TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
830 Power Building

SEP 22 1978

Director of Nuclear Reactor Regulation
Attention: Mr. William H. Regan, Jr., Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analyses
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Regan:

In the Matter of the Application of Tennessee Valley Authority	) Dockets Nos:	50-438
	)	50-439
	STN	50-518
	STN	50-519
	STN	50-520
	STN	50-521
	STN	50-553
	STN	50-554

During the construction licensing for the Bellefonte Nuclear Plant (BLNP), the Hartsville Nuclear Plants (HNP), and the Phipps Bend Nuclear Plant (PBNP), TVA agreed to perform drift deposition studies associated with mechanical and natural draft cooling towers. The state of the art of drift deposition impact estimation and evaluation has advanced considerably since these commitments were made. Consequently, TVA believes that additional studies are no longer necessary. Enclosed is an assessment supporting this conclusion based on data and modeling capability which show very low expected levels of emission, transport, deposition, and impact potential for these nuclear plants.

The assessment indicates that freshwater constituents are not present in high concentration and will not be sufficiently concentrated by or emitted by the proposed cooling towers for each plant. Expected rates of deposition are well within the natural rainfall and soil constituent ranges of variability. The criterion proposed in Regulatory Guide 4.11, Revision 1, is 20 kg/ha-yr as a threshold for additional studies. The PBNP values of about 6 kg/ha-yr, the HNP values of about 1 kg/ha-yr, and the BLNP values of about 1 kg/ha-yr are far below this present guidance. Therefore, with your concurrence, TVA does not plan to conduct any drift deposition studies for these plants.

Very truly yours,

J. E. Gilleland
Assistant Manager of Power

Enclosure

C002 E5 1/1 + Docket Info
ADD Miner Echols R Boyce Nashville Knoxville

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ENCLOSURE

ASSESSMENT OF THE NEED FOR EXTENSIVE COOLING TOWER DRIFT DEPOSITION STUDIES

TVA has made commitments to the Nuclear Regulatory Commission (NRC) to study drift deposition and the resulting impact on the terrestrial ecosystem from the operation of natural draft cooling towers.[1,2,3] These commitments were made at a time when little was known concerning drift deposition impacts from freshwater cooling towers, and when only preliminary model estimates of drift deposition rates were available. These preliminary modeling[4] results predicted offsite drift deposition rates greater than 25 kg/ha-yr at the Phipps Bend[5,6] and Hartsville[7] Nuclear Plants.

Recent modeling efforts using the same drift model,[4] but with onsite meteorological data, a drift droplet distribution based on observations at cooling towers fitted with state-of-the-art drift eliminators,[8] and plant-specific design and operating information, have resulted in substantially lower estimates. The preliminary estimates were much higher because of the degree of conservatism of some of the model input parameters.

In addition to the substantially reduced estimates of offsite drift deposition, analyses showed that the amount of trace metals and micronutrients deposited by cooling tower drift is well below the natural variability of these elements observed in terrestrial ecosystems. Further, the amount of solids deposited by natural precipitation during a Tennessee Valley investigation is several times that which was estimated to occur offsite from cooling tower drift deposition.

Based on this new evidence it is TVA's position that it is unnecessary to perform additional extensive drift deposition studies.

This position is further substantiated by NRC's recognition of new information on drift and deposition as shown in Regulatory Guide 4,11, "Terrestrial Environmental Studies for Nuclear Power Stations," Revision 1. The regulatory guide recognizes the need for thorough evaluation of environmental impacts, but also recognizes the importance of not dissipating resources on needless programs of limited value.

The need to monitor drift deposition effects on terrestrial biota is specifically addressed on pages 4.11-5 and 4.11-6 of the regulatory guide and is stated in the following two paragraphs.

> If the drift from either freshwater or saltwater towers is likely to contain toxic substances, their concentrations are measured unless it is clear that the amounts and concentrations are sufficiently low to preclude both short-term and cumulative adverse effects. Adverse biological effects can usually be ruled out with

reasonable certainty for most elements and compounds found in nature when the expected additions combined with preexisting levels would not raise the concentration of the toxic substance outside the range of variation normally found in the biota or soils of the region.

Chemical analyses of soils, plants, and animals in the drift field of freshwater cooling towers are not usually needed when all of the following apply: (1) the dominant salts are harmless mixtures of biological nutrients as shown in table 4; (2) the expected deposition beyond the site boundary is less than 20 kg/ha-yr (no more than 50 percent in any 30-day period during the growing season) of mixed salts; and (3) the drift does not contain toxic elements or compounds in amounts that could be hazardous to plants or animals either by direct or indirect exposure over the expected lifetime of the facility.

Model Estimates

Predicted drift deposition rates for the Phipps Bend, Hartsville, and Bellefonte Nuclear Plants are presented in table 1. These predicted values are based on a drift deposition model developed by P. R. Slawson, et al.,[4] which uses site-specific meteorological data and realistic cooling tower design information. These model calculations are based on meteorological data for the following periods: Phipps Bend, May 1, 1976-April 30, 1977; Bellefonte, September 1, 1976-April 30, 1977; and Hartsville, January 1, 1977-May 31, 1977. These periods of record, used in the drift model calculations, are limited by the availability of validated meteorological data at the respective sites.

As the data periods show, yearly deposition estimates for the Bellefonte and Hartsville Plants are based on less than a full year of meteorology. However, the part of the year used for the calculations represents that portion for which maximum offsite drift deposition rates are expected. For comparison purposes, drift deposition rates calculated for these periods were extrapolated to a full year. Therefore, the computed values are considered to be overestimates of yearly drift deposition for these plants. The approximate site boundary distance in each directional sector is indicated in the drift deposition matrix for each plant shown in table 1. As seen in this attachment, offsite drift deposition rates for all three plants generally average below 1 kg/ha-yr, with a peak offsite value of 6 kg/ha-yr at the Phipps Bend Plant.

Natural Toxic Element Levels in Soils and Vegetation Compared to Additions from Drift Deposition

The possible accumulation of toxic elements and compounds resulting from cooling tower drift is another important facet in assessing drift impacts on the terrestrial ecosystem. Table 2 presents the results of computations of the amount of deposition on the soil surface and vegetation uptake of trace metals and select micronutrients (based on site-specific water quality) for an assumed drift deposition rate of 6 kg/ha-yr. The natural variability of these elements in soils and vegetation is also presented. As is evident from the comparison of calculated concentrations to the natural occurrence of each

element, the annual additions of these elements to the terrestrial ecosystem are far below natural variability. If the elements are assumed to accumulate in the soil, remaining available for plant uptake over the anticipated life of the facility, concentrations in the soil and vegetation would be, at most, on the lower end of the range of natural variability.

Solids Deposited by Precipitation

The final argument supporting elimination of the commitments to conduct drift deposition studies consists of a comparison of offsite drift deposition rates to the solids deposited by natural precipitation. Attachment 1 presents the calculations of wet deposition based on an estimate of the total dissolved solids content of precipitation collected at the Land Between the Lakes. The data show solids deposition from natural precipitation to be about 90 kg/ha-yr, which is at least 15 times as great as the maximum estimated offsite drift deposition for the nuclear plants examined. Although not identical in composition, drift and natural precipitation are comprised mostly of plant macronutrients and chemical compounds commonly found in nature, making the comparison reasonable.

Summary

Comparing the results summarized in the attachments to the criteria outlined in Regulatory Guide 4.11 Revision 1 leads to the conclusion that a full-scale drift impact study for application to these nuclear plants should not be required. Predicted offsite drift deposition occurs at a rate below the regulatory guide limit of 20 kg/ha-yr, is not expected to exceed 10 kg/ha-yr in any 30-day period during the growing season, contains only minute quantities of toxic elements, and is composed primarily of harmless mixtures of biological nutrients. Therefore, drift deposition from operation of the heat dissipation systems at these plants is expected to produce no measurable terrestrial impact.

References

1. Final Environmental Statement - Bellefonte Nuclear Plant Units 1 and 2, Appendix L, May 1974.

2. TVA response to NRC question 10.7 pertaining to the Phipps Bend Environmental Report, April 1976.

3. Memorandum, J. Clement Burdick to Those listed, "Proposed Hartsville Nuclear Plants - Limited Work Authorization and Conditions for Conducting Work Under Same," April 30, 1976.

4. Slawson, P. R., and A. Kumar, "Cooling Tower Drift Deposition - Program Guide to ENDRIFT II," Tennessee Valley Authority, Air Quality Branch, April 1976.

5. Wigley, T.M.L., and P. R. Slawson, "Drift, Visible Plume Length and Fogging Potential Calculations for Natural Draft and Mechanical Draft Cooling Systems at Phipps Bend and Yellow Creek," Tennessee Valley Authority, Air Quality Branch, February 1975.

6. Final Environmental Statement - Phipps Bend Nuclear Plant Units 1 and 2.

7. Wigley, T.M.L., and P. R. Slawson, "Drift Analysis for the Hartsville Nuclear Plant," Tennessee Valley Authority, Air Quality Branch, September 1974.

8. Cooling Tower Environment - 1974, ERDA Symposium Series, CONF-740 302, 1975.

TABLE 1

PHIPPS BEND (5/1/76 - 4/30/77) DATE PRINTED 09/30/77

DEPOSITION (KG/HEC) PAGE 1 OF 2

DIST (M)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0- 200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
200- 400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
400- 600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
600- 800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
800- 1000	0.0	0.00	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0
1000- 1200	0.0	0.01	0.15	0.13	0.0	0.02	0.0	0.02	0.0	0.03	0.03	0.05	0.04	0.01	0.02	0.01
1200- 1400	0.08	0.10	0.34	0.26	0.11	0.13	0.06	0.10	0.17	0.26	0.46	0.43	0.21	0.10	0.08	0.12
1400- 1600	0.24	0.39	1.05	0.61	0.53	0.39	0.19	0.38	0.64	1.25	2.34	1.93	0.59	0.35	0.23	0.42
1600- 1800	0.36	0.59	1.70	1.24	0.87	0.63	0.30	0.59	0.99	2.22	4.96	3.82	1.18	0.62	0.45	0.64
1800- 2000	0.36	0.58	1.78	1.52	0.92	0.65	0.33	0.62	1.02	2.54	6.05	4.54	1.34	0.66	0.53	0.63
2000- 2200	0.22	0.31	1.05	1.14	0.45	0.38	0.22	0.26	0.52	1.46	4.38	3.10	1.02	0.45	0.36	0.28
2200- 2400	0.12	0.15	0.63	0.61	0.25	0.22	0.12	0.16	0.28	0.83	2.25	1.66	0.55	0.24	0.17	0.18
2400- 2600	0.09	0.15	0.56	0.59	0.25	0.16	0.10	0.13	0.25	0.67	1.66	1.33	0.39	0.17	0.13	0.12
2600- 2800	0.08	0.15	0.57	0.55	0.24	0.15	0.09	0.12	0.25	0.63	1.52	1.29	0.34	0.16	0.12	0.10
2800- 3000	0.03	0.08	0.38	0.39	0.12	0.07	0.03	0.04	0.10	0.26	0.84	0.66	0.12	0.06	0.05	0.04
3000- 3200	0.00	0.06	0.30	0.34	0.06	0.04	0.01	0.00	0.02	0.10	0.57	0.43	0.05	0.02	0.02	0.00
3200- 3400	0.01	0.06	0.35	0.43	0.10	0.07	0.02	0.00	0.03	0.13	0.84	0.65	0.06	0.02	0.02	0.01
3400- 3600	0.01	0.04	0.30	0.45	0.11	0.08	0.02	0.00	0.04	0.12	0.95	0.76	0.08	0.02	0.02	0.01
3600- 3800	0.01	0.03	0.33	0.45	0.10	0.05	0.02	0.00	0.03	0.11	0.90	0.71	0.07	0.02	0.02	0.01
3800- 4000	0.01	0.03	0.36	0.50	0.11	0.07	0.02	0.01	0.03	0.12	0.97	0.77	0.08	0.02	0.02	0.01
4000- 4200	0.01	0.03	0.33	0.42	0.10	0.07	0.02	0.00	0.03	0.10	0.86	0.73	0.08	0.02	0.02	0.01
4200- 4400	0.01	0.03	0.28	0.34	0.08	0.06	0.02	0.00	0.02	0.08	0.62	0.59	0.05	0.01	0.01	0.01
4400- 4600	0.01	0.02	0.25	0.33	0.09	0.05	0.02	0.00	0.02	0.06	0.55	0.57	0.04	0.01	0.01	0.01
4600- 4800	0.00	0.01	0.19	0.28	0.06	0.03	0.01	0.00	0.01	0.04	0.37	0.41	0.03	0.00	0.01	0.01
4800- 5000	0.00	0.01	0.19	0.25	0.05	0.03	0.01	0.0	0.01	0.04	0.31	0.34	0.03	0.00	0.01	0.00

Site Boundary

DIST (M)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
5000- 5200	0.00	0.01	0.18	0.24	0.05	0.03	0.01	0.0	0.01	0.04	0.30	0.32	0.03	0.00	0.01	0.00
5200- 5400	0.00	0.01	0.16	0.21	0.04	0.03	0.01	0.0	0.01	0.03	0.26	0.27	0.02	0.00	0.00	0.00
5400- 5600	0.00	0.01	0.16	0.22	0.04	0.03	0.01	0.0	0.01	0.03	0.25	0.26	0.02	0.00	0.00	0.00
5600- 5800	0.00	0.01	0.16	0.22	0.05	0.03	0.01	0.0	0.01	0.03	0.25	0.26	0.02	0.00	0.00	0.00
5800- 6000	0.00	0.00	0.16	0.21	0.05	0.03	0.01	0.0	0.01	0.03	0.23	0.24	0.02	0.00	0.00	0.00
6000- 6200	0.00	0.00	0.14	0.20	0.05	0.02	0.01	0.0	0.01	0.02	0.19	0.20	0.02	0.00	0.00	0.00
6200- 6400	0.00	0.00	0.12	0.17	0.04	0.02	0.01	0.0	0.00	0.01	0.15	0.16	0.02	0.00	0.00	0.00
6400- 6600	0.00	0.00	0.10	0.15	0.03	0.01	0.00	0.0	0.00	0.01	0.11	0.12	0.01	0.0	0.00	0.00
6600- 6800	0.00	0.00	0.07	0.09	0.02	0.01	0.00	0.0	0.00	0.01	0.09	0.10	0.01	0.0	0.00	0.00
6800- 7000	0.00	0.00	0.06	0.08	0.02	0.01	0.00	0.0	0.00	0.01	0.07	0.07	0.01	0.0	0.00	0.00
7000- 7200	0.00	0.00	0.05	0.07	0.02	0.01	0.00	0.0	0.0	0.01	0.06	0.06	0.01	0.0	0.00	0.00
7200- 7400	0.00	0.00	0.06	0.07	0.02	0.01	0.00	0.0	0.0	0.01	0.06	0.05	0.01	0.0	0.00	0.00
7400- 7600	0.00	0.00	0.05	0.07	0.01	0.01	0.00	0.0	0.0	0.01	0.05	0.04	0.01	0.0	0.00	0.00
7600- 7800	0.00	0.00	0.05	0.07	0.01	0.01	0.00	0.0	0.0	0.01	0.05	0.04	0.01	0.0	0.00	0.00
7800- 8000	0.00	0.00	0.05	0.07	0.01	0.00	0.00	0.0	0.0	0.01	0.05	0.04	0.01	0.0	0.00	0.00
8000- 8200	0.00	0.00	0.05	0.06	0.01	0.00	0.00	0.0	0.0	0.01	0.05	0.03	0.01	0.0	0.00	0.00
8200- 8400	0.00	0.0	0.04	0.05	0.01	0.00	0.00	0.0	0.0	0.01	0.05	0.03	0.01	0.0	0.00	0.00
8400- 8600	0.00	0.0	0.04	0.05	0.01	0.00	0.00	0.0	0.0	0.00	0.04	0.03	0.01	0.0	0.00	0.00
8600- 8800	0.00	0.0	0.03	0.05	0.01	0.00	0.00	0.0	0.0	0.00	0.03	0.02	0.00	0.0	0.00	0.00
8800- 9000	0.00	0.0	0.02	0.04	0.00	0.00	0.00	0.0	0.0	0.00	0.03	0.02	0.00	0.0	0.00	0.00
9000- 9200	0.00	0.0	0.02	0.03	0.00	0.00	0.00	0.0	0.0	0.00	0.03	0.01	0.00	0.0	0.00	0.00
9200- 9400	0.00	0.0	0.02	0.03	0.00	0.00	0.00	0.0	0.0	0.00	0.03	0.01	0.00	0.0	0.00	0.00
9400- 9600	0.00	0.0	0.02	0.03	0.00	0.00	0.00	0.0	0.0	0.00	0.02	0.01	0.00	0.0	0.00	0.00
9600- 9800	0.00	0.0	0.02	0.02	0.00	0.00	0.00	0.0	0.0	0.00	0.02	0.01	0.00	0.0	0.00	0.00
9800-10000	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00
> 10000	0.01	0.02	0.19	0.24	0.03	0.03	0.04	0.02	0.03	0.12	0.51	0.34	0.13	0.03	0.02	0.01

HARTSVILLE, 1/1/77 - 5/31/77, CORRECTED TO FULL YEAR — DATE PRINTED 10/17/77

DEPOSITION (KG/HEC) — PAGE 1 OF 2

DIST (M)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0- 200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
200- 400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
400- 600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
600- 800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
800- 1000	0.11	0.04	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04	0.0	0.00	0.0
1000- 1200	1.03	0.29	0.02	0.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.14	0.01	0.50	0.24
1200- 1400	0.58	0.31	0.09	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.04	0.05	0.39	0.18
1400- 1600	0.02	0.20	0.09	0.01	0.0	0.0	0.00	0.00	0.0	0.0	0.0	0.01	0.0	0.06	0.04	0.00
1600- 1800	0.02	0.30	0.14	0.01	0.0	0.0	0.05	0.05	0.0	0.0	0.0	0.06	0.0	0.11	0.14	0.07
1800- 2000	0.02	0.19	0.09	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.05	0.04	0.06
2000- 2200	0.03	0.22	0.12	0.03	0.0	0.0	0.01	0.03	0.01	0.03	0.05	0.00	0.03	0.13	0.16	0.11
2200- 2400	0.09	0.09	0.04	0.02	0.02	0.0	0.02	0.02	0.04	0.06	0.04	0.03	0.04	0.15	0.23	0.18
2400- 2600	0.41	0.31	0.12	0.04	0.04	0.0	0.0	0.01	0.04	0.12	0.21	0.21	0.53	0.54	0.91	0.14
2600- 2800	0.55	0.40	0.16	0.05	0.06	0.04	0.04	0.04	0.07	0.15	0.38	0.39	0.75	0.81	1.13	0.17
2800- 3000	1.03	0.72	0.46	0.28	0.30	0.61	0.44	0.14	0.23	0.24	0.63	0.67	1.45	1.35	1.75	0.45
3000- 3200	1.10	0.68	0.61	0.41	0.37	0.83	0.57	0.18	0.24	0.24	0.74	0.74	1.69	1.53	1.95	0.44
3200- 3400	1.06	0.59	0.75	0.47	0.39	0.97	0.71	0.18	0.22	0.16	0.69	0.81	1.73	1.68	1.90	0.31
3400- 3600	0.81	0.50	0.74	0.51	0.49	1.11	0.80	0.19	0.23	0.06	0.54	0.73	1.26	1.47	1.20	0.24
3600- 3800	0.56	0.35	0.58	0.41	0.41	0.92	0.70	0.14	0.18	0.05	0.44	0.57	0.93	1.19	0.96	0.19
3800- 4000	0.42	0.24	0.30	0.19	0.21	0.43	0.40	0.07	0.08	0.05	0.36	0.32	0.63	0.89	0.96	0.11
4000- 4200	0.38	0.24	0.26	0.17	0.20	0.40	0.33	0.08	0.08	0.05	0.36	0.25	0.54	0.94	1.09	0.11
4200- 4400	0.36	0.28	0.45	0.32	0.39	0.46	0.38	0.20	0.15	0.05	0.38	0.26	0.52	1.03	1.26	0.17
4400- 4600	0.42	0.36	0.48	0.37	0.43	0.49	0.35	0.21	0.15	0.05	0.34	0.23	0.50	0.94	1.26	0.22
4600- 4800	0.41	0.36	0.46	0.36	0.40	0.45	0.29	0.20	0.12	0.06	0.34	0.21	0.48	0.90	1.23	0.24
4800- 5000	0.38	0.37	0.45	0.36	0.37	0.33	0.21	0.15	0.06	0.03	0.29	0.16	0.36	0.78	1.24	0.25

Site Boundary

DIST (M)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
5000- 5200	0.26	0.28	0.47	0.42	0.39	0.34	0.20	0.18	0.06	0.0	0.10	0.07	0.11	0.48	0.84	0.27
5200- 5400	0.23	0.28	0.43	0.38	0.38	0.35	0.19	0.17	0.05	0.0	0.09	0.07	0.10	0.51	0.88	0.27
5400- 5600	0.23	0.26	0.40	0.36	0.37	0.33	0.17	0.13	0.05	0.0	0.08	0.07	0.07	0.48	0.84	0.26
5600- 5800	0.21	0.25	0.34	0.32	0.38	0.33	0.15	0.14	0.04	0.0	0.07	0.07	0.05	0.45	0.72	0.25
5800- 6000	0.18	0.23	0.13	0.21	0.29	0.27	0.12	0.08	0.02	0.0	0.05	0.05	0.08	0.40	0.62	0.23
6000- 6200	0.15	0.21	0.19	0.22	0.27	0.27	0.17	0.13	0.04	0.0	0.05	0.06	0.09	0.38	0.62	0.24
6200- 6400	0.17	0.20	0.21	0.24	0.29	0.29	0.17	0.14	0.04	0.0	0.05	0.06	0.10	0.41	0.65	0.24
6400- 6600	0.15	0.19	0.21	0.24	0.27	0.28	0.16	0.13	0.03	0.0	0.03	0.06	0.09	0.34	0.54	0.23
6600- 6800	0.14	0.15	0.19	0.21	0.23	0.24	0.14	0.11	0.03	0.0	0.02	0.05	0.09	0.27	0.46	0.20
6800- 7000	0.14	0.10	0.19	0.24	0.20	0.25	0.13	0.11	0.02	0.0	0.01	0.06	0.12	0.28	0.43	0.19
7000- 7200	0.14	0.10	0.21	0.24	0.21	0.26	0.13	0.11	0.03	0.0	0.0	0.06	0.13	0.30	0.41	0.18
7200- 7400	0.13	0.10	0.25	0.25	0.22	0.27	0.19	0.14	0.03	0.0	0.0	0.06	0.13	0.32	0.39	0.18
7400- 7600	0.06	0.07	0.22	0.18	0.18	0.22	0.16	0.11	0.02	0.0	0.0	0.05	0.11	0.22	0.27	0.12
7600- 7800	0.06	0.05	0.19	0.17	0.16	0.20	0.14	0.09	0.02	0.0	0.0	0.06	0.10	0.18	0.24	0.09
7800- 8000	0.06	0.05	0.17	0.16	0.16	0.19	0.13	0.08	0.02	0.0	0.0	0.06	0.09	0.18	0.24	0.09
8000- 8200	0.05	0.05	0.17	0.14	0.15	0.17	0.10	0.07	0.02	0.0	0.0	0.05	0.07	0.17	0.22	0.08
8200- 8400	0.05	0.04	0.15	0.12	0.11	0.12	0.06	0.07	0.01	0.0	0.0	0.04	0.04	0.16	0.19	0.07
8400- 8600	0.04	0.03	0.11	0.10	0.09	0.10	0.05	0.06	0.01	0.0	0.0	0.04	0.03	0.16	0.18	0.07
8600- 8800	0.04	0.04	0.10	0.09	0.09	0.09	0.03	0.05	0.01	0.0	0.0	0.04	0.03	0.14	0.15	0.06
8800- 9000	0.04	0.04	0.11	0.08	0.09	0.09	0.04	0.04	0.01	0.0	0.0	0.04	0.03	0.11	0.13	0.05
9000- 9200	0.03	0.04	0.11	0.08	0.09	0.09	0.04	0.04	0.01	0.0	0.0	0.04	0.03	0.10	0.13	0.04
9200- 9400	0.03	0.03	0.09	0.08	0.09	0.08	0.03	0.03	0.01	0.0	0.0	0.04	0.03	0.09	0.12	0.04
9400- 9600	0.03	0.03	0.07	0.08	0.09	0.07	0.03	0.03	0.00	0.0	0.0	0.04	0.03	0.08	0.11	0.04
9600- 9800	0.03	0.03	0.05	0.07	0.08	0.07	0.03	0.02	0.00	0.0	0.0	0.04	0.03	0.08	0.10	0.04
9800-10000	0.03	0.03	0.03	0.07	0.07	0.07	0.03	0.02	0.00	0.0	0.0	0.03	0.03	0.07	0.10	0.04
> 10000	0.35	0.20	0.80	1.29	1.27	1.24	0.34	0.16	0.08	0.0	0.0	0.47	0.55	0.59	1.28	0.54

DEPOSITION (KG/HEC)

DIST (M)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0- 200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
200- 400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
400- 600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
600- 800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
800- 1000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00
1000- 1200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.01
1200- 1400	0.03	0.04	0.0	0.00	0.0	0.0	0.0	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.03	0.02
1400- 1600	0.08	0.09	0.03	0.02	0.02	0.01	0.0	0.01	0.02	0.02	0.07	0.01	0.01	0.02	0.12	0.06
1600- 1800	0.11	0.11	0.07	0.05	0.04	0.01	0.0	0.01	0.04	0.09	0.14	0.04	0.00	0.01	0.11	0.06
1800- 2000	0.12	0.13	0.14	0.09	0.06	0.04	0.01	0.02	0.07	0.17	0.32	0.11	0.02	0.01	0.09	0.07
2000- 2200	0.24	0.50	0.34	0.16	0.15	0.09	0.04	0.04	0.15	0.41	1.18	0.43	0.13	0.08	0.15	0.16
2200- 2400	0.26	0.63	0.47	0.21	0.16	0.11	0.05	0.06	0.19	0.53	1.55	0.57	0.19	0.10	0.18	0.18
2400- 2600	0.28	0.77	0.55	0.23	0.16	0.10	0.05	0.07	0.23	0.61	1.83	0.67	0.25	0.13	0.22	0.20
2600- 2800	0.23	0.71	0.49	0.20	0.14	0.08	0.05	0.07	0.21	0.56	1.77	0.64	0.25	0.13	0.22	0.17
2800- 3000	0.15	0.49	0.33	0.13	0.09	0.04	0.03	0.05	0.14	0.38	1.29	0.40	0.16	0.08	0.14	0.11
3000- 3200	0.11	0.29	0.20	0.08	0.05	0.03	0.01	0.03	0.07	0.22	0.83	0.20	0.06	0.03	0.07	0.07
3200- 3400	0.09	0.28	0.18	0.08	0.04	0.03	0.01	0.02	0.07	0.20	0.88	0.17	0.06	0.03	0.06	0.05
3400- 3600	0.10	0.30	0.18	0.07	0.03	0.02	0.01	0.02	0.07	0.19	0.88	0.13	0.05	0.02	0.06	0.04
3600- 3800	0.10	0.33	0.20	0.07	0.03	0.01	0.01	0.02	0.08	0.21	1.02	0.13	0.05	0.02	0.06	0.04
3800- 4000	0.08	0.29	0.19	0.06	0.03	0.01	0.01	0.02	0.08	0.20	0.96	0.09	0.04	0.01	0.05	0.03
4000- 4200	0.05	0.25	0.15	0.07	0.02	0.01	0.00	0.02	0.06	0.17	0.91	0.07	0.02	0.00	0.04	0.03
4200- 4400	0.05	0.25	0.13	0.06	0.02	0.01	0.00	0.02	0.07	0.18	0.94	0.06	0.02	0.00	0.03	0.03
4400- 4600	0.05	0.26	0.13	0.06	0.02	0.01	0.00	0.03	0.07	0.19	0.99	0.06	0.01	0.00	0.03	0.02
4600- 4800	0.05	0.26	0.12	0.06	0.02	0.01	0.00	0.02	0.07	0.18	0.94	0.05	0.01	0.00	0.02	0.02
4800- 5000	0.04	0.24	0.09	0.05	0.02	0.02	0.01	0.02	0.06	0.14	0.81	0.03	0.01	0.00	0.02	0.02

Site Boundary

DEPOSITION (KG/HEC)

DIST (M)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
5000- 5200	0.03	0.20	0.08	0.04	0.02	0.02	0.01	0.02	0.05	0.11	0.60	0.02	0.01	0.00	0.02	0.01
5200- 5400	0.02	0.16	0.06	0.04	0.01	0.02	0.00	0.02	0.03	0.08	0.42	0.01	0.00	0.00	0.01	0.01
5400- 5600	0.01	0.13	0.04	0.04	0.01	0.02	0.01	0.01	0.03	0.06	0.34	0.01	0.00	0.00	0.00	0.00
5600- 5800	0.01	0.12	0.04	0.03	0.01	0.02	0.01	0.01	0.03	0.07	0.32	0.01	0.00	0.00	0.00	0.00
5800- 6000	0.01	0.11	0.04	0.04	0.01	0.02	0.01	0.02	0.03	0.08	0.33	0.01	0.00	0.00	0.00	0.00
6000- 6200	0.01	0.12	0.04	0.03	0.02	0.02	0.01	0.02	0.03	0.06	0.28	0.01	0.00	0.00	0.00	0.00
6200- 6400	0.01	0.10	0.04	0.03	0.01	0.02	0.01	0.01	0.02	0.05	0.24	0.00	0.00	0.0	0.00	0.00
6400- 6600	0.01	0.10	0.04	0.03	0.01	0.02	0.01	0.01	0.02	0.05	0.24	0.00	0.00	0.0	0.00	0.00
6600- 6800	0.01	0.08	0.03	0.02	0.01	0.01	0.00	0.01	0.02	0.05	0.21	0.00	0.00	0.0	0.00	0.00
6800- 7000	0.00	0.07	0.03	0.02	0.01	0.01	0.00	0.01	0.02	0.05	0.16	0.00	0.00	0.0	0.00	0.00
7000- 7200	0.00	0.06	0.03	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.11	0.00	0.00	0.0	0.00	0.00
7200- 7400	0.00	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.08	0.00	0.00	0.0	0.00	0.00
7400- 7600	0.00	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.06	0.00	0.00	0.0	0.00	0.00
7600- 7800	0.00	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.00	0.00	0.0	0.00	0.00
7800- 8000	0.00	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.0	0.0	0.0	0.0	0.00
8000- 8200	0.00	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.0	0.0	0.0	0.0	0.0
8200- 8400	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.0	0.0	0.0	0.0	0.0
8400- 8600	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.0	0.0	0.0	0.0	0.0
8600- 8800	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.0	0.0	0.0	0.0	0.0
8800- 9000	0.00	0.01	0.01	0.00	0.00	0.00	0.0	0.00	0.00	0.01	0.02	0.0	0.0	0.0	0.0	0.0
9000- 9200	0.00	0.01	0.01	0.00	0.00	0.00	0.0	0.00	0.00	0.01	0.02	0.0	0.0	0.0	0.0	0.0
9200- 9400	0.00	0.01	0.01	0.00	0.00	0.00	0.0	0.00	0.00	0.01	0.01	0.0	0.0	0.0	0.0	0.0
9400- 9600	0.00	0.01	0.01	0.00	0.00	0.00	0.0	0.00	0.00	0.01	0.01	0.0	0.0	0.0	0.0	0.0
9600- 9800	0.00	0.01	0.01	0.00	0.00	0.00	0.0	0.00	0.00	0.01	0.01	0.0	0.0	0.0	0.0	0.0
9800-10000	0.00	0.01	0.01	0.00	0.00	0.00	0.0	0.00	0.00	0.01	0.01	0.0	0.0	0.0	0.0	0.0
> 10000	0.00	0.04	0.08	0.02	0.00	0.00	0.0	0.01	0.00	0.02	0.01	0.0	0.0	0.0	0.0	0.0

TABLE 2

OBSERVED RANGES OF TRACE METALS IN PLANTS AND SOILS (PPM)

	Pb[3]	Hg[1]	Cd[5,4]	Cr[2]	As[3]	Cu[5]	Zn[5]	Ni[5]
Soil	2-200	0.03-0.8	0.01-7	Trace-250	0.3-38	2-100	10-300	10-1000
Plants	25-150	0.015	0.2-9.6	0.01-1	0.2	4-15	8-15	15

CALCULATED TRACE METAL ACCUMULATION IN SOIL AND PLANTS FROM COOLING TOWER DRIFT FOR 1-YEAR OF OPERATION AT HARTSVILLE, PHIPPS BEND, AND BELLEFONTE NUCLEAR PLANTS (PPM)[a]

	Pb	Hg	Cd	Cr	As	Cu	Zn	Ni
Hartsville								
Soil	0.046	0.0002	0.006	0.006	Not Detectable	0.077	0.104	0.192
Plants[b]	0.106	0.00001	0.032	0.00006	Not Detectable	c	c	0.01
Phipps Bend								
Soil	0.0093	.0002	0.00145	<0.00145	0.0029	0.0354	0.082	<0.0157
Plants[b]	0.021	0.00001	0.0078	<0.000015	0.00009	c	c	<0.0008
Bellefonte								
Soil	0.0028	.0001	.0003	.0017	0.0017	<0.019	0.061	<0.015
Plants[b]	0.0065	0.000005	0.0016	0.000017	0.000051	c	c	<0.00076

a. Calculations are based on site-specific water quality data and an annual drift deposition rate of 6 kg/ha.

b. Plant concentrations are calculated from soil concentrations using the ratio of concentration of metal in the plant to concentration in the soil given in Table III of "Trace Metals in Soils, Plants and Animals," D. J. Lisk, Advances in Agronomy, Vol. 24, No. 1, 1972-325.

c. Ratio of trace metal concentration in plants to concentration in soil is not given in the referenced publication for these elements.

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ATTACHMENT 1

CHEMICAL DEPOSITION FROM PRECIPITATION AT THE LAND BETWEEN THE LAKES

From data on the chemical composition of precipitation collected at the Land Between the Lakes, for the period 3/29/76 - 3/31/77, a rough estimate of 8.78 ppm for total dissolved solids (TDS) can be made. This is an underestimate of the probably TDS content because only data on SO_4, NO_3, NH_3, Mg,Ca, Cl, Na, and K concentration are available for calculation. The chemical deposition from 40 inches of precipitation with a TDS content of 9.78 ppm is about 89.2 kg/ha/year. The computation of this value is as follows:

$$\frac{8.78 \text{ gr solids}}{10^6 \text{ gr water}} * \frac{40 \text{ inches water}}{\text{Yr}} * 2.54 \frac{\text{cm}}{\text{in}} * \frac{10^4 \text{ cm}^2}{\text{m}^2} * \frac{1 \text{ gr water}}{\text{cm}^3} = 8.92$$

$$\text{gr solids/m}^2\text{-year}$$

$$= 89.2 \text{ kg/ha/year}$$