Metropolitan Water Reclamation District of Greater Chicago

RESEARCH AND DEVELOPMENT DEPARTMENT

REPORT NO. 07-43

TUNNEL AND RESERVOIR PLAN

MAINSTREAM TUNNEL SYSTEM

2006 ANNUAL GROUNDWATER MONITORING REPORT

July 2007

Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

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July 27, 2007

Ms. Marcia Willhite, Chief
Bureau of Water
Illinois Environmental Protection Agency
P. O. Box 19276
Springfield, IL 62794–9276

Dear Ms. Willhite:

Subject: Tunnel and Reservoir Plan, Mainstream Tunnel System, 2006 Annual Groundwater Monitoring Report

Enclosed are three copies of "Tunnel and Reservoir Plan, Mainstream Tunnel System, 2006 Annual Groundwater Monitoring Report."

Very truly yours,

Louis Kollias
Director
Research and Development

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TUNNEL AND RESERVOIR PLAN
MAINSTREAM TUNNEL SYSTEM
2006 ANNUAL GROUNDWATER MONITORING REPORT

Research and Development Department
Louis Kollias, Director

July 2007

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INTRODUCTION

This report contains 2006 data for the TARP Mainstream Tunnel System compiled from monitoring of groundwater elevations in observation wells, and monitoring of groundwater quality in water quality monitoring wells. The observation wells are all sampled once every two months while the monitoring wells are sampled at varying frequency. Monitoring wells QM–53, QM–56, QM–58, QM–61, QM–66, QM–68 through QM–74, QM–76, QM–77, and QM–81 are sampled three times per year (Illinois Environmental Protection Agency [IEPA] memoranda July 9, 2004, and February 23, 2006). Monitoring wells QM–62 through QM–65, QM–67, QM–75, QM–78 through QM–80, and QM–82 are sampled six times per year (IEPA memorandum July 9, 2004). Sampling of water quality wells QM–51, QM–52, QM–54, QM–55, QM–57, and QM–60 was discontinued with the approval of the IEPA (memorandum dated May 4, 1994). Water quality monitoring well QM–59 has been dry since February 1995 and is no longer being monitored. The observation wells and water quality monitoring wells are located along the length of the Mainstream Tunnel between Morton Grove and Hodgkins.

Monitoring Data

Appendix AI contains a location map of observation wells OM–1 through OM–23 located along the Mainstream Tunnel System.

Table AII–1 in Appendix AII contains groundwater elevation data for the year 2006 for observation wells OM–1 through OM–23 located along the Mainstream Tunnel System. Table AII–1 also contains the yearly minimum, mean, and maximum water level elevations of each observation well.

Appendix AIII contains a location map of water quality monitoring wells QM–53 through QM–82 located along the Mainstream Tunnel System.

Tables AIV–1 and AIV–2 of Appendix AIV contain water quality data for the year 2006 pertaining to water quality monitoring wells QM–53 through QM–82 located along the Mainstream Tunnel System.

All of the wells in the Mainstream system were visited for the required number of samples. However, in some instances the samples could not be collected. Water quality well QM–62 could not be sampled in 2006 because the pump could not be activated because of a structural problem with the well. A decision is being made on the well's future. Water quality well QM–66 could not be sampled on November 16, 2006, because there was insufficient water in the well to collect a sample. Water quality well QM–70 could not be sampled on May 3, 2006, or August 8, 2006, because the pump was inoperable due to electrical problems. Water quality well QM–75 could not be sampled on June 1, 2006, or June 21, 2006, because there was insufficient water in the well for a sample, or on August 17, 2006, due to an electrical problem with the well. Water

quality well QM–76 could not be sampled on April 25, 2006, because of an obstruction blocking access to the well.

Summary of Data

Observation Wells Water Level Elevation Data. In Figure 1, the 2006 groundwater level elevation data for the observation wells (OM–1 through OM–23) of the Mainstream Tunnel System have been plotted. In this figure, minimum, mean, and maximum water level elevations of all the observation wells are plotted to show fluctuations in water level elevations during 2006. Table AII–1 in Appendix AII contains the groundwater level elevation data for the year 2006 for the observation wells located in the Mainstream Tunnel System.

Water Quality Monitoring Wells Data. Tables 1 through 5 contain summary statistics of the water quality parameters for the year 2006 for water quality monitoring wells QM–53 through QM–82 in the Mainstream Tunnel System. These statistics are computed from the 2006 data collected from each water quality well. The summary statistics include minimum, mean, maximum, standard deviation (Std. Dev.), median and coefficient of variation (Coeff. Var.) for all nine water quality parameters analyzed during 2006. The nine water quality parameters are: chloride (Cl), conductivity (Cond.), fecal coliform (FC), hardness as $CaCO_3$ (Hard.), ammonia as NH_4^+–N, pH, sulfate (SO_4), total dissolved solids (TDS), and total organic carbon (TOC).

TABLE 1: SUMMARY STATISTICS OF THE 2006 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–53, QM–56, QM–58, QM–61, AND QM–62

Parameter		Well Number				
		QM–53	QM–56	QM–58	QM–61	QM–62
Cl, mg/L	Minimum	14	37	16	56	—
	Mean	16	38	18	58	—
	Maximum	20	40	19	60	—
	Std. Dev.	3	2	2	2	—
	Median	14	38	18	57	—
	Coeff. Var.	22	4	9	4	—
Cond., µmhos/cm	Minimum	150	218	218	220	—
	Mean	195	283	313	401	—
	Maximum	235	380	458	603	—
	Std. Dev.	43	86	127	192	—
	Median	199	250	264	380	—
	Coeff. Var.	22	30	41	48	—
FC,[1] cfu/100 mL	Minimum	1	1	1	1	—
	Geo. Mean	1	1	1	1	—
	Maximum	1	1	1	1	—
	Geo. Std. Dev.	0	0	0	0	—
	Median	1	1	1	1	—
	Coeff. Var.	0	0	0	0	—
Hard., as $CaCO_3$, mg/L	Minimum	122	121	258	118	—
	Mean	125	126	268	121	—
	Maximum	132	131	277	126	—
	Std. Dev.	6	5	10	4	—
	Median	122	125	268	119	—
	Coeff. Var.	5	4	4	4	—
NH_4^+–N, mg/L	Minimum	0.04	0.41	0.88	0.20	—
	Mean	0.06	0.45	0.91	0.23	—
	Maximum	0.08	0.50	0.97	0.24	—
	Std. Dev.	0.02	0.05	0.05	0.02	—
	Median	0.06	0.44	0.88	0.24	—
	Coeff. Var.	33.33	10.18	5.71	10.19	—

TABLE 1 (Continued): SUMMARY STATISTICS OF THE 2006 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–53, QM–56, QM–58, QM–61, AND QM–62

Parameter		Well Number				
		QM–53	QM–56	QM–58	QM–61	QM–62
pH	Minimum	7.4	7.4	7.4	7.3	—
	Mean	7.7	7.6	7.5	7.6	—
	Maximum	8.1	7.7	7.6	7.9	—
	Std. Dev.	0.4	0.2	0.1	0.3	—
	Median	7.7	7.6	7.5	7.6	—
	Coeff. Var.	4.5	2.0	1.3	3.9	—
SO_4, mg/L	Minimum	35	11	169	9	—
	Mean	36	15	178	16	—
	Maximum	37	18	184	22	—
	Std. Dev.	1	4	8	7	—
	Median	35	15	180	16	—
	Coeff. Var.	3	24	4	42	—
TDS, mg/L	Minimum	166	244	454	272	—
	Mean	214	271	491	329	—
	Maximum	296	292	540	378	—
	Std. Dev.	71	24	44	54	—
	Median	180	276	480	338	—
	Coeff. Var.	33	9	9	16	—
TOC, mg/L	Minimum	0.5	0.6	0.8	0.7	—
	Mean	0.6	0.6	0.9	0.8	—
	Maximum	0.7	0.7	1.0	0.9	—
	Std. Dev.	0.1	0.1	0.1	0.1	—
	Median	0.5	0.6	0.9	0.7	—
	Coeff. Var.	20.4	9.1	11.1	15.1	—

[1]For purposes of statistical evaluation, fecal coliform values less than 1 were set equal to 1.

TABLE 2: SUMMARY STATISTICS OF THE 2006 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–63 THROUGH QM–67

Parameter		Well Number				
		QM–63	QM–64	QM–65	QM–66	QM–67
Cl, mg/L	Minimum	46	55	295	258	186
	Mean	50	58	356	261	214
	Maximum	52	62	395	264	230
	Std. Dev.	3	3	37	4	15
	Median	51	59	362	261	218
	Coeff. Var.	5	5	10	2	7
Cond., µmhos/cm	Minimum	750	281	528	766	563
	Mean	1746	652	1079	2178	722
	Maximum	2205	873	2148	3590	1441
	Std. Dev.	526	264	747	1997	353
	Median	1889	788	658	2178	579
	Coeff. Var.	30	40	69	92	49
FC,[1] cfu/100 mL	Minimum	1	1	1	1	160
	Geo. Mean	20	19	1	1	483
	Maximum	20000	20000	10	1	3300
	Geo. Std. Dev.	104	100	4	0	4
	Median	1	1	1	1	240
	Coeff. Var.	534	529	250	0	274
Hard., as CaCO3, mg/L	Minimum	566	198	538	5	281
	Mean	819	216	573	13	317
	Maximum	903	233	590	20	360
	Std. Dev.	131	14	21	11	32
	Median	880	218	582	13	317
	Coeff. Var.	16	6	4	85	10
NH_4^+–N, mg/L	Minimum	1.70	1.87	4.21	0.45	8.18
	Mean	1.83	1.99	5.98	1.19	8.69
	Maximum	1.98	2.12	7.15	1.93	9.53
	Std. Dev.	0.11	0.10	1.14	1.05	0.49
	Median	1.81	1.98	6.10	1.19	8.67
	Coeff. Var.	6.14	5.17	19.11	87.94	5.67

TABLE 2 (Continued): SUMMARY STATISTICS OF THE 2006 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–63 THROUGH QM–67

Parameter		Well Number				
		QM–63	QM–64	QM–65	QM–66	QM–67
pH	Minimum	7.0	7.0	6.9	7.1	7.0
	Mean	7.5	7.4	7.2	7.4	7.4
	Maximum	7.9	7.7	7.5	7.6	7.7
	Std. Dev.	0.4	0.3	0.2	0.4	0.3
	Median	7.7	7.4	7.2	7.4	7.5
	Coeff. Var.	4.9	3.9	3.4	4.8	3.9
SO_4, mg/L	Minimum	619	33	93	55	2
	Mean	1447	39	202	77	32
	Maximum	4277	45	237	99	43
	Std. Dev.	1397	4	54	31	15
	Median	922	39	221	77	38
	Coeff. Var.	97	10	27	40	48
TDS, mg/L	Minimum	1234	444	1178	1068	838
	Mean	1581	504	1349	1407	869
	Maximum	1800	564	1442	1746	890
	Std. Dev.	194	44	96	479	18
	Median	1581	505	1377	1407	872
	Coeff. Var.	12	9	7	34	2
TOC, mg/L	Minimum	1.6	1.2	4.2	1.3	3.0
	Mean	1.9	1.3	5.6	1.5	3.3
	Maximum	2.1	1.4	6.7	1.7	3.5
	Std. Dev.	0.2	0.1	0.9	0.3	0.2
	Median	1.9	1.2	5.7	1.5	3.2
	Coeff. Var.	10.5	6.7	16.4	18.9	6.7

[1]For purposes of statistical evaluation, fecal coliform values less than 1 were set equal to 1.

TABLE 3: SUMMARY STATISTICS OF THE 2006 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–68 THROUGH QM–72

Parameter		Well Number				
		QM–68	QM–69	QM–70	QM–71	QM–72
Cl, mg/L	Minimum	42	33	49	121	124
	Mean	47	39	49	125	126
	Maximum	50	49	49	130	127
	Std. Dev.	5	9	0	5	2
	Median	50	35	49	124	126
	Coeff. Var.	10	22	0	4	1
Cond., µmhos/cm	Minimum	211	246	552	375	299
	Mean	276	442	552	738	550
	Maximum	384	546	552	997	686
	Std. Dev.	94	170	0	324	218
	Median	233	535	552	842	666
	Coeff. Var.	34	38	0	44	40
FC,[1] cfu/100 mL	Minimum	1	1	1	1	1
	Geo. Mean	1	1	1	1	1
	Maximum	1	1	1	1	1
	Geo. Std. Dev.	0	0	0	0	0
	Median	1	1	1	1	1
	Coeff. Var.	0	0	0	0	0
Hard., as $CaCO_3$, mg/L	Minimum	196	154	154	198	207
	Mean	199	158	154	202	208
	Maximum	204	161	154	205	210
	Std. Dev.	4	4	0	4	2
	Median	197	158	154	204	208
	Coeff. Var.	2	2	0	2	1
NH_4^+–N, mg/L	Minimum	0.53	0.81	0.30	0.36	0.29
	Mean	1.00	0.84	0.30	0.38	0.33
	Maximum	1.32	0.85	0.30	0.40	0.37
	Std. Dev.	0.42	0.02	0.00	0.02	0.04
	Median	1.15	0.85	0.30	0.39	0.32
	Coeff. Var.	41.58	2.76	0.00	5.43	12.37

TABLE 3 (Continued): SUMMARY STATISTICS OF THE 2006 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–68 THROUGH QM–72

Parameter		Well Number				
		QM–68	QM–69	QM–70	QM–71	QM–72
pH	Minimum	7.0	7.3	7.8	7.6	7.2
	Mean	7.4	7.8	7.8	7.7	7.6
	Maximum	7.6	8.1	7.8	7.8	7.9
	Std. Dev.	0.3	0.5	0.0	0.1	0.4
	Median	7.5	8.1	7.8	7.7	7.8
	Coeff. Var.	4.4	5.9	0.0	1.3	5.0
SO_4, mg/L	Minimum	34	44	54	72	1
	Mean	38	46	54	74	1
	Maximum	42	49	54	79	2
	Std. Dev.	4	3	0	4	1
	Median	37	45	54	72	1
	Coeff. Var.	11	6	0	5	43
TDS, mg/L	Minimum	278	302	328	452	358
	Mean	341	346	328	511	436
	Maximum	376	420	328	580	544
	Std. Dev.	55	64	0	65	97
	Median	370	316	328	502	406
	Coeff. Var.	16	19	0	13	22
TOC, mg/L	Minimum	0.5	0.9	0.7	0.8	0.5
	Mean	0.6	0.9	0.7	0.8	0.7
	Maximum	0.6	1.0	0.7	0.9	0.8
	Std. Dev.	0.1	0.1	0.0	0.1	0.2
	Median	0.6	0.9	0.7	0.8	0.7
	Coeff. Var.	10.2	6.2	0.0	6.9	22.9

[1]For purposes of statistical evaluation, fecal coliform values less than 1 were set equal to 1.

TABLE 4: SUMMARY STATISTICS OF THE 2006 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–73 THROUGH QM–77

Parameter		Well Number				
		QM–73	QM–74	QM–75	QM–76	QM–77
Cl, mg/L	Minimum	32	49	14	13	11
	Mean	40	50	19	15	12
	Maximum	44	50	23	17	14
	Std. Dev.	7	1	5	3	2
	Median	43	50	21	15	11
	Coeff. Var.	17	1	24	19	14
Cond., µmhos/cm	Minimum	491	352	193	480	209
	Mean	499	415	301	495	249
	Maximum	512	449	361	509	278
	Std. Dev.	11	55	93	21	36
	Median	494	445	348	495	259
	Coeff. Var.	2	13	31	4	14
FC,[1] cfu/100 mL	Minimum	1	1	1	1	1
	Geo. Mean	1	1	1	1	1
	Maximum	1	1	1	1	1
	Geo. Std. Dev.	0	0	0	0	0
	Median	1	1	1	1	1
	Coeff. Var.	0	0	0	0	0
Hard., as $CaCO_3$, mg/L	Minimum	147	93	61	34	37
	Mean	150	94	62	40	39
	Maximum	156	96	64	45	41
	Std. Dev.	5	2	2	8	2
	Median	148	94	62	40	39
	Coeff. Var.	3	2	2	20	5
NH_4^+–N, mg/L	Minimum	0.16	0.13	0.16	0.14	0.05
	Mean	0.17	0.17	0.27	0.19	0.11
	Maximum	0.19	0.20	0.42	0.24	0.15
	Std. Dev.	0.02	0.04	0.14	0.07	0.05
	Median	0.17	0.18	0.22	0.19	0.13
	Coeff. Var.	8.81	21.21	51.05	37.22	48.10

TABLE 4 (Continued): SUMMARY STATISTICS OF THE 2006 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–73 THROUGH QM–77

Parameter		Well Number				
		QM–73	QM–74	QM–75	QM–76	QM–77
pH	Minimum	7.7	7.9	7.5	8.7	8.4
	Mean	7.7	8.0	7.6	8.9	8.5
	Maximum	7.7	8.1	7.8	9.0	8.6
	Std. Dev.	0.0	0.1	0.2	0.2	0.1
	Median	7.7	8.1	7.5	8.9	8.4
	Coeff. Var.	0.0	1.4	2.3	2.4	1.4
SO_4, mg/L	Minimum	1	1	10	49	2
	Mean	2	2	14	56	2
	Maximum	2	3	20	63	3
	Std. Dev.	1	1	6	10	1
	Median	2	2	11	56	2
	Coeff. Var.	35	50	40	18	25
TDS, mg/L	Minimum	272	232	186	260	114
	Mean	299	307	216	295	173
	Maximum	352	408	260	330	210
	Std. Dev.	46	91	39	49	51
	Median	272	282	202	295	194
	Coeff. Var.	15	30	18	17	30
TOC, mg/L	Minimum	1.1	1.1	0.6	0.7	0.7
	Mean	3.6	1.2	0.7	0.8	0.8
	Maximum	8.7	1.2	0.8	0.8	1.0
	Std. Dev.	4.4	0.1	0.1	0.1	0.2
	Median	1.1	1.2	0.7	0.8	0.8
	Coeff. Var.	120.8	4.9	14.3	9.4	18.3

[1]For purposes of statistical evaluation, fecal coliform values less than 1 were set equal to 1.

TABLE 5: SUMMARY STATISTICS OF THE 2006 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–78 THROUGH QM–82

Parameter		Well Number				
		QM–78	QM–79	QM–80	QM–81	QM–82
Cl, mg/L	Minimum	13	19	14	19	28
	Mean	16	19	15	24	29
	Maximum	24	20	15	31	30
	Std. Dev.	5	1	1	6	1
	Median	14	19	15	21	29
	Coeff. Var.	29	3	4	27	3
Cond., µmhos/cm	Minimum	300	258	178	380	268
	Mean	442	458	276	385	398
	Maximum	535	541	325	394	478
	Std. Dev.	108	126	62	8	90
	Median	475	535	308	382	436
	Coeff. Var.	24	27	22	2	23
FC,[1] cfu/100 mL	Minimum	1	1	1	1	1
	Geo. Mean	1	1	1	1	1
	Maximum	1	2	1	1	1
	Geo. Std. Dev.	0	1	0	0	0
	Median	1	1	1	1	1
	Coeff. Var.	0	36	0	0	0
Hard., as $CaCO_3$, mg/L	Minimum	10	9	20	19	14
	Mean	11	10	21	26	14
	Maximum	11	10	21	29	15
	Std. Dev.	1	0.4	1	6	0
	Median	11	10	21	29	14
	Coeff. Var.	5	4	2	22	3
NH_4^+–N,[2] mg/L	Minimum	0.02	0.02	0.02	0.03	0.02
	Mean	0.10	0.06	0.05	0.07	0.05
	Maximum	0.31	0.25	0.14	0.11	0.15
	Std. Dev.	0.11	0.09	0.05	0.04	0.05
	Median	0.07	0.02	0.02	0.08	0.03
	Coeff. Var.	106.77	150.18	103.81	55.11	102.76

TABLE 5 (Continued): SUMMARY STATISTICS OF THE 2006 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–78 THROUGH QM–82

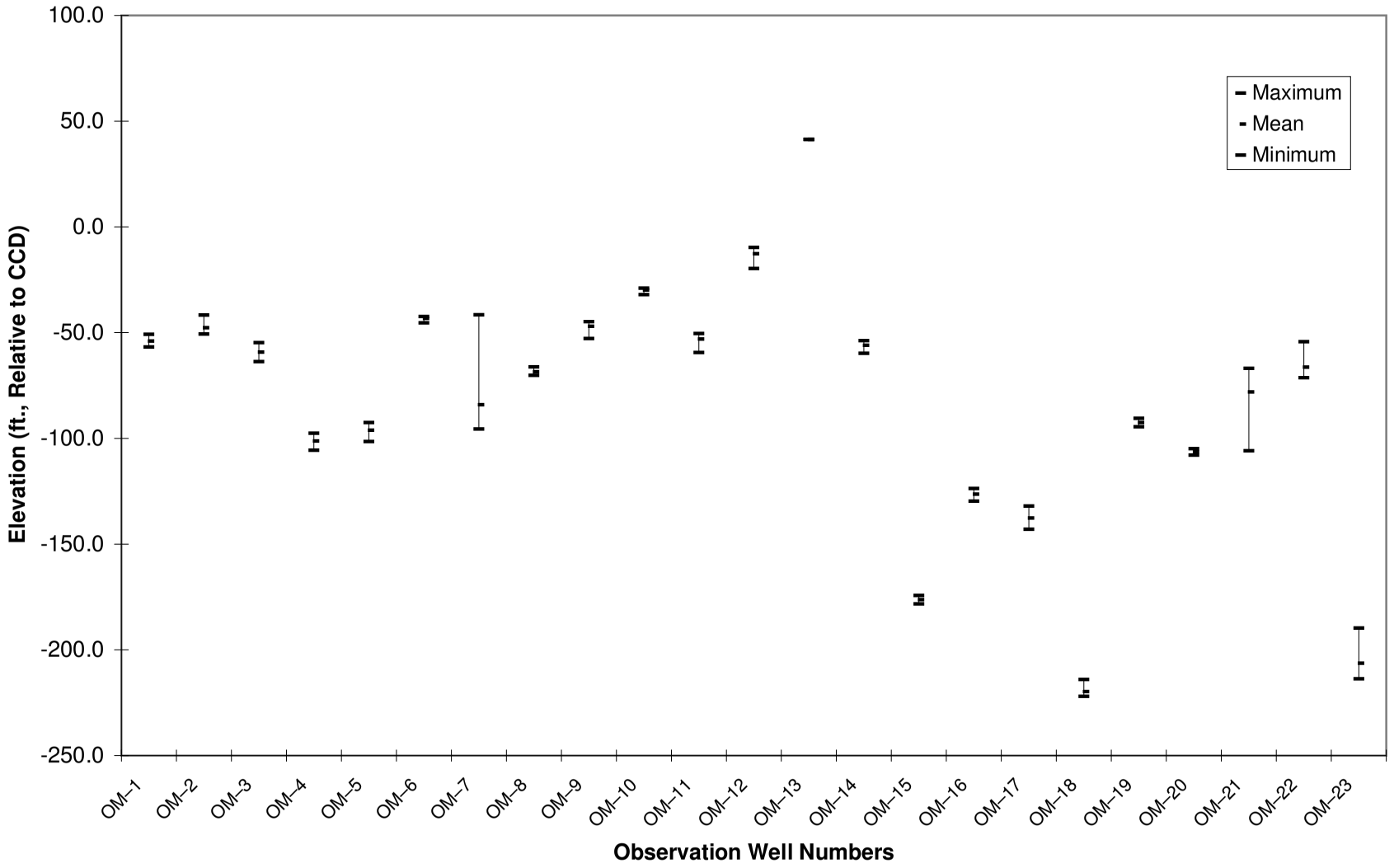
Parameter		Well Number				
		QM–78	QM–79	QM–80	QM–81	QM–82
pH	Minimum	7.4	7.1	7.3	8.4	7.2
	Mean	7.8	7.8	7.7	8.4	7.9
	Maximum	8.9	8.9	8.8	8.4	8.7
	Std. Dev.	0.6	0.6	0.5	0.0	0.5
	Median	7.7	7.8	7.5	8.4	8.0
	Coeff. Var.	7.1	7.5	7.1	0.0	6.5
SO_4, mg/L	Minimum	47	18	2	12	9
	Mean	60	22	4	12	12
	Maximum	88	31	6	12	15
	Std. Dev.	14	5	2	0	2
	Median	55	20	3	12	12
	Coeff. Var.	24	22	47	0	18
TDS, mg/L	Minimum	290	288	176	196	260
	Mean	333	324	218	225	289
	Maximum	352	358	266	254	320
	Std. Dev.	24	31	31	29	23
	Median	342	323	218	226	290
	Coeff. Var.	7	9	14	13	8
TOC,[3] mg/L	Minimum	0.2	0.5	0.5	0.5	0.8
	Mean	0.2	0.6	0.9	0.7	1.1
	Maximum	0.4	1.0	1.0	1.0	1.5
	Std. Dev.	0.1	0.2	0.2	0.3	0.2
	Median	0.2	0.6	1.0	0.5	1.1
	Coeff. Var.	37.3	31.0	22.3	43.3	22.3

[1]For purposes of statistical evaluation, fecal coliform values less than 1 were set equal to 1.

[2]For purposes of statistical evaluation, NH_4^+–N values less than 0.02 (the detection limit) were set equal to 0.02.

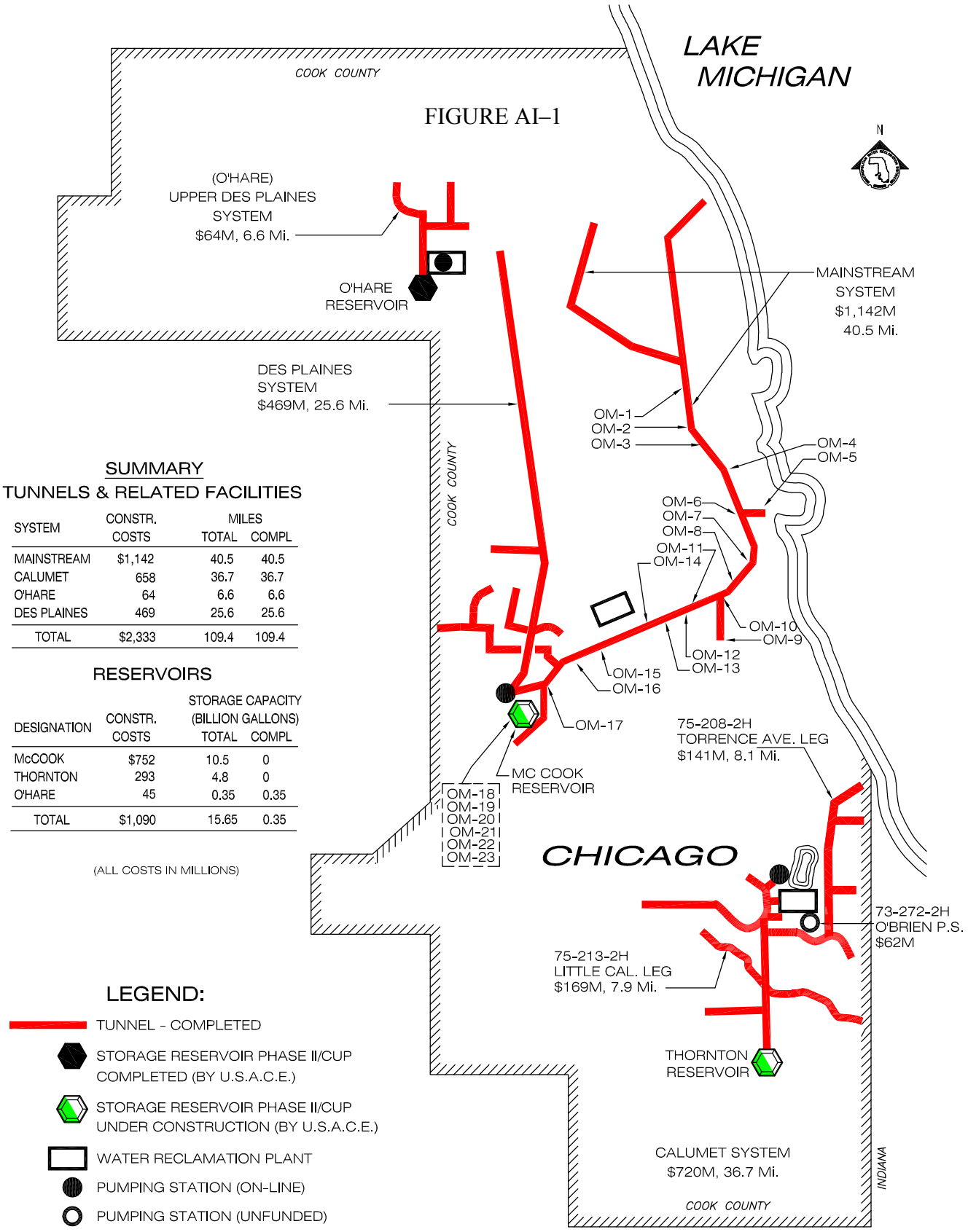
[3]For purposes of statistical evaluation, TOC values less than 0.2 (the detection limit) were set equal to 0.2.

FIGURE 1: 2006 MINIMUM, MEAN, AND MAXIMUM WATER LEVEL ELEVATIONS FOR THE MAINSTREAM TUNNEL SYSTEM OBSERVATION WELLS



APPENDIX AI

LOCATION MAP OF GROUNDWATER OBSERVATION WELLS OM–1 THROUGH OM–23 IN THE MAINSTREAM TUNNEL SYSTEM



SUMMARY
TUNNELS & RELATED FACILITIES

SYSTEM	CONSTR. COSTS	MILES TOTAL	MILES COMPL
MAINSTREAM	$1,142	40.5	40.5
CALUMET	658	36.7	36.7
O'HARE	64	6.6	6.6
DES PLAINES	469	25.6	25.6
TOTAL	$2,333	109.4	109.4

RESERVOIRS

DESIGNATION	CONSTR. COSTS	STORAGE CAPACITY (BILLION GALLONS) TOTAL	STORAGE CAPACITY (BILLION GALLONS) COMPL
McCOOK	$752	10.5	0
THORNTON	293	4.8	0
O'HARE	45	0.35	0.35
TOTAL	$1,090	15.65	0.35

(ALL COSTS IN MILLIONS)

MAINSTREAM TUNNEL SYSTEM LOCATION MAP OF GROUNDWATER OBSERVATION WELLS

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

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APPENDIX AII

2006 GROUNDWATER LEVEL ELEVATION DATA FOR OBSERVATION WELLS OM–1 THROUGH OM–23 IN THE MAINSTREAM TUNNEL SYSTEM

TABLE AII–1: 2006 GROUNDWATER LEVEL ELEVATION* DATA FOR OBSERVATION WELLS OM–1 THROUGH OM–23 IN THE MAINSTREAM TUNNEL SYSTEM

Date	Observation Well											
	OM–1	OM–2	OM–3	OM–4	OM–5	OM–6	OM–7	OM–8	OM–9	OM–10	OM–11	OM–12
	feet											
1/6/06	-53.8	-49.7	-59.7	-101.6	-97.5	-43.4	-90.6	-66.2	-45.8	-29.0	-51.4	-9.7
3/3/06	-56.8	-50.7	-59.7	-100.6	-97.5	-43.4	-92.6	-70.2	-46.8	-30.0	-54.4	-13.7
4/21/06	-54.8	-41.7	-59.7	-101.6	-94.5	-45.4	-92.6	-68.2	-45.8	-30.0	-51.4	-10.7
5/26/06	-53.8	-49.7	-63.7	-105.6	-101.5	-42.4	-95.6	-69.2	-52.8	-32.0	-59.4	-9.7
8/18/06	-53.8	-48.7	-57.7	-100.6	-93.5	-42.4	-91.6	-69.2	-45.8	-29.0	-51.4	***
10/6/06	-50.8	-45.7	-54.7	-97.6	-92.5	-42.4	-41.6	-68.2	-44.8	-29.0	-50.4	-19.7
Minimum	-56.8	-50.7	-63.7	-105.6	-101.5	-45.4	-95.6	-70.2	-52.8	-32.0	-59.4	-19.7
Mean	-54.0	-47.7	-59.2	-101.3	-96.2	-43.2	-84.1	-68.5	-47.0	-29.8	-53.1	-12.7
Maximum	-50.8	-41.7	-54.7	-97.6	-92.5	-42.4	-41.6	-66.2	-44.8	-29.0	-50.4	-9.7

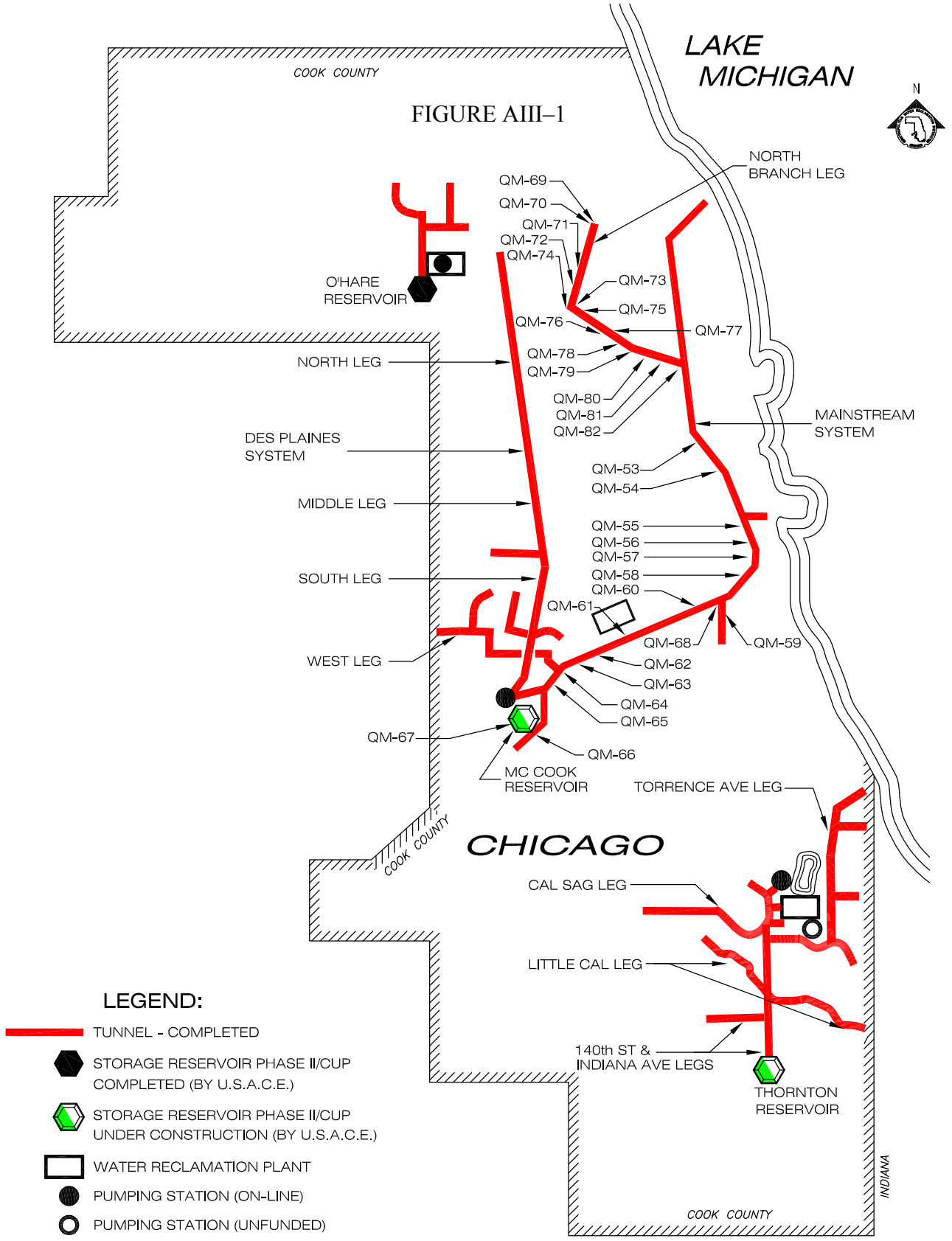
TABLE AII–1 (Continued): 2006 GROUNDWATER LEVEL ELEVATION* DATA FOR OBSERVATION WELLS OM–1 THROUGH OM–23 IN THE MAINSTREAM TUNNEL SYSTEM

Date	Observation Well										
	OM–13	OM–14	OM–15	OM–16	OM–17	OM–18	OM–19	OM–20	OM–21	OM–22	OM–23
	feet										
1/6/06	41.4	-55.8	-178.3	-129.7	-138.0	**	-94.5	**	-105.9	-71.3	-213.7
3/3/06	41.4	-55.8	-176.3	-123.7	-139.0	**	-93.5	**	-87.9	-54.3	-189.7
4/21/06	41.4	-54.8	-174.3	-126.7	-137.0	-214.0	-92.5	-104.9	-66.9	-71.3	-203.7
5/26/06	41.4	-55.8	-176.3	-126.7	-137.0	-222.0	-90.5	-107.9	-67.9	-70.3	-211.7
8/18/06	41.4	-59.8	-174.3	-124.7	-143.0	-222.0	-91.5	****	-70.9	-60.3	-208.7
10/6/06	41.4	-53.8	-178.3	-126.7	-132.0	-221.0	-92.5	****	-68.9	-70.3	-210.7
Minimum	41.4	-59.8	-178.3	-129.7	-143.0	-222.0	-94.5	-107.9	-105.9	-71.3	-213.7
Mean	41.4	-56.0	-176.3	-126.4	-137.7	-219.8	-92.5	-106.4	-78.1	-66.3	-206.4
Maximum	41.4	-53.8	-174.3	-123.7	-132.0	-214.0	-90.5	-104.9	-66.9	-54.3	-189.7

*Relative to Chicago City Datum.
**Reading could not be taken because construction blocked access to well.
***Access to well vault covered by dumpster, blocking access to well.
****Road to well was flooded.

APPENDIX AIII

LOCATION MAP OF GROUNDWATER QUALITY
MONITORING WELLS QM–53 THROUGH QM–82
IN THE MAINSTREAM TUNNEL SYSTEM



MAINSTREAM TUNNEL SYSTEM LOCATION MAP OF GROUNDWATER QUALITY MONITORING WELLS

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

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APPENDIX AIV

2006 GROUNDWATER QUALITY MONITORING DATA FOR WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

TABLE AIV–1: 2006 pH, CONDUCTIVITY, TEMPERATURE, HARDNESS, AMMONIA NITROGEN, AND CHLORIDE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	pH[1]	Cond.[1] µmhos/cm	Temp. °C	Hard. as $CaCO_3$ mg/L	NH_4^+–N mg/L	Cl mg/L
QM–53	1/30/06	8.1	235	11	122	0.08	14
QM–53	4/26/06	7.4	150	11	122	0.06	14
QM–53	7/6/06	7.7	199	12	132	0.04	20
QM–56	1/30/06	7.7	380	12	125	0.50	40
QM–56	4/26/06	7.4	218	13	121	0.44	37
QM–56	7/6/06	7.6	250	14	131	0.41	38
QM–58	6/22/06	7.4	218	14	258	0.88	19
QM–58	7/13/06	7.5	264	14	277	0.97	18
QM–58	10/26/06	7.6	458	13	268	0.88	16
QM–61	1/30/06	7.6	380	13	118	0.24	56
QM–61	4/26/06	7.3	220	13	119	0.24	60
QM–61	7/6/06	7.9	603	15	126	0.20	57
QM–62	1/19/06	Well could not be sampled					
QM–62	2/16/06	Well could not be sampled					
QM–62	4/27/06	Well could not be sampled					
QM–62	7/1/06	Well could not be sampled					
QM–62	9/12/06	Well could not be sampled					
QM–62	11/17/06	Well could not be sampled					
QM–63	1/19/06	7.1	2205	13	901	1.74	47
QM–63	2/16/06	7.0	2104	11	879	1.95	51
QM–63	4/27/06	7.7	1639	14	903	1.98	52
QM–63	7/6/06	7.9	1913	16	881	1.81	52
QM–63	10/5/06	7.7	750	13	566	1.80	46
QM–63	10/24/06	7.7	1864	12	786	1.70	50
QM–64	1/19/06	7.0	833	13	203	1.94	55
QM–64	2/16/06	7.2	873	12	233	2.02	58
QM–64	4/26/06	7.2	281	14	214	1.87	59
QM–64	7/6/06	7.6	797	16	228	2.10	62

TABLE AIV–1 (Continued): 2006 pH, CONDUCTIVITY, TEMPERATURE, HARDNESS, AMMONIA NITROGEN, AND CHLORIDE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	pH[1]	Cond.[1] µmhos/cm	Temp. °C	Hard. as $CaCO_3$ mg/L	NH_4^+–N mg/L	Cl mg/L
QM–64	10/5/06	7.6	349	15	198	1.91	55
QM–64	10/24/06	7.7	778	13	222	2.12	61
QM–65	2/1/06	7.0	528	13	589	7.15	395
QM–65	3/23/06	7.2	575	13	559	4.21	295
QM–65	6/22/06	7.5	740	14	582	5.81	347
QM–65	7/13/06	7.5	565	12	581	6.38	377
QM–65	8/3/06	7.2	2148	15	590	7.10	385
QM–65	10/18/06	6.9	1920	14	538	5.22	338
QM–66	5/11/06	7.1	766	13	20	0.45	264
QM–66	8/3/06	7.6	3590	18	5	1.93	258
QM–66	11/16/06	Well could not be sampled					
QM–67	2/1/06	7.2	600	13	360	9.53	218
QM–67	3/23/06	7.0	568	13	341	8.87	230
QM–67	5/11/06	7.7	587	13	334	8.18	224
QM–67	6/22/06	7.6	563	14	300	8.59	217
QM–67	7/13/06	7.7	571	15	287	8.74	211
QM–67	8/3/06	7.4	1441	15	281	8.24	186
QM–68	3/23/06	7.0	384	12	204	0.53	42
QM–68	6/22/06	7.5	211	14	196	1.15	50
QM–68	7/13/06	7.6	233	14	197	1.32	50
QM–69	6/1/06	7.3	246	12	161	0.85	35
QM–69	8/10/06	8.1	535	13	158	0.85	49
QM–69	11/16/06	8.1	546	11	154	0.81	33
QM–70	3/30/06	7.8	552	12	154	0.30	49
QM–70	5/3/06	Well could not be sampled					
QM–70	8/8/06	Well could not be sampled					

TABLE AIV–1 (Continued): 2006 pH, CONDUCTIVITY, TEMPERATURE, HARDNESS, AMMONIA NITROGEN, AND CHLORIDE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	pH[1]	Cond.[1] µmhos/cm	Temp. °C	Hard. as $CaCO_3$ mg/L	NH_4^+–N mg/L	Cl mg/L
QM–71	3/30/06	7.6	997	11	204	0.36	121
QM–71	6/22/06	7.8	842	13	205	0.39	124
QM–71	12/21/06	7.7	375	11	198	0.40	130
QM–72	2/9/06	7.2	299	10	208	0.37	127
QM–72	8/24/06	7.8	666	16	210	0.29	124
QM–72	11/16/06	7.9	686	11	207	0.32	126
QM–73	3/30/06	7.7	491	12	156	0.16	43
QM–73	6/22/06	7.7	512	13	148	0.17	44
QM–73	7/27/06	7.7	494	13	147	0.19	32
QM–74	4/27/06	7.9	352	12	93	0.13	50
QM–74	6/22/06	8.1	449	14	94	0.18	49
QM–74	7/27/06	8.1	445	12	96	0.20	50
QM–75	2/9/06	7.5	361	12	61	0.22	23
QM–75	3/30/06	7.8	348	12	64	0.16	14
QM–75	6/1/06			Well could not be sampled			
QM–75	6/21/06			Well could not be sampled			
QM–75	8/17/06			Well could not be sampled			
QM–75	9/14/06	7.5	193	12	62	0.42	21
QM–76	4/25/06			Well could not be sampled			
QM–76	7/27/06	9.0	509	16	34	0.24	17
QM–76	11/30/06	8.7	480	12	45	0.14	13
QM–77	4/27/06	8.6	209	12	37	0.13	14
QM–77	7/27/06	8.4	278	13	39	0.15	11
QM–77	11/30/06	8.4	259	10	41	0.05	11
QM–78	2/9/06	7.4	420	11	11	0.10	13
QM–78	3/23/06	7.5	300	10	10	<0.02	13
QM–78	6/1/06	7.7	535	12	11	0.08	19
QM–78	6/21/06	7.7	535	12	11	0.04	14

TABLE AIV–1 (Continued): 2006 pH, CONDUCTIVITY, TEMPERATURE, HARDNESS, AMMONIA NITROGEN, AND CHLORIDE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	pH[1]	Cond.[1] µmhos/cm	Temp. °C	Hard. as $CaCO_3$ mg/L	NH_4^+–N mg/L	Cl mg/L
QM–78	8/24/06	8.9	530	19	11	0.05	24
QM–78	9/14/06	7.6	330	12	10	0.31	13
QM–79	2/9/06	7.1	530	11	9	<0.02	20
QM–79	3/23/06	7.8	258	11	10	<0.02	19
QM–79	6/1/06	7.8	539	12	10	0.04	20
QM–79	6/21/06	7.8	539	12	10	<0.02	19
QM–79	8/24/06	8.9	541	13	10	<0.02	19
QM–79	9/14/06	7.6	340	12	10	0.25	19
QM–80	2/9/06	7.3	299	11	20	<0.02	15
QM–80	3/23/06	7.5	178	11	21	<0.02	14
QM–80	6/1/06	7.5	317	13	20	0.06	15
QM–80	6/21/06	7.5	317	13	21	<0.02	15
QM–80	8/24/06	8.8	325	18	21	<0.02	14
QM–80	9/14/06	7.7	220	13	21	0.14	14
QM–81	6/1/06	8.4	380	13	19	0.08	19
QM–81	8/10/06	8.4	394	14	29	0.11	21
QM–81	11/16/06	8.4	382	13	29	0.03	31
QM–82	2/9/06	7.2	408	12	14	0.03	30
QM–82	3/23/06	7.8	268	12	14	<0.02	28
QM–82	6/1/06	8.1	464	14	15	0.06	30
QM–82	6/21/06	8.1	464	14	14	<0.02	29
QM–82	8/24/06	8.7	478	15	14	<0.02	28
QM–82	9/14/06	7.6	304	13	14	0.15	29

[1]Unfiltered samples, all others were filtered through 0.45 µm membrane.

TABLE AIV–2: 2006 SULFATE, TOTAL ORGANIC CARBON, TOTAL DISSOLVED SOLIDS, FECAL COLIFORM, WATER ELEVATION, AND RECHARGE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	SO_4 mg/L	TOC mg/L	TDS mg/L	FC[1] cfu/100 mL	Water Elevation[2] Feet	Recharge[3] Hours
QM–53	1/30/06	35	0.7	166	<1	-46	<4
QM–53	4/26/06	37	0.5	180	<1	-44	<4
QM–53	7/6/06	35	0.5	296	<1	-39	<4
QM–56	1/30/06	11	0.7	244	<1	-75	<4
QM–56	4/26/06	15	0.6	276	<1	-76	<4
QM–56	7/6/06	18	0.6	292	<1	-76	<4
QM–58	6/22/06	184	0.9	540	<1	-105	<4
QM–58	7/13/06	169	1.0	480	<1	-103	<4
QM–58	10/26/06	180	0.8	454	<1	-106	<4
QM–61	1/30/06	9	0.9	272	<1	-179	<4
QM–61	4/26/06	22	0.7	338	<1	-179	<4
QM–61	7/6/06	16	0.7	378	<1	-178	<4
QM–62	1/19/06			Well could not be sampled			
QM–62	2/16/06			Well could not be sampled			
QM–62	4/27/06			Well could not be sampled			
QM–62	7/1/06			Well could not be sampled			
QM–62	9/12/06			Well could not be sampled			
QM–62	11/17/06			Well could not be sampled			
QM–63	1/19/06	4277	2.1	1574	<1	-184	<4
QM–63	2/16/06	1137	2.0	1588	<1	-182	<4
QM–63	4/27/06	967	2.0	1800	<1	-182	<4
QM–63	7/6/06	877	1.6	1720	<1	-179	<4
QM–63	10/5/06	619	1.8	1234	> 20000	-139	<4
QM–63	10/24/06	804	1.7	1570	2800	-186	<4
QM–64	1/19/06	38	1.2	534	<1	-163	<4
QM–64	2/16/06	45	1.3	470	1	-160	<4
QM–64	4/26/06	38	1.2	444	<1	-161	<4
QM–64	7/6/06	33	1.2	564	<1	-161	<4

TABLE AIV–2 (Continued): 2006 SULFATE, TOTAL ORGANIC CARBON, TOTAL DISSOLVED SOLIDS, FECAL COLIFORM, WATER ELEVATION, AND RECHARGE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	SO_4 mg/L	TOC mg/L	TDS mg/L	FC[1] cfu/100 mL	Water Elevation[2] Feet	Recharge[3] Hours
QM–64	10/5/06	40	1.4	492	> 20000	-126	<4
QM–64	10/24/06	40	1.2	518	2300	-164	<4
QM–65	2/1/06	222	6.3	1392	<1	-187	<48
QM–65	3/23/06	219	4.2	1178	<1	-189	<48
QM–65	6/22/06	237	5.4	1362	<1	-185	<48
QM–65	7/13/06	212	6.0	1442	<1	-182	<48
QM–65	8/3/06	93	6.7	1416	<1	-178	<48
QM–65	10/18/06	229	5.0	1306	10	-103	<48
QM–66	5/11/06	99	1.3	1068	<1	-304	<48
QM–66	8/3/06	55	1.7	1746	<1	-305	<48
QM–66	11/16/06	Well could not be sampled					
QM–67	2/1/06	43	3.5	838	3300	-163	<48
QM–67	3/23/06	36	3.1	878	2000	-170	<48
QM–67	5/11/06	39	3.0	862	260	-168	<48
QM–67	6/22/06	39	3.1	874	160	-170	<48
QM–67	7/13/06	30	3.3	870	220	-171	<48
QM–67	8/3/06	2	3.5	890	210	-167	<48
QM–68	3/23/06	34	0.6	278	<1	-132	<48
QM–68	6/22/06	42	0.6	370	<1	-133	<48
QM–68	7/13/06	37	0.5	376	<1	-132	<48
QM–69	6/1/06	45	0.9	302	<1	-37	<48
QM–69	8/10/06	44	1.0	420	<1	-36	<48
QM–69	11/16/06	49	0.9	316	<1	-35	<48
QM–70	3/30/06	54	0.7	328	<1	-70	<48
QM–70	5/3/06	Well could not be sampled					
QM–70	8/8/06	Well could not be sampled					

TABLE AIV–2 (Continued): 2006 SULFATE, TOTAL ORGANIC CARBON, TOTAL DISSOLVED SOLIDS, FECAL COLIFORM, WATER ELEVATION, AND RECHARGE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	SO_4 mg/L	TOC mg/L	TDS mg/L	FC[1] cfu/100 mL	Water Elevation[2] Feet	Recharge[3] Hours
QM–71	3/30/06	72	0.8	452	<1	-67	<48
QM–71	6/22/06	79	0.8	502	<1	-52	<48
QM–71	12/21/06	72	0.9	580	<1	-57	<48
QM–72	2/9/06	2	0.8	358	<1	-66	<48
QM–72	8/24/06	1	0.5	544	<1	-65	<48
QM–72	11/16/06	1	0.7	406	<1	-72	<48
QM–73	3/30/06	1	1.1	272	<1	-147	<48
QM–73	6/22/06	2	8.7	352	<1	-153	<48
QM–73	7/27/06	2	1.1	272	<1	-155	<48
QM–74	4/27/06	3	1.2	408	<1	-22	<48
QM–74	6/22/06	2	1.1	282	<1	-64	<48
QM–74	7/27/06	1	1.2	232	<1	-55	<48
QM–75	2/9/06	20	0.8	202	<1	-57	<48
QM–75	3/30/06	11	0.7	186	<1	-58	<48
QM–75	6/1/06			Well could not be sampled			
QM–75	6/21/06			Well could not be sampled			
QM–75	8/17/06			Well could not be sampled			
QM–75	9/14/06	10	0.6	260	<1	-57	<48
QM–76	4/25/06			Well could not be sampled			
QM–76	7/27/06	49	0.8	330	<1	-181	<48
QM–76	11/30/06	63	0.7	260	<1	-180	<48
QM–77	4/27/06	2	0.7	210	<1	-170	<48
QM–77	7/27/06	2	0.4	194	<1	-168	<48
QM–77	11/30/06	3	0.8	114	<1	-155	<48
QM–78	2/9/06	88	0.4	348	<1	-147	<48
QM–78	3/23/06	54	0.2	352	<1	-151	<48
QM–78	6/1/06	54	0.2	290	<1	-154	<48

TABLE AIV–2 (Continued): 2006 SULFATE, TOTAL ORGANIC CARBON, TOTAL DISSOLVED SOLIDS, FECAL COLIFORM, WATER ELEVATION, AND RECHARGE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	SO_4 mg/L	TOC mg/L	TDS mg/L	FC[1] cfu/100 mL	Water Elevation[2] Feet	Recharge[3] Hours
QM–78	6/21/06	59	0.2	352	<1	-154	<48
QM–78	8/24/06	55	0.2	336	<1	-155	<48
QM–78	9/14/06	47	<0.2	322	<1	-154	<48
QM–79	2/9/06	31	0.7	358	<1	-139	<48
QM–79	3/23/06	19	0.6	296	<1	-140	<48
QM–79	6/1/06	20	0.5	288	<1	-141	<48
QM–79	6/21/06	21	0.5	308	<2	-141	<48
QM–79	8/24/06	20	0.5	338	<1	-141	<48
QM–79	9/14/06	18	0.4	356	<1	-142	<48
QM–80	2/9/06	5	0.5	224	<1	-134	<48
QM–80	3/23/06	2	0.3	196	<1	-136	<48
QM–80	6/1/06	2	0.2	176	<1	-125	<48
QM–80	6/21/06	3	0.4	236	<1	-125	<48
QM–80	8/24/06	3	0.4	212	<1	-135	<48
QM–80	9/14/06	6	0.4	266	<1	-134	<48
QM–81	6/1/06	12	0.4	196	<1	-131	<48
QM–81	8/10/06	12	0.5	226	<1	-131	<48
QM–81	11/16/06	12	0.5	254	<1	-131	<48
QM–82	2/9/06	15	1.5	266	<1	-183	<48
QM–82	3/23/06	9	1.1	284	<1	-183	<48
QM–82	6/1/06	12	1.2	260	<1	-185	<48
QM–82	6/21/06	12	1.1	306	<1	-185	<48
QM–82	8/24/06	12	0.8	296	<1	-183	<48
QM–82	9/14/06	10	0.9	320	<1	-186	<48

[1]Unfiltered samples, all others were filtered through 0.45 µm membrane.
[2]Water level elevations are relative to Chicago City Datum.
[3]Refers to elapsed time after initial drawdown before the well recovered sufficiently for sampling.