APPENDIX K

SITE-WIDE MASS BALANCE

APPENDIX K

SITE-WIDE MASS BALANCE

This appendix presents the results of a site-wide mass balance evaluation conducted for construction of the proposed Piñon Ridge Project facilities. The mass balance considered construction for operations, as well as eventual closure of the project, which includes construction of the tailings cell closure covers.

INTRODUCTION

The site-wide material balance considered grading (i.e., cut and fill) materials for construction of all major facilities for the Piñon Ridge Project. These facilities included:

- Mill area construction;
- Construction of Tailings Cells A through C (constructed in three phases);
- Construction of the evaporation ponds (constructed in two phases);
- Construction of the ore pads and associated dumping platform;
- Site drainage construction, including the east and west stormwater ponds;
- Roadway construction; and
- Tailings cell closure cover construction.

Only native soil materials were considered in the mass balance, i.e., roadbase, rockfill, and other imported materials were not considered.

ASSUMPTIONS

The top three inches of all cut areas were considered to be topsoil. Topsoil material may be used for ET cover material (at the discretion of Kleinfelder), but this material volume was not considered as usable fill in the material balance. The total volume of topsoil materials requiring stockpiling is 103,440 cubic yards based on 95 percent compaction during stockpile construction.

Based on laboratory test results, the in-situ soil density was assumed to be 100 pounds per cubic foot (pcf). Likewise, the compacted fill density for all materials except the interim closure cover was

assumed to be 112 pcf based on compaction to 95 percent of the standard Proctor maximum dry density (ASTM D 698). Interim closure cover was assumed to be compacted to 85 percent of the standard Proctor maximum dry density, corresponding to 100 pcf.

METHOD

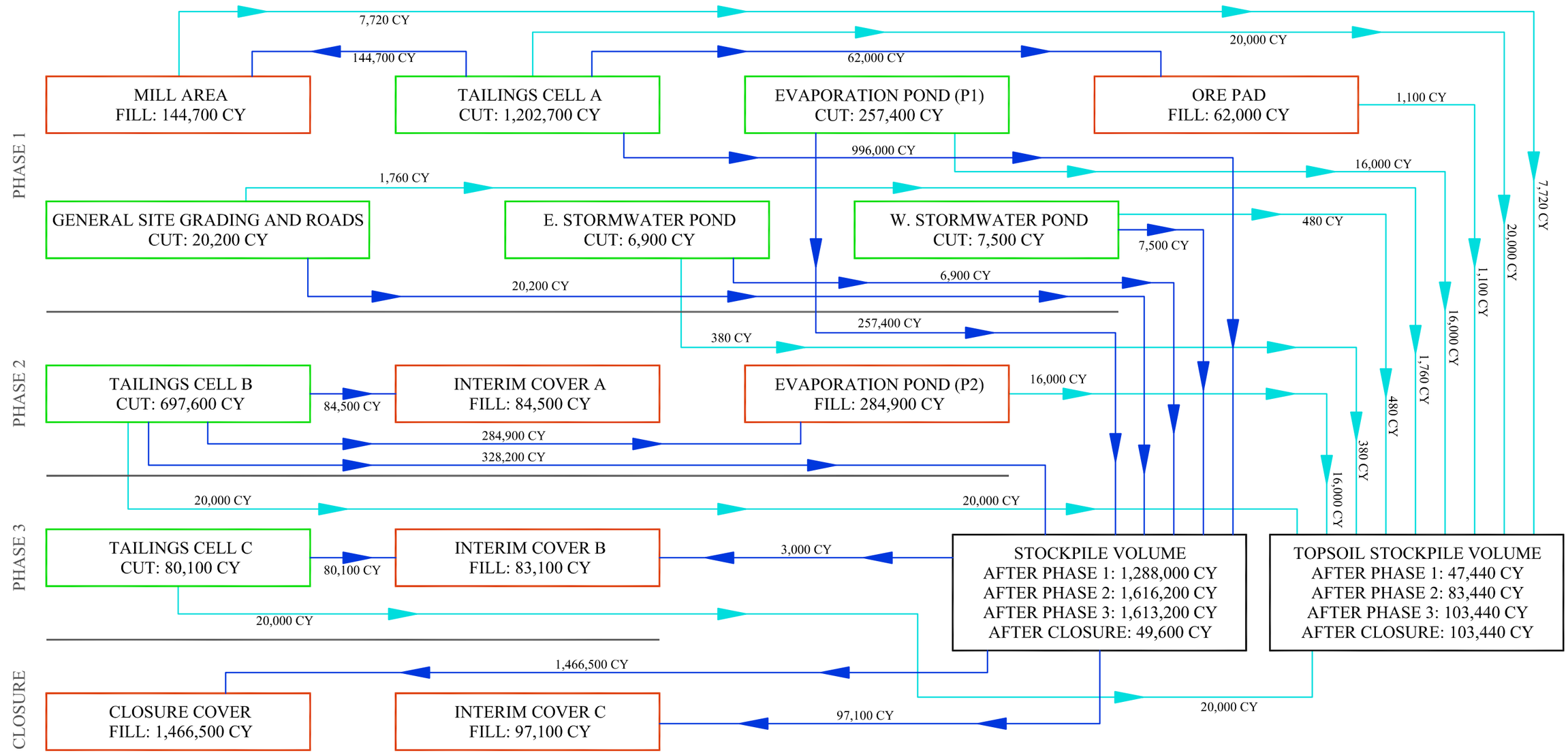
In general, calculations involved adjusting all cut/fill volumes to their equivalent volumes at a density of 112 pcf. With only a few exceptions, this reduced all cut volumes and did not affect fill volumes. Once all volume quantities had a common basis, the resulting cut or fill surplus for each major structure was included in the site-wide mass balance.

An iterative approach was used to balance the cuts and fills associated with major structures and grading across the site. For instance, a previous iteration of the site-wide mass balance indicated a soil deficiency when considering construction for operations through closure of the project. As a result of this material deficiency, the tailings cell grading plan was modified, which included lowering of the tailings cells to generate additional cut materials for future use in the closure cover.

The bedrock generally slopes up to the north, so Tailings Cell A is the deepest (designed almost entirely in cut), followed by Tailings Cells B and C.

RESULTS

The final tailings cell configurations effectively balance the cut and fill quantities required for construction of the major facilities for the Piñon Ridge Project through closure of the tailings cells. The calculation presented in Appendix K-1 estimates that 50,000 cubic yards of excess material will remain available (i.e., requiring stockpiling) after closure. It should be noted, however, that an additional approximately 200,000 cubic yards of material will be available if the mill area (including ore pads) is regraded to the original topography. A flow diagram for site construction is provided as Figure K-1. The size of the soil stockpile (excluding waste materials) reaches a maximum volume of approximately 1.6 million cubic yards (based on a density of 112 pcf) after construction of Tailings Cell B. The topsoil stockpile reaches a maximum size of 100,000 cubic yards after construction of Tailings Cell C.



LEGEND

- EXCESS CUT AVAILABLE
- FILL REQUIRED
- FLOW LINE (CUT TO FILL)
- FLOW LINE (TOPSOIL)
- PHASE DIVISION

NOTES

1. ALL QUANTITIES SHOWN HAVE BEEN ADJUSTED TO THE EQUIVALENT COMPACTED VOLUMES, ASSUMING NATIVE MATERIAL WITH A DENSITY OF 100 PCF AND COMPACTED MATERIAL WITH A DENSITY OF 112 PCF. INTERIM COVER FILL IS ASSUMED TO BE PLACED AT 100 PCF.
2. MASS BALANCE DEVELOPED ONLY FOR USE OF ON-SITE SOIL SOURCE MATERIALS. IMPORTED MATERIALS ARE EXCLUDED.
3. MATERIAL PROVIDED THROUGH REGRADING OF MILL AND ORE PAD AREAS AT CLOSURE HAS NOT BEEN ACCOUNTED FOR.
4. TOPSOIL MATERIAL FLOWS HAVE BEEN INCLUDED AND ASSUME IN-SITU (100 PCF) DENSITY. TOPSOIL MATERIAL VOLUMES ARE NOT INCLUDED IN THE CUT/FILL VOLUMES LISTED FOR EACH FACILITY.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
A	10/08	JDE	ISSUED FOR CLIENT REVIEW	JDE	KFM	JMJ

ENERGY FUELS RESOURCES CORPORATION
PIÑON RIDGE PROJECT
MONTROSE COUNTY, COLORADO

TITLE

SITE-WIDE MASS BALANCE DIAGRAM

Golder Associates
DENVER, COLORADO

PROJECT No.		073-81694
DESIGN	JDE	7/08
CADD	JDE	8/08
CHECK	KFM	8/08
REVIEW	JMJ	8/08

FILE No. FLOW DIAGRAM
SCALE NTS REV. A

FIGURE K-1

Plot Time: 09/26/08 16:32

APPENDIX K-1

SITE-WIDE MASS BALANCE CALCULATIONS

Golder Associates	Subject Piñon Ridge Project	Made by JDE	Job No 073-81694
	Site-Wide Mass Balance	Checked by	Date 08/12/08
	Post Tailings Cell Regrading	Approved by	Sheet No 1 of 2

OBJECTIVE:

Evaluate the cut and fill materials balance associated with all major proposed structures at the Piñon Ridge site for operations through closure. Materials balance conducted for general site earthworks only, and excludes materials which are anticipated to be imported.

GIVEN:

- Golder grading plans for the tailings cells, evaporation ponds, ore pads, and east stormwater pond with raw cut and fill quantities (all quantities are cubic yards)
  - Tailings Cell A[1]: Cut – 1,712,000, Fill – 308,000
  - Tailings Cell B[1]: Cut – 1,386,000, Fill – 522,000
  - Tailings Cell C[1]: Cut – 1,270,000, Fill – 1,036,000
  - Evaporation Pond (Phase 1): Cut – 460,000, Fill – 139,000
  - Evaporation Pond (Phase 2): Cut – 174,000, Fill – 426,000
  - One-Acre Ore Pad: Fill – Fill – 8,300
  - Five-Acre Ore Pad: Cut – 1,100, Fill – 16,700
  - Ore Dumping Platform and Ramps: Fill – 18,400
  - Cushion Material (Five-Acre Ore Pad): Fill – 18,600
  - East Stormwater Pond: Cut – 8,400, Fill – 300
- Email from Dave Adams of Kleinfelder on 23 July 2008 (cut quantities omit top 3 inches of material which is considered waste)
  - West Stormwater Pond: Cut – 9,333, Fill – 842, Waste – 481
  - Mill Area: Cut – 33,371, Fill – 174,519, Waste – 7,749
  - Roadways: Cut – 35,197, Fill – 9,684
- Memorandum from Alan Kuhn of Kleinfelder on 9 July 2008
  - Interim Closure Cover (Tailings Cell A): Fill – 94,560
  - Interim Closure Cover (Tailings Cell B): Fill – 93,110
  - Interim Closure Cover (Tailings Cell C): Fill – 108,800
  - Closure Cover: 1,466,530
    - Radon Barrier (Cell A): Fill – 362,640
    - Radon Barrier (Cell B): Fill – 356,520
    - Radon Barrier (Cell C): Fill – 428,650
    - ET Cover (All Cells): Fill – 318,720

ASSUMPTIONS:

- The upper 3 inches of all cut areas is considered waste and is unsuitable for use as fill material
- Average in-situ soil density is 100 pounds per cubic foot (pcf)
- Average compacted dry density for all materials except the interim closure cover is 112 pcf (assumes 95% compaction based on Standard Proctor maximum dry density)
- Interim closure cover dry density is 100 pcf (assumes 85% compaction based on Standard Proctor maximum dry density)

[1] Quantities include rock excavation

METHOD:

All cut and fill volumes were adjusted to account for waste and density differences (i.e., when 100 pcf in-situ material is compacted to 112 pcf, the volume is reduced). This was done by adjusting all quantities to an equivalent volume at 112 pcf. The adjusted cut and fill volumes were then compared for each structure and the differences were summed.

RESULTS:

This analysis indicates that there will be an excess of 50,000 cubic yards of fill material. Excess cut generated during Tailings Cell construction will be slightly more than enough for construction of the cover material at closure. Figure 1 shows a flow diagram of the cuts and fills throughout the construction process.

REFERENCES:

Golder Associates Inc. (Golder). 2008. Design drawings current as of July 2008.

Kleinfelder, Inc. (Kleinfelder). 2008a. Email from Dave Adams, *RE: Piñon Cut/Fill Quantities*. 23 July 2008.

Kleinfelder, Inc. (Kleinfelder). 2008b. Memorandum from Alan Kuhn, *Piñon Ridge Mill Volume Estimate for Earthwork, Rock and Vegetation for Closure*. 9 July 2008.

ATTACHMENT 1

CUT/FILL BALANCE CALCULATIONS

Average in-situ dry density	**100 pcf**
Average compacted dry density (1)	**112 pcf**
Interim cover dry density (2)	**100 pcf**

Notes:

(1) Assumes 95 percent of standard Proctor maximum dry density

(2) Assumes 85 percent of standard Proctor maximum dry density

(3) The above densities are based on averages of the laboratory data presented below

Standard Proctor Results

ID	Maximum Dry Density (pcf)	95% MDD (pcf)	85% MDD (pcf)
GA-TP-01 @ 5-10'	116.5	110.7	99.0
GA-TP-02 @ 2-6'	119.0	113.1	101.2
GA-TP-03 @ 4-9'	118.8	112.9	101.0
GA-TP-04 @ 2-5'	117.0	111.2	99.5
GA-TP-04 @ 5-10'	120.4	114.4	102.3
GA-TP-05 @ 0-9.5'	118.1	112.2	100.4
GA-TP-07 @ 1.5-9'	116.9	111.1	99.4
GA-TP-09 @ 1-11'	116.9	111.1	99.4

In-Situ Dry Density from Initial State of Undisturbed Triaxial Tests

ID	Initial Dry Density (pcf)
GA-BH-42 @ 10-11'	83.8
GA-BH-47 @ 2-3.5'	89.9

In-Situ Dry Density from Natural Moisture Content Testing

ID	Initial Dry Density (pcf)
GA-BH-01	100.4
GA-BH-03	95.5
GA-BH-03	98.6
GA-BH-06	100.9
GA-BH-06	116.4
GA-BH-08	107.3
GA-BH-08	98.6
GA-BH-08	81.1
GA-BH-12	135.6
GA-BH-14	84.6
GA-BH-16	99.6
GA-BH-23	98.6
GA-BH-35	92.5
GA-BH-40	96.5
GA-BH-40	99.5
GA-BH-48	89.3
GA-BH-48	94.0
GA-BH-27	99.2
GA-BH-33	116.6
GA-BH-42	114.0
GA-BH-42	83.8
GA-BH-42	109.6
GA-BH-42	99.0
GA-BH-41	106.8
GA-BH-41	113.0
GA-BH-41	98.8
GA-BH-47	89.9

Raw Quantities

Structure	Total Cut (CY)	CUT less waste(CY)[1]	FILL (CY)
Tailings Cell A	1,712,000	1,692,000	308,000
Tailings Cell B	1,386,000	1,366,000	522,000
Tailings Cell C	1,270,000	1,250,000	1,036,000
Evaporation Pond (P1)	460,000	444,000	139,000
Evaporation Pond (P2)	174,000	158,000	426,000
Ore Pad [2]	1,100	0	62,000
Mill Area	41,120	33,400	174,500
East Stormwater Pond	8,400	8,020	300
West Stormwater Pond	9,810	9,330	840
General Site Grading and Roads	35,200	33,440	9,700
Interim Cover (Cell A)	0	0	94,600
Interim Cover (Cell B)	0	0	93,100
Interim Cover (Cell C)	0	0	108,800
Closure Cover	0	0	1,466,530

NOTES

(1) Topsoil is considered waste and is assumed to be the upper 3 inches of cut. Tailings cells assume 3 inches of waste over 50 acres each, and evaporation ponds assume 3 inches of waste over 40 acres for each phase. Waste generated from general site grading and roads is assumed to be 5 percent of the total cut.

(2) Includes 1-acre ore pad, 5-acre ore pad, ore dumping platform, and cushion fill

(3) Quantities are not adjusted for shrinkage/swelling

Adjusted Quantities

Area	Adj. Cut (CY)	Adj. Fill (CY)	Adj. Excess Cut (CY)[1]	Stockpile (CY)	Waste[5] (CY)
Tailings Cell A	1,510,714	308,000	1,202,714	1,202,714	20,000
Tailings Cell B	1,219,643	522,000	697,643	1,900,357	20,000
Tailings Cell C	1,116,071	1,036,000	80,071	1,980,429	20,000
Evaporation Pond (P1)	396,429	139,000	257,429	2,237,857	16,000
Evaporation Pond (P2)	141,071	426,000	-284,929	1,952,929	16,000
Ore Pad [2]	0	62,000	-62,000	1,890,929	1,100
Mill Area	29,821	174,500	-144,679	1,746,250	7,720
East Stormwater Pond	7,161	300	6,861	1,753,111	380
West Stormwater Pond	8,330	840	7,490	1,760,601	480
General Site Grading and Roads	29,857	9,700	20,157	1,780,758	1,760
Interim Cover (Cell A)	0	84,464	-84,464	1,696,294	0
Interim Cover (Cell B)	0	83,125	-83,125	1,613,169	0
Interim Cover (Cell C)	0	97,143	-97,143	1,516,026	0
Closure Cover	0	1,466,530	-1,466,530	49,496	0
			Excess Fill Available	**49,496**	103,440
			Additional Cut Required	**0**	

NOTES

(1) Topsoil is considered waste and is assumed to be the upper 3 inches of cut

(2) Includes 1-acre ore pad, 5-acre ore pad, ore dumping platform, and cushion fill

(3) Cut quantities have been adjusted to equivilent in-place (compacted) volumes based on an average density of 112 pcf

(4) Interim cover fill quantities (compacted at 100 pcf) have been adjusted to an equivilent volume of 112 pcf material

(5) Waste can be used for ET cover