MONITORING AND RESEARCH DEPARTMENT

REPORT NO. 18-21

TUNNEL AND RESERVOIR PLAN

CALUMET TUNNEL SYSTEM

ANNUAL GROUNDWATER MONITORING REPORT

FOR 2017

July 2018

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Director of Monitoring and Research

July 31, 2018

Chief
Bureau of Water
Illinois Environmental Protection Agency
P. O. Box 19276
Springfield, IL 62794-9276

Dear Sir or Madam:

Subject: Tunnel and Reservoir Plan, Calumet Tunnel System, Annual Groundwater Monitoring Report for 2017

Attached are three copies of "Tunnel and Reservoir Plan, Calumet Tunnel System, Annual Groundwater Monitoring Report for 2017."

Very truly yours,

Albert E. Cox
Environmental Monitoring and Research Manager
Monitoring and Research Department

AC:PS:cm
cc w/att: Ms. Sally K. Swanson (USEPA Region 5 - WC15J) - (2)
Mr. Podczerwinski
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TUNNEL AND RESERVOIR PLAN
CALUMET TUNNEL SYSTEM
ANNUAL GROUNDWATER MONITORING REPORT
FOR 2017

Monitoring and Research Department
Edward W. Podczerwinski, Director

July 2018

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°C	degrees Celsius
CCD	Chicago City Datum
CFU	colony forming units
CTS	Calumet Tunnel System
Cl^-	chloride
District	Metropolitan Water Reclamation District of Greater Chicago
EC	electrical conductivity
FC	fecal coliform
ft	feet
hr	hour
IEPA	Illinois Environmental Protection Agency
L	liter
m	meter
mg	milligram
mS	millisiemens
NH_3-N	ammonia nitrogen
SO_4^{2-}	sulfate
TDS	total dissolved solids
Temp	temperature
TOC	total organic carbon

ANNUAL DATA FOR MONITORING AND OBSERVATION WELLS

Introduction

All monitoring and observation wells are located along the length of the Calumet Tunnel System (CTS). Four monitoring wells (QC-1, -2, -2-1, and -2-2) and 11 observation wells (OC-1 through OC-11) are located along the tunnel between Crawford Avenue and the Calumet Water Reclamation Plant. Seventeen monitoring wells (QC-3 through QC-19) are located between 140th Street and Indiana Avenue, nine (QC-20 through QC-28) are along Torrence Avenue, and nine (QC-29 through QC-37) along the Little Calumet River (Figures 1 and 2). Monitoring well QC-3 was abandoned with the approval of the Illinois Environmental Protection Agency (IEPA).

The monitoring wells were sampled based on the modified groundwater monitoring program for the Metropolitan Water Reclamation District of Greater Chicago (District)'s Tunnel and Reservoir Plan (TARP) as briefly described below.

Modified Groundwater Monitoring Program

In a letter dated July 13, 2017, the IEPA accepted the modifications for the District's TARP groundwater monitoring program effective from January 2017 for a period of three years (2017 – 2019). Under the revised monitoring plan, three wells (QC-2, QC-4, and QC-17), which had fecal coliform detected in 10 percent or more of samples during the period 1995 – 2013, will be sampled for four events of TARP tunnel fills, based on the water levels in the TARP following storm events. The fill event-based criterion that triggers a fill event sampling is when the level of water in the TARP Calumet tunnels reaches -150 ft Chicago City Datum (CCD). At each event, sampling is done weekly for three weeks. The samples collected during the first week of sampling are analyzed for all parameters in the current monitoring program, including: pH, temperature, electrical conductivity, total dissolved solids, hardness, ammonia nitrogen, total organic carbon, chloride, sulfate, and fecal coliform. However, the samples from the second and third week are analyzed for only fecal coliform.

The other 28 wells associated with the CTS are sampled once per year. These wells had fecal coliform detected in less than 10 percent of samples during the period 1995 – 2013.

Groundwater elevations in the monitoring wells were measured during each sampling event, while elevations in the observation wells were measured biweekly with a minor variation. The groundwater level in monitoring well (QC-8.1) no longer yields sufficient sample for analysis. However, this well was converted to an observation well several years ago, and its groundwater elevations are still measured biweekly.

Based on further evaluation of the monitoring wells, QC-1 did not function following repairs, and QC-3 and QC-8 were abandoned many years ago. Therefore, these wells will also be added to the group of other wells (QC-32, QC-33, QC-34, QC-36, and QC-37) discontinued for monitoring under the modified groundwater monitoring program.

FIGURE 1: MAP OF MONITORING WELLS IN THE CALUMET TUNNEL SYSTEM

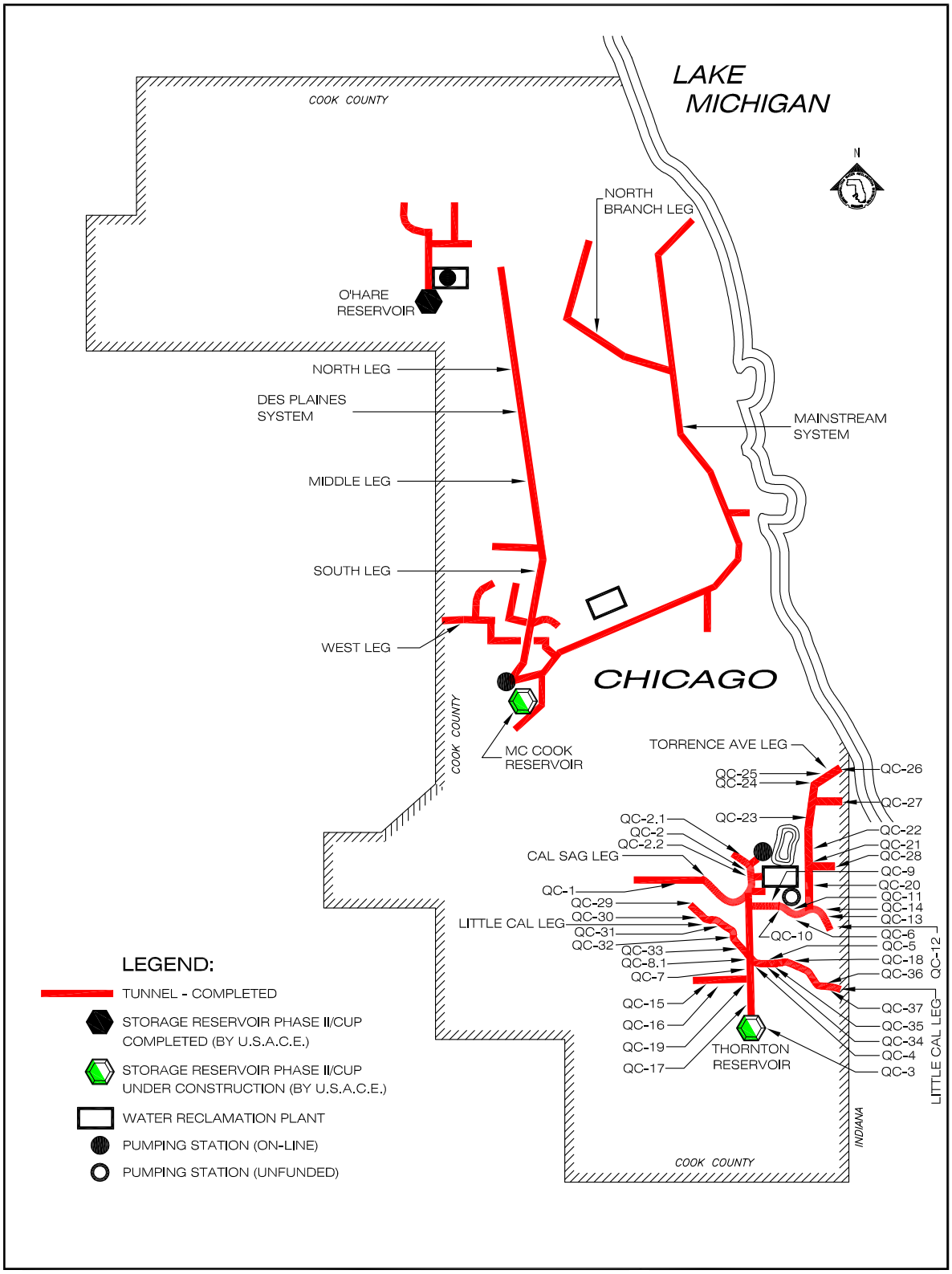
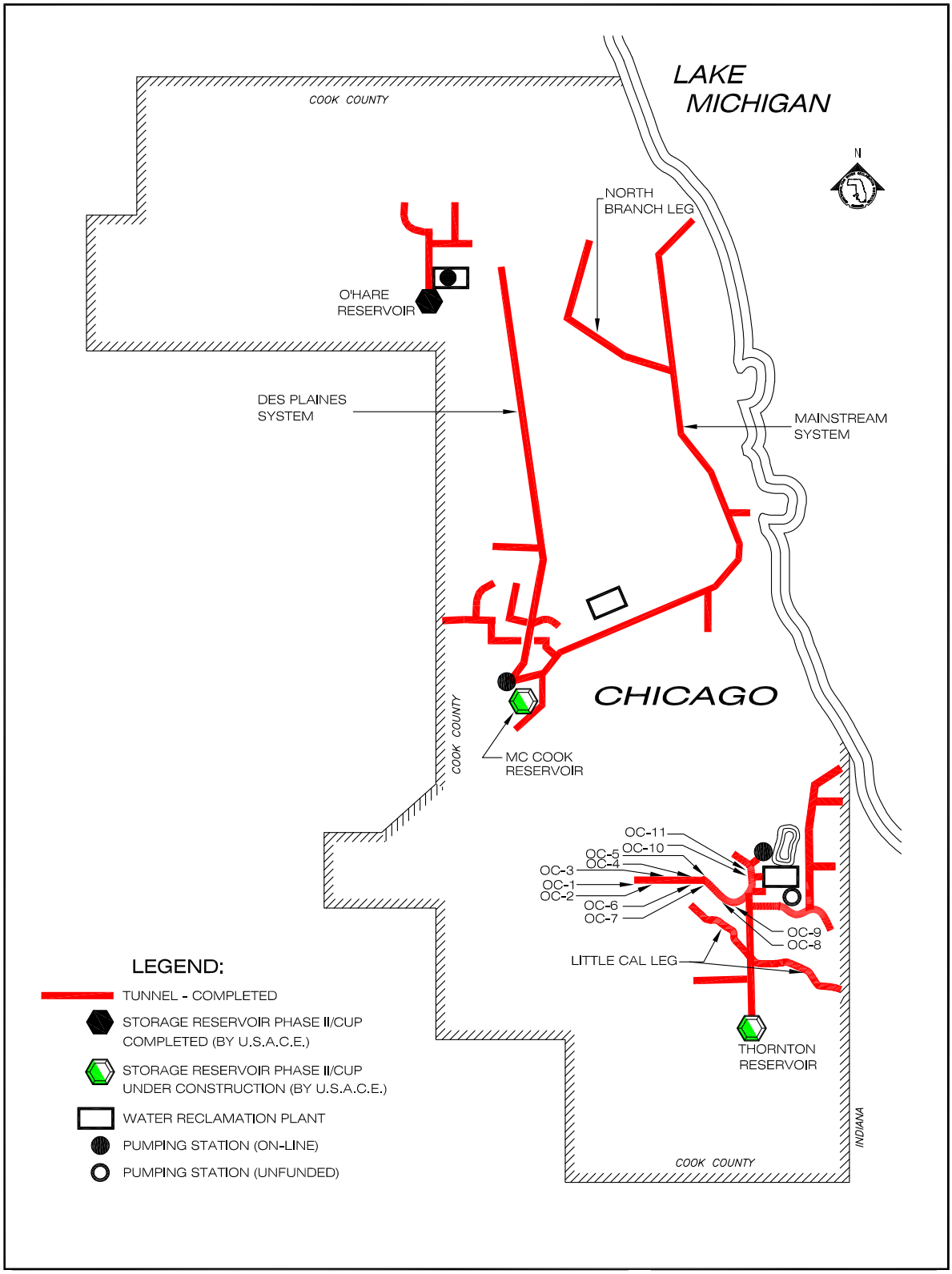


FIGURE 2: MAP OF OBSERVATION WELLS IN THE CALUMET TUNNEL SYSTEM



Summary of Data

Monitoring Wells. The analytical data for groundwater sampled during 2017 from fill-based monitoring wells QC-2, QC-4 and QC-17, along with descriptive statistics, are presented in Table 1. Physical characteristics, such as elevation, groundwater temperature, and estimated time of recharge for each well between initial drawdown and sampling, are also included. The fecal coliform data for groundwater sampled during 2017 from these monitoring wells are presented in Table 2. The analytical data for groundwater from the wells sampled once per year are presented in Table 3. Fecal coliform counts in all the annual sampling wells were undetectable (<1 CFU/100 mL).

Observation Wells. Groundwater elevations for observation wells OC-1 through -11 were measured at the required frequencies. There was only one reading in October due to personnel shortage because the highest priority was placed on fill event sampling of TARP wells. Adjusted elevations were calculated relative to the CCD (579.48 ft. above mean sea level) at the intersection of Madison and State Streets (Table 4). The minimum, mean, and maximum values for each well were calculated and plotted to determine fluctuations in groundwater elevations during the year (Figure 3). Generally, these fluctuations appeared to be minimal or within expected ranges throughout the year in most wells. However, there were notable fluctuations in groundwater elevations: 57 ft at OC-1, 9 ft at OC-3 and OC-4, 15 ft at OC-8.1, 19 ft at OC-9 and OC-10, and 11 ft at OC-11.

TABLE 1: ANALYSIS OF CHEMICAL AND PHYSICAL PARAMETERS IN GROUNDWATER FROM FILL EVENT MONITORING WELLS IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN SAMPLED DURING 2017 AND DESCRIPTIVE STATISTICS OF EACH OF THE PARAMETERS

Well	Fill Event	Sample Date	pH	EC	TDS	TOC	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Temp	Water Elevation[2]	Recharge Time
				mS/m	---------- mg/L ----------						^{0}C	ft	hr
QC-2	F1	04/06/17	7.5	58.2	330	1.4	29	25	0.1	83	12.6	-312	<48
	F2	05/04/17	N/S[1]	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	F3	08/03/17	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
	F4	11/02/17	7.6	73.3	394	1.9	52	50	0.5	82	13.4	-320	<48
		Minimum	7.5	58.2	330	1.4	29	25	0.12	82	12.6	-312	
		Median	7.6	65.8	362	1.7	41	38	0.30	83	13.0	-316	
		Mean	7.6	65.8	362	1.7	41	38	0.30	83	13.0	-316	
		Maximum	7.6	73.3	394	1.9	52	50	0.47	83	13.4	-320	
		Standard deviation	0.04	107	45	0.3	16	18	0.25	0.7	0.6	-5.7	
		Coefficient of variation (%)	0.5	16	13	22	40	48	84	1.0	4.4	1.8	
QC-4	F1	04/06/17	8.8	71.4	422	<1.0	10	22	<0.10	14	11.6	-258	<48
	F2	05/04/17	8.7	65.4	446	<1.0	8	17	0.15	10	11.8	-253	<48
	F3	08/03/17	8.7	69.2	404	<1.0	8	15	<0.10	10	13.4	-254	<48
	F4	10/19/17	8.8	71.7	428	1.5	9	19	0.16	12	12.6	-254	<48
		Minimum	8.7	65.4	404	<1.0	8	15	<0.10	10	11.6	-253	
		Median	8.7	70.3	425	<1.0	8.5	18	0.13	11	12.2	-254	
		Mean	8.7	69.4	425	1.1	8.8	18	0.13	12	12.4	-255	
		Maximum	8.8	71.7	446	1.5	10	22	0.16	14	13.4	-258	
		Standard deviation	0.07	29	17	0.3	1.0	2.8	0.03	1.9	0.80	-2.0	
		Coefficient of variation (%)	0.8	4.2	4	22	11	15	23	17	6.7	0.9	

TABLE 1 (Continued): ANALYSIS OF CHEMICAL AND PHYSICAL PARAMETERS IN GROUNDWATER FROM FILL EVENT MONITORING WELLS IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN SAMPLED DURING 2017 AND DESCRIPTIVE STATISTICS OF EACH OF THE PARAMETERS

Well	Fill Event	Sample Date	pH	EC	TDS	TOC	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Temp	Water Elevation[2]	Recharge Time
				mS/m	----------			mg/L		----------	^0C	ft	hr
QC-17	F1	04/06/17	7.9	77.9	438	<1.0	6	181	0.17	147	11.7	-216	<48
	F2	05/04/17	7.9	74.9	488	<1.0	7	175	0.29	150	11.9	-199	<48
	F3	08/03/17	7.7	78.5	474	<1.0	6	183	0.22	154	13.6	-230	<48
	F4	10/19/17	7.9	79.4	492	1.5	6	196	0.25	152	12.8	-219	<48
		Minimum	7.7	74.9	438	<1.0	6	175	0.17	147	11.7	-199	
		Median	7.9	78.2	481	<1.0	6	182	0.24	151	12.4	-218	
		Mean	7.9	77.7	473	1.1	6.3	184	0.23	151	12.5	-216	
		Maximum	7.9	79.4	492	1.5	7	196	0.29	154	13.6	-230	
		Standard deviation	0.1	20	25	0.25	0.5	8.7	0.05	3.0	0.9	-12.8	
		Coefficient of variation (%)	1.7	2.5	5.2	22	8	4.8	22	2.0	7.0	5.9	

[1]Cannot get sample from the well due to pump malfunction.
[2]Relative to Chicago City Datum (579.48 ft above mean sea level) at intersection of Madison and State Streets.

TABLE 2: ANALYSIS OF FECAL COLIFORM IN GROUNDWATER FROM FILL EVENT MONITORING WELLS WITH DESCRIPTIVE STATISTICS IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN SAMPLED DURING 2017

Well	Fill Event	Week 1 Sample Date	Week 1	Week 2	Week 3
			---------- CFU/100 ml ----------		
QC-2	F1	04/06/17	550	700	NA[1]
	F2	05/04/17	NA	NA	NA
	F3	8/3/2017	NA	NA	NA
	F4	10/19/17	NA	NA	40
		Minimum	550	700	40
		Median	550	700	40
		Mean[2]	550	700	40
		Maximum	550	700	40
QC-4	F1	04/06/17	<1	<1	NR[3]
	F2	05/04/17	1	<1	<1
	F3	08/03/17	<1	<1	NR
	F4	10/19/17	2	<1	<1
		Minimum	<1	<1	<1
		Median	1	1	1
		Mean	1	1	1
		Maximum	2	<1	<1
QC-17	F1	04/06/17	<1	<1	NR
	F2	05/04/17	<1	<1	NR
	F3	08/03/17	<1	<1	NR
	F4	10/19/17	2	21	<1
		Minimum	<1	<1	<1
		Median	1	1	1
		Mean	1	2	1
		Maximum	2	21	<1

[1]NA: Cannot get sample from the well due to pump malfunction..
[2]Geometric mean calculated
[3]NR: Sampling is not required because the Fecal Coliform level was below detection limit in the previous week

TABLE 3: ANALYSIS OF CHEMICAL AND PHYSICAL PARAMETERS AND FECAL COLIFORM IN GROUNDWATER FROM ANNUAL SAMPLING WELLS IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN SAMPLED DURING 2017

Well	Sample Date	pH	EC	TDS	TOC	Cl^-	SO_4^{2-}	NH_3-N	Hardness	Temp	Water Elevation[1]	Fecal Coliform
			mS/m	mg/L						^{0}C	ft	CFU/100 ml
QC-2-1	12/06/17	7.8	87	512	1.2	33	5	0.68	65	12.1	-318	<1
QC-2-2	08/24/17	8.5	60	326	1.5	12	26	0.28	34	14	-300	<1
QC-5	06/14/17	8.7	92	586	<1.0	34	10	<0.10	9	13.2	-245	<1
QC-6	06/14/17	8.8	75	530	1.0	14	<5	0.25	17	13.6	-229	<1
QC-7	06/14/17	8.4	69	466	1.0	18	<5	0.17	12	13.6	-185	<1
QC-9	06/14/17	7.8	44	358	<1.0	8	34	0.19	62	15.2	-275	<1
QC-10	02/15/17	8.7	66	376	<1.0	29	<10	0.27	10	12.1	-177	<1
QC-11	02/15/17	8.2	47	278	<1.0	20	<10	0.18	21	12.5	-206	<1
QC-12	02/22/17	7.5	123	802	<1.0	33	279	0.74	140	12.6	-235	<1
QC-13	02/22/17	7.9	65	392	<1.0	51	20	0.62	35	12.6	-250	<1
QC-14	08/24/17	7.6	120	668	2.8	136	5	0.49	148	13.8	-215	<1
QC-15	08/24/17	8.4	49	276	<1.0	11	<5	0.25	13	13.8	-223	<1
QC-16	12/06/17	8.1	78	470	1.1	22	77	<0.10	58	10.6	-286	<1
QC-18	09/20/17	9.2	58	406	<1.0	7	30	0.16	7	12.4	-220	<1
QC-19	09/20/17	8.2	59	434	<1.0	6	143	0.37	107	13.2	-191	<1
QC-20	04/26/17	7.5	45	256	<1.0	19	11	0.11	24	13.8	-256	<1
QC-21	04/26/17	8.2	53	316	3.1	17	8	<0.10	31	14	-252	<1
QC-22	08/30/17	7.3	33	248	1.6	14	6	0.26	34	14.6	-257	<1
QC-23	08/30/17	9.1	52	288	<1.0	19	<5	<0.10	5	12.9	-241	<1
QC-24	08/30/17	8.6	38	222	<1.0	25	<5	0.16	13	13.5	-238	<1
QC-25	06/21/17	8.0	39	246	<1.0	13	16	0.14	31	15.3	-253	<1
QC-26	06/21/17	8.7	48	274	<1.0	14	<5	<0.10	7	13.4	-247	<1
QC-27	06/21/17	8.5	41	258	<1.0	30	<5	0.14	23	14.2	-223	<1
QC-28	04/26/17	8.8	42	242	<1.0	12	<5	<0.10	17	14.1	-262	<1
QC-29	09/28/17	7.6	119	710	1.3	142	157	1.09	275	13.2	-67	<1
QC-30	09/28/17	8.2	69	428	1	20	99	0.6	79	12.8	-135	<1
QC-31	09/28/17	7.9	83	530	1.2	16	197	1.08	231	12.9	-65	<1
QC-35	12/06/17	8.3	142	886	1.5	34	39	0.19	16	11.8	-170	<1

[1]Relative to Chicago City Datum (579.48 ft above sea level) at intersection of Madison and State Streets.

TABLE 4: GROUNDWATER ELEVATIONS FOR OBSERVATION WELLS IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN MEASURED DURING 2017

Date[1]	Observation Well No.											
	OC-1	OC-2	OC-3	OC-4	OC-5	OC-6	OC-7	OC-8	OC-8.1	OC-9	OC-10	OC-11
	Elevation (ft)[2]											
01/13/17	-38	-26	-159	-160	N/S[3]	N/S	N/S	N/S	-225	-197	-227	-221
01/27/17	-39	-25	-160	-157	N/S	-76	N/S	N/S	-226	N/S	-228	-221
02/10/17	-39	-26	-153	-159	-148	-78	N/S	-186	-224	-209	-223	-221
02/27/17	-38	-26	-153	-159	-149	-73	N/S	-186	-225	-212	-224	-223
03/10/17	-37	-25	-154	-157	-147	-74	N/S	-188	-223	N/S	-223	-221
03/21/17	-38	-24	-152	-157	-145	-73	-204	N/S	-218	-213	-223	-217
04/21/17	-38	-23	-156	-159	N/S	-69	-208	N/S	-222	N/S	-220	-226
04/27/17	-37	-22	-154	-157	-146	-68	-205	N/S	-217	N/S	-216	-221
05/19/17	-39	-22	-156	N/S	N/S	-70	N/S	N/S	-220	N/S	-220	N/S
05/30/17	-76	-24	-156	-158	N/S	-68	-208	N/S	-222	N/S	-210	-224
06/09/17	-29	-22	-151	N/S	-143	-71	-207	N/S	-219	N/S	-209	N/S
06/23/17	-19	-24	N/S	N/S	N/S	-71	N/S	N/S	-221	N/S	N/S	N/S
07/25/17	-39	-24	N/S	-155	N/S	-80	-209	N/S	-222	N/S	N/S	N/S
07/27/17	-39	-26	N/S	N/S	N/S	-81	N/S	N/S	-221	N/S	N/S	N/S
08/15/17	-39	-25	-154	N/S	N/S	-74	-209	N/S	-224	N/S	N/S	N/S
08/23/17	-40	-26	-160	-161	N/S	-78	-204	N/S	-229	N/S	N/S	N/S
09/06/17	-42	-25	-157	-157	N/S	-77	-210	N/S	-226	N/S	N/S	N/S
09/22/17	-41	-26	-157	-160	N/S	-77	-207	N/S	-226	-213	N/S	-221
10/05/17	-41	-26	-158	-158	N/S	-77	-207	N/S	-225	-214	-217	N/S
11/22/17	-37	-24	-155	-157	N/S	-81	-210	N/S	-221	N/S	-221	-218
11/29/17	-39	-25	-154	-155	N/S	-79	-208	N/S	-219	-216	-219	-220
12/01/17	-37	-24	-156	-152	N/S	-78	-204	N/S	-214	-212	-215	-221
12/06/17	-38	-24	-155	-154	N/S	-80	-206	N/S	-215	-214	-216	-223

[1]Date measurements were taken.
[2]Relative to Chicago City Datum (mean of 579.48' above sea level) at intersection of State and Madison Streets.
[3]Wells inaccessible at various times due to heavy snow, locked gate, muddy road conditions, fallen trees, high weeds, and flooding.

FIGURE 3: MINIMUM, MEAN, AND MAXIMUM WATER ELEVATIONS FOR OBSERVATION WELLS IN THE CALUMET TUNNEL SYSTEM OF THE TUNNEL AND RESERVOIR PLAN MEASURED DURING 2017