspondence to DOE as conditions for approval of the design of the east face of the Rocky Flats Present Landfill.

Sincerely,

R.H. Birk

Robert H. Birk

Enclosures

RECEIVED
APR - 7 2005

ADMIN RECORD

BZ-A-000838

1/51

cc w/Encls.:
B. Davis, K-H
Administrative Record

cc w/o Encls.:
M. Aguilar, USEPA
S. Gunderson, CDPHE
D. Shelton, K-H

Present Landfill Accelerated Action

Design Specifications Division 2

SPEC-02221-0943
EARTHWORK

APPROVED	APPROVED AS CORRECTED
NOT APPROVED	REVISE AND SUBMIT

APPROVAL IS FOR CONFORMANCE TO THE SITE DESIGN PROCESS AND WITH THE DESIGN CONCEPT OF THE CALCULATIONS, PLANS, AND SPECIFICATIONS.

PROJECT CHIEF ENGINEER DATE

SPEC-02221-0943
EARTHWORK — REGRADING

PART 1 GENERAL

1.01 SUMMARY

The existing surface of the landfill has not been modified since waste placement operations ceased. The existing surface of the landfill will be regraded to match slopes and contours of the final Synthetic Geocomposite cover surface grades as shown on the Drawings. This section includes procedures that may be required for preparation, excavation, and relocation of existing interim cover soils, and various import soils that make up the final cover profile. Solid waste relocation is not anticipated.

Placement of imported grade fill is anticipated, presuming to continue with immediate placement of the 6-inches of cushion soils once the interim cover soils have been manipulated in accordance with the design drawings. Subsequent soil layer will include a 10-inch cushion layer and a 2 foot soil layer.

1.02 DEFINITIONS

A. INTERIM COVER SOILS

Any materials generated from breaking the plane of the existing Interim Cover of the landfill for purposes of manipulating the surface contours or elevations of the Interim Cover in order to establish initial slopes or elevations required in accordance with the design drawings.

B. GRADE FILL

Soil from a CONTRACTOR approved borrow source which is free of hazardous or solid waste materials and free of ice or snow, organic soils, vegetation, wood, peat, or other unsuitable material. Grade fill shall be a material that is readily capable of being compacted as an engineered fill material and will be used to fulfill the requirement for additional fill during preparation of the regrade surface and the perimeter channels. It is intended that Rocky Flats Alluvium fulfill this requirement.

C. COVER LAYER SOIL (ROCKY FLATS ALLUVIUM)

Soil from a CONTRACTOR approved borrow source which is free of hazardous or solid waste materials and free of ice or snow, organic soils, vegetation, wood, peat, or other unsuitable material. Cover layer soil shall be a material that is readily capable of being compacted as an engineered fill material. This material will be used to fulfill the requirement for additional fill during preparation of the regrade surface and for the top final two feet of the final cover.

D. CUSHION SOIL

Soil from a CONTRACTOR approved borrow source which is free of hazardous or solid waste materials and free of ice or snow, organic soils, vegetation, wood, peat, and is similar to the gradation listed in Table A of this section. Cushion Layer Soil shall be a material that is readily capable of being compacted as an engineered fill material and will be used to provide a 10-inch cushion above the geosynthetic composite cover components for the placement of the rock layer, and to provide a 6-inch cushion for the construction of geosynthetic composite cover.

1.03 SUBMITTALS

The following shall be submitted in accordance with Section 01305 SUBMITTAL PROCEDURES:

A. Equipment:
Motor Grader (Caterpillar 14G or equivalent)
Self-Propelled Scraper (Caterpillar 627 or equivalent)
Bulldozer (Caterpillar D-6 LGP or equivalent)
Self-Propelled Compactor (Caterpillar 815B or equivalent)

B. Geotechnical test results demonstrating soil source compliance with this specification and the Construction QA/QC plan.

C. Certified waybills and delivery tickets for all materials.

1.04 CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL

The SUBCONTRACTOR shall abide by all qualification and submittal requirements of the Construction QA/QC (QA/QC) plan.

Work will be monitored and tested in accordance with the requirements of the QA/QC Plan.

The SUBCONTRACTOR shall be aware of all activities outlined in the Construction QA/QC plan, and the SUBCONTRACTOR shall account for these activities in the construction schedule. No additional cost shall be allowed to the CONTRACTOR as a result of the performance of the QA/QC activities of the SUBCONTRACTOR.

1.05 MEASUREMENT AND PAYMENT

A. Measurement for Payment

Make measurements of time and materials necessary to support monthly project status reports that include an estimate of project percent complete.

B. Payment

Payment will be made as outlined in Section 01270: MEASUREMENTS AND PAYMENT

PART 2 MATERIALS

2.01 GRADE FILL

If required, supply per definition above.

2.02 ROCKY FLATS ALLUVIUM

Supply per definition above.

2.03 CUSHION LAYER SOIL

Supply per definition above.

PART 3 EXECUTION

3.01 PREPARATION

A. Before commencement of construction of the cover system, the site shall be prepared in accordance with the following:

1. Place temporary erosion protection as required per Section 02228: EROSION CONTROL.

2. The existing landfill grade (i.e. top surface of the existing landfill Interim Cover) shall be close-mowed in accordance with Section 02110: SITE PREPARATION. All trees shall be cut flush to original ground surface or subgrade and stumps/roots removed.

3. The landfill regrade cut and fill program portrayed in the project design drawings shall be established in accordance with standard construction staking practice and to tolerances established in this section and in accordance with Section 01722: FIELD ENGINEERING. All staking shall be maintained as required to support construction activities necessary to establish the landfill regrade surface as portrayed in the project design drawings.

4. The landfill surface outside the area of the regrade cut and fill program shall be investigated for bearing capacity performance and suitability as a subgrade surface. This landfill subgrade area shall be proof-rolled using a rubber-tired roller or loaded scraper, operating at a speed not to exceed 5 miles per hour. Rubber-tired rollers shall contain a minimum of four wheels per axle equipped with pneumatic tires such as a CAT PS-110 or approved equivalent. Rubber-tired rollers shall have a minimum operating weight of 25,000 pounds and shall be equipped with tires of sufficient size to maintain a tire pressure between 80 and 100 pounds per square inch during operation. Proof-rolling shall consist of a minimum of 2 coverages with a coverage defined as a single pass of the entire vehicle. If used, scrapers shall have a minimum loaded operating weight of 150,000 pounds and shall make a minimum of 2 coverages with a coverage defined as the area in direct contact with the tires of the scraper due to a single pass of the entire vehicle. Areas with unacceptable deflections (in the order of 1 to 3 inches) shall be repaired at the direction of the CTR, such that deflections are less than 1 inch when proof-rolled again.

5. Remove unsuitable grade fill, or bridge the area with material capable of adequately limiting deflection. Proof roll and repeat as necessary.

6. Assure fill area is not impacted by ice, snow, and/or frozen material prior to beginning placement.

7. Unsuitable soil shall be excavated and placed in accordance with the following subsections.

3.02 EXCAVATION/REGRADING

A. Where excavation of materials from the cut and fill program, or of unsuitable soil, is required the following procedure shall be initiated:

1. Excavate/remove soils or waste items in accordance with the regrade cut and fill program. During excavation of materials from or within the existing Interim Cover of the Landfill, follow all instruction and requirements of the Health and Safety Work Control Document and Field Implementation Work Control Document as they relate to the exposure and monitoring of waste, and subsequent decontamination procedures as appropriate. Transport excavated materials to fill area.

2. Proof roll final excavation surface and over excavate to remove unsuitable material that will not form an adequate regrade surface for the final cover layer. Replace with grade fill in accordance with Paragraph 3.04. During regrading activities, the entire surface of the landfill area will be traversed with heavy equipment to achieve a minimum compaction performance standard of 95 percent standard Proctor dry density (ASTM D698). The development of the method to achieve this compaction goal will be accomplished using a test fill prior to construction to determine the number of required of passes with a piece of equipment to achieve the required compaction. If any areas of unacceptable deflections (in the order of 1 to 3 inches) are encountered, they shall be repaired at the direction of the CRT such that deflections are less than 1 inch when proof-rolled again.

3. Placement of grade fill may be required to maintain positive drainage if excavation extends beyond the limit of excavation shown on the Drawings, or below excavation grades shown. Grade fill shall be placed in accordance with Section 3.04 of this Specification and as such to facilitate the placement of overlying fill and cover materials. If wet soil/material is encountered at a depth greater than 2 feet, placement of bridging materials (e.g. washed rock in excess of 1 1/2" minimum dimension) in the area, or other methods approved by the DESIGNER to improve bearing capacity will be performed.

3.03 DEWATERING

A. No surface dewatering is expected from the current site conditions, or the cut and fill program for the subgrade. However, if dewatering is required, the following procedure shall be initiated:

1. Maintain surface water control and free drainage such that all incidental waters of precipitation and dust control are retained within the footprint of the landfill waste boundary.

2. If necessary, provide surface water pumps, hoses and other necessary equipment and labor to keep excavation free of standing water. Water coming in contact with soil shall be collected and disposed per Section 02720: LIQUIDS REMOVAL.

3.04 INTERIM COVER SOIL - REGRADE MATERIAL PLACEMENT

For the execution of the regrade preparation cut and fill program, the following placement procedure shall be initiated where placement is required:

1. Scarify prepared surface before placement of fill material to provide bonding between materials.

2. Begin construction of subgrade fill at lowest point of fill below grade and construct in layers by spreading and leveling material during placement. Spread individual layers to uniform thickness throughout and approximately parallel with finished grade within current working area of fill placement. Step transition between work areas as filling progresses to prevent vertical joints within fill.

3. Place materials uniformly in maximum 1-foot loose lifts within current working area of fill placement.

4. Compact materials by traversing with a minimum of 6 passes with a CAT 815B compactor, or alternate piece of equipment approved by the CTR before placing next lift. Revisions to the number of passes and equipment type may only be made with the CTR's approval.

5. Maintain lifts to provide positive drainage away from construction.

6. Where material for fill consists of rock, rubble, or waste material of such size as to render placing in 1-foot layers impractical, material may be placed in layers not exceeding in thickness the approximate average size of larger materials provided individual pieces are so placed that there will be no nesting, and voids are filled with smaller soil or waste materials.

7. Do not place frozen materials, and do not place materials on frozen surfaces. Frozen materials are defined as soil with a temperature less than 32°F or containing visible ice crystals, or clods of frozen soil larger than 4 inches in any direction.

8. Supplemental aeration may be necessary to facilitate drying.

9. Wet soil shall be spread over an area to receive fill and shall be allowed to air dry to a sufficient state that it may be compacted and may serve as adequate material for placement of overlying fill and cover materials.

3.05 6-INCH CUSHION LAYER SOIL PLACEMENT

For the execution of the 6-inch foundation layer preparation program, the following placement procedure shall be initiated:

1. Place foundation soils in accordance with this Specification and the approved design drawings and design report.

2. The regraded landfill surface shall be scarified to promote bonding between materials.

3. Place materials in a uniform single thickness of material sufficiently thick to accommodate establishing grade of the final surface, and to account for settlement due to grading. This process is intended to form a uniformly thick soil mass of a minimum finished thickness of 6 inches, free of large voids throughout and approximately parallel with finished grade within current working area of final cover placement. Remove cobbles greater than 0.5 inches and break down clods to less than 4 inches in maximum dimension. In general the 6-inch cushion soil will meet the physical characteristics of the "pit fine" soils detailed in Appendix D of the Design Analysis Report. A typical grain size distribution for this material is included in the table below.

TABLE A

Sieve Size	Percent Finer
0.5 in.	100.0
0.375 in.	96.5
#4	81.3
#10	66.1
#20	50.9
#40	38.2
#60	30.5
#100	25.0
#200	20.5

4. Materials shall be placed at a final compaction of 95 percent standard proctor dry density (ASTM D698) with a moisture requirement of ±2 percent of the optimum moisture content (OMC) as measured by standard proctor density (ASTM D698).

3.06 10 –INCH CUSHION LAYER SOIL PLACEMENT

For the execution of the 10-inch cushion layer preparation program, the following placement procedure shall be initiated:

1. Place cushion soils in accordance with this Specification and the approved design drawings and design report.

2. The soil will be placed in front of the equipment such that the equipment does not drive directly on top of the geosynthetic components of the liner. The soil will be

spread using a Caterpillar Low-Ground Pressure D-6 bulldozer (or equivalent).

3. Place materials in a uniform single thickness of material sufficiently thick to accommodate establishing grade of the final surface, and to account for settlement due to grading. This process is intended to form a uniformly thick soil mass of a minimum finished thickness of 10 inches, free of large voids throughout and approximately parallel with finished grade within current working area of final cover placement. Remove cobbles greater than 0.5 inches and break down clods to less than 4 inches in maximum dimension. In general the 10-inch cushion soil will meet the physical characteristics of the "pit fine" soils detailed in Appendix D of the Design Analysis Report. A typical grain size distribution for this material is included in the table below.

TABLE B

Sieve Size	Percent Finer
0.5 in.	100.0
0.375 in.	96.5
#4	81.3
#10	66.1
#20	50.9
#40	38.2
#60	30.5
#100	25.0
#200	20.5

4. Materials shall be placed at a final compaction of 95 percent standard proctor dry density (ASTM D698) with a moisture requirement of ±2 percent of the optimum moisture content (OMC) as measured by standard proctor density (ASTM D698).

3.07 ROCKY FLATS ALLUVIUM FINAL COVER SOIL PLACEMENT

The final soil cover shall be placed with minimal compaction. For the execution of the final soil cover, the following placement elements and procedures shall be followed:

1. Place final cover soils in accordance with this Specification and the design drawings. The borrow source (Rocky Flats Alluvium) for the layer of final cover soils will be provided by the SUBCONTRACTOR.

2. The soil cover materials will be placed in stockpiles directly from the trucks onto the top of the Rock Layer system. No trucks will be allowed to drive on top of the Rock Layer rock surface. Soil will be placed and pushed forward across the Rock Layer surface.

3. Soil materials will be evenly spread across on the top surface to reach grading requirements as depicted in the design drawings, using a Caterpillar Low-Ground Pressure D-6 bulldozer (or equivalent).

4. Place materials in one uniform lift to create a interim finished thickness of 22-inches (minimum). The intent is for the material to be sufficiently thick to establish final surface grades as shown on the design drawings. Placement is intended to form a uniformly thick soil mass of a minimum finished thickness of 22-inches, free of large voids throughout and parallel with finished grade within current working area of final cover placement.

5. Place an additional 2 to 3 inches of materials in one uniform lift to create a final finished soil layer thickness of 24-inches (minimum). Placement of this material shall be sufficiently thick to reach final surface grades as shown on the design drawings. The soil for this final layer will be obtained from the stockpile of soil that was grubbed from the surface of the landfill at the beginning of the project. These soils contain the root systems and organic matter that had previously established on the interim cover, and will facilitate the establishment of the new vegetation.

6. Samples of the soil cover, both the 22-inch lift and 2-inch lift will be sampled and tested in accordance with the QA/QC Plan to determine the gradation of these soils. This testing is for the purpose of documenting in-place soil gradation in the project completion report.

3.08 FIELD QUALITY ASSURANCE/QUALITY CONTROL

A. Grade Fill Placement and Compaction

In accordance with the Construction QA/QC plan.

B. Tolerances

1. The regrade of the landfill surface shall be within 0.5 feet horizontal and ±0.1 feet vertical of the control points shown on the Drawings, and meet the minimum slope requirements shown on the drawings unless approved in writing by the CTR.
2. For the cushion, foundations, rock and cover soil layers, the thickness of the layers shall be within 0.0 ft to +0.2 ft of the specified thickness.

C. Final Grades

In accordance with the QA/QC Plan, the completed design subgrades shall be surveyed by SUBCONTRACTOR and approved by Site QA Manager before further placement of cover materials.

*****END OF SECTION*****

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TABLE 4.2

EARTHWORK QA/QC SUMMARY
100% DESIGN - PRESENT LANDFILL DESIGN, RFETS, GOLDEN, COLORADO

Quality Control Item	CQAP Section	Specification Section	QA/QC Item	Method	Requirements	QC Action	QA Action
General Project	1.1	01310, 01320	Submittal	QA/QC Personnel Requirements	Submit to EPA/CDPHE 10 days prior to construction, including alternates.	NA	NA
			Construction Photographs	Digital Camera	Sufficient pre-construction, construction, and post-construction photographs to document the process.	Daily	Review
			RFI Log	Documentation	Submit RFI log weekly to EPA/CDPHE or whenever a change is made.	Review	Review and Approve
			Daily Reports	Documentation	QA Daily and QC Daily.	Submit QC Dailies to SQAM for Review	Submit QA Report to CTR
Site Preparation	4.0	02110	Grubbing within limit of waste	Visual inspection	Ensure areas are close mowed.	Continuous	Continuous
			Grubbing outside limit of waste	Visual inspection	Ensure the vegetation is removed and area is scarified to 6-inches.	Continuous	Continuous
Rocky Flats Alluvium	4.6	02221	Submittal	Proposed Equipment List	Submit prior to use.	Review	Review and Approve
			Submittal	Geotechnical Test Results	Submit prior to use.	Review	Review and Approve
			Submittal	Certified Waybills	Submit prior to use.	Review	Review and Approve
			Field density	Method Specification	See Specification 02221	Continuous	Oversight of QC
			Atterberg limits	ASTM D 4318	Consistent with initial borrow area sampling as determined by the CQAE.	1/6,500 cy	1 per 20 QC samples (minimum of 1)
			Sieve analysis (with USCS classification)	ASTM D 422	Consistent with initial borrow area sampling as determined by the CQAE.	1/6,500 cy	
			Placement Documentation	Visual inspection	Ensure and document that no trucks traverse the rock layer when placing RFA. Place in uniform lifts.	Continuous	Oversight of QC
			Placement Documentation	ASTM D 5519, ASTM D 422 on 22-inch and 2-inch layer only of 24-inch soil cover	Document gradation of soil cover only.	1/6,500 cy	1 per 20 QC samples (minimum of 1)
Cushion Soils	4.6	02221	Submittal	Proposed Equipment List	Submit prior to use.	Review	Review and Approve
			Submittal	Geotechnical Test Results	Submit prior to use.	Review	Review and Approve
			Submittal	Certified Waybills	Submit prior to use.	Review	Review and Approve
			Field density	ASTM D 2922	95% of maximum dry density +- 2 percent optimum moisture content	1/5,000 ft2/lift	1 per 20 QC samples (minimum of 1)
			Field Density Calibration	Standard Counts	Conduct daily standard counts per Manufacturer's representative.	Daily when device is used	Oversight of QC
			Field Density Verification	ASTM D 1556, ASTM D 2167	Verify ASTM D 2922 results	1/20 field density	Oversight of QC
			Field Moisture Verification	ASTM D 2216	Verify ASTM D 2922 moisture	1/20 field density	Oversight of QC

TABLE 4.2

EARTHWORK QA/QC SUMMARY
100% DESIGN - PRESENT LANDFILL DESIGN, RFETS, GOLDEN, COLORADO

Quality Control Item	CQAP Section	Specification Section	QA/QC Item	Method	Requirements	QC Action	QA Action
Cushion Soils Cont.	4.6	02221	Failed Density Test	ASTM D 2922	Two confirmatory tests adjacent to failed test. If either fails, area needs to be reworked.	As needed	Oversight of QC
			Laboratory compaction	ASTM D 698	Report	1/6,500 cy	1 per 20 QC samples (minimum of 1)
			Atterberg limits	ASTM D 4318	Consistent with initial borrow area sampling as determined by the CQAE	1/6,500 cy	
			Sieve analysis (with USCS classification)	ASTM D 422	Consistent with initial borrow area sampling as determined by the CQAE	1/6,500 cy	
			Placement Documentation	Visual inspection	For GCL cushion, scarify regraded surface, place in 6-inch lifts, remove clods greater than 4-inches in any dimension. For rock cushion, place with D6LGP in a single uniform lift removing clods greater than 4-inches in any direction. Ensure fill is moisture-conditioned in accordance with Test Fill Program.	Continuous	Oversight of QC
			Placement Documentation	Visual inspection	Underlying surface is clean, free of all foreign debris, not disturbed by traffic or other operations, and maintained in a satisfactory condition.	Continuous	Oversight of QC
			Placement Documentation	Visual inspection	The underlying material is accepted by the SQAM and has not changed detrimentally.	Continuous	Continuous
Regrade Soil	4.1	02221	Material Type	Visual inspection	Free of ice, snow, organic soils, vegetation, wood, peat, stones larger than 6-inches in any direction.	Continuous	Oversight of QC
			Field density	ASTM D 2922, D 3017, D 1556, or D 2167 or as developed in Test Fill	95% of maximum dry density or as developed in Test Fill Program.	1/5,000 ft2/lift	1 per 20 QC samples (minimum of 1)
			Proof-rolling	See Specification 02221, paragraph 3.01	Unacceptable deflection between 1-3 inches	Full coverage	Full coverage
			Unstable Areas	Remove unstable material or bridge	Remedy to less than 1-inch of deflection	Approve remedy installation and proof-roll	Approve remedy installation and proof-roll

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TABLE 4.2

EARTHWORK QA/QC SUMMARY
100% DESIGN - PRESENT LANDFILL DESIGN, RFETS, GOLDEN, COLORADO

Quality Control Item	CQAP Section	Specification Section	QA/QC Item	Method	Requirements	QC Action	QA Action
Regrade Soil Cont.	4.1	02221	Placement Documentation	Visual inspection	Scarify before fill is placed, place in maximum 1-foot lifts, and step transition work areas to prevent vertical joints. Do not place fill on frozen surfaces (less than 32°F) or surfaces containing ice crystals or clods of frozen soil larger than 4-inches.	Continuous	Oversight of QC
			Placement Documentation	Visual inspection	Verify that the soil within the top 6-inches does not contain refuse, debris, vegetation, or any material that may leave voids in the subgrade.	Continuous	Oversight of QC
			Placement Documentation	Visual inspection	Document placement and compaction including lift thickness, type of equipment used, and number of passes. Minimum of 6 passes with a CAT 815B compactor or in accordance with the Test Fill Program.	Continuous	Oversight of QC
			Placement Documentation	Visual inspection	Document placement and compaction including lift thickness, type of equipment used, and number of passes.	Continuous	Oversight of QC
Drainage Rock (gas collection trenches, anchor trench)	4.7	02245	Submittal	Proposed Equipment List	Submit prior to use.	Review	Review and Approve
			Submittal	Geotechnical Test Results	Submit prior to use.	Review	Review and Approve
			Submittal	Certified Waybills	Submit prior to use.	Review	Review and Approve
			Sieve analysis	ASTM D 422	See 02245 2.01C	1/6,500 cy	1 per 20 QC samples (minimum of 1)
			Laboratory compaction	ASTM D 1557	Report	1/6,500 cy	1 per 20 QC samples (minimum of 1)
			Layer thickness	Survey	See paragraph 3.06, Specification 02714	Oversight	Oversight
			Placement Documentation	Visual inspection	Area to receive drainage rock to be lined with separation geotextile per CQAP Table 4.1 with 6-inch end and edge overlaps, including the top of the drainage rock.	Continuous	Oversight of QC

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TABLE 4.2

EARTHWORK QA/QC SUMMARY
100% DESIGN - PRESENT LANDFILL DESIGN, RFETS, GOLDEN, COLORADO

Quality Control Item	CQAP Section	Specification Section	QA/QC Item	Method	Requirements	QC Action	QA Action
Seep Passive Treatment System	4.7	11100	Component Documentation	Visual inspection	General appearance, dimensions, soundness, etc. Concrete shall be dense, close textured, and free of blisters, cracks, roughness, and exposure of reinforcement.	As materials arrive on-site	As materials arrive on-site
			Placement Documentation	Visual inspection	Installed to design, precautions to prevent damage, subgrade prepared to specifications, condition of subgrade has not changed detrimentally, field tested or Specifications, backfilled to Specifications.	Continuous	Oversight of QC
Riprap and Riprap Bedding	4.10	02245	Submittal	Proposed Equipment List	Submit prior to use.	Review	Review and Approve
			Submittal	Geotechnical Test Results	Submit prior to use.	Review	Review and Approve
			Submittal	Certified Waybills	Submit prior to use.	Review	Review and Approve
			Field gradation	Visual inspection	See Table 02245-2	1/Material type (i.e., 6-inch or 9-inch riprap)	1/Material type (i.e., 6-inch or 9-inch riprap)
			Sieve analysis	ASTM C 136 or ASTM D 5519	See Table 02245-2	1/Material type (i.e., 6-inch or 9-inch riprap)	1 per 20 QC samples (minimum of 1)
			Specific gravity	ASTM C 127	2.5 or greater	Review of supplier's test data for each riprap gradation	Review of supplier's test data for each riprap gradation
			Absorption	ASTM C 127	2% or less		
			LA abrasion	ASTM C 131	≤ 10% loss for 100 revs., or ≤ 40% loss for 500 revs.		
			Sodium sulfate soundness	ASTM C 88	≤ 10% loss		
			Placement Documentation	Visual inspection	Place to produce a well-graded mass using a zero-drop height. Begin placement downslope and proceed upslope. Ensure no organic or soft friable material is present.	Continuous	Oversight of QC
			Placement Documentation	Visual inspection	Underlying subgrade is smooth and free of soft areas and voids and meets grading requirements.	Continuous	Oversight of QC
			Placement Documentation	Visual inspection	All work on underlying materials is complete and accepted by SQAM.	Continuous	Oversight of QC
			Placement Documentation	Visual inspection	The condition of the underlying layer has not changed detrimentally during installation and repaired if necessary.	Continuous	Oversight of QC
Rock Layer	4.5	02222	Submittal	Proposed Equipment List	Submit prior to use.	Review	Review and Approve
			Submittal	Geotechnical Test Results	Submit prior to use.	Review	Review and Approve
			Submittal	Certified Waybills	Submit prior to use.	Review	Review and Approve

TABLE 4.2

EARTHWORK QA/QC SUMMARY
100% DESIGN - PRESENT LANDFILL DESIGN, RFETS, GOLDEN, COLORADO

Quality Control Item	CQAP Section	Specification Section	QA/QC Item	Method	Requirements	QC Action	QA Action
Rock Layer Cont.	4.5	02222	Field gradation	Visual inspection	See Specification 02222-2.01	Daily inspections as material is delivered	Daily inspections as material is delivered
			Sieve analysis	ASTM C 136 or ASTM D 5519	See Specification 02222-2.01	1/6,500 cy	1 per 20 QC samples (minimum of 1)
			Unconfined compressive strength	ASTM D 2938	4,000 psi	1/6,500 cy	1 per 20 QC samples (minimum of 1)
			Placement Documentation	Visual inspection	Place with a maximum void space of 2-inches, keep larger rocks well distributed, and do not drive equipment on placed rocks.	Continuous	Oversight of QC
			Placement Documentation	Visual inspection	Underlying cushion soil is clean, free of all foreign debris, not disturbed by traffic or other operations, and maintained in a satisfactory condition.	Continuous	Oversight of QC
			Placement Documentation	Visual inspection	Underlying materials is accepted by the SQAM and has not changed detrimentally.	Continuous	Oversight of QC
Seeding	4.11	02900	Submittal	List of proposed equipment	Submit prior to use.	Review	Review and Approve
			Submittal	Certified copy of seed analysis	Submit prior to use.	Review	Review and Approve
			Submittal	Seed bag tickets	Submit prior to use.	Review	Review and Approve
			Submittal	Documentation of seed calibration	Submit prior to use.	Review	Review and Approve
			Topsoil Sieve Analysis	USDA	Report	Review	Review and Approve
			Topsoil Organic Content	USDA	Report	Review	Review and Approve
			Topsoil N,P,K	USDA	Report	Review	Review and Approve
			Surface Inspection	Visual inspection	Topsoil is free from hard lumps, plants, roots, gravel, cinders, and stones over 1-inch in any dimension.	Continuous	Oversight of QC
As-Built Surveys	4.12	01310	Top of regrade	See requirements in Specification 01310	Verify elevations required by design.	As required	As required, at the discretion of the CQAE.
			Top of subgrade		Verify elevations required by design.		
			Gas management system (trench alignments)		Verify trench locations required by design.		

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TABLE 4.2

EARTHWORK QA/QC SUMMARY
100% DESIGN - PRESENT LANDFILL DESIGN, RFETS, GOLDEN, COLORADO

Quality Control Item	CQAP Section	Specification Section	QA/QC Item	Method	Requirements	QC Action	QA Action
As-Built Surveys Cont.	4.12	01310	Geosynthetics panel layout	See requirements in Specification 01310	Obtain as-built survey of all geosynthetic panel layouts.	As required	As required, at the discretion of the CQAE.
			Anchor trench alignment		Verify location and slope required by design.		
			Top of 10-inch cushion layer		Verify elevations required by design.		
			Top of rock layer		Verify elevations required by design.		
			Top of final surface		Verify elevations required by design.		
			Perimeter drainage channel (slope and width)		Verify slope and width of channel required by design		
			Diversion berm toe of slope		Verify slope required by design.		
			Seep treatment system layout		Verify location and elevations required by design.		
			Final project completion site topographic map		Verify compliance with design.		

Notes:

Test methods refer to American Society for Testing and Materials (ASTM) standard test methods.
* = Minimum of 1 test per backfill area.
≤ = less than or equal
% = percent
cm/s = centimeters per second
CQAE = Construction Quality Assurance Engineer
cy = cubic yards
ft2 = square foot
LA = Los Angeles
QA = quality assurance
QC = quality control
revs = revolutions
USCS = Unified Soil Classification System

ACCELERATED ACTION DESIGN FOR THE PRESENT LANDFILL ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

FINAL DESIGN ANALYSIS

Prepared for:
Kaiser-Hill Company, L.L.C.
Golden, Colorado

Prepared by:
Earth Tech, Inc.
Englewood, Colorado

Project No. 57378.4001

March 2005

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LIST OF ACRONYMS AND ABBREVIATIONS

CDPHE	Colorado Department of Public Health and Environment
CDR	Conceptual Design for the Present Landfill Closure Cover, Rocky Flats Environmental Technology Site (CDR) (DBS&A 2002)
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CSI	Construction Specifications Institute
CTR	Contractor's Technical Representative
DBS&A	Daniel B. Stephens & Associates, Inc.
DOE	Department of Energy
Earth Tech	Earth Tech, Inc.
EPA	Environmental Protection Agency
FML	flexible membrane liner
g	gravity
GAC	granular-activated carbon
GCL	geosynthetic clay liner
GDN	geosynthetic drainage net
GSE	Gundle/STL Environmental
H:V	horizontal:vertical
HDPE	high-density polyethylene
HELP	Hydraulic Evaluation of Landfill Performance
IM/IRA	Interim Measure/Interim Remedial Action
lb	pound
LFG	landfill gas
LLDPE	linear low-density polyethylene
NAG	North American Green
NRCS	National Resource Conservation Service
oz/yd^2	ounces per square yard
PLF	Present Landfill
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RUSLE	Revised Universal Soil Loss Equation
sq. ft.	square feet
WEQ	Wind Erosion Equation

PREFACE

This design was developed based on the Statement of Work for the Accelerated Action Design for the Present Landfill, Subcontract No. KH-020525, and the Design Basis for the Accelerated Action Design.

The design includes the following five submittals:

- The Design Analysis found in Volume I which includes a narrative description of the cover design (Final Design Analysis February 2005);
- The Design Analysis Appendices found in Volume II which includes supporting technical calculations (95% Design Revision 1 Submittal August 2004);
- Appendix G – Slope Stability Analysis (Revised Final Design Submittal January 2005);
- Revised design drawings including all drawings to support construction (Revised Drawings January 2005)
- Construction specifications consistent with the Construction Specification Institute (CSI) specifications template (Final Design Submittal Specifications October 2004); and
- The construction quality assurance/quality control plan (Final Design Submittal Construction Quality Assurance/Quality Control Pan October 2004).

The design for the cover was developed using the following guidelines:

- The asbestos areas will not be disturbed.
- The major layers of the cover, from the top down, consist of:
  - Two feet of Rocky Flats Alluvium soil;
  - One foot rock layer to deter burrowing animals;
  - Ten inches of cushion layer soil;
  - Geosynthetic composite drainage net (GDN);
  - Flexible membrane liner (FML);
  - Geosynthetic clay liner (GCL); and
  - Six inches of GCL cushion soil.
- The top slopes of the cover will be between 3 and 5 percent. Side slopes will not exceed 4 feet horizontal to 1 foot vertical (4H:1V) including the east face slope.
- The pond and wetlands east of the Present Landfill will not dictate the design of the remedy, but the impacts will be minimized.

This design report has been organized into two volumes and a set of construction documents. Volume 1 includes the design analysis report and tables. Volume II includes the supporting technical appendices (Appendices A through M). Construction documents include a set of engineering drawings, the Specifications, and the Construction Quality Assurance (QA)/Quality Control (QC) Plan. The drawings contain information related to existing conditions, site regrading, final design grades, cover configuration, surface water management, seep treatment, and supporting details. The Specifications and Construction QA/QC Plan contain detailed instructions on cover construction and construction quality.

1.0 INTRODUCTION

1.1 SCOPE OF DESIGN ANALYSIS

The design for the Present Landfill (PLF) Closure Project was prepared to support the closure of the Rocky Flats Environmental Site (RFETS) PLF. This document contains information covering general parameters, functional and technical requirements, design objectives, design assumptions, and design calculations applicable to the landfill's geosynthetic composite cover design. Specifically, this design analysis report provides the following information:

- Design basis, main assumptions, design criteria, and site constraints;
- Descriptions of landfill cover components and their design functions;
- Description of the design drawings and specifications;
- Demonstration that the landfill cover components will function as designed;
- Results of design-related borrow soils materials testing; and
- Engineering analyses and calculations used to develop the cover design.

1.1.1 Design Basis

The accelerated action for the PLF will be consistent with the requirements of a landfill closure as a Resource Conservation and Recovery Act (RCRA) interim status unit. These regulations for closure allow for a prescriptive cover design for the PLF. The design of the PLF cover system was developed to comply with the substantive requirements of RCRA (40 Code of Federal Regulations [CFR] 265). This includes the design of a cover with adequate slope stability factors of safety, adequate flow capacity for the existing internal drainage systems, adequate surface water runoff controls, and adequate resistance to surface erosion.

1.1.2 Design Criteria

The design criteria for the PLF are functional requirements used as the basis for the design. The design criteria presented in the design include both minimum requirements that were formulated by compiling pertinent regulations, the Rocky Flats Cleanup Agreement (RFCA), industry standards, and engineering judgment to ensure proper design of the cover.

The design of the cover will meet the following criteria to establish a stable cover system:

- Minimum final grade top slopes requirement of 2 percent and maximum top slopes of 5 percent (Environmental Protection Agency [EPA] 2002) with anticipated slopes at 3 percent to 5 percent;

- Provide for ventilation under the cover to ensure the functional integrity of the final cover;

- Accommodate anticipated settlement and subsidence of the landfill and cover;

- Determine slope limitations on the final cover profile to maintain stability of the cover with factor of safety of 1.5 for static conditions and 1.0 for seismic conditions using a seismic coefficient of 0.06g. Alternatively for seismic, the deformation from a seismically induced permanent displacement must be 12-inches or less;

- Determine surface water drainage patterns and the physical characteristics of the landfill and surrounding area to promote efficient surface water runoff and collection associated with a 100-year storm event with additional capacity to handle the 1000-year 24-hour event; and

- Minimize surface soil erosion to a maximum of 2 tons per acre per year (EPA 1991);

1.1.3 Main Assumptions and Site Constraints

One of the fundamental pieces of information necessary to develop plans for the PLF Accelerated Action is to establish the lateral extent of wastes. The extent of waste identified on the design drawings was determined in previous site investigations, and by examination of aerial photographs taken from 1945 through 1990.

Other assumptions used during the design include the following:

- The variability, depth, areal extent, and engineering properties of on-site soils, overburden soils, and underlying geologic units have been sufficiently characterized during previous site investigations but additional information was gathered for purposes of this design.

- Existing design drawings of above- and/or belowground structures on-site represent as-built conditions.

Design of the PLF cover was completed under the following site constraints:

- The cover would be constructed with top slopes of 3 to 5 percent;
- Impacts to the East Landfill Pond wetlands would be minimized; and
- Existing subsurface drainage systems must remain operational after closure of the PLF.

1.2 ORGANIZATION OF DESIGN ANALYSIS

This design analysis is organized into five sections: this introduction (Section 1.0), the general site setting (Section 2.0), a summary of the design activities (Section 3.0), a summary of the design drawings and specifications (Section 4.0), and references (Section 5.0). Also included in Volume II are appendices covering the evaluation of landfill gas (LFG) generation, frost depth evaluation, flexible membrane liner (FML) evaluation, borrow soil identification geotechnical data, cover performance evaluation, settlement evaluation, stability evaluation, surface water management assessment, erosion loss evaluation, geotextile clogging evaluation, landfill seep treatment requirements, geosynthetic property evaluations, and interim cover test pits logs. The engineering drawings, Specifications, and QA/QC plan are included under a separate cover.

2.0 GENERAL SITE SETTING

The RFETS is located on a 6,550-acre site in Sections 1 through 4 and 9 through 15 of Township 2 South, Range 70 West, 6th Principal Meridian, approximately 16 miles northwest of Denver, Colorado, in northern Jefferson County.

2.1 SITE DESCRIPTION

The PLF occupies an area of approximately 20 acres, with an additional 9 acres of buttress and pond. The landfill was placed into service in August 1968 for the disposal of uncontaminated solid wastes, including office trash, paper, rags, personal protective equipment, construction and demolition debris, scrap metal, empty waste containers, used filters, and electrical components.

The majority of waste was solid wastes, including office trash, paper, rags, PPE, construction and demolition debris, scrap metal, empty waste containers, used filters, and electrical components. Waste containing hazardous constituents that was disposed in the landfill included containers partially filled with paint, solvents, degreasing agents, and foam polymers; wipes and rags contaminated with these materials; paint and oil filters; and metal cuttings and shavings coated with hydraulic oil and carbon tetrachloride. A total of 241 non-hazardous solid waste streams and 97 potentially hazardous solid waste streams were disposed in the Present landfill. Procedures were implemented to stop the disposal of hazardous waste into the Present Landfill in the fall of 1986.

Further data on the PLF and its physical status are available in the *Final Interim Measure/Interim Remedial Action for Operable Unit 7 (IHSS 114)* and *RCRA Closure of the RFETS Present Landfill.*

2.2 PREVIOUS REPORTS

A number of previous reports have been prepared for the site for the purpose of evaluating physical characteristics, potential contamination and remedial actions/designs. Previous reports reviewed for this design include:

- Phase II Geologic Characterization Data Acquisition Surface Geologic Mapping of the Rocky Flats Plant and Vicinity (EG&G 1992a);
- OU 7 Final Work Plan, Rocky Flats Plant (EG&G 1994a);
- RCRA Annual Groundwater Monitoring Report for Regulated Units at the Rocky Flats Plant (EG&G 1994b);
- Rocky Flats Environmental Technology Site, OU7, Closure Plan North Slurry Wall (Terra Matrix 1995); and
- Passive Seep Collection and Treatment System (Department of Energy [DOE] 1995).

3.0 SUMMARY OF DESIGN ACTIVITIES

3.1 LANDFILL GAS EVALUATION

The LFG evaluation included an estimation of the LFG generation potential (LFG flux) and an evaluation of the potential impact of this flux on the cover given the cover soil properties and thickness.

3.1.1 Landfill Gas Generation Potential

In an attempt to quantify potential LFG emissions at the PLF located at RFETS and to determine the need for a gas collection and control system, Earth Tech completed an evaluation of the LFG generation potential by reviewing existing documentation to determine waste disposal rates and waste characteristics. These data were then used as input to the EPA LFG Generation Model. The Evaluation of Landfill Gas Generation Report (Earth Tech 2002), support data, and model outputs generated from this evaluation are included in Appendix A.

The Evaluation of Landfill Gas Generation Report presents an evaluation of the Daniel B. Stephens & Associates (DBS&A) assessment of LFG generation for the PLF included in the Conceptual Design for the Present Landfill Closure Cover, Rocky Flats Environmental Technology Site ([CDR] DBS&A 2002). After reviewing the LFG generation assessment, Earth Tech found that the waste volume used for the LFG generation calculation did not exclude the non-organic waste material. Earth Tech reviewed the waste stream data (Appendix A of EG&G 1994c) and estimated that only 50 percent of the total waste volume is organic and decomposable (Appendix A, Attachments 1 and 2). A revised gas generation analysis was performed using the EPA LFG Generation Model, and a new gas generation rate was calculated (Appendix A, Attachment 3). From the LFG generation rate, a new LFG flux through the landfill final cover was also calculated and compared with the values presented in the CDR.

The values for the LFG generation rate and flux from this re-evaluation (20.31 cubic feet per minute [cfm] and 2.22×10^{-5} cfm/square foot [sq. ft.]) were significantly less than the values given in the CDR (gas generation rate of 50.3 cfm and flux of 1×10^{-4} cfm/sq. ft.). Therefore, the

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amount of gas that will be emitted through the landfill cover will be substantially less than previously anticipated.

Based on these calculations, Earth Tech believes that it is likely that a gas collection system or venting layer would not be required to control gas migration.

3.1.2 Recommendations for Landfill Gas Collection System

An evaluation of LFG production indicates that gas migration would not likely be a problem. However, because of the impermeable nature of the geosynthetic final cover, a passive gas venting system is recommended to assure pressure stabilization with atmospheric conditions.

3.2 FROST DEPTH AND IMPACT EVALUATION

The Accelerated Action Design for the PLF at Rocky Flats calls for a landfill cap that includes a GCL. An evaluation of the feasibility of installing a GCL for the purpose of designing a composite cover over the PLF was completed. As part of this evaluation, the frost depth was estimated to assess the adequacy of the cover thickness with respect to GCL protection.

3.2.1 Evaluation of Frost Penetration Depth

The penetration of frost into a soil or cobble layer depends on several climatic parameters and soil/cobble properties for a given location. Using site-specific climatic data, the design frost depth for the PLF was evaluated using the Modified Berggren equation. Using this model, the estimated frost penetration depth for a cobble-only layer is 30 inches. The design frost depth derived from this method can be used to represent the worst-case scenario of climatic extremes. The estimated frost penetration depth for a soil-only layer is 1.5 feet (18 inches). The full evaluation is presented in Appendix B.

3.2.2 Frost Depth and Impact Conclusions

Design frost depth values were estimated at 18 inches for a soil cover and 30 inches for a cobble cover. Considering a design frost depth of 18 to 30 inches in the Rocky Flats area, a soil layer of 24 inches combined with 12 inches of rock would provide an overall 36-inch thick layer that should be sufficient to protect the GCL against extreme weather effects. Including the rock cushion soil, the GCL is protected by a 46-inch layer of soil and rock.

3.3 FLEXIBLE MEMBRANE LINER EVALUATION

The Accelerated Action Design for the PLF at Rocky Flats calls for a landfill cap that includes a FML. Several material types are available for FMLs, including high-density polyethylene (HDPE), linear low-density polyethylene (LLDPE), and polyvinyl chloride (PVC). Both the HDPE and the LLDPE are available textured to increase friction and improve slope stability.

3.3.1 FML Evaluation Criteria

The objective of this option analysis is to aid in the selection of the optimal FML material type based on cost, flexibility, puncture/tear resistance, and chemical integrity. To accomplish the objective, product data sheets from Gundle/STL Environmental (GSE), AGRU America, and Poly-Flex were consulted for HDPE smooth, HDPE textured, LLDPE smooth, and LLDPE textured materials. For PVC, Colorado Lining, Watersaver Company, and PVC Geomembrane Institute data sheets were consulted. The full evaluation is presented in Appendix C.

3.3.2 FML Property Requirements

Based on currently anticipated performance requirements, 40-mil LLDPE has the appropriate engineering properties for this application and will function adequately as a component of the geocomposite cover. LLDPE provides similar puncture resistance, tear resistance, and breaking strength compared to HDPE. However, the superior break elongation of LLDPE is beneficial for installation as a cover over a landfill that may experience differential settlement. Though 40-mil LLDPE is sufficient, 60-mil LLDPE will be used for the PLF cover system as a conservative measure. Further evaluation of LLDPE physical properties is presented in Appendix L.

3.4 SOIL EVALUATION

Geotechnical testing was conducted on the pit fines soils or cushion soils available at the nearby Centennial Quarry, LaFarge Bluestone Quarry, and existing Rocky Flats Alluvium material present on the landfill. Geotechnical properties are summarized in Table 3-1. Laboratory reports are included in Appendix D. Project specific geotechnical data will be gathered by the construction subcontractor for the Rocky Flats Alluvium. Once available, the data will be used to verify applicable design aspects during construction and will be summarized in the project completion certification report.

3.5 LANDFILL COVER PROFILE OVERVIEW AND COMPONENT DESIGN

The final configuration of the PLF cover system was designed to accomplish the following:

- Minimize infiltration of precipitation into the waste;
- Promote good surface drainage;
- Resist erosion;
- Prevent slope failure; and
- Separate waste from vectors.

The components of the PLF cover system will consist of the following layers (from top to bottom):

- Two feet of Rocky Flats Alluvium soil,
- One-foot rock layer to deter burrowing animals,
- Ten inches of cushion layer soil,
- GDN for lateral drainage,
- An FML hydraulic barrier layer,
- A GCL hydraulic barrier layer, and
- Six-inches of GCL cushion soil.

A passive LFG venting system is incorporated in the GCL cushion soil layer. Revegetation of the PLF cover with native species was specified consistent with the Final Interim Measure/Interim Remedial Action (IM/IRA). A rock layer was added to the overall cover profile below the 24-inch infiltration soil layer to be consistent with the Final IM/IRA to reduce the impact of burrowing animals. The rock layer will consist of a 12-inch layer of rock with a maximum rock size of 10 inches.

3.6 LANDFILL COVER PERFORMANCE EVALUATION

The preliminary performance of the cover configuration was evaluated using the Hydraulic Evaluation of Landfill Performance (HELP) model to predict the water balance based on cover configuration, soil and plant characteristics, and climatic conditions. Model simulations were conducted using preliminary data that define the borrow area soil characteristics and plant cover conditions. The objective of these simulations was to use the model as a screening tool to assess the suitability of potential cover components.

3.6.1 Model Predictions

The HELP model water balance predictions for the cover are provided in Table 3-2. Model input/output files are included in Appendix E. The simulations resulted in acceptable head levels within the GDN and no seepage through the hydraulic barrier (FMC/GCL) layer.

3.7 LANDFILL COVER DESIGN CALCULATIONS

The following sections discuss supporting information and calculations related to regrading and contour development, settlement of the cover, slope stability issues, surface water management, and erosion control.

3.7.1 Landfill Regrade, Subgrade and Final Grade Contour Development

Before the cover system is placed, the surface of the landfill will be regraded and compacted sufficiently to support the proposed cover system. Following regrading, areas within the limit of cover will receive 6 inches of cushion soil, and the subgrade will then be ready for cover system placement. Once the cover system is constructed, the landfill will achieve the final grades that were designed to eliminate surface water ponding and allow surface water to drain off the landfill to perimeter drainage channels. As part of the regrading and subgrade preparation, portions of the PLF interim cover will be excavated (cut) and relocated to areas that require fill. Only portions of the interim cover are planned for excavation and relocation; waste materials will not be excavated. Test pits were excavated in the interim cover in the fall of 2003 to establish interim cover depths in sensitive cut locations. Test pit logs are located in Appendix M. Should wastes materials be found that conflict with the pre-grade elevations, the pre-grade surface design, control point elevations, and other layer design drawings will be modified to incorporate the new data.

The completed subgrade and compaction work will provide a surface slope within the limit of the geosynthetic composite cover between 3 and 5 percent to provide for surface water drainage.

These surface slopes will cover the majority of the landfill and will typically lead to 4H:1V side slopes outside the limits of the geosynthetic composite cover and on the east slope of the landfill.

During regrading activities, the entire surface of the landfill area will be traversed with heavy equipment to achieve sufficient compaction prior to GCL cushion soil placement. The development of the method to achieve this compaction goal will be accomplished using a test fill prior to construction to determine the number of required of passes with a piece of equipment to achieve the required compaction. The method used must be approved by QA/QC personnel, the Contractor's Technical Representative (CTR), the EPA, and the Colorado Department of Public Health and Environment (CDPHE). The maximum allowable deflection will be developed in the test fill and is anticipated at 1 to 3 inches. If any areas exceed the approved maximum deflection, they will be repaired as determined by the engineering team based on the field conditions.. The design regrade surface is shown on Drawing 51781-005 of the landfill design drawing set. Once the regrade surface is approved, GCL cushion soils will be placed at 95% standard Proctor (ASTM D 698) to complete the subgrade surface.

3.7.2 Settlement of Proposed Cover

Settlement of the proposed cover system at the PLF may occur as a result of consolidation of the waste material and placement of the cover system. The magnitude of this settlement will depend on a number of factors, including:

- Thickness of waste;
- Type of waste (e.g., construction debris and municipal waste);
- Density or void ratio of the in-place wastes;
- Amount of decomposable materials;
- Groundwater conditions;
- Type of foundation soils;
- Weight of the cover; and
- Age of the placed waste (i.e., landfill operational history).

Excessive total or differential settlement of the cover system can have the following effects:

- Increased permeability of final cover soils because of cracking and depressions;
- Slope instability because of modified side slopes; or
- Surface water drainage disruption or ponding because of changes in design slopes.

An analysis was conducted to determine if the foundation soils beneath the landfill could contribute to the overall settlement of the cover system. Information regarding the claystone bedrock conditions underlying the PLF was obtained from the Technical Memorandum, Final Work Plan, Operable Unit No. 7 (EG&G 1994c).

No geotechnical data was found that indicated the claystone bedrock's engineering properties; however, borings conducted at the PLF documented that the claystone bedrock layer was very hard and moderately weathered (see Appendix F Attachment 3 for borehole logs). A literature review indicates that a moderately to highly weathered claystone can have a blow count greater than 30 and is likely to have a compressive strength greater than or equal to 4 tons/sq. ft. (8,000 pounds (lbs)/sq. ft.) (NAVFAC DM-7.1, Soil Mechanics). The pressure (approximately 2.1 tons/sq. ft.) exerted by the landfill waste and the proposed cover system does not exceed the compressive strength of the claystone; therefore, no settlement of the claystone foundation layer would be expected to occur.

The composition of the waste in the PLF is reported to consist of construction debris, nonhazardous wastes, dried sanitary sewage sludge, and wastes generated as a result of Rocky Flats industrial activity maintenance operations (EG&G 1994a). This differs from municipal landfills, which commonly contain a mixture of household, commercial and industrial wastes resulting in biodegradation and settlement likely more than would be expected in the PLF. Additionally, the daily waste intake rate was reported to reach a maximum of approximately 130 cubic yards per day (EG&G 1994a) and, based on solid waste industry studies, the amount of daily cover soil used at the landfill is higher than most municipal solid waste landfills. Based on historical operational information, the PLF's waste to soil ratio would have likely been 2:1 or 3:1, which would provide a denser and less compressible waste mass. Settlement calculations performed in previous studies of the site (i.e., the CDR [DBS&A 2002] and the OU7 Final Work Plan [EG&G 1994a]), as well as in this design analysis, modeled the in-place waste using parameters for municipal solid waste, which likely provides conservative settlement values.

Settlement in a landfill occurs under two different processes. Primary waste settlement will occur within approximately the first five years after placement of waste, whereas secondary (long-term) settlement due to waste decomposition processes will decrease with time, but will continue following closure of the landfill (Qian 2002). No new wastes have been placed in the PLF since 1998, therefore, most of primary settlement has already occurred. Any future settlement at the PLF likely would be caused by long-term waste decomposition. Additional settlement may occur at the time of subgrade preparation and compaction to 95 percent of the maximum standard Proctor density (ASTM D 698) and during placement of the cover. The subgrade contours shown on Drawing 51781-007 of the design plan set represent minimum 3-5 percent slopes after compaction of the landfill surface.

The degree of long-term waste settlement has been investigated during three previous investigations at the PLF using four of the most widely accepted methods: the Sowers Method, the modified Sowers Method, the Gibson and Lo Models, and the Power Creep Law. The three investigations provide relatively consistent results predicting long-term settlement ranging from 0.5 to 2.25 feet depending on the model used.

Settlement calculations were completed using the proposed cover system profile (i.e., 6-inch GCL cushion soil layer, geosynthetics, 10-inch rock cushion layer, 12-inch rock layer, and 24-inch Rocky Flats Alluvium or soil infiltration layer). The methodology used to evaluate settlement involved selecting points on the cover surface, computing the settlement at each point, and evaluating the resulting change in surface elevation. Points were selected (see Appendix F, Attachment 1) from the longitudinal axis of the landfill (i.e., where maximum waste depths occur). The change in elevation resulting from waste settlement at each, point was calculated using the Sowers Method and applied over the cover longitudinal cross-section by lowering the landfill's surface elevation. Total waste settlement amounts of 1.41 to 1.91 feet over the 30-year post-closure period were calculated. The CDR reported 30-year settlement rates of 0.22 to 1.32 feet along the approximate same longitudinal axis.

Prior to placement of the soil layer material, the landfill surface will be cleared of vegetation and compacted to further reduce potential settlement in the waste layer. Primary consolidation of these soils should occur during placement but is calculated and included in the total settlement.

Long-term settlement of the cover soil was determined using the same methodology as used for the waste layer. Primary and long-term settlement of the soil did not exceed 0.1 foot during the 30-year post-closure period. Settlement determinations and revised landfill top slopes along the longitudinal axis are presented in Table 3-3.

Most of the settlement will occur in the thicker sections (i.e., the center) of the landfill. The revised post-settlement elevations were plotted on the final grading plan and the revised top of landfill slopes in the north-south direction (i.e., perpendicular to the longitudinal axis) were calculated. Point F is the design high point of the proposed cover system. If settlement at this location occurs in the amount of 1.75 feet, the top slope elevation to the north will decrease to approximately 4.5 percent and to the south to approximately 3.1 percent. Settlement of the proposed cover system will not hinder surface water runoff from the landfill surface to the perimeter channels.

3.7.3 Stability of Proposed Cover System and East Sideslope

Slope stability of the proposed cover system for the PLF was analyzed using PCSTABL5M software to determine whether the cover will be stable, under both static and dynamic (seismic) conditions. The modes of possible slope failure are through translational forces through weak soil layers and rotational failures within surfaces passing through the cover system and underlying wastes.

The stability of the proposed cover system and the east sideslope is controlled by the following:

- Properties of the foundation soils,
- Strength characteristics and weight of the in-place waste,
- Inclination of the proposed slopes,
- Interface friction between the geosynthetics,

- Saturated waste levels in the landfill, and
- Ability of the cover to drain freely.

The objective of the slope stability analysis is to assess the stability of long-term conditions (post-closure conditions) and to study the effect of seismic loading on the anticipated slopes. PCSTABL5M models were conducted for a section of the landfill from the final 4% cover slope to the 4H:1V east face. The Modified Bishop Method was used on the east slope to model a rotational failure where waste and underlying bedrock fail. The Modified Janbu Method, which uses a block-type failure, was used for the cover system. The model inputs/outputs are found in Appendix G.

The stability analyses was completed under static and seismic loading conditions. For static conditions, a 1.5 factor of safety was used. For seismic loading conditions, a bedrock acceleration coefficient of 0.06g was used as determined in the Geotechnical Investigation Phase 3 Stability Analysis Technical Support Memorandum of the Accelerated Action Design for the Original landfill (Earth Tech 2004). This is equal to one-half of the peak bedrock acceleration as determined as part of the 1994 study of both the probabilistic and deterministic site-specific seismic shaking hazard in 1994 by Risk Engineering. If this factor of safety was calculated below 1.0, then a deformation analysis was conducted to verify that the design met the criteria of permanent seismically induced displacements of less than 12-inches.

Results of the stability analysis are found in Appendix G and summarized in Table 3-4. These slope stability calculations indicate that the cover system and the underlying materials will meet the required factors of safety for both static and pseudostatic conditions. Models were conducted with Rocky Flats soil data and PLF geosynthetic interface data. Static factors of safety were above 1.5 while pseudostatic factors of safety were above 1.0, meeting the design criteria.

3.7.4 Surface Water Management - Drainage Considerations and Design

The design approach to the PLF storm water control focuses on the need to provide a surface water management system that will adequately collect and convey the run-on to and runoff from the landfill from a 100-year 24-hour storm event with freeboard capacity to handle the 1000-year 24-hour storm.

SEDCAD4 software was used to model the 100-year and 1000-year storm run-on and runoff surface water flows. The software is based on the National Resource Conservation Service (NRCS) approach for rainfall distribution and on the NRCS curve number/unit hydrograph approach to predict peak flows. The NRCS storm-type distributors are considered very conservative leading to higher peak flows than almost any actual measured storm.

The landfill and surrounding grading used in the surface water analysis included:

- Existing grades surrounding the PLF (Attachment 1 of Appendix H) were taken from topographic maps obtained during previous studies conducted on the PLF. Grades around the landfill are 2.0 percent to the west, 2.0 percent to the north and south, and 10 percent to the east.
- Proposed final grades (Drawing 51781-008 of the landfill cover design plan set) for the PLF. Top-of-landfill grades average 4 percent while the east face has a slope of 25 percent.

The PLF drainage basin was initially characterized in the Rocky Flats Drainage and Flood Control Master Plan (EG&G 1992b) and verified during the completion of this calculation. The slope of the run-on drainage basin is estimated at approximately 2.0 percent. The design final cover basin slope is 4.0 percent, with the steepest slope (25 percent) occurring on the east sideslope of the landfill. The time of concentration for the subwatersheds was calculated assuming an overland flow component, a grassed waterway flow, and channel flow. Overland flow was limited to reduce the time of concentrations, leading to higher peak flows.

Flows from each sub-area from a 100-year storm event were calculated based on grading information obtained from Attachment 1 of Appendix H. These flows were used to verify the size of the current runoff collection channels and check the capacity of access road culverts. Two channels currently exist to control run-on and runoff from the landfill. These channels are located on the north and south sides of the PLF next to the perimeter access road. The north and south perimeter channels and the cover diversion berm design parameters for the 100-year storm event are summarized in Table 3-5. Where possible, the existing channel will be maintained

after being widened to a 10-foot bottom. In other portions, the channel will be relocated closer to the limit of the cover to capture drainage from the GDN (see Drawing 51781-009).
Design culvert capacities were determined using the SEDCAD4 software. Existing culverts on the north and under the east embankment road will be replaced with larger culverts. In addition, a new culvert will be placed to convey water from the northwest perimeter channel under the access road.

Temporary (or until vegetation has established) erosion control measures will be required for disturbed areas that are not covered by vegetation and for the newly constructed surface water channels. During construction activities, methods that will be employed to minimize erosion include:

- The amount of area disturbed at any one time will be minimized.
- Temporary surface water diversion measures will be implemented to minimize surface water flow across disturbed areas. If necessary, straw bale barriers, silt fencing, and sediment traps will be constructed to control potential erosion. Straw bale barriers will be placed across the flow path within temporary or permanent channels. Silt fencing will be placed at the toes of the fill to intercept sediment from the slopes before it enters the perimeter channels.
- Finalized grades will be seeded as quickly as possible according to Specification 02900.

Temporary and permanent erosion protection for the perimeter channels and berms was determined using the North American Green (NAG) Erosion Control Materials Design Software, Version 4.2. NAG SC150 or equivalent will be placed on disturbed areas, sideslopes, and channel bottoms. It was chosen due to a 2-year usable life, which will provide temporary erosion control until vegetation is established.

Once the surface water controls were designed to the 100-year 24-hour storm, the 1000-year 24-hour storm of 6.4 inches was placed in the design. The flow depths for the 1000-year storm were then compared to the total depth with freeboard of the 100-year 24-hour storm. The analysis shows that the 1-foot of freeboard included in the design is adequate to handle the 1000-year 24-

hour storm. In the case of culverts, diameters were increased for two of the culverts to handle the water from the 1000-year 24-hour storm.

3.7.5 Cover and East Slope Rainfall and Wind Soil Erosion Loss

3.7.5.1 Rainfall Soil Erosion Loss

Soil erosion at the PLF will occur when soil particles are displaced and carried away by storm water. The rate at which this erosion occurs depends on the properties of the cover soil, the slope of the land, rainfall intensity and duration, and the volume and characteristics of the water flow.

Calculations were performed to evaluate the potential for rainfall and wind erosion at the PLF and to determine if additional erosion control measures are required. The evaluation of potential rainfall erosion of the PLF final cover surface was based on the following design criteria:

1. The flat portion of the PLF consists of a 4 percent slope and a maximum drainage distance to a diversion berm of 800 feet.

2. The east face of the PLF consists of a 4H:1V slope and a maximum drainage distance of 260 feet.

3. The design erosion rate shall not exceed 2.0 tons/acre/year per Section 2.2.5.3 of the Technical Guidance for RCRA/CERCLA Final Covers (EPA 2002).

The soil erosion rate due to rainfall was calculated using the Revised Universal Soil Loss Equation (RUSLE). The RUSLE predicts the average soil losses in runoff from a given site based on specific physical and management erosion variables. Soil erosion is based on the formula:

$$A = R \times K \times LS \times C \times P$$

Where:

A = the computed soil loss per unit area in tons per acre per year
R = the rainfall and runoff factor, which varies with location and climate
K = the soil erodibility factor which depends on the site soil type
LS = the topographic factor (slope-length factor/slope steepness factor), which accounts for the site slope gradient and length of slope
C = the cover and management factor, which accounts for the ground cover (grass, weeds, etc.)

P = the support practice factor, which accounts for contouring, terracing, or other runoff control devices

The U.S. Department of Agriculture has developed a program that computes rainfall soil erosion using data for different sections of the country. These data are contained in databases that have been incorporated into the program.

Rain erosion for several cover conditions was calculated and results are found in Appendix I. The results show that when the Rocky Flats Alluvium reaches a mature state, rain erosion is 0.41 tons/acre/year on the cover slope regardless if vegetation has established. If the cover slope is bare before the Rocky Flats Alluvium reaches a mature state similar to the conditions immediately after construction, the rain erosion rate is 1.80 tons/acre/year or near the maximum allowable. Bare conditions are unlikely since the cover slope will be seeded and mulched resulting in a rain erosion rate of 1.20 tons/acre/year. Once the vegetation has established, the rain erosion rain erosion rate is 0.46 tons/acre/year. Rain erosion on the east slope was found to be excessive unless permanent erosion controls are installed resulting in a rate of 0.32 tons/acre/year.

3.7.5.2 Wind Erosion Loss Calculations

The erosion rate due to wind was calculated using the Wind Erosion Equation (WEQ) (Appendix I). The WEQ predicts the long-term average soil losses due to wind from a given site based on specific physical and management erosion variables. Wind erosion is based on the formula:

$$E = f(I, K, C, L, V)$$

Where:

E = the estimated average annual soil loss in tons per acre per year
f = function of (not a straight-line mathematical relationship)
I = soil erodibility index
K = soil surface roughness factor
C = the climatic factor
L = the unsheltered distance across a field in the direction of the prevailing winds
V = the vegetative cover factor

The Rocky Flats site is noted for its strong, gusty winds. Wind speeds can exceed 75 miles per hour, and gusts may exceed 100 miles per hour. However, northwesterly wind directions and wind speeds under 15 miles per hour are the predominant wind conditions at the PLF.

Wind erosion for several cover conditions was calculated and results are found in Appendix I. The results show that when the Rocky Flats Alluvium reaches a mature state, wind erosion is 0 tons/acre/year on both the cover slope and the east slope regardless if vegetation has established. If the slopes are bare before the Rocky Flats Alluvium reaches a mature state, the wind erosion is excessive. Bare conditions are unlikely since the cover slope will be seeded and mulched resulting in a wind erosion rate of 0.30 tons/acre/year. The same erosion rate of 0.30 tons/acre/year applies when vegetation has established.

The Revised WEQ software recommended by the Technical Guidance for RCRA/CERCLA Final Covers (EPA 2002) was used to determine wind soil erosion. However, the software calculated 0.0 tons/acre/year so these values are not used further in the design.

3.7.5.3 Rainfall and Wind Erosion Summary

The total erosion (wind + rainfall) for the PLF cover slope is 1.50 tons/acre/year with mulch and 0.76 tons/acre/year with established vegetation. When Rocky Flats Alluvium reaches its mature state, the erosion on the cover slope is 0.41 tons/acre/year. The east face calculations were based on permanent erosion controls and result in a total erosion of 0.62 tons/acre/year. Table 3-6 provides a summary of rainfall erosion, wind erosion, and total erosion for the cover slope and East Face slope.

3.8 BIOTA LAYER

Based on regulator comments on the conceptual design, a biota layer was added to the overall cover provide below the 24-inch infiltration soil layer. In consultation with the U.S. Fish and Wildlife Service, it was determined that the biota layer will be required to prevent burrowing into the waste by prairie dogs on the top, relatively flat surfaces of the cover, and badgers on the eastern slope. The biota layer will consist of a 12-inch layer of rock with a maximum size of 10 inches.

3.9 VEGETATION

Re-vegetation of the PLF cover with native species will control erosion, and assure longevity and compatibility with the surrounding environment. To meet these objectives:

- A minimum of 2" layer of previously grubbed Rocky Flats Alluvium sandy loam will be placed over a 22" layer of undifferentiated, characterized Rocky Flats alluvium.
- Compaction of both layers will be minimized. The final cover will be prepared for planting using scarification, ripping, or discing, as appropriate, to break up the compacted soil. Also, measures will be taken during seedbed preparation to ensure that the sandy loam layer is not inappropriately mixed with the substrate.
- The landfill surface will be planted with native seed mix (in consultation with USFWS and the EPA). The seed mix has already been agreed to. Specification 02900 will be implemented during seeding.
- Hydro-mulching and matting will be used during seeding operations.
- During re-vegetation weeds will be controlled.

The progress of re-vegetation will be monitored using the Site-wide Vegetation Criteria (under development). The Site-wide Vegetation Criteria may be incorporated into the post-closure agreement, the Record of Decision, or both, as appropriate.

3.10 GEOTEXTILE CLOGGING EVALUATION

Appendix J presents calculations in support of geotextile clogging evaluations to assist in geotextile size selection. The calculation demonstrates that the properties of an 8-ounce per square yard (oz/yd^2) geotextile are preferred for the cover system. Therefore, the GDN must have 8 oz/yd^2 geotextile on both sides.

3.11 SEEP TREATMENT SYSTEM

Groundwater potentially contaminated with leachate exiting from the landfill as surface seeps needs to be identified and located during pre-design activities and construction activities. Uncontrolled seeps can cause a buildup of hydrostatic pressure behind the low-permeability layer, resulting in decreased stability of the cover system.

An emergency spillway is located on the south side of the pond embankment. The spillway is a trapezoidal, earth-cut spillway that is 6 feet deep and 10 feet wide at the bottom. A 6-foot by

8-foot concrete box culvert carries spillway discharge under the access road and into the drainage way below the embankment. There is a weir on the upstream side of the box culvert. Water from the East Pond can spill over this structure when the pond surface elevation exceeds 5,921 feet. The pond embankment has an approximate elevation of 5,926.3 feet.

3.11.1 Existing Seep Condition

The current landfill seep treatment system as originally constructed comprised a collection grid, a separating and venting vault, a passive filter and chemical treatment system, and a riprap outfall, as shown in Drawing 51781-0015, Detail 1 and 2. The seep collection grid consists of four 8-foot-long slotted PVC pipes leading to a 3-inch Schedule 80 PVC solid pipe. This pipe conveys the seep water to a concrete separation and venting vault. Originally, the seep water passed through a pipe to a steel tank housing a set of filters and three granular activated carbon (GAC) drums. The seep water passed through the filters and each of the GAC drums, and then was discharged onto 4-inch diameter riprap. This portion of the system has since been removed, and the water now flows from the venting vault through piping and discharges onto a flagstone aeration system for treatment.

3.11.2 Proposed Seep Treatment Modification

The modification design for the new seep treatment system is presented in Appendix K and primarily consists of replacing the existing flagstone aeration system with a tank containing steps to provide the aeration function of the former flagstone.

4.0 LANDFILL COVER DESIGN DRAWINGS AND SPECIFICATIONS FOR CONSTRUCTION MATERIALS

4.1 DESIGN DRAWINGS

The information presented in this design analysis report is reflected in the design drawings that form an integral part of the design for the PLF closure. These drawings document existing conditions, final conditions, and construction details. The drawings include:

Drawing	Description
51781-X001	RFETS PLF Cover Sheet
51781-001	Vicinity Map and Drawing Index
51781-002	Traffic Flow Patterns
51781-003	Existing Conditions
51781-004	Cut/Fill ISOPACH Top of Regraded Surface
51781-005	Design Top of Regraded Surface
51781-006A	Design Perimeter Channel
51781-006B	Anchor Trench
51781-006C	Grade Breaks
51781-007	Design Top of Subgrade
51781-008	Design Top of Final Cover
51781-009	Surface Water Management Plan
51781-010	Gas Management System
51781-011	Landfill Cross Sections
51781-012	Landfill Cover and Surface Water Details
51781-013A	Landfill Cover Details - East Face
51781-013B	Anchor Trench – East Face
51781-014	Gas Management Details
51781-015	Existing Seep Passive Treatment System
51781-016	New Seep Passive Treatment System Layout
51781-017	New Seep Passive Treatment System Detail
51781-018	New Seep Passive Treatment System Detail

4.2 SPECIFICATIONS FOR CONSTRUCTION MATERIALS (UPDATE TO CURENT)

This section provides an index of the Specification sections used from the 16 CSI Divisions. Divisions used for the design and construction of the cover for the PLF at RFETS are as follows:

- Division 1 – General Requirements (21 Sections);
- Division 2 – Site Construction (13 Sections);
- Division 11 – Equipment (four Sections); and
- Divisions 4 through 16 – Not Used.

These specifications follow recommended procedures and philosophy of the CSI, as adopted by Earth Tech. The specifications are provided under separate cover.

5.0 REFERENCES

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