Shieldalloy PEmails

From: John Hayes
Sent: Thursday, November 20, 2008 6:38 AM
To: 'Jenny Goodman'
Subject: FW: Information Regarding Engineeer Barrier Design and Sampling Locations in SMC Storage Yard
Attachments: SMC Storage Yard Investigation Location Coordinates 11-12-08.pdf; Infiltration Evapotranspiration Modeled Assumptions111008.pdf

Jenny

I'm forwarding the attached memorandum Infiltration & Evapotranspiration Modeled Assumptions dated November 11, 2008 that SMC has developed for use in the RESRAD model because of the multi layered engineer barrier design. The second attachment is a listing of the coordinates from where the various storage yard materials and subsurface samples were collected.

As I have mentioned SMC has under its control and custody all of the samples collected of various storage yard materials and subsurface samples. They believe there is adequate volume of to permit NRC and NJDEP to take splits of the samples if you desire. We have not decided whether we will accept that offer.

Jack

Hearing Identifier: Shieldalloy_DP_Public_EX
Email Number: 18

Mail Envelope Properties (D841D501B2C4D244B75AB897F70C1494846662D16A)

Subject: FW: Information Regarding Engineeer Barrier Design and Sampling Locations in SMC Storage Yard
Sent Date: 11/20/2008 6:37:55 AM
Received Date: 11/20/2008 6:37:57 AM
From: John Hayes

Created By: John.Hayes@nrc.gov

Recipients:
'"Jenny Goodman"' <Jenny.Goodman@dep.state.nj.us>
Tracking Status: None

Post Office: HQCLSTR01.nrc.gov

Files	**Size**	**Date & Time**	
MESSAGE	719	11/20/2008 6:37:57 AM	
SMC Storage Yard Investigation Location Coordinates 11-12-08.pdf			70956
Infiltration Evapotranspiration Modeled Assumptions111008.pdf			17245

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Storage Yard Material Investigation Locations Shieldalloy Metallurgical Corporation		
Sample No.	**Location[1]**	
	Northing	**Easting**
GRID-BASED AND OBSERVATIONAL STORAGE YARD MATERIAL SAMPLE LOCATIONS		
AREA 1		
1-A	258026.377	346712.603
1-B	258002.493	346780.308
1-C	258083.324	346783.486
1-1	257984.594	346684.071
1-2	258026.709	346680.443
1-3	258047.990	346692.845
1-4	258061.863	346709.795
1-5	258075.745	346728.699
1-6	258091.882	346749.070
1-7	258110.595	346771.209
1-8	258128.444	346803.398
1-9	258145.924	346840.628
1-10	258088.204	346847.478
1-11	258065.485	346835.509
1-12	258038.347	346827.357
1-13	258018.377	346815.469
1-14	258005.922	346798.388
1-15	257995.178	346776.907
1-16	257981.193	346752.225
1-17	257964.598	346721.059
AREA 2		
2-A	258005.871	346903.337
2-B	258001.383	346893.839
2-19	258012.259	346909.098
2-20	258009.849	346899.202
2-18	258022.427	346891.103
2-34	258026.688	346882.858
2-33	258019.617	346865.801
2-32	258007.999	346868.681
2-31	257994.771	346874.185
2-21	257999.305	346895.257
2-22	257979.395	346895.649
2-23	257966.207	346892.699
2-30	257975.563	346877.421
2-24	257955.847	346877.913
2-25	257960.758	346861.074
2-26	257954.556	346847.840
2-27	257949.258	346837.545
2-28	257953.469	346816.783
2-29	257946.941	346805.336

AREA 3		
3-120	258155.870	346944.242
3-121	258125.706	346955.694
3-122	258099.946	346903.939
2S (3-123)	258269.085	346844.503
AREA 4		
4-A	258306.660	346855.814
4-B	258311.150	346713.167
4-C	258374.435	346694.452
4-69	258345.820	346868.291
4-70	258337.466	346824.052
4-71	258332.556	346776.607
3S (4-72)	258415.790	346705.628
4-73	258267.912	346789.912
4-74	258263.237	346737.453
4-75	258207.688	346772.989
4-76	258191.296	346707.400
4-77	258209.189	346662.297
4-78	258281.820	346618.755
4-79	258293.341	346652.682
4-80	258292.126	346704.739
4-81	258356.617	346656.226
4-82	258414.407	346653.147
1S (4-83)	258119.033	346888.742
4-84	258324.694	346700.821
4-85	258351.112	346745.605
AREA 5		
5-A	258315.518	346914.723
5-B	258306.247	346923.576
5-C	258295.654	346906.808
5-D	258286.821	346920.260
5-E	258277.914	346955.069
5-F	258262.033	347023.490
5-G	258226.292	346989.967
5-H	258223.395	346945.447
5-I	258224.222	346934.289
5-J	258205.767	346889.436
5-K	258173.106	346836.284
5-35	258280.344	346891.398
5-37	258288.441	346924.912
5-36	258310.793	346911.734
5-38	258282.299	346943.630
5-39	258270.275	346965.251
5-40	258273.094	346994.680
5-41	258264.210	347015.996
5-43	258233.025	347005.327
5-42	258209.762	347022.142
5-44	258215.537	346982.799
5-45	258223.615	346960.938
5-46	258211.862	346932.440

5-47	258215.311	346921.284
5-48	258222.311	346895.299
5-49	258217.262	346883.169
5-50	258223.258	346865.537
5-51	258219.226	346840.425
AREA 6		
6-A	258453.804	346527.268
6-B	258454.136	346517.070
6-C	258426.151	346584.839
6-D	258393.034	346562.535
6-86	258389.212	346595.686
6-87	258396.409	346575.967
6-88[2]	258398.637	346557.840
6-89	258401.925	346542.937
6-90	258407.815	346529.556
6-91	258413.887	346516.157
6-92	258422.814	346502.013
6-93	258438.906	346487.788
6-94	258478.618	346485.237
6-95	258474.561	346504.084
6-96	258469.247	346520.404
6-97	258463.691	346535.696
6-98	258458.653	346550.398
6-99	258452.738	346564.436
6-100	258446.617	346578.502
6-101	258439.302	346592.568
6-102	258428.673	346606.689
AREA 7		
7-A	258352.834	346517.906
7-B	258352.353	346523.713
7-C	258374.197	346515.405
7-D	258376.851	346513.736
7-E	258339.637	346467.819
7-F	258338.318	346466.063
7-G	258344.533	346463.656
7-H	258321.727	346481.784
7-I	258327.953	346487.862
7-J	258288.079	346507.263
7-K	258287.047	346465.774
7-L	258284.651	346467.182
AREA 8		
8-A	257990.376	346575.751
8-103	257970.218	346584.968
8-104	257963.015	346558.819
8-105	257980.955	346465.005
8-106	257992.538	346533.471
5BD (8-107)	258042.986	346540.471
6BD (8-108)	258018.316	346500.895
8-109	258063.677	346506.061
8-110	258091.499	346472.793

4BD (8-111)	258107.292	346513.003
8-112	258128.949	346524.901
8-113	258149.473	346564.898
8-114	258135.226	346633.198
8-115	258104.671	346606.955
8-116	258076.159	346577.065
8-117	258033.411	346586.924
8-118	258015.288	346599.682
8-119	257995.331	346567.013
AREA 9		
9-A	258181.366	346488.121
9-B	258190.030	346497.714
9-123	346485.978	258228.933
9-124	346584.049	258225.617
9-125	346586.418	258185.358
9-126	346474.606	258176.358
SUBSURFACE SAMPLE LOCATIONS		
HA-1 (background)	347332.605	258187.274
HA-2 (background)	347303.090	257915.852
HA-3	346873.203	258088.584
HA-4	346451.477	258046.378
HA-5	346531.575	258405.289
HA-6	346619.276	258402.398
LOCATION OF CROSS-SECTION THROUGH BAGHOUSE DUST		
P8 X-CUT	346455.080	258035.390

[1] - New Jersey Plane Coordinate System; NAD 83

[2] - Grid sample 6-88 was submitted with samples 1S, 2S, 3S, 4BD, 5BD and 6BD for initial SPLP analyses.

INFILTRATION & EVAPOTRANSPIRATION MODEL ASSUMPTIONS
November 11, 2008

The RESRAD Manual defines the infiltration rate, I, as the quantity of water that percolates through a soil barrier covering waste based upon the annual precipitation, plus irrigation minus the amount of runoff and evapotranspiration:

$$I = (1 - C_e)[(1 - C_r)P_r + I_{rr}]$$

I = Infiltration Rate (m/yr)
C_e = Evaporation Coefficient (dimensionless)
C_r = Runoff Coefficient (dimensionless)
P_r = Precipitation (m/yr)
I_{rr} = Irrigation Rate (m/yr) – No Irrigation Proposed at SMC

This equation is specific to barriers with a single set of parameters (i.e., a single, uniform layer or cap).

In the case of a multi-layered engineered barrier, such as that proposed at the Shieldalloy Metallurgical Corporation (SMC) site in Newfield, New Jersey, the aforementioned equation cannot be used directly to predict infiltration rate because it does not contain provisions for more than one layer. Therefore, an alternative approach is required.

The SMC engineered barrier is loosely described as a crushed stone erosion layer underlain by a low permeability soil layer, in turn underlain by a very high permeability crushed aggregate drainage/root penetration layer, and further underlain by a very low permeability clay layer. The above equation from the RESRAD computer model can thus only serve as a predictor of the quantity of precipitation that will penetrate the upper low permeability soil layer and enter the very high permeability crushed aggregate drainage/root penetration layer.

To model the different functions of the various layers of the engineered barrier at SMC's Newfield site for dose assessment purposes, the infiltration penetrating the entire cap must first account for evapotranspiration of water from the more permeable (and under an "all controls fail" scenario potentially-vegetated) upper layer of the engineered barrier (i.e., above the clay barrier layer), while the runoff from the upper layer, as well as absorption/storage of water in soil pores within the barrier, are conservatively neglected.[1] Once the water enters the very high permeability drainage/root penetration layer, it is allowed to drain freely along the surface of the very low permeability clay layer to the surface drain at the toe of slope. There is no measurable evapotranspiration in this zone and the amount of water that penetrates the clay layer is only a function of the time the water remains in contact with the clay surface and the permeability of the clay. The infiltration through the clay layer is treated as a function of the runoff coefficient for the clay, with the precipitation being that which infiltrates the overlying soil layer.

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[1]Shieldalloy Metallurgical Corporation, *Decommissioning Plan for the Newfield Facility*, Appendix B, Attachment 6, Rev. 1b Interim, Page 2, August 21, 2008.

The Infiltration Rate through *all* of the layers of the SMC engineered barrier is therefore calculated as precipitation (P_r) minus evapotranspiration (ET_r) through the uppermost soil layer, minus the runoff (Q_d) of water at the surface of the clay barrier layer after water has percolated through the overlying cover and drainage layers as follows:

$$I = P_r - ET_r - Q_d$$

where ET_r = the evapotranspiration rate (m/yr); P_r = the precipitation rate (m/yr); and Q_d = runoff of water at the surface of the clay barrier (irrigation rate is assumed to be 0 m/year). The value of Q_d is equal to C_r x (P_r - ET_r), where C_r = the runoff coefficient for the clay barrier layer.

Since the RESRAD model uses the equation noted at the beginning of this memorandum to derive an infiltration rate for any barrier, whether single- or multi-layer, the values used for precipitation rate, runoff coefficient and/or evapotranspiration coefficient cannot be the default values from the RESRAD code in the case of a multi-layer barrier. Therefore, a site-specific infiltration rate was determined for the multi-element SMC barrier, and the evapotranspiration coefficient in the model was varied until the equation produced the site-specific infiltration rate.[2],[3]

Using the equation for infiltration provided in the RESRAD manual, the evapotranspiration coefficient, C_e, is expressed as a function of the infiltration rate (I) as follows (where I_{rr} = the irrigation rate (m/yr):[4]

$$I = (1-C_e)[(1-C_r)P_r + I_{rr}]$$

or :

$$I /[(1 - C_r)P_r + I_{rr}] = 1 - C_e$$

For the SMC multi-layer engineered barrier, the following variables were thus used as input to the calculations: ET_r = 0.768 meters per year;[5] P_r = 1.05 meters per year;[6] I_{rr} = 0 meters per

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[2] The evapotranspiration coefficient is the ratio of the total volume of water vapor that is transferred to the atmosphere through evapotranspiration, to the total volume of water available within the root zone of the soil (U.S.Nuclear Regulatory Commission, *Development of Probabilistic RESRAD 6.0 and RESRAD-Build 3.0 Computer Codes*, NUREG-6697, Appendix C, Section 4.3, November, 2000). Evapotranspiration, the combination of evaporation from the soil surface and transpiration from vegetation, is defined as the process by which water is changed into vapor from the liquid or solid state (through heat energy) and carried into the atmosphere.

[3]Shieldalloy Metallurgical Corporation, *Decommissioning Plan for the Newfield Facility*, Appendix B, Attachment 6, Rev. 1b Interim, August 21, 2008.

[4]Argonne National Laboratory, *User's Manual for RESRAD Version 6*, ANL-EAD-4, Appendix E, Equation E.4, July, 2001.

[5]Shieldalloy Metallurgical Corporation, *Decommissioning Plan for the Newfield Facility*, Appendix B, Attachment 6, Rev. 1b Interim, Page 5, August 21, 2008.

[6]Shieldalloy Metallurgical Corporation, *Decommissioning Plan for the Newfield Facility*, Appendix B, Attachment

year;[7] and C_r = 0.9.[8] For the engineered barrier as designed, the infiltration through the clay barrier layer (I) is thus 0.028 meters per year for the "As-Designed Condition".[9] Therefore, the evapotranspiration coefficient (C_e) is 0.73.[10]

6, Rev. 1b Interim, Page 2, August 21, 2008.

[7]Because the barrier will have a rock cover, no irrigation waters will be applied.

[8]Shieldalloy Metallurgical Corporation, *Decommissioning Plan for the Newfield Facility*, Appendix B, Attachment 6, Rev. 1b Interim, Page 4 (Table 1), August 21, 2008.

[9]Shieldalloy Metallurgical Corporation, *Decommissioning Plan for the Newfield Facility*, Appendix B, Attachment 6, Rev. 1b Interim, Table 1, Page 3, August 21, 2008.

[10]Shieldalloy Metallurgical Corporation, *Decommissioning Plan for the Newfield Facility*, Appendix B, Attachment 6, Rev. 1b Interim, Table 1, Page 4, August 21, 2008.