Tennessee Valley Authority
John Sevier Fossil Plant
Dry Fly Ash Landfill (IDL 37-0097)

GROUNDWATER ASSESSMENT MONITORING REPORT APRIL 2014

Prepared by

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June 4, 2014

DOCUMENT CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information.

Terrell B. Slider
Senior Manager, Regional Gas Operations
June 5, 2014

EXECUTIVE SUMMARY

The April 2014 semiannual *Groundwater Assessment Monitoring - Phase 2* event of the Class II Dry Fly Ash Landfill, Permit number IDL 37-0097 at the John Sevier Fossil Plant, was conducted by TVA April 7-10, 2014. Sample collection and analysis were performed in accordance with requirements set by Tennessee Department of Environment and Conservation (TDEC) Rule 0400-11-01-.04, the approved facility groundwater monitoring plan, and other site-specific monitoring requirements outlined by TDEC. Results given in Table 2 indicate no GWPS exceedances for Appendix II constituents. For the non-Appendix II parameters given in Table 3, UPL exceedances were observed for alkalinity (all downgradient wells), ammonia (well W29), boron (wells W28, W29, W30, W31), chloride (well W30), fluoride (wells W30 and W31), manganese (wells W28, W29, and W30), pH (wells W28, W29, W30), potassium (well W31), sodium (wells W28, W30, and W31), specific conductivity (all downgradient wells), strontium (wells W28, W30, and W31), and sulfate (all downgradient wells). In addition to monitoring well data, effluent sample results and flow rate data are provided for the facility leachate collection system. All water samples were analyzed by Test America in Nashville, TN (TAN), an EPA-certified laboratory.

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INTRODUCTION

This report provides results of the April 2014 semiannual monitoring event of *Groundwater Assessment Monitoring - Phase 2* for the Class II Dry Fly Ash Landfill, Permit number IDL 37-0097 at the John Sevier Fossil Plant (JSF). In addition to monitoring well data, effluent sample results and flow rate data are provided for the facility leachate collection system (LCS). All water samples were analyzed by Test America in Nashville, TN (TAN), an EPA-certified laboratory. Sample collection and analysis were performed in accordance with Tennessee Department of Environment and Conservation (TDEC) Rule 0400-11-01-.04 and the approved facility groundwater monitoring plan (March 2013). In addition, site-specific monitoring requirements of *Groundwater Assessment Monitoring - Phase 2* were followed, as outlined in the letter dated April 5, 2007 from W.N. Smith (TDEC) to G.G. Park (TVA).

GROUNDWATER SAMPLING

Groundwater sampling was conducted April 7-10, 2014 by W.F. Nichols and Colt Minton of TVA at monitoring wells 1, W28 through W32, and at the LCS. A peristaltic pump was used to purge and sample all wells, except well 1, which was sampled with a non-dedicated centrifugal pump. The LCS water sample was collected directly from the discharge pipe at the coal yard drainage basin. Quality control (QC) duplicate samples were collected from well W28. An equipment blank was collected between wells W30 and well W31. Field parameters (i.e., temperature, specific conductance, pH, dissolved oxygen, and oxidation-reduction potential) were monitored during well purging using a flow-through cell and calibrated instruments. Wells were purged utilizing either conventional purging of a minimum two well volumes or EPA's Low Stress (low-flow) purging procedures[1]. Low-flow sampling involves pumping from the well at a rate that equals inflow of groundwater through the well screen, then sampling after three consecutive five-minute intervals showed stable readings of field parameters (+/-10% difference for several readings). Field data sheets are included in Appendix A.

Following collection, samples were transferred to new sample bottles with appropriate preservatives, where applicable. The samples were then sealed, labeled, recorded on a

[1]US EPA Region 1, *Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells*, Revision 3. Revised January 19, 2010.

custody form, and placed in a container for transport. Samples were delivered to TAN for analysis on April 11, 2014, by overnight courier. Copies of the sample custody records are given in Appendix B.

ANALYTICAL RESULTS

Table 1 presents Groundwater Protection Standards (GWPS) for facility constituents falling under Appendix II of Rule 0400-11-01-.04; GWPS are as defined in Section IV(1)(d) of *TDEC Ground Water Monitoring Guidance for Solid Waste Landfill Units Policy*. Per Policy, GWPS require consideration of the constituent MCL listed in Appendix III of Rule 0400-11-01-.04, and for constituents having no MCL (cobalt, copper, tin, vanadium, and zinc), EPA preliminary remediation goals (PRG - now Regional Screening Levels (RSL)) for tap water may be applied pursuant to *Section IV(1)(d)(iii)* of the *Policy.* Table 2 presents a summary of the laboratory analytical results for the Appendix II samples. Other permit-required groundwater constituent results are presented in Table 3. LCS sample data are given in Table 4. Laboratory analyses of all samples were completed within recommended sample holding times. The complete laboratory report is presented in Appendix C and includes analytical methods, detection limits, and any data qualifiers.

EVALUATION OF ASSESSMENT MONITORING DATA

Facility constituents falling under Appendix II of Rule 0400-11-01-.04 were evaluated against their GWPS; the remaining non-Appendix II facility constituents were statistically evaluated using either parametric or non-parametric prediction intervals, depending on data normality, applied on an interwell basis with no verification samples. Application of interwell comparison was agreed upon by TDEC and TVA during a June 2, 2010 teleconference. Upper prediction limits (UPL) for the original permit-required constituents presented in Table 3 were computed using historical data for upgradient well 1 collected between January 6, 2000, and April 10, 2014 (Appendix D). The data set was truncated to eliminate results prior to 2000. This provides greater confidence in the results since the use of more modern sampling protocol had been implemented. It also provides more conservatism in the background data pool.

Table 1. Groundwater Protection Standards

Parameter	Units	UPL	MCL	GWPS	GWPS Source
Antimony	µg/L	6	6	6	TDEC
Arsenic	µg/L	2.5	10	10	TDEC
Barium	µg/L	259	2,000	2,000	TDEC
Beryllium	µg/L	2.7	4	4	TDEC
Cadmium	µg/L	1	5	5	TDEC
Chromium	µg/L	4	100	100	TDEC
Cobalt	µg/L	2	N/A	11	EPA-RSL
Copper	µg/L	10	N/A	620	EPA-RSL
Cyanide	mg/L	0.01	N/A	N/A	N/A
Lead	µg/L	2	15	15	TDEC
Mercury	µg/L	0.2	2	2	TDEC
Nickel	µg/L	3.3	100	100	TDEC
Selenium	µg/L	2	50	50	TDEC
Silver	µg/L	2	100	100	TDEC
Sulfide	mg/L	1	N/A	N/A	N/A
Thallium	µg/L	2	2	2	TDEC
Tin	µg/L	490	N/A	22,000	EPA-RSL
Vanadium	µg/L	2	N/A	180	EPA-RSL
Zinc	µg/L	95.5	N/A	4,700	EPA-RSL

TDEC - Solid Waste Processing and Disposal Rule 0400-11-01-.04
EPA-RSL - EPA Regional Screening Limit (Health-based Standard)

Results given in Table 2 indicate no GWPS exceedances for Appendix II constituents. For the non-Appendix II parameters given in Table 3, UPL exceedances were observed for alkalinity (all downgradient wells), ammonia (well W29), boron (wells W28, W29, W30, W31), chloride (well W30), fluoride (wells W30 and W31), manganese (wells W28, W29, and W30), pH (wells W28, W29, W30), potassium (well W31), sodium (wells W28, W30, and W31), specific conductivity (all downgradient wells), strontium (wells W28, W30, and W31), and sulfate (all downgradient wells).

Table 2. April 7-10, 2014 Appendix II Constituent Groundwater Monitoring Results

Analytical Results for Appendix II Constituents								**Groundwater Protection Standard (GWPS)**	**MCL**	**Comparison to GWPS[b]**				
Parameter	**Units**	**1** upgradient	**W28[a]** downgradient	**W29** downgradient	**W30** downgradient	**W31** downgradient	**W32** downgradient			**W28**	**W29**	**W30**	**W31**	**W32**
Antimony	µg/L	<2	<2	<2	<2	<2	<2	6	6	L	L	L	L	L
Arsenic	µg/L	<2	<2	<2	<2	<2	<2	10	10	L	L	L	L	L
Barium	µg/L	227	17.9	20.3	22.2	31.5	53.7	2,000	2,000	L	L	L	L	L
Beryllium	µg/L	<2	<2	<2	<2	<2	<2	4	4	L	L	L	L	L
Cadmium	µg/L	<1	1.295	<1	<1	1.46	<1	5	5	L	L	L	L	L
Chromium	µg/L	<2	<2	<2	<2	<2	<2	100	100	L	L	L	L	L
Cobalt	µg/L	<2	2.9	<2	2.75	<2	<2	11	N/A	L	L	L	L	L
Copper	µg/L	<2	<2	<2	<2	<2	<2	620	N/A	L	L	L	L	L
Cyanide	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	N/A	N/A	L	L	L	L	L
Lead	µg/L	<2	<2	<2	<2	<2	<2	15	15	L	L	L	L	L
Mercury	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	2	2	L	L	L	L	L
Nickel	µg/L	<2	<2	<2	2.05	<2	<2	100	100	L	L	L	L	L
Selenium	µg/L	<2	<2	<2	<2	<2	<2	50	50	L	L	L	L	L
Silver	µg/L	<2	<2	<2	<2	<2	<2	100	100	L	L	L	L	L
Sulfide	mg/L	<1	<1	<1	<1	<1	<1	N/A	N/A	L	L	L	L	L
Thallium	µg/L	<2	<2	<2	<2	<2	<2	2	2	L	L	L	L	L
Tin	µg/L	<50	<50	<50	<50	<50	<50	22,000	N/A	L	L	L	L	L
Vanadium	µg/L	<2	<2	<2	<2	<2	<2	180	N/A	L	L	L	L	L
Zinc	µg/L	<25	<25	<25	<25	<25	<25	4,700	N/A	L	L	L	L	L

[a] *Reported concentrations are averages of duplicate samples.*

[b] *L = less than or equal to the GWPS; G = greater than the GWPS*

Table 3. April 7-10, 2014 Other Permit-Required Constituent Groundwater Monitoring Results

Analytical Results for Other Permit-Required Constituents								Upper Prediction Limits (UPL)[b]	MCL	Comparison to UPL[c]				
Parameter	Units	1 upgradient	W28 downgradient	W29 downgradient	W30 downgradient	W31 downgradient	W32[a] downgradient			W28	W29	W30	W31	W32
Alkalinity	mg/L	216	290.5	335	352	317	279	222	--	G	G	G	G	G
Aluminum	µg/L	< 100	< 100	< 100	< 100	< 100	< 100	200	--	L	L	L	L	L
Ammonia	mg/L	< 0.1	0.1155	0.158	0.125	0.129	< 0.1	0.14	--	L	G	L	L	L
Boron	µg/L	65.4	3020	1020	4020	13600	53.9	225	--	G	G	G	G	L
Chloride	mg/L	8.47	12.15	3.45	15.5	7.96	11.5	15.204	--	L	L	G	L	L
Fluoride	mg/L	< 0.1	< 0.1	0.132	0.272	0.274	< 0.1	0.23	4	L	L	G	G	L
Iron	µg/L	188	279.5	< 100	< 100	< 100	< 100	5,400	--	L	L	L	L	L
Manganese	µg/L	28	2690	4180	3130	5.53	< 2	52.934	--	G	G	G	L	L
Nitrate-Nitrite	mg/L	0.187	< 0.1	0.184	< 0.1	0.393	0.761	0.854	10	L	L	L	L	L
pH	SU	7.1	6.4	6.2	6.4	6.7	6.6	6.5-7.6	--	Low	Low	Low	W	W
Potassium	mg/L	< 1	1.115	< 1	1.28	11.1	1.29	1.7	--	L	L	L	G	L
Redox	mV	170	332	394	320	358	374	625.433	--	L	L	L	L	L
Sodium	mg/L	6.62	21.35	9.29	33.8	80.3	7.09	9.649	--	G	L	G	G	L
Sp. Cond.	µmhos/cm	483	1731	881	2218	2438	620	499	--	G	G	G	G	G
Strontium	µg/L	751	883.5	833	4320	3870	291	867	--	G	L	G	G	L
Sulfate	mg/L	31.8	740	159	997	1190	45.4	31.8	--	G	G	G	G	G
Temperature	°C	18.6	14.7	12.6	14	12.8	14.6	18.6	--	L	L	L	L	L

[a] *Reported concentrations are averages of duplicate samples.*

[b] *Established April 2014; based on background data (well 1) from 01/06/00 to 04/10/2014.*

[c] *L = less than or equal to UPL; G = greater than UPL; W = within the LPL to UPL range (pH only); Low = Below the LPL (pH only)*

Table 4. April 7, 2014 Leachate Collection System Monitoring Results

Parameter	Units	Concentration
Alkalinity	mg/L	366
Aluminum	ug/L	5580
Ammonia (as N)	mg/L	0.109
Antimony	ug/L	< 2
Arsenic	ug/L	2.65
Barium	ug/L	33
Beryllium	ug/L	< 2
Boron	ug/L	343
Cadmium	ug/L	< 1
Chloride	mg/L	3.5
Chromium	ug/L	4.79
Cobalt	ug/L	2.01
Copper	ug/L	3.67
Cyanide	mg/L	< 0.01
Fluoride	mg/L	0.226
Iron	ug/L	8710
Lead	ug/L	3.84
Manganese	ug/L	264
Mercury	ug/L	< 0.2
Nickel	ug/L	3.26
Nitrate-Nitrite	mg/L	1.18
pH	s.u.	6.5
Potassium	mg/L	4.47
Redox	mV	405
Selenium	ug/L	< 2
Silver	ug/L	< 2
Sodium	mg/L	3.29
Sp. Cond.	umhos/cm	376
Strontium	ug/L	612
Sulfate	mg/L	84.2
Sulfide	mg/L	< 1
Temperature	°C	16.1
Thallium	ug/L	< 2
Tin	ug/L	< 50
Vanadium	ug/L	9.86
Zinc	ug/L	< 25

**L = less than or equal to MCL; G = greater than MCL*

Time-series graphs of Appendix II sample constituent data for wells 1, W28, W29, W30, W31, and W32 are presented in Appendix E. All constituent concentration trends are stable or declining. Nickel concentrations in most facility wells saw increases in magnitude from 2007 to 2013, likely due to a change in laboratories and analytical methods, but have since reduced to near non-detectable levels in all wells. Sporadic spikes in cadmium concentrations in well W31 have been noted since a change in laboratories in 2007, and were the focus of a previous investigation into an analytical interference. It should also be noted that, historically, the maximum value detected for either of these constituents is less than half the applicable MCL.

Beginning in the Spring of 2014, TVA has begun construction activities to install a compacted clay cap and flexible membrane liner over the northwest portion of the dry fly ash stack. This activity involves the use of heavy construction equipment which may cause temporary fluctuations in local groundwater quality. Results from the next sampling event will be evaluated to determine if an impact has resulted from this activity.

HYDROGEOLOGIC CONDITIONS

Groundwater levels measured in site monitoring wells on April 7, 2014, prior to sample collection are given in Table 5. The groundwater potentiometric surface derived from these measurements is presented on Figure 1. Groundwater generally flows northwestward across the fly ash landfill toward the Holston River. The monitored aquifer is a shallow aquifer not utilized for drinking water; downgradient flow is on TVA property and ultimately discharges to the Holston River.

Table 5. April 7, 2014 Groundwater Level Measurements

Well No.	Top of Casing Elevation (m)	Depth to Water (m)	Water Elevation (m)	Bottom Depth (m)
1	349.04	3.20	345.84	23.13
W28	331.54	5.70	325.84	8.59
W29	328.71	3.09	325.62	6.44
W30	328.99	1.81	327.18	6.12
W31	330.59	2.87	327.72	5.36
W32	336.48	4.89	331.59	7.80

An average hydraulic gradient of approximately 0.0182 is estimated between the southeastern and northwestern boundaries of the landfill. The shallow alluvial aquifer underlying the dry fly ash landfill exhibits a mean horizontal hydraulic conductivity of 0.006 m/d ($7x10^{-6}$ cm/s). The local Darcy flux is therefore estimated to be approximately $1.1x10^{-4}$ m/d.

LEACHATE COLLECTION SYSTEM DISCHARGE

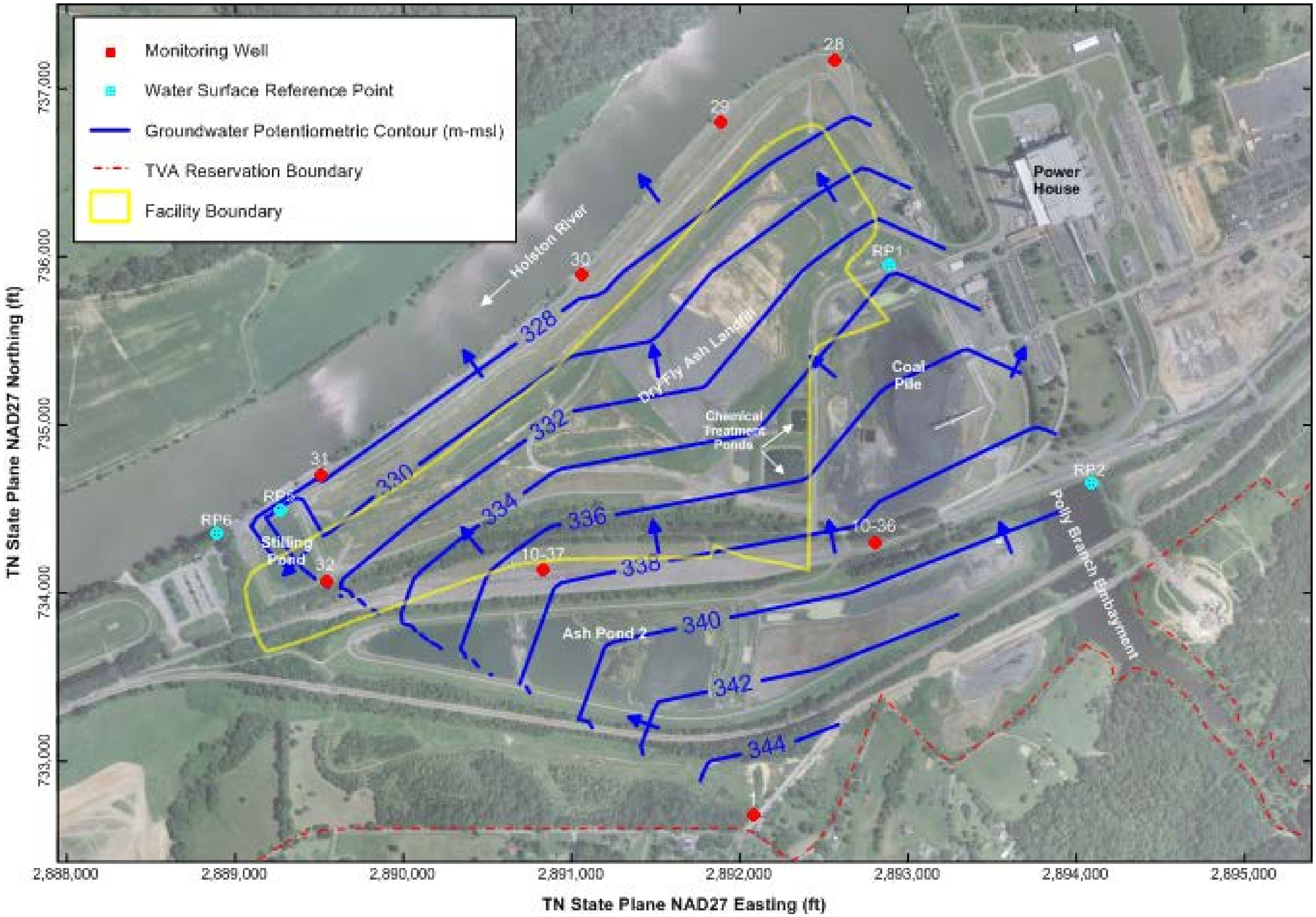
Appendix F provides a complete record of average daily discharge estimates for the LCS since operation began in April 2000. Three additional pumps were placed into service with the addition of a toe drain system for the Dry Fly Ash Stack during the spring of 2011. Also included at the bottom of the table is the estimated average LCS discharge rate observed during the past seven month monitoring period, i.e., between November 25, 2013 and May 12, 2014. Pumpage during this period averaged approximately 9.867 gpd.

CONCLUSIONS

Groundwater monitoring data for the April 7-10, 2014, sampling event indicated no GWPS exceedance for any Appendix II parameter. For the non-Appendix II parameters given in Table 3, UPL exceedances were observed for alkalinity (all downgradient wells), ammonia (well W29), boron (wells W28, W29, W30, W31), chloride (well W30), fluoride (wells W30 and W31), manganese (wells W28, W29, and W30), pH (wells W28, W29, W30), potassium (well W31), sodium (wells W28, W30, and W31), specific conductivity (all downgradient wells), strontium (wells W28, W30, and W31), and sulfate (all downgradient wells).

Beginning in the Spring of 2014, TVA has begun construction activities to install a compacted clay cap and flexible membrane liner over the northwest portion of the dry fly ash stack. This activity involves the use of heavy construction equipment which may cause temporary fluctuations in local groundwater quality. The next facility groundwater monitoring network sampling is expected to be in November 2014. Results from that event will be evaluated to determine if an impact has resulted from the construction activity.

Figure 1. Groundwater Potentiometric Surface on April 7, 1014



APPENDIX A

FIELD DATA SHEETS

APPENDIX B

SAMPLE CUSTODY RECORD

APPENDIX C

LABORATORY ANALYTICAL REPORT

APPENDIX D

WELL 1 BACKGROUND DATA (2000-2014) AND STATISTICAL ANALYSIS OUTPUT

APPENDIX E

TIME-SERIES GRAPHS OF SAMPLE CONSTITUENT DATA

APPENDIX F

LEACHATE COLLECTION SYSTEM DISCHARGE DATA