

Annual Groundwater Monitoring Report

Public Service Company of Oklahoma

Northeastern 3&4 Power Station

Landfill CCR Management Unit

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Oologah, Oklahoma

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Table of Contents

I.	Overview	1
II.	Groundwater Monitoring Well Locations and Identification Numbers	3
III.	Monitoring Wells Installed or Decommissioned	5
IV.	Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion	5
V.	Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency	5
VI.	Other Information Required	5
VII.	Description of Any Problems Encountered in 2017 and Actions Taken	6
VIII.	A Projection of Key Activities for the Upcoming Year	6

Appendix I

Appendix II

I. Overview

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Public Service Company of Oklahoma's (PSO's), a wholly-owned subsidiary of American Electric Power Company (AEP), Northeastern 3&4 Power Station. The Oklahoma Department of Environmental Quality (ODEQ) and USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2018.

In general, the following activities were completed:

- Existing monitoring wells were utilized to establish a certified groundwater monitoring system around the CCR management unit pursuant AEP's *Groundwater Monitoring Network Design Report*(10/2017);
- Groundwater samples were collected and analyzed for Appendix III and Appendix IV constituents, as specified in AEP's *Groundwater Sampling and Analysis Plan* (2016);
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Background groundwater quality data was collected for each Appendix III and Appendix IV constituent;
- Detection Monitoring sampling was initiated;
- A statistical process to evaluate groundwater data was prepared, certified, and posted to AEP's CCR website (*Statistical Analysis Plan*-AEP 2017). The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance," USEPA, 2009). Data evaluation is underway.

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit, all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs included in Appendix I;

- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations (Attached as **Appendix II**, where applicable);
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network meeting the requirements of 40 CFR 257.91 (submitted to ODEQ 10/19/2017 for approval with State regulation), the monitoring well locations and their corresponding identification.

Upgradient wells are MW-7D and MW-8D

Downgradient wells are MW-3D, MW-6D, MW-9D and MW-15

III. Monitoring Wells Installed or Decommissioned

There were no monitoring wells installed or decommissioned in 2017. The network design, as summarized in the *Groundwater Monitoring Network Design Report* (10/2017) and as posted at the CCR web site for Northeastern 3&4 Power Station, did not change. That design report, discusses the facility location, the hydrogeological setting, the hydrostratigraphic units, the uppermost aquifer, downgradient monitoring well locations and the upgradient monitoring well locations.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality data collected during the establishment of background quality. Static water elevation data from each monitoring event also are shown in Appendix I, along with the groundwater velocity calculations, and potentiometric maps depicting the groundwater flow direction, developed after each sampling event.

V. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

As of this first annual groundwater report date there has been no transition between detection monitoring and assessment monitoring. Detection monitoring will continue in 2018. The sampling frequency of twice per year will be maintained for the Appendix III parameters (boron, calcium, chloride, fluoride, pH, sulfate and total dissolved solids).

Regarding defining an alternate monitoring frequency, the groundwater velocity is high enough at this facility that no modification of the twice-per-year detection monitoring effort is needed.

VI. Other Information Required

At the appropriate time the geochemical analyses, coupled with the statistical analyses of the groundwater quality data, will determine whether an alternate source or alternate sources are affecting groundwater chemistry. In those cases where an alternate source(s) demonstration is made, those analyses and supporting information will be presented as well.

VII. Description of Any Problems Encountered in 2017 and Actions Taken

In order to capture an adequate groundwater sample volume for analysis, the sampling effort requires that the wells are purged and then allowed to recharge for at least 8 hours in order to complete the sampling efforts. Low flow techniques cause the wells to go dry. Additionally, MW-9D did not produce adequate sampling volumes for Radium analysis. Therefore sampling efforts continue in MW-9D in order to complete the background data set for Radium.

VIII. A Projection of Key Activities for the Upcoming Year

Key activities for 2018 include:

- Detection monitoring on a twice per year schedule;
- Continue the collection of groundwater samples to complete the background data set;
- Evaluation of the first detection monitoring results from a statistical analysis viewpoint, looking for any statistically significant increases, or decreases when pH is considered;
- Respond to data received in light of what the Federal CCR rule requires;
- Preparation of the second annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.

Table 1: Groundwater Data Summary
Northeastern Plant - Landfill

Parameter	Unit	MW-3D												
		1/25/2017	3/14/2017	4/25-4/27/2017	5/18/2017	6/15-6/16/2017	6/27-6/28/2017	7/12/2017	8/4/2017	8/17/2017	8/30/2017	9/13/2017	9/20/2017	10/11/2017
		Background												Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	0.00144 J	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	0.00163 J	-
Arsenic	mg/L	<0.00105 U	<0.00105 U	0.00330 J	0.0106	0.00148 J	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	0.00260 J	0.00452 J	0.00114 J	-
Barium	mg/L	0.111	0.100	0.0896	1.04	0.150	0.0976	0.118	0.124	0.274	0.244	0.430	0.267	-
Beryllium	mg/L	<0.00002 U	<0.00002 U	<0.00002 U	0.000920 J	0.0000800 J	0.0000900 J	0.0000500 J	0.0000700 J	0.000170 J	0.000160 J	0.000350 J	0.000170 J	-
Boron	mg/L	0.919	0.913	0.972	0.789	0.873	0.840	0.864	0.856	0.841	0.840	0.877	0.853	0.878
Cadmium	mg/L	<0.00007 U	<0.00007 U	0.000260 J	0.000610 J	0.000220 J	0.000450 J	0.0000800 J	0.000210 J	0.000240 J	0.000330 J	0.000490 J	0.000210 J	-
Calcium	mg/L	111	120	110	163	137	194	129	135	138	136	152	139	134
Chloride	mg/L	16.0	14.0	14.0	12.0	12.0	13.0	13.0	12.0	23.0	12.0	11.0	11.0	13.0
Chromium	mg/L	0.00200	<0.00023 U	0.000350 J	0.0181	0.00123	0.00480	0.000410 J	0.000820 J	0.00311	0.00236	0.00632	0.00274	-
Cobalt	mg/L	<0.00014 U	<0.00014 U	0.00130 J	0.00532	0.00109 J	0.00269 J	0.000820 J	0.000840 J	0.00183 J	0.00154 J	0.00297 J	0.00141 J	-
Combined Radium	pCi/L	2.15	1.46	0.419	2.44	1.71	2.43	14.3	2.24	2.33	2.22	1.57	2.16	-
Fluoride	mg/L	<0.083 U	1.00	0.770 J	<0.083 U	0.847 J	0.759 J	<0.083 U	0.738 J	<0.083 U	0.714 J	<0.083 U	<0.083 U	<0.083 U
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	0.00324 J	0.000830 J	0.00299 J	<0.00068 U	0.000800 J	<0.00068 U	<0.00068 U	0.00155 J	<0.00068 U	-
Lithium	mg/L	0.0170	0.0160	0.0151	0.0194	0.0145	0.0184	0.0144	0.0134	0.0150	0.0147	0.0164	0.0151	-
Mercury	mg/L	<0.000005 U	<0.000005 U	<0.000005 U	0.0000100 J	<0.000005 U	0.00000700 J	<0.000005 U	0.0000130 J	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	-
Molybdenum	mg/L	<0.005 U	<0.005 U	0.00197 J	0.00415 J	0.00304 J	0.0793	0.00322 J	0.00308 J	0.00291 J	0.00268 J	0.00274 J	0.00333 J	-
Selenium	mg/L	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	0.00100 J	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	658	648	662	598	742	766	728	710	728	696	848	724	722
Sulfate	mg/L	174	175	181	192	225	232	210	227	213	216	212	214	218
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	0.00102 J	<0.00086 U	-
pH	SU	7.46	-	7.94	-	7.33	7.29	6.86	6.74	6.81	6.85	6.79	6.94	6.92

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1: Groundwater Data Summary
Northeastern Plant - Landfill

Parameter	Unit	MW-6D								
		6/15-6/16/2017	6/27-6/28/2017	7/12-7/13/2017	8/4/2017	8/17/2017	8/30/2017	9/13/2017	9/20/2017	10/11/2017
		Detection								
Antimony	mg/L	<0.00093 U	0.00128 J	<0.00093 U	<0.00093 U	0.00126 J	<0.00093 U	<0.00093 U	0.00118 J	-
Arsenic	mg/L	0.00199 J	<0.00105 U	<0.00105 U	<0.00105 U	0.00118 J	0.00206 J	0.00119 J	0.00193 J	-
Barium	mg/L	0.113	0.170	0.107	0.128	0.0995	0.103	0.109	0.0750	-
Beryllium	mg/L	0.000180 J	0.0000600 J	0.000220 J	0.000220 J	0.000190 J	0.000220 J	0.000310 J	0.000140 J	-
Boron	mg/L	3.51	0.877	3.49	3.64	3.55	3.41	2.96	3.81	3.74
Cadmium	mg/L	0.000800 J	0.000370 J	0.000560 J	0.000930 J	0.000440 J	0.000360 J	0.000490 J	0.000220 J	-
Calcium	mg/L	201	133	218	222	211	210	237	196	165
Chloride	mg/L	28.0	29.0	30.0	31.0	30.0	30.0	32.0	32.0	29.0
Chromium	mg/L	0.00599	0.000860 J	0.00682	0.00662	0.00677	0.00668	0.00815	0.00386	-
Cobalt	mg/L	0.00373 J	0.00109 J	0.00382 J	0.00339 J	0.00307 J	0.00303 J	0.00371 J	0.00227 J	-
Combined Radium	pCi/L	1.82	1.92	1.78	1.12	1.16	1.06	1.38	1.43	-
Fluoride	mg/L	0.805 J	0.760 J	<0.083 U	0.766 J	0.729 J	0.716 J	0.541 J	<0.083 U	0.960 J
Lead	mg/L	0.00348 J	0.000760 J	0.00500	0.00496 J	0.00325 J	0.00250 J	0.00328 J	0.00233 J	-
Lithium	mg/L	0.0220	0.0136	0.0224	0.0192	0.0193	0.0183	0.0211	0.0170	-
Mercury	mg/L	0.0000120 J	<0.000005 U	0.00000700 J	0.0000160 J	0.0000110 J	<0.000005 U	<0.000005 U	<0.000005 U	-
Molybdenum	mg/L	0.0850	0.00279 J	0.0618	0.0821	0.0813	0.0858	0.0580	0.0810	-
Selenium	mg/L	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	1050	1020	1040	1020	1020	986	1140	1010	1030
Sulfate	mg/L	508	524	504	532	509	522	521	505	545
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	7.49	7.89	7.29	6.35	6.91	7.19	7.05	7.05	6.91

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1: Groundwater Data Summary
Northeastern Plant - Landfill

Parameter	Unit	MW-7D									
		6/15-6/16/2017	6/27-6/28/2017	7/12-7/13/2017	8/4/2017	8/17/2017	8/30/2017	9/13/2017	9/20/2017	10/4/2017	10/11/2017
		Background									Detection
Antimony	mg/L	0.00188 J	<0.00093 U	<0.00093 U	0.00106 J	<0.00093 U	0.00284 J	0.00211 J	<0.00093 U	0.00128 J	-
Arsenic	mg/L	0.0132	0.0101	0.0105	0.00368 J	0.0135	0.00928	0.0131	0.0731	0.0143	-
Barium	mg/L	0.101	0.136	0.140	0.158	0.307	0.503	0.773	3.84	0.751	-
Beryllium	mg/L	0.000140 J	0.000190 J	0.000250 J	0.000570 J	0.000530 J	0.000760 J	0.00114	0.00550	0.00118	-
Boron	mg/L	1.18	1.22	1.40	1.39	1.20	1.15	1.07	1.05	0.990	1.01
Cadmium	mg/L	<0.00007 U	0.000170 J	0.000170 J	0.000150 J	0.000310 J	0.000490 J	0.000890 J	0.00530	0.00129	-
Calcium	mg/L	94.5	126	121	133	130	181	236	918	297	392
Chloride	mg/L	171	196	299	383	489	525	56.0	662	418	733
Chromium	mg/L	0.00360	0.00607	0.00600	0.00911	0.0144	0.0203	0.0306	0.146	0.0299	-
Cobalt	mg/L	0.00273 J	0.00245 J	0.00268 J	0.00541	0.00451 J	0.00658	0.00891	0.0491	0.0103	-
Combined Radium	pCi/L	2.97	3.86	3.09	2.94	2.36	2.31	3.79		3.55	-
Fluoride	mg/L	0.937 J	<0.083 U	1.83	2.02	2.27	3.25	2.39	0.590 J	2.07	3.24
Lead	mg/L	0.00118 J	0.00289 J	0.00318 J	0.00323 J	0.00714	0.00755	0.0104	0.0703	0.0134	-
Lithium	mg/L	0.118	0.151	0.116	0.0876	0.118	0.134	0.153	0.226	0.166	-
Mercury	mg/L	0.00000700 J	0.0000100 J	<0.000005 U	0.0000230 J	0.00000900 J	0.0000170 J	0.0000220 J	0.0000540	0.0000280	-
Molybdenum	mg/L	0.0270	0.0208	0.0255	0.0284	0.0291	0.0485	0.0429	0.0510	0.0326	-
Selenium	mg/L	0.00283 J	0.00187 J	0.00280 J	0.00401 J	0.00164 J	0.0185	0.0168	0.0194	0.0162	-
Total Dissolved Solids	mg/L	1700	1870	2120	2260	2700	3090	3670	3840	2970	4310
Sulfate	mg/L	635	698	725	841	872	1120	156	1630	1260	1550
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	6.72	8.28	7.84	6.93	7.28	7.39	7.20	7.12	7.16	7.48

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1: Groundwater Data Summary
Northeastern Plant - Landfill

Parameter	Unit	MW-8D											
		1/25/2017	3/15/2017	4/24-4/27/2017	5/18/2017	6/15-6/16/2017	6/27-6/28/2017	7/12-7/13/2017	8/4/2017	8/17/2017	8/30/2017	9/13/2017	10/11/2017
		Background											Detection
Antimony	mg/L	<0.00093 U	0.00500	0.00256 J	0.00713	0.0203	0.00467 J	0.00328 J	0.00232 J	0.00794	0.00508	0.00378 J	-
Arsenic	mg/L	0.00700	<0.00105 U	0.00448 J	0.0103	0.0134	0.00178 J	0.00270 J	0.00430 J	0.00580	0.00952	0.00704	-
Barium	mg/L	1.17	1.66	2.32	7.14	7.37	5.29	3.72	1.90	2.38	3.86	4.51	-
Beryllium	mg/L	<0.00002 U	<0.00002 U	0.000120 J	0.000460 J	0.000740 J	0.0000800 J	0.000130 J	0.000170 J	0.000220 J	0.000750 J	0.000450 J	-
Boron	mg/L	1.31	1.29	1.28	1.27	1.34	1.29	1.36	1.35	1.35	1.36	1.36	1.32
Cadmium	mg/L	0.00100	0.00200	0.000930 J	0.00507	0.00826	0.00254	0.00141	0.000970 J	0.00139	0.00275	0.00182	-
Calcium	mg/L	446	417	376	529	861	416	381	416	450	586	479	445
Chloride	mg/L	12000	13200	11200	14600	10200	11200	11800	11800	11300	12300	12300	11600
Chromium	mg/L	0.00400	0.00100	<0.00023 U	0.00894	0.0154	0.000590 J	<0.00023 U	0.00102	0.00175	0.0143	0.00662	-
Cobalt	mg/L	<0.00014 U	<0.00014 U	0.00145 J	0.00592	0.0108	0.00385 J	0.00235 J	0.00265 J	0.00273 J	0.00653	0.00430 J	-
Combined Radium	pCi/L	7.48	4.66	5.29	5.58	5.37	-	-	9.67	6.39	5.98	-	-
Fluoride	mg/L	<0.083 U	<0.083 U	0.240 J	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U
Lead	mg/L	<0.00068 U	<0.00068 U	0.000900 J	0.00659	0.00560	0.00231 J	0.00214 J	0.00282 J	0.00217 J	0.00511	0.00289 J	-
Lithium	mg/L	1.44	1.10	1.07	1.30	1.22	1.14	1.19	1.08	1.12	1.19	1.23	-
Mercury	mg/L	<0.000005 U	<0.000005 U	0.0000100 J	0.0000220 J	0.0000250	0.0000120 J	0.0000150 J	0.0000120 J	<0.000005 U	0.0000290	0.0000300	-
Molybdenum	mg/L	<0.005 U	<0.005 U	0.000910 J	0.00243 J	0.00281 J	0.00120 J	0.00168 J	0.00190 J	0.00191 J	0.00340 J	0.00453 J	-
Selenium	mg/L	0.00600	<0.00099 U	0.00391 J	0.00370 J	0.00371 J	0.00134 J	0.00578	0.00603	0.00605	0.00474 J	0.00466 J	-
Total Dissolved Solids	mg/L	20800	19000	20800	22300	20100	21000	21100	22200	22400	23000	23000	21900
Sulfate	mg/L	144	72.0	58.0	112	122	116	128	113	103	112	126	300
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	7.10	-	7.34	-	7.21	7.04	7.15	6.98	6.94	6.99	6.89	6.90

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1: Groundwater Data Summary
Northeastern Plant - Landfill

Parameter	Unit	MW-9D									
		6/15-6/16/2017	6/27-6/28/2017	7/12/2017	8/4/2017	8/17/2017	8/30/2017	9/13/2017	10/4/2017	10/11/2017	10/31/2017
										Detection	
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-	-
Arsenic	mg/L	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	-	-
Barium	mg/L	0.188	0.0582	0.0699	0.132	0.196	0.323	0.399	0.410	-	-
Beryllium	mg/L	0.000320 J	<0.00002 U	0.0000500 J	0.000170 J	0.000220 J	0.000370 J	0.000400 J	0.000430 J	-	-
Boron	mg/L	7.09	7.01	7.63	7.59	7.46	6.93	6.78	6.68	7.07	-
Cadmium	mg/L	0.000810 J	0.000260 J	<0.00007 U	0.000540 J	0.000250 J	0.000910 J	0.000680 J	0.00240	-	-
Calcium	mg/L	229	191	244	337	328	354	366	304	288	-
Chloride	mg/L	100	232	98.0	60.0	216	64.0	293	180	314	-
Chromium	mg/L	0.0123	0.000890 J	0.00409	0.00715	0.00952	0.0201	0.0133	0.0148	-	-
Cobalt	mg/L	0.00618	0.00714	0.00569	0.00734	0.00817	0.0151	0.0129	0.00838	-	-
Combined Radium	pCi/L	0.931	-	-	-	-	-	-	-	-	0.683
Fluoride	mg/L	0.986 J	0.899 J	2.19	0.695 J	0.681 J	<0.083 U	0.370 J	<0.083 U	1.52	-
Lead	mg/L	0.00702	0.00124 J	0.00236 J	0.00426 J	0.00533	0.00927	0.00828	0.00969	-	-
Lithium	mg/L	0.0239	0.0165	0.0222	0.0216	0.0240	0.0296	0.0326	0.0322	-	-
Mercury	mg/L	0.00000900 J	<0.000005 U	<0.000005 U	0.0000170 J	0.0000110 J	0.0000160 J	0.0000160 J	0.0000150 J	-	-
Molybdenum	mg/L	0.173	0.166	0.151	0.117	0.0982	0.0938	0.0784	0.0738	-	-
Selenium	mg/L	0.00500	<0.00099 U	0.00132 J	0.00357 J	0.00353 J	0.00294 J	0.00280 J	0.00383 J	-	-
Total Dissolved Solids	mg/L	1460	1110	2150	2260	2490	2390	2830	2300	2190	-
Sulfate	mg/L	781	876	1050	1220	1190	1190	1240	1080	1080	-
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-	-
pH	SU	7.13	-	7.41	7.04	7.10	7.28	7.18	7.26	7.09	-

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1: Groundwater Data Summary
Northeastern Plant - Landfill

Parameter	Unit	MW-15												
		1/25/2017	3/13/2017	4/25-4/27/2017	5/18/2017	6/15-6/16/2017	6/27-6/28/2017	7/12-7/13/2017	8/4/2017	8/17/2017	8/30/2017	9/13/2017	9/20/2017	10/11/2017
		Background												Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	0.00131 J	0.00138 J	<0.00093 U	<0.00093 U	0.00163 J	0.00156 J	0.000990 J	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	<0.00105 U	<0.00105 U	0.00285 J	0.0136	0.00756	0.00440 J	0.00377 J	0.00373 J	0.00444 J	0.00632	0.00418 J	0.00387 J	-
Barium	mg/L	0.107	0.100	0.0557	0.0521	0.212	0.0987	0.150	0.0942	0.133	0.0649	0.0543	0.0492	-
Beryllium	mg/L	<0.00002 U	<0.00002 U	<0.00002 U	<0.00002 U	0.000250 J	0.0000200 J	0.000120 J	0.0000800 J	0.0000900 J	0.0000400 J	0.0000300 J	<0.00002 U	-
Boron	mg/L	9.45	8.23	9.44	10.2	9.74	9.75	9.87	9.66	9.53	9.59	9.13	9.65	9.62
Cadmium	mg/L	<0.00007 U	<0.00007 U	<0.00007 U	0.000260 J	0.000640 J	<0.00007 U	0.0000900 J	0.0000900 J	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	87.0	104	73.1	52.2	126	79.2	110	86.3	93.1	64.9	68.0	67.6	80.1
Chloride	mg/L	19.0	28.0	78.0	111	24.0	22.0	19.0	19.0	18.0	17.0	17.0	15.0	46.0
Chromium	mg/L	0.00300	0.00300	0.000230 J	0.000960 J	0.00857	0.00179	0.00403	0.00151	0.00330	0.000860 J	<0.00023 U	0.000230 J	-
Cobalt	mg/L	<0.00014 U	<0.00014 U	0.000640 J	0.000620 J	0.00396 J	0.00129 J	0.00264 J	0.00140 J	0.00169 J	0.000780 J	0.000660 J	0.000770 J	-
Combined Radium	pCi/L	0.505	1.24	0.203	1.10	1.22	1.65	0.287	0.914	0.649	0.393	1.07	0.887	-
Fluoride	mg/L	2.00	2.00	1.83	2.00	1.96	1.87	1.89	1.76	1.69	2.03	1.67	0.642 J	1.95
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	0.00170 J	0.00525	0.00242 J	0.00287 J	0.00136 J	0.00144 J	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	0.0120	0.0100	0.00786	0.00834	0.0115	0.00722	0.00910	0.00752	0.00823	0.00629	0.00635	0.00621	-
Mercury	mg/L	<0.000005 U	<0.000005 U	<0.000005 U	0.0000220 J	0.0000200 J	0.0000220 J	0.00000900 J	0.0000210 J	0.0000150 J	0.0000100 J	0.00000800 J	<0.000005 U	-
Molybdenum	mg/L	0.643	0.550	0.614	0.605	0.662	0.644	0.668	0.647	0.642	0.656	0.638	0.652	-
Selenium	mg/L	<0.00099 U	<0.00099 U	0.00183 J	0.0223	0.0125	0.00576	0.00900	0.00600	0.00595	0.00924	0.00145 J	0.00377 J	-
Total Dissolved Solids	mg/L	1110	1110	1130	1090	1060	1070	1080	1030	1110	1040	1080	1040	1120
Sulfate	mg/L	530	551	558	596	559	616	632	612	572	590	584	543	593
Thallium	mg/L	<0.00086 U	<0.00086 U	0.00105 J	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	7.98	-	7.64	-	7.94	8.54	8.21	7.60	7.83	6.73	8.58	7.47	7.64

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

NE CCR Units

Landfill Distance between wells.

	MW1D	MW2D	MW3D	MW4D	MW5D	MW6D	MW7D	MW8D	MW9D	MW10D	MW11D	MW12D	MW13D	MW14	MW15	MW-16	MW-17
MW1D	-	1310.9	1432.3	2423.7	692.7	1022.1	1379.1	837.6	1071.3	425.4	759.9	1071.5	1400.8	393.3	1262.4	1063.5	1081.8
MW2D		-	1634.9	2820.3	640.46	853.7	2044.8	2024.5	470.4	1458.2	854.0	532.9	284.9	1651.2	96.8	538.6	931.7
MW3D			-	1185.0	1596.7	783.1	642.6	2178.2	1166.8	1869.4	1843.4	1907.6	1932.2	1360.9	1548.4	1095.7	702.8
MW4D				-	2749.0	1975.0	1059.3	2997.7	2365.6	2367.5	2969.9	3084.3	3110.0	2198.6	2735.2	2297.8	1875.8
MW5D					-	887.4	1814.0	1365.3	654.3	795.2	292.2	385.4	701.4	1086.4	658.8	699.6	981.5
MW6D						-	1214.7	1864.0	391.2	1405.8	1155.3	1134.2	1151.9	1181.5	773.9	131.6	11.7
MW7D							-	1942.1	1607.6	1758.5	2006.3	2168.0	2306.8	1139.0	1969.5	1525.8	1167.2
MW8D								-	1885.8	563.4	1244.4	1633.3	2036.8	828.7	2015.9	1902.5	1916.8
MW9D									-	1363.6	895.9	809.8	738.2	1345.5	385.8	78.5	486.6
MW10D										-	702.5	1081.7	1465.2	671.1	1442.0	1371.0	1461.4
MW11D											-	395.4	801.6	1145.4	851.1	969.7	1237.4
MW12D												-	418.7	1473.7	583.2	884.4	1229.6
MW13D													-	1774.2	389.2	837.6	1234.9
MW14														-	1604.9	1309.3	1221.9
MW15															-	470.7	856.8
MW-16																-	396.9
MW-17																	-

Welsh landfill MW monitoring wells

	MW1D	MW2D	MW3D	MW4D	MW5D	MW6D	MW7D	MW8D	MW9D	MW10D	MW11D	MW12D	MW13D	MW14	MW15	MW-16	MW-17
TD(ft bgs)	55.00	33.50	63.04	50.00	55.00	58.22	58.65	63.54	63.09	68.00	48.00	42.00	48.00	42.00	45.00	78.96	74.21
TOC, ft	638.07	638.19	630.65	625.00	636.84	636.66	626.46	629.32	637.04	639.32	628.27	623.67	619.06	640.89	637.71	637.26	636.52

Date																	
03/16/16	NG	NG	38.08	NG	NG	34.91	13.58	32.39	55.41	NG	NG	NG	NG	75.78	54.94	60.29	57.63
05/16/16	NG	NG	37.04	NG	NG	33.64	29.65	42.78	55.69	NG	NG	NG	NG	76.16	55.99	60.18	54.88
07/20/16	NG	NG	NG	NG	NG	NG	NG	45.93	NG	NG	NG	NG	NG	75.02	60.38	60.41	52.50
09/19/16	NG	NG	37.70	NG	NG	33.75	22.87	52.27	56.02	NG	NG	NG	NG	74.03	61.14	61.11	49.56
10/06/16	NG	NG	37.65	NG	NG	NG	NG	58.6	NG	NG	NG	NG	NG	dry	61.28	dry	dry
01/25/17	NG	NG	37.13	NG	NG	NG	NG	54.25		NG	NG	NG	NG	74.14	54.15	61.73	51.11
03/14/17	NG	NG	37.15	NG	NG	34.80	21.81	46.88	57.59	NG	NG	NG	NG	37.29	64.32	62.24	49.92
05/17/17	NG	NG	37.22	NG	NG	34.26	7.63	54.12	56.35	NG	NG	NG	NG	72.09	45.41	58.44	54.37
06/15/17	NG	NG	37.26	NG	NG	33.22	9.15	59.79	56.29	NG	NG	NG	NG	76.13	55.76	60.25	55.94
06/27/17	NG	NG	37.31	NG	NG	33.29	27.50	61.46	60.35	NG	NG	NG	NG	77.92	58.64	62.67	55.61
07/12/17	NG	NG	38.02	NG	NG	34.06	43.72	60.87	60.36	NG	NG	NG	NG	77.63	59.81	61.61	57.03
10/11/17		55.24	57.89	37.42	43.26	27.37	33.58	57.38	61.51	61.89	69.04	47.86	18.56	41.32	75.94	59.45	61.62

NE Landfill

Hydraulic gradient. Use row 58 10/11/2017

	MW1D	MW2D	MW3D	MW4D	MW5D	MW6D	MW7D	MW8D	MW9D	MW10D	MW11D	MW12D	MW13D	MW14	MW15
MW1D	-	0.00192993	0.007261	0.00045	0.0384599	0.01981138	0.0099706	0.0179328	0.0071689	0.0295016	0.0031847	0.0207935	0.0036337	0.0454649	0.00362
MW2D		-	0.007909	0.000511	0.0455454	0.02668353	0.0054872	0.0061696	0.0109486	0.0068713	0.0001288	0.0465566	0.0089869	0.0092963	0.021085
MW3D				0.009696	0.0101712	0.01257902	0.0375829	0.01167	0.0154958	0.0122764	0.0069545	0.0062276	0.008017	0.0207799	0.009668
MW4D				-	0.0100873	0.01080534	0.0119515	0.0046469	0.0027858	0.0048406	0.0004478	0.0075771	0.0012862	0.0076367	0.001272
MW5D					-	0.00720073	0.0222657	0.030513	0.0524538	0.0492857	0.0994626	0.0113117	0.0452375	0.0409809	0.047378
MW6D						-	0.0279911	0.0189222	0.0713902	0.0233326	0.0196221	0.0017898	0.0219987	0.0322739	0.032071
MW7D							-	0.0006539	0.0037757	0.0006824	0.0056473	0.0166188	0.0037541	0.0036261	0.004661
MW8D								-	0.0038923	0.0043838	0.0101255	0.0228379	0.0048753	0.0034511	0.005184
MW9D									-	0.0035715	0.0058712	0.0369972	0.0035086	0.007581	0.008061
MW10D										-	0.0144193	0.0321996	0.0050914	0.0079418	0.005534
MW11D											-	0.0624621	0.0033308	0.0134975	0.002526
MW12D												-	0.0653721	0.0272521	0.046038
MW13D													-	0.0072088	0.001336
MW14														-	0.008293
MW15															-
MW-16															
MW-17															

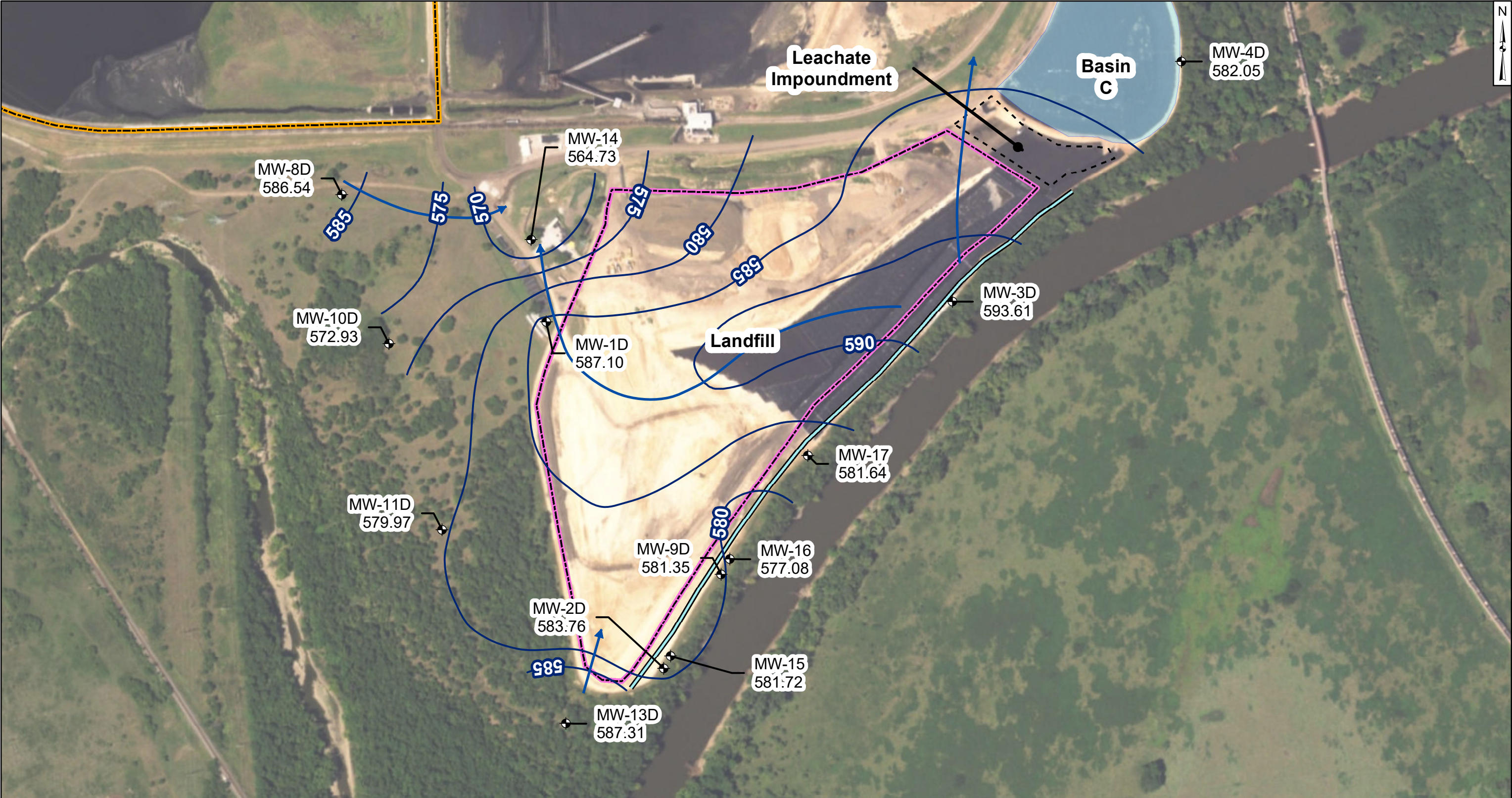
Groundwater elevations, sea level

	MW1D	MW2D	MW3D	MW4D	MW5D	MW6D	MW7D	MW8D	MW9D	MW10D	MW11D	MW12D	MW13D	MW14	MW15
TOC, ft	638.07	638.19	630.65	625.00	636.84	636.66	626.46	629.32	637.04	639.32	628.27	623.67	619.06	640.89	637.71

																	(dh/dl)								
																	gradient	v(ft/yr)							
03/16/16	NG			NG		592.57	NG			NG		601.75	612.88	596.93	581.63	NG	NG	NG	565.11	582.77	612.88	565.11	0.051	21.22	
05/16/16	NG			NG		593.61	NG			NG		603.02	596.81	586.54	581.35	NG	NG	NG	564.73	581.72	603.02	564.73	0.055	22.88	
07/20/16	NG			NG			NG			NG			NG	583.39	NG	NG	NG	NG	565.87	577.33	584.02	565.87	0.020	8.32	
09/19/16	NG			NG		592.95	NG			NG		602.91	603.59	577.05	581.02	NG	NG	NG	566.86	576.57	603.59	566.86	0.056	23.30	
10/06/16	NG			NG		593.00	NG			NG			NG	570.72	NG	NG	NG	NG	dry	576.43	576.43	570.72	0.010	4.16	
01/25/17	NG			NG		593.52	NG			NG			NG	575.07	NG	NG	NG	NG	566.75	583.56	585.41	566.75	0.019	7.90	
03/14/17	NG			NG		593.50	NG			NG		601.86	604.65	582.44	579.45	NG	NG	NG	603.60	573.39	604.65	573.39	0.057	23.71	
05/17/17	NG			NG		593.43	NG			NG		602.40	618.83	575.20	580.69	NG	NG	NG	568.80	592.30	618.83	568.80	0.055	22.88	
06/15/17	NG			NG		593.39	NG			NG		603.44	617.31	569.53	580.75	NG	NG	NG	564.76	581.95	617.31	564.76	0.058	24.13	
06/27/17	NG			NG		593.34	NG			NG		603.37	598.96	567.86	576.69	NG	NG	NG	562.97	579.07	603.37	562.97	0.068	28.29	
07/12/17	NG			NG		592.63	NG			NG		602.60	582.74	568.45	576.68	NG	NG	NG	563.26	577.90	602.60	563.26	0.066	27.46	
10/11/17		582.83	580.30			593.23	581.74	609.47				603.08	569.08	567.81	575.15	570.28	580.41	605.11	577.74	564.95	578.26	609.47	564.95	0.099	41.18

effective porosity(n) = 0.045
Hydraulic conductivity of aquifer (k) = 18.72 ft/yr
Max gradient (dh/dl)
0.099 10/11/2017

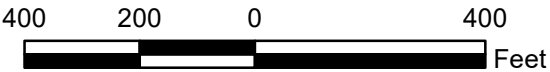
$$v = k \frac{(dh / dl)}{n}$$



- Legend**
- Groundwater Monitoring Well
 - Groundwater Elevation Contour
 - Inferred Groundwater Elevation Contour
 - Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected 5/16/2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level (ft. msl).
- Only wells screened in the Bandera Shale were used for contouring.



**Potentiometric Contours - Uppermost Aquifer
Landfill
May 2016**

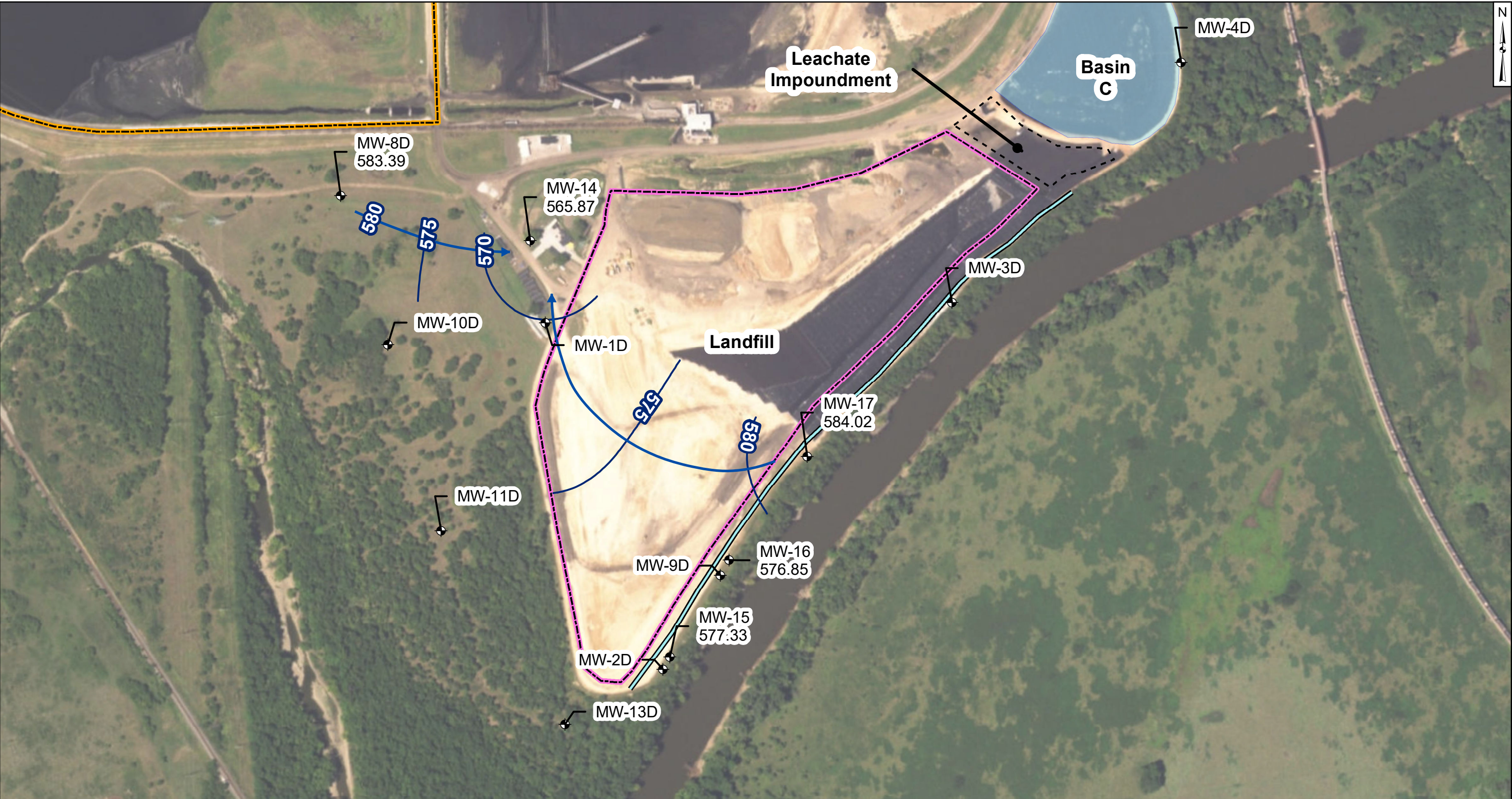
AEP Northeastern Power Plant
Oologah, Oklahoma

Geosyntec
consultants

Columbus, Ohio

2018/01/05

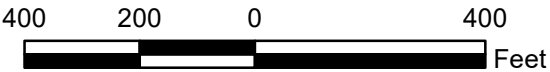
Figure
1



- Legend**
- Groundwater Monitoring Well
 - Groundwater Elevation Contour
 - Inferred Groundwater Elevation Contour
 - Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected 7/20/2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level (ft. msl).
- Only wells screened in the Bandera Shale were used for contouring.



**Potentiometric Contours - Uppermost Aquifer
Landfill
July 2016**

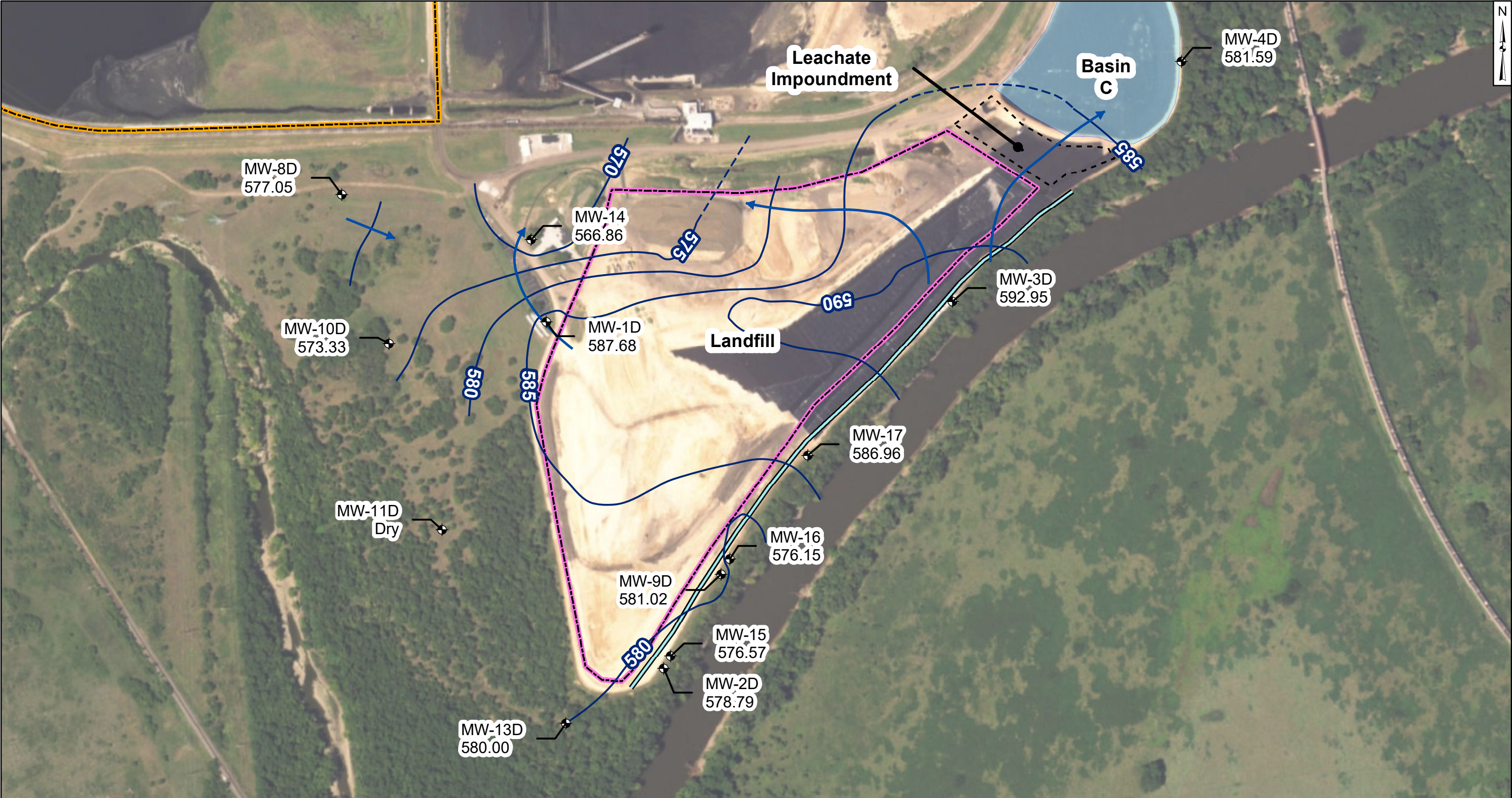
AEP Northeastern Power Plant
Oologah, Oklahoma

Geosyntec
consultants

Columbus, Ohio

2018/01/05

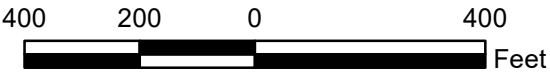
Figure
2



- Legend**
- Groundwater Monitoring Well
 - Groundwater Elevation Contour
 - Inferred Groundwater Elevation Contour
 - Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected 9/19/2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level (ft. msl).
- Only wells screened in the Bandera Shale were used for contouring.



**Potentiometric Contours - Uppermost Aquifer
Landfill
September 2016**

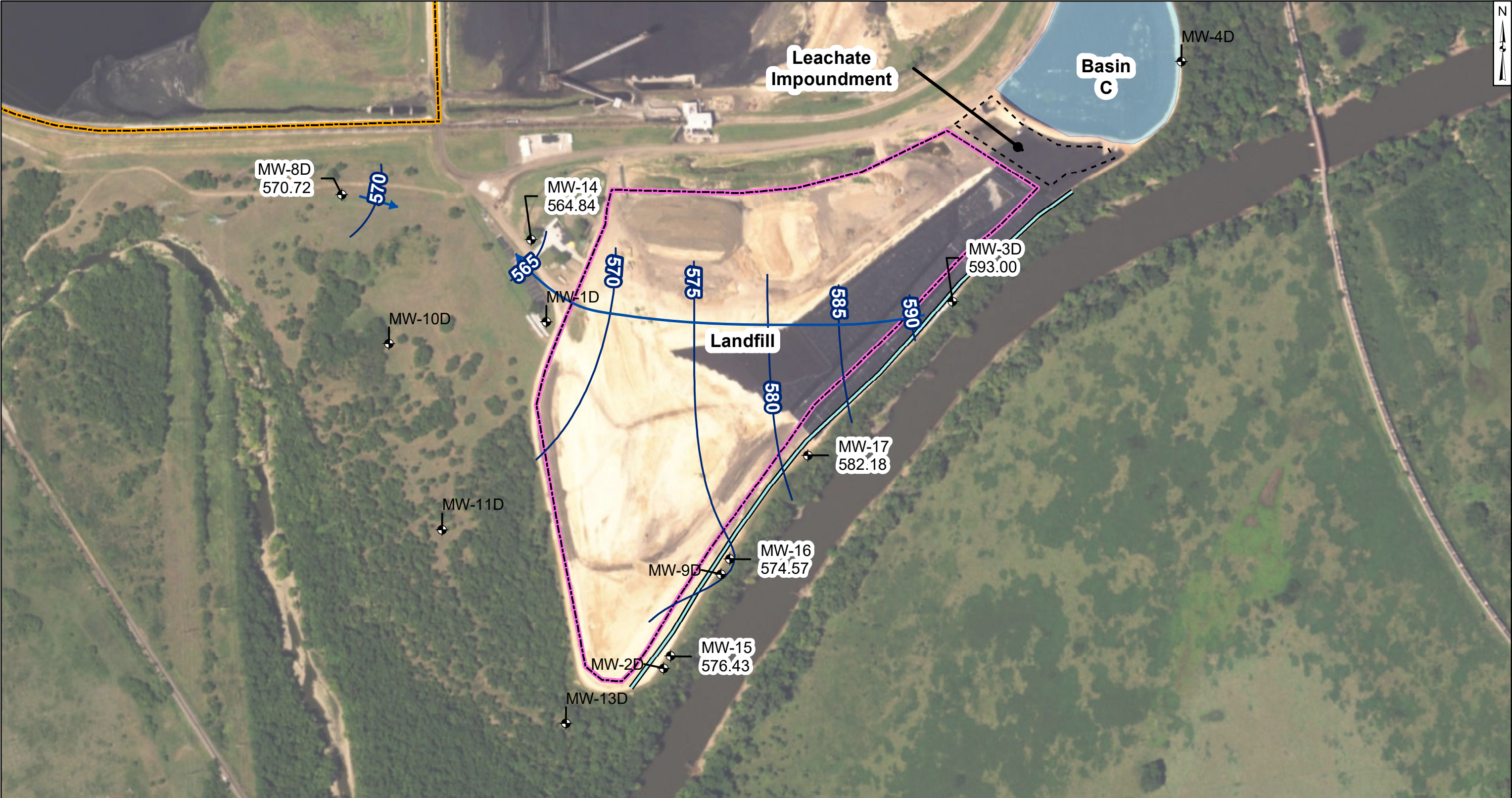
AEP Northeastern Power Plant
Oologah, Oklahoma

Geosyntec
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Columbus, Ohio

2018/01/05

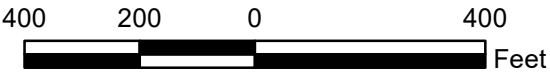
Figure
3



- Legend**
- Groundwater Monitoring Well
 - Groundwater Elevation Contour
 - Inferred Groundwater Elevation Contour
 - Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected 10/6/2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level (ft. msl).
- Only wells screened in the Bandera Shale were used for contouring.



**Potentiometric Contours - Uppermost Aquifer
Landfill
October 2016**

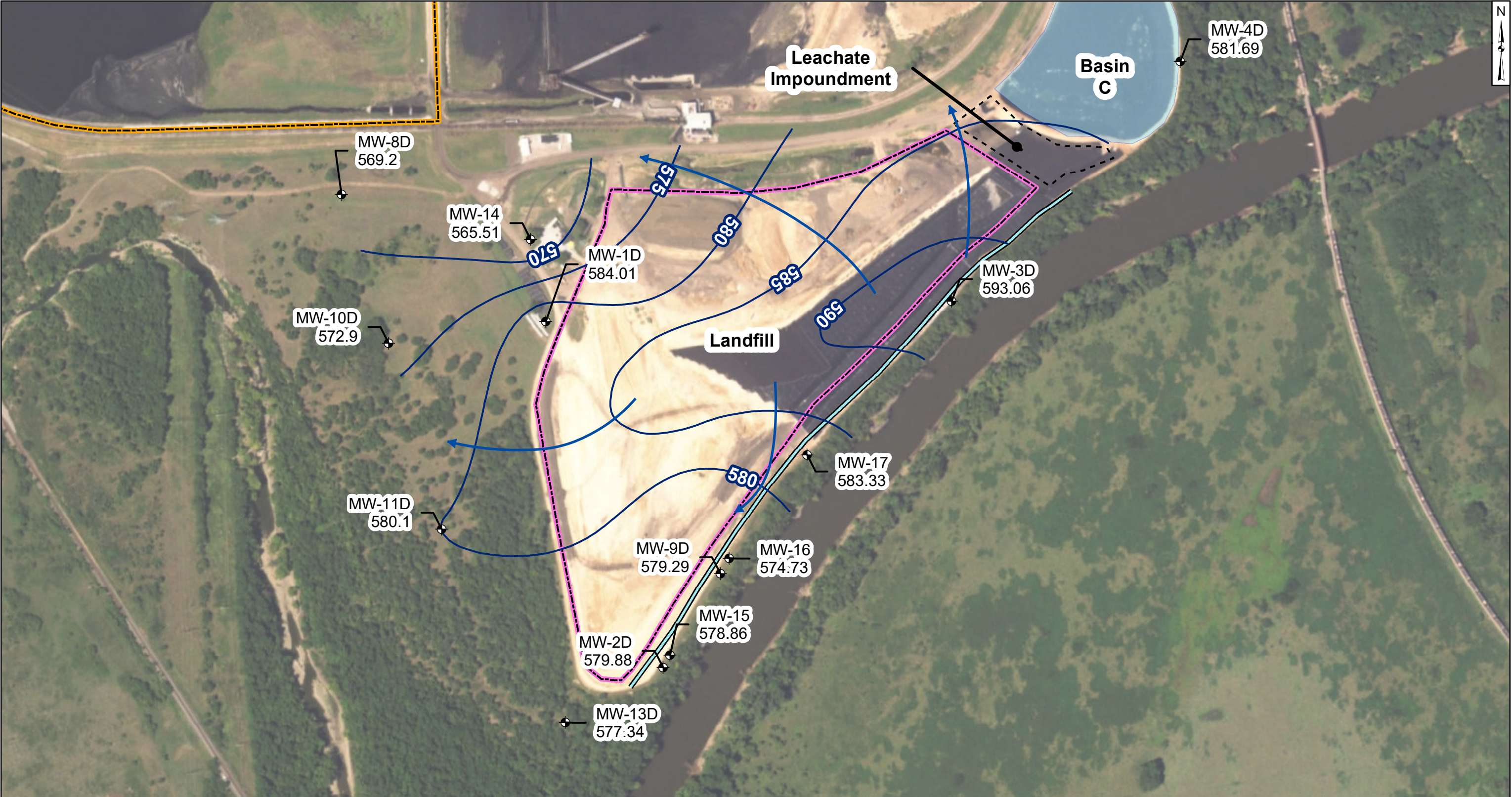
AEP Northeastern Power Plant
Oologah, Oklahoma

Geosyntec
consultants

Columbus, Ohio

2018/01/05

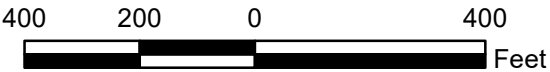
Figure
4



- Legend**
- Groundwater Monitoring Well
 - Groundwater Elevation Contour
 - Inferred Groundwater Elevation Contour
 - Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected 11/9/2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level (ft. msl).
- Only wells screened in the Bandera Shale were used for contouring.



**Potentiometric Contours - Uppermost Aquifer
Landfill
November 2016**

AEP Northeastern Power Plant
Oologah, Oklahoma

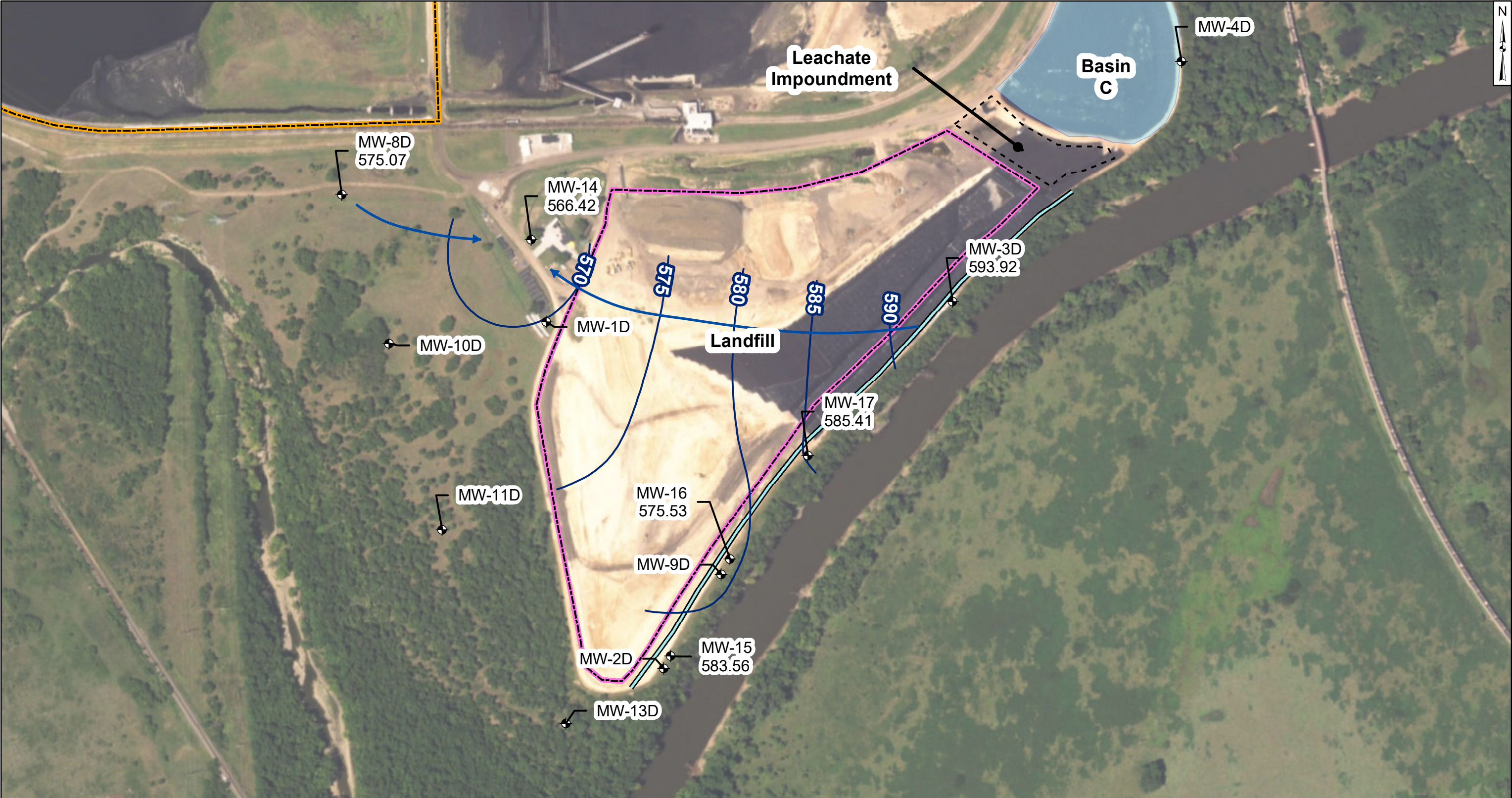
Geosyntec
consultants

Columbus, Ohio

2018/01/05

Figure

5



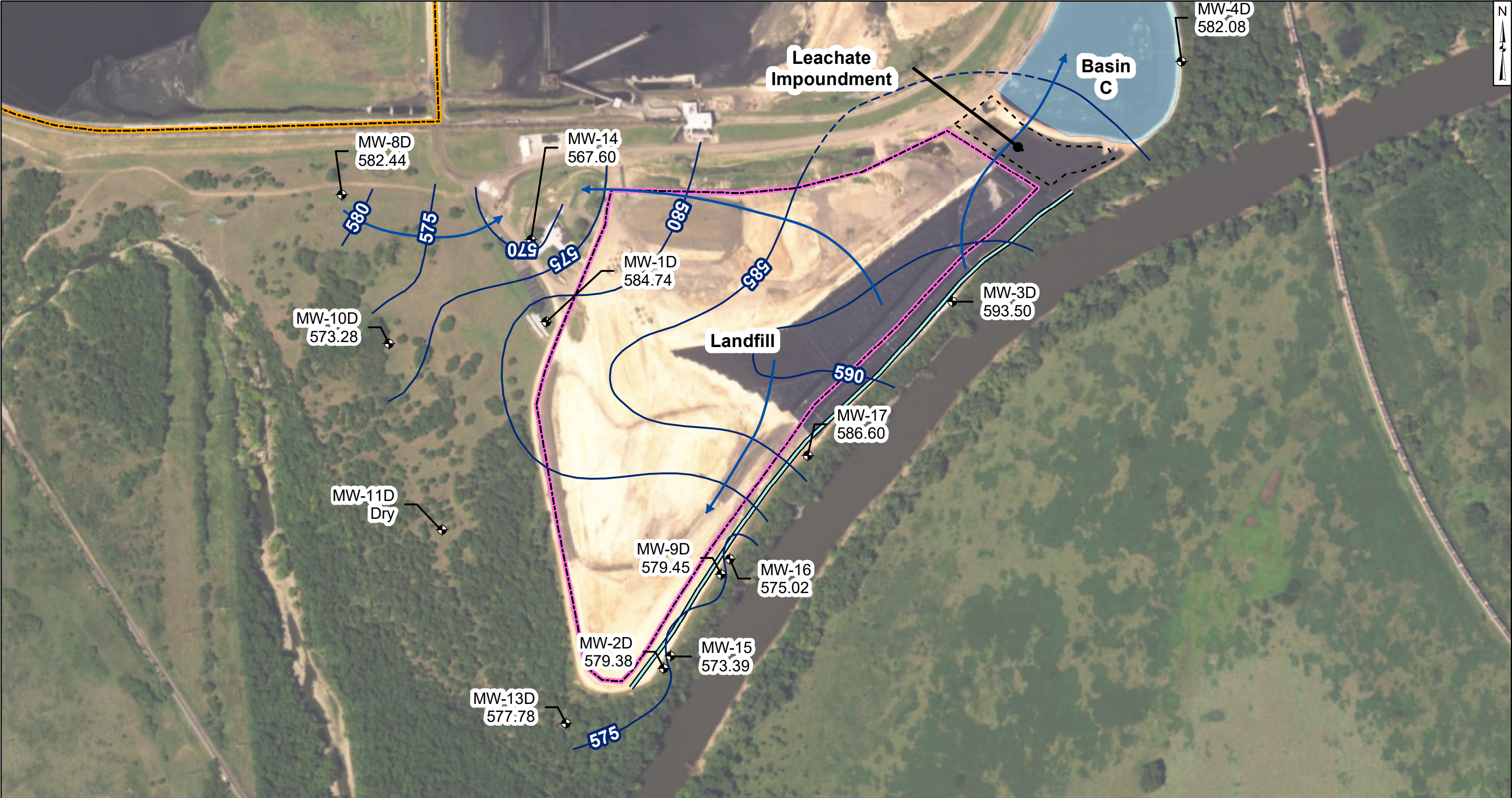
- Legend**
- Groundwater Monitoring Well
 - Groundwater Elevation Contour
 - Inferred Groundwater Elevation Contour
 - Approximate Groundwater Flow Direction

Notes

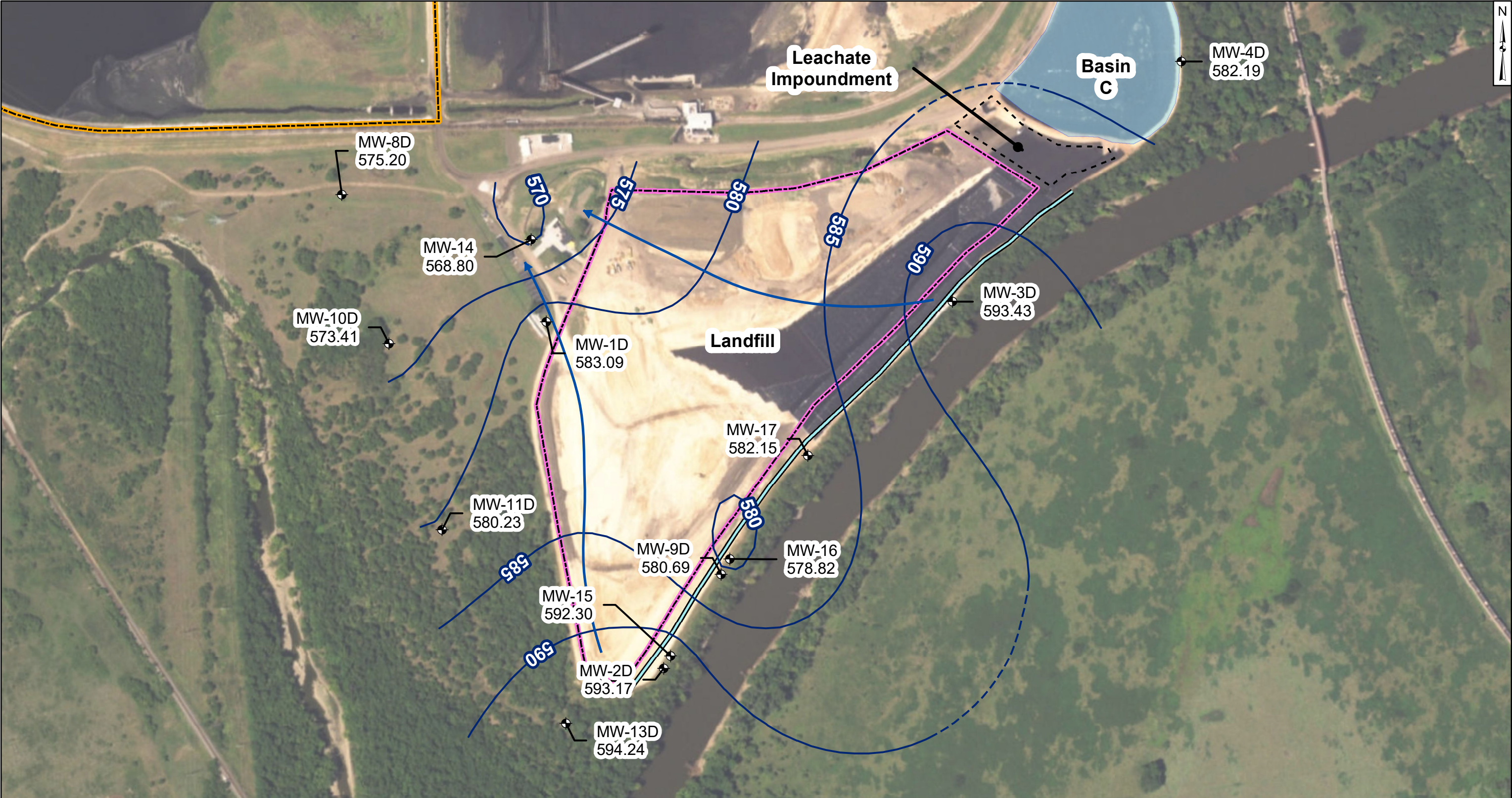
- Monitoring well coordinates and water level data (collected 1/25/2017) provided by AEP.
- Groundwater elevation units are feet above mean sea level (ft. msl).
- Only wells screened in the Bandera Shale were used for contouring.



Potentiometric Contours - Uppermost Aquifer Landfill January 2017 AEP Northeastern Power Plant Oologah, Oklahoma	
Geosyntec consultants	Figure 6
Columbus, Ohio	2018/01/05



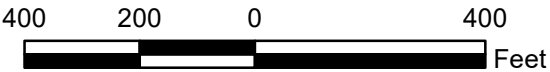
Legend <ul style="list-style-type: none">Groundwater Monitoring WellGroundwater Elevation ContourInferred Groundwater Elevation ContourApproximate Groundwater Flow Direction	Notes <ul style="list-style-type: none">- Monitoring well coordinates and water level data (collected 3/14/2017) provided by AEP.- Groundwater elevation units are feet above mean sea level (ft. msl).- Only wells screened in the Bandera Shale were used for contouring.	<div>400 200 0 400</div> <div>Feet</div>	Potentiometric Contours - Uppermost Aquifer Landfill March 2017 AEP Northeastern Power Plant Oologah, Oklahoma		
			<div>Geosyntec consultants</div>		Figure 7
			Columbus, Ohio	2018/01/06	



- Legend**
- Groundwater Monitoring Well
 - Groundwater Elevation Contour
 - Inferred Groundwater Elevation Contour
 - Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected 5/17/2017) provided by AEP.
- Groundwater elevation units are feet above mean sea level (ft. msl).
- Only wells screened in the Bandera Shale were used for contouring.



**Potentiometric Contours - Uppermost Aquifer
Landfill
May 2017**

AEP Northeastern Power Plant
Oologah, Oklahoma

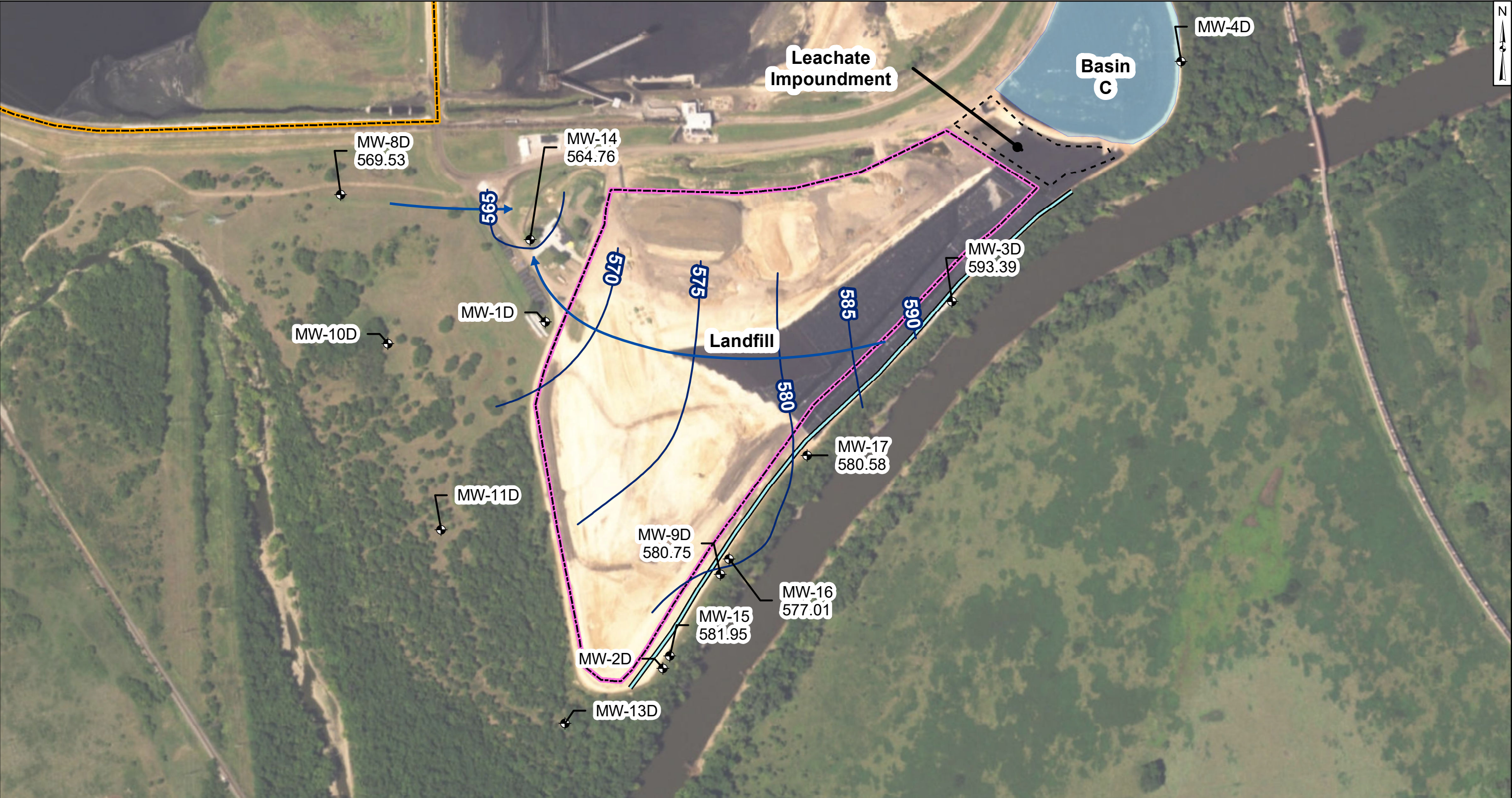
Geosyntec
consultants

Columbus, Ohio

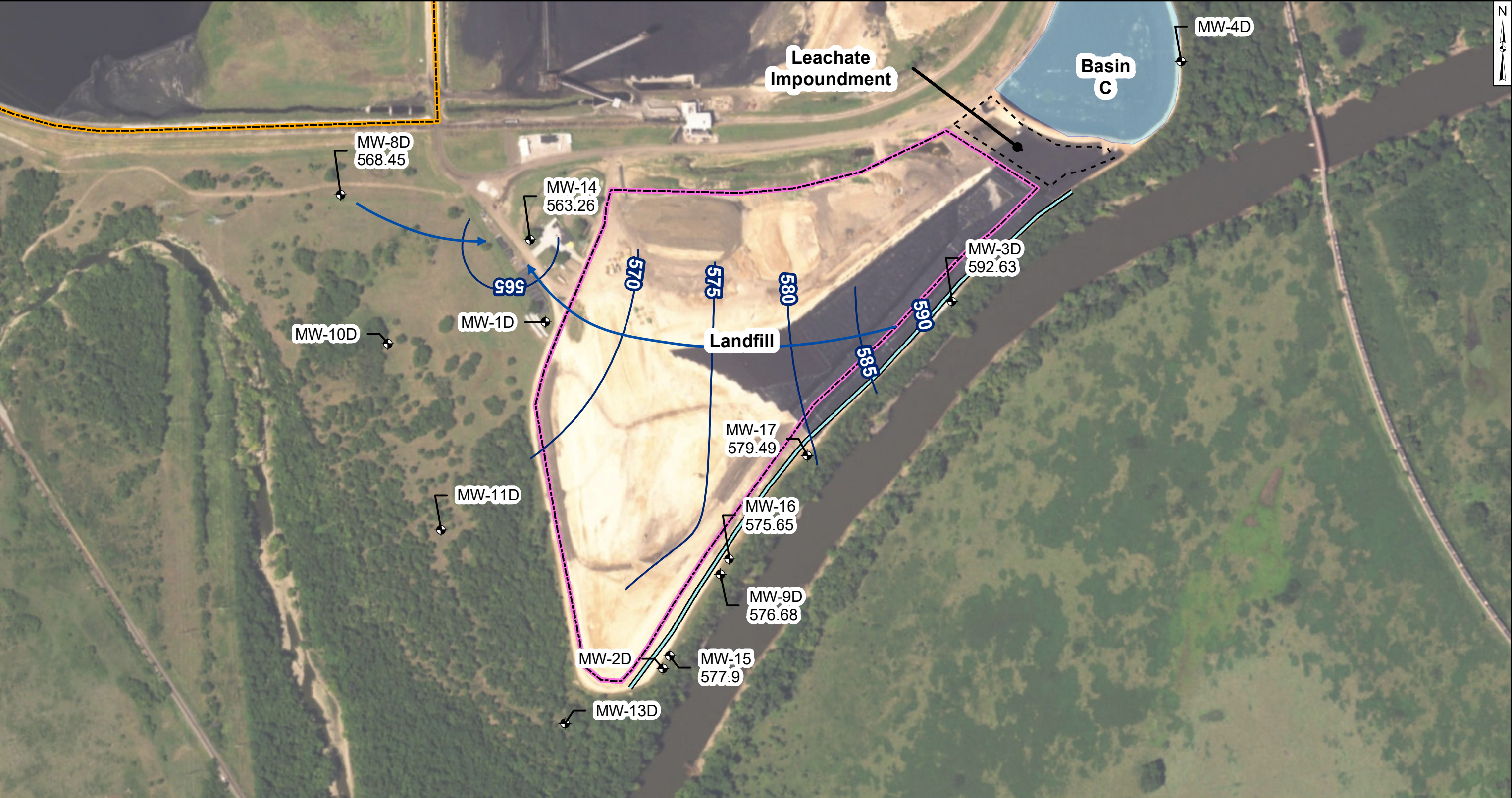
2018/01/06

Figure

8



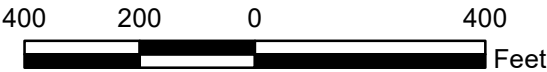
Legend <ul style="list-style-type: none">Groundwater Monitoring WellGroundwater Elevation ContourInferred Groundwater Elevation ContourApproximate Groundwater Flow Direction	Notes <ul style="list-style-type: none">- Monitoring well coordinates and water level data (collected 6/15/2017) provided by AEP.- Groundwater elevation units are feet above mean sea level (ft. msl).- Only wells screened in the Bandera Shale were used for contouring.	<div>400 200 0 400</div> <div>Feet</div>	Potentiometric Contours - Uppermost Aquifer Landfill June 2017	
			AEP Northeastern Power Plant Oologah, Oklahoma	
			<div>Geosyntec consultants</div>	
Columbus, Ohio		2018/01/06	Figure 9	



- Legend**
- Groundwater Monitoring Well
 - Groundwater Elevation Contour
 - Inferred Groundwater Elevation Contour
 - Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected 7/12/2017) provided by AEP.
- Groundwater elevation units are feet above mean sea level (ft. msl).
- Only wells screened in the Bandera Shale were used for contouring.



**Potentiometric Contours - Uppermost Aquifer
Landfill
July 2017**

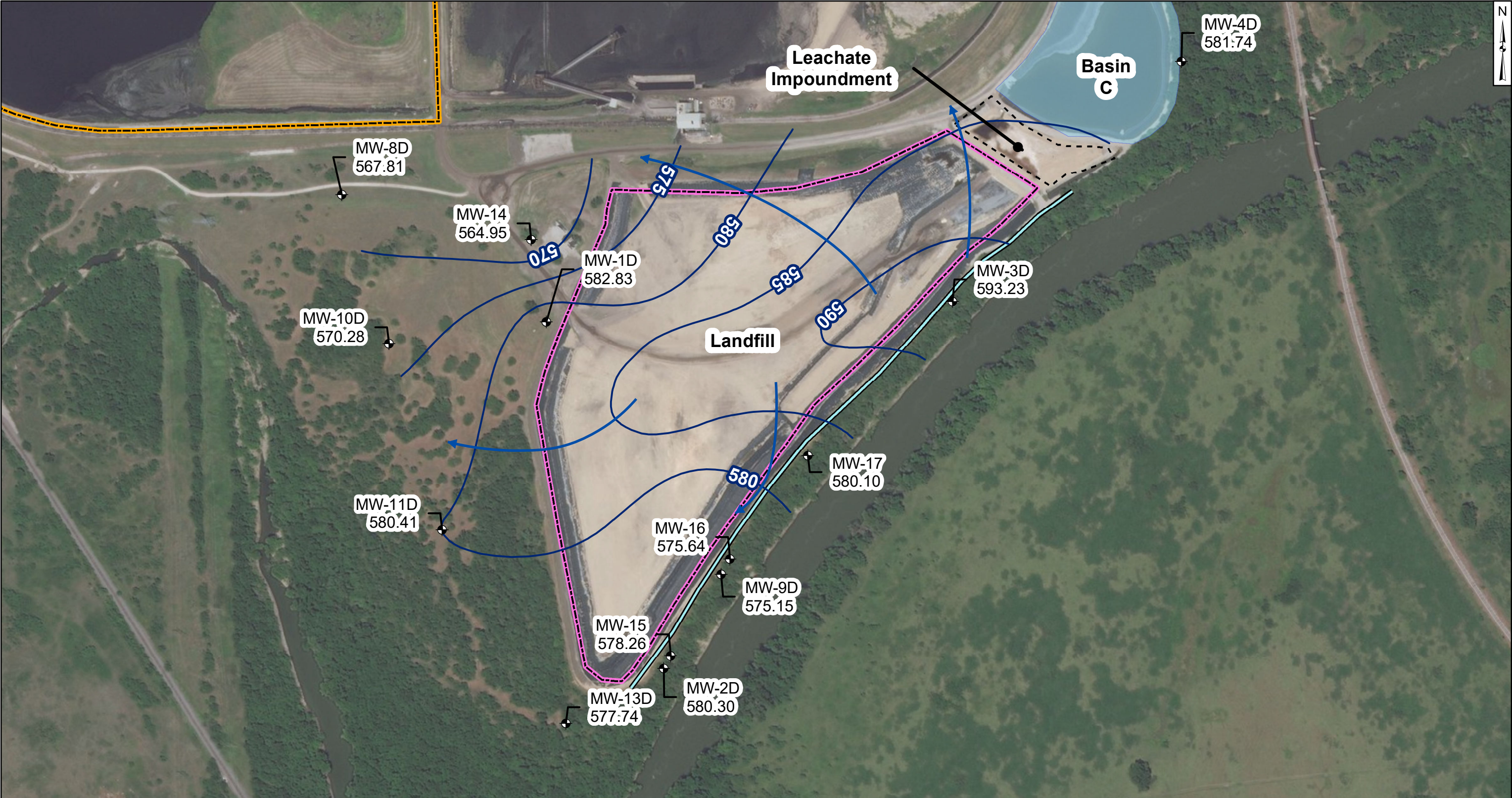
AEP Northeastern Power Plant
Oologah, Oklahoma

Geosyntec
consultants

Columbus, Ohio

2018/01/06

Figure
10



Legend <ul style="list-style-type: none">Groundwater Monitoring WellGroundwater Elevation ContourInferred Groundwater Elevation ContourApproximate Groundwater Flow Direction	Notes <ul style="list-style-type: none">- Monitoring well coordinates and water level data (collected 10/11/2017) provided by AEP.- Groundwater elevation units are feet above mean sea level (ft. msl).- Only wells screened in the Bandera Shale were used for contouring.	<div>400 200 0 400</div> <div>Feet</div>	Potentiometric Contours - Uppermost Aquifer Landfill October 2017 AEP Northeastern Power Plant Oologah, Oklahoma		
			<div>Geosyntec consultants</div>		Figure 11
			Columbus, Ohio	2018/01/27	

APPENDIX II

Not applicable