

Protecting Our Water Environment



Metropolitan Water Reclamation District of Greater Chicago

***RESEARCH AND DEVELOPMENT
DEPARTMENT***

REPORT NO. 03-7

REPORT ON THE O'HARE CUP RESERVOIR FILL EVENT

EXPERIMENT CONDUCTED FROM AUGUST 13, 2002

THROUGH SEPTEMBER 3, 2002

March 2003

Metropolitan Water Reclamation District of Greater Chicago

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REPORT ON THE O'HARE CUP RESERVOIR FILL EVENT EXPERIMENT
CONDUCTED FROM AUGUST 13, 2002 THROUGH SEPTEMBER 3, 2002

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Particular thanks are due Ms. Laura Franklin, Principal Office Support Specialist, for her diligence in typing the

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INTRODUCTION

A full-scale experiment was conducted from August 13, 2002 to September 3, 2002 at O'Hare CUP Reservoir to study the potential for odor formation during storage of combined sewer overflows (CSOs) without mechanical aeration. This was a follow-up experiment to the one that was conducted from May 12, 2002 to June 12, 2002. As in the first experiment, the objective of this experiment was to use the information collected in this full-scale experiment in the evaluation of aeration systems of the future McCook and Thornton Reservoirs.

The experimental plan dated April 19, 2002 for the O'Hare CUP reservoir experiment (Appendix AI) was followed in this experiment. The experimental plan calls for two scenarios, one a Manmade Fill Event, and the other a Natural Fill Event. The fill event covered in this report was a Natural Fill Event.

The O'Hare CUP Reservoir experimental plan was put into effect following the Natural Fill Event which occurred on Tuesday, August 13, 2002. The O'Hare CUP Reservoir began filling with CSO at 2015 hours (military time) and became static at 1517 hours (military time) on Wednesday, August 14, 2002. A total of 60 million gallons of CSO was captured in

the reservoir. Approximately 3.19 inches of rain was recorded on August 13 for this storm event. Reservoir influent sampling and in-situ sampling for dissolved oxygen (DO), BOD₅, total suspended solids (TSS), volatile suspended solids (VSS), and ammonia (NH₄-N) were performed according to the test protocol given in Appendix AI.

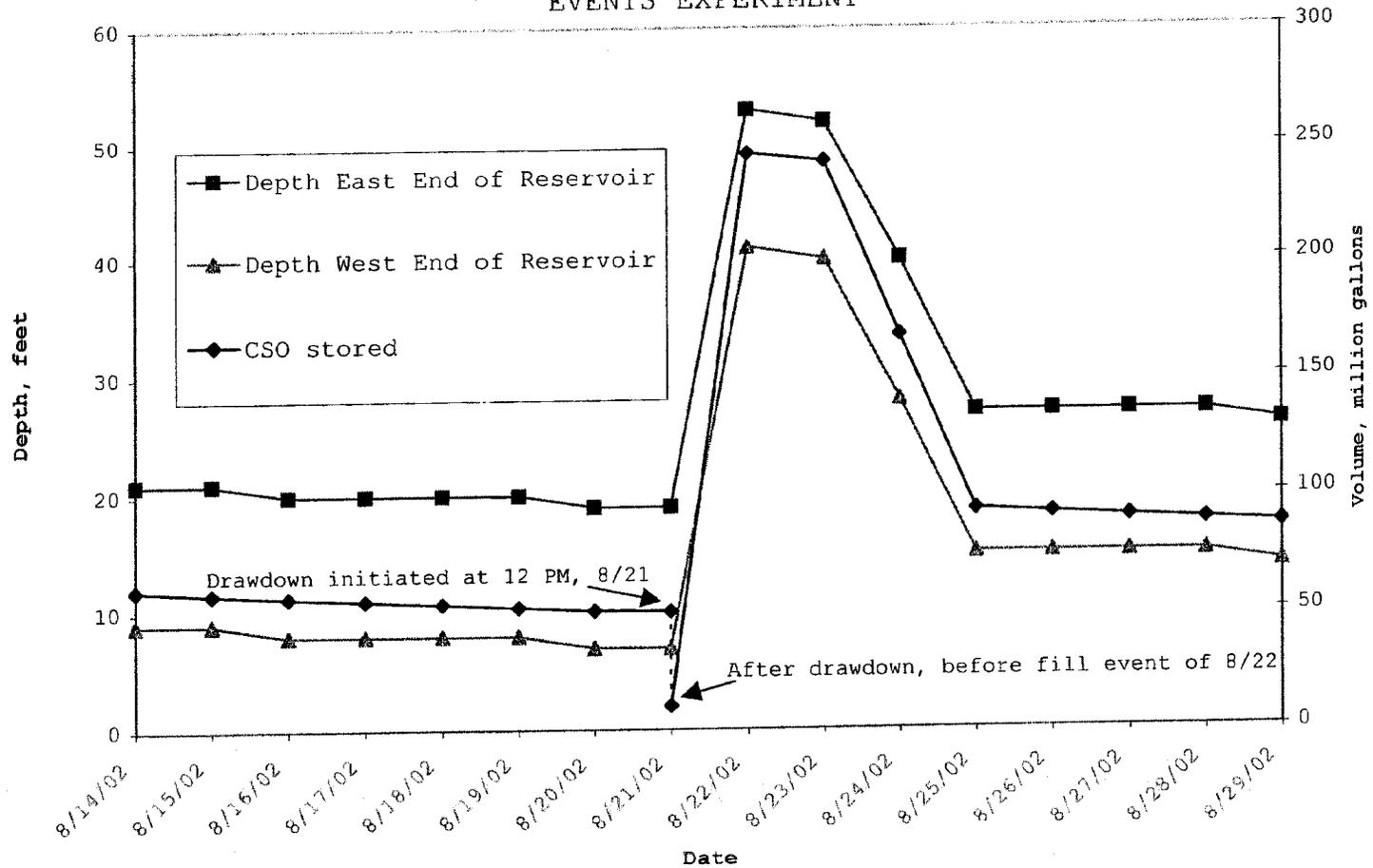
From August 14 to August 20, a gradual decline in liquid volume was observed. On August 20, the volume of the CSO in the reservoir was 50 million gallons. This loss in CSO volume was attributed to leaks in the gates separating the reservoir from the tunnel system, resulting in some of the stored CSO draining back to the James C. Kirie WRP. This decrease in liquid volume and corresponding depths of water in the reservoir during August 14 through August 29 can be seen in Figure 1. The difference in water depths between east and west ends of the reservoir is due to the fact that the bottom of the reservoir is sloped, and is unrelated to the leakage problem. During this period, water elevation in the reservoir varied from 21 feet to 19 feet on the east side of the reservoir and from 9 to 7 feet on the west side of the reservoir.

On Wednesday, August 21, the draining of the reservoir was initiated because of heavy rains forecast by the U.S. National weather Service. Early Thursday (August 22) morning at

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FIGURE 1

VARIATION IN WATER DEPTH AND CSO VOLUME STORED DURING THE O'HARE CUP RESERVOIR AUGUST 13, 2002 THROUGH SEPTEMBER 3, 2002 FILL EVENTS EXPERIMENT



0330 hours (military time), the reservoir began filling with CSO. There was still about 10.6 million gallons of CSO from the previous fill event in the reservoir that had not been drained before the beginning of the August 22 fill event. The reservoir went static at 2200 hours (military time) on Thursday August 22, containing about 246 million gallons of CSO. Approximately 4.78 inches of rain fell on August 22 for this storm event.

After the fill event of August 22 when the reservoir became static in the late evening of August 22, the decision was made to start the experiment again. However, the reservoir was drained over the weekend of August 24-25 to 93.1 million gallons of CSO volume in keeping with the test protocol given in Appendix AI. Again reservoir influent sampling as well as in-situ sampling for DO, BOD₅, TSS, VSS, and NH₄-N were performed according to the test protocol given in Appendix AI.

On Friday, August 30, due to concerns over possible mosquito breeding related to West Nile Virus, the reservoir was drained and the draining was completed at 0915 hours (military time) on Tuesday, September 3. Sediment samples were collected after the reservoir was drained and sediment depths measured on Tuesday, September 3, 2002.

The draining of the reservoir was initiated at 1730 hrs on Friday, August 30 and the water in the reservoir was aerated while it was being drained. The draining of the reservoir was continued over the weekend of August 31 - September 1, 2002. Because of evening hours, no odor monitoring could be done while the reservoir was being drained and aerated.

As there was always some volume of CSO in the reservoir from August 13 through September 3, 2002, this entire period is being considered as one event for the purposes of this report.

RESULTS

Liquid sampling, DO readings, and odor monitoring were conducted during this experiment as described below.

Reservoir Influent Sampling

Hourly liquid samples were collected of the CSO inflows to the reservoir during the two fill events. The samples were analyzed for BOD₅, TSS, NH₄-N, nitrite (NO₂-N), and nitrate (NO₃-N). The results of the analyses are given in Tables AII-1 and AII-2 and plotted in Figures AII-1 and AII-2 in Appendix AII.

The concentration ranges of these parameters for the August 13-14 Fill Event are as follows: BOD₅ 15 to 28 mg/L, with a mean value of 21 mg/L, TSS 28 to 64 mg/L, with a mean value of 41 mg/L, NH₄-N 2.08 to 5.12 mg/L with a mean value of 4.07 mg/L, NO₂-N 0.00 to 1.18 mg/L with a mean value of 0.29 mg/L, NO₃-N 0.02 to 1.30 mg/L with a mean value of 0.31 mg/L. Based on the mean concentrations of BOD₅ and TSS, it can be said that the CSO captured was on the low end of the current McCook Reservoir design assumption of BOD₅ 30 to 80 mg/L and TSS 100-200 m/L.

Additional samples of CSO inflow were collected at 2330 hours on August 13 and analyzed for fecal coliform and

dissolved oxygen. The results of these analyses are 4.8 mg/L of dissolved oxygen and >6000 CTS/100 mL fecal coliforms as given in Table AII-1.

The results of the analyses for the second fill event of August 22-23 are given in Table AII-2. The concentration ranges of these parameters are: BOD₅ 9 to 25 mg/L with a mean value of 14 mg/L, TSS 26 to 111 mg/L with a mean value of 51 mg/L, NH₄-N 0.58 to 1.22 mg/L with a mean value of 0.93 mg/L, NO₂-N 0.04 to 0.09 mg/L with a mean value of 0.07 mg/L, NO₃-N 1.62 to 3.19 mg/L with a mean value of 2.85 mg/L. Based on the mean concentration of BOD₅ and TSS, it can be said that the CSO captured in the reservoir during the fill event of August 22-23 was weaker in strength than the current McCook CUP Reservoir design assumptions of BOD₅ 30 to 80 mg/L, and TSS 100 to 200 mg/L.

One more grab sample of CSO inflow was taken during the fill event of August 22-23 at 0530 hrs for DO determination. Its value was 8.0 mg/L as reported in Table AII-2.

Stored Liquid Sampling

Liquid grab samples were collected in the reservoir using a small remote controlled boat (RCB) at three locations along the south side of the reservoir namely, East South (ES),

Middle South (MS), and West South (WS) at various depths as shown in Figure AII-3. These samples were analyzed for BOD₅, NH₄-N, TSS, and VSS. The first set of samples were collected from August 15 through 21. The concentration ranges for these parameters are: BOD₅ 8 to 39 mg/L, TSS 6 to 118 mg/L, VSS 0 to 36 mg/L, and NH₄-N 3.36 to 6.24 mg/L as can be seen in Table AII-3. The second set of samples was collected from August 26 through August 31. These samples were also analyzed for BOD₅, NH₄-N, TSS, and VSS. The concentration ranges for these parameters for the second set of samples were: BOD₅ 0 to 12 mg/L, NH₄-N 0.24 mg/L to 1.91 mg/L, TSS 4 mg/L to 33 mg/L, and VSS 0 mg/L to 24 mg/L. The results of these analyses are shown in Table AII-4. In addition, three sets of samples were collected from the reservoir for the analysis of chlorophyll a during the period August 14 through August 28. The chlorophyll a concentrations ranged from 0.638 µg/L to 314.163 µg/L indicating algal growth in the reservoir during the period of the experiment. All chlorophyll a samples at various locations were collected from the reservoir at a depth of five feet. The results of these analyses are shown in Table AII-5.

Stored Liquid Measurements of Dissolved Oxygen and Temperature

Dissolved oxygen and temperature readings in the reservoir were taken with a probe mounted on the RCB on the south side of the reservoir, at three locations namely, East South (ES), Middle South (MS), and West South (WS) at various depths of the reservoir. The sampling locations are shown in Figure AII-3. The results of these readings are given in Table AII-6 and plots of DO versus time are shown in Figure AII-4. As can be seen from Table AII-6 the DO concentrations varied from 0.00 to 18.8 mg/L and temperatures varied from 22.0 °C to 31.8 °C.

It was planned to take DO measurements at three depths, namely, 5-ft, 10-ft, and 15-ft from the surface of the water at all three locations. However, it was not possible to take DO reading at all three depths at all locations because of water depth constraints.

Air Emission Monitoring

Daily odor and H₂S monitoring at five locations around the reservoir was done as per the experimental plan. The odor monitoring locations are shown in Figure AII-5. The results shown in Table AII-7 show the concentrations of H₂S in parts per billion (ppb), in the ambient air at five locations around

the reservoir. The concentrations of H₂S in the ambient air around the reservoir varied from 2 to 15 ppb indicating practically no H₂S-related odors produced as a result of storage of CSO in the reservoir. Table AII-8 contains qualitative odor evaluations of the same five locations as perceived by persons conducting the odor surveys.

No strong or very strong odors were perceived as a result of odor monitoring. Only in 34 out of the total 94 observations were very faint to easily noticeable odors perceived, and no odors were perceived at all for 60 out of a total of 94 observations. Again, odor intensity perceived was infrequent and very low in intensity, indicating no significant odor impact resulting from the storage of CSOs.

Sediment Measurements

Bottom sediment samples were collected on September 3, 2002 from 14 locations after the reservoir was drained and the depths of the sediment deposits were measured. The locations of the of the depth measurements of sediment deposits are shown in Figure AIII-1. The data on sediment deposit depths, along with total solids (TS) and total volatile solids (TVS) concentrations are given in Table AIII-1.

The depth of sediments varied from 0.06 to 2.25 inches with a mean value of 0.47 inch. The mean TS concentration of the sediments was 17.47 percent with 29.16 percent volatile solids. The mean sediment depth from this fill event is lower than the mean sediment depth 0.6 inches measured during the May-June 2002 fill event. The mean sediment depth was also on the low end of projected estimates for a comparable size fill event at the McCook and Thornton Reservoirs (0.6 to 3.6 inches projected).

Another set of sediment depth measurements was collected from six pans specially installed for this experiment at the bottom of this reservoir. The locations of these pans are shown in Figure AIII-1 and the results of depth measurements are shown in Table AIII-2. The depths of the sediments in the pans varied from 0.06 to 1.50 inches with a mean value of 0.36 inches. The mean sediment depth in the pans in this experiment is considerably lower than 1.73 inches measured during the May-June 2002 fill event experiment. The purpose of the sediment depth measurement in the pans was to compare the results of sediment deposits in stationary containers such as the pans (13 1/2" L x 10" W x 10" D) with that of freely moving sediments in the rest of the reservoir.

The mean depth of sediments deposit in pans is somewhat lower (0.36 inches) compared to the mean depth of sediment deposits of 0.47 inches in the reservoir. This difference is not considered significant.

DISCUSSION OF RESULTS

Odor Production

The objective of this follow-up experiment to the May-June 2002 full-scale Natural-Fill Event experiment was the same i.e. to determine the odor potential from the CSO stored in the O'Hare CUP Reservoir without aeration and to use the information in the evaluation of aeration systems of the future McCook and Thornton Reservoirs. As can be seen from Table AII-7, the maximum H₂S measured in the ambient air during the 21 days at any of the five locations around the reservoir was 15 ppb. The threshold odor concentration for H₂S (given by the USEPA) is 25 ppb. Similarly, qualitative odor perception by the individuals conducting the odor survey given in Table AII-8 indicate very little or no odor problem experienced during the experiment. Qualitative odor survey results shown in Table AII-8 indicates that no odor was perceived at all for 60 out of a total 94 observations, and strong or very strong odor was never perceived during the entire period of this experiment.

Dissolved Oxygen in the Stored Liquid

As can be seen from Table AII-6 and Figure AII-4, DO levels in the reservoir varied widely. However, after the August

22 Fill Event the DO in the reservoir began to steadily rise. The low DO for August 27 can be attributed to oil/grease on the probe as noted in Table AII-6. However, the reason for low DO readings on August 29 at station CS2/10 cannot be explained.

DO concentrations showed a similar pattern to those of the May-June 2002 experiment. Similar patterns included a rise in DO after several days storage of the CSO in the reservoir. The rise and fall in DO concentrations could be due to the presence of algae in the reservoir beginning August 21 (Table AII-5). Also, a rise in DO concentration can partly be attributed to the second fill event of August 22 which took place during the experiment.

Comparison of Influent and Stored Liquid Quality

The BOD₅ values of the CSO stored in the reservoir ranged from 0 to 39 mg/L and the TSS ranged from 4 to 118 mg/L during the 21 day holding period. In comparison to these BOD₅ and TSS values, BOD₅ in the influent to the reservoir during the August 13 fill event varied from 15 to 28 mg/L and TSS varied from 28 to 64 mg/L. The BOD₅ during the August 22 fill event, varied from 9 to 25 mg/L, and TSS varied from 26 mg/L to 111 mg/L.

CONCLUSIONS

The main conclusions of the report are:

1. Based on the results of the full-scale experiment conducted at the O'Hare CUP Reservoir from August 13, 2002 through September 3, 2002, it can be concluded that the future McCook and Thornton Reservoirs may not require maintenance of 2 mg/L DO throughout the reservoir as provided in the proposed design in order to ensure a reasonably odor free environment in the vicinity of these two reservoirs during the storage of CSOs. This finding is consistent with the conclusion drawn from the previous study conducted during the O'Hare CUP Reservoir May 12, 2002 and June 4, 2002 fill events.
2. During a 21-day holding period of CSOs, without any aeration, no significant odors emanated from the reservoir even though dissolved oxygen concentrations in the stored CSOs dropped to near zero for a number of days.
3. The depth of the sediment deposits at the bottom of the reservoir found during this experiment

was lower than the depth of sediment deposits during the O'Hare CUP Reservoir May 12, 2002 and June 4, 2002 fill events. This finding leads to the conclusion that the actual sediment deposits for a comparable size fill event in the McCook and Thornton Reservoirs would be lower than the projected estimates of the sediment deposits for these two reservoirs.

APPENDIX AI

EXPERIMENTAL PLAN FOR O'HARE CUP RESERVOIR
(REVISED 4-19-02)

EXPERIMENTAL PLAN FOR O'HARE CUP RESERVOIR
(Revised 4-19-02)

Objective

To study the potential for odor formation during storage of CSOs without mechanical aeration. To study the potential for release of odors from anaerobic sediments. To use the information gained to aid in the design of the future McCook and Thornton Reservoirs.

Experimental Protocol (based upon perceived concerns of the Corps of Engineers)

I. Man-made Fill Event

Experiment 1

During a rain event, M&O will operate the Kirie WRP such that approximately 60 million gallons of combined sewage (approximately 21 feet of liquid depth at the deep end) will enter the O'Hare CUP Reservoir. Based upon an analysis of historical data, M&O will attempt to obtain a rain/sewage mix that will result in a BOD₅ of from 80 to 100 mg/l. As the reservoir fills, collect liquid samples of the influent flow to the reservoir for chemical analysis as is currently done using the automatic sampling system currently in place.

Do not turn on the surface aerators.

When the reservoir has reached a static condition with no further inflow (approximately 21-foot depth at deep end), conduct daily measurements of dissolved oxygen concentrations at six locations equally spaced around the perimeter of the reservoir at depths of 5, 10, and 20 feet at each location [a 20-foot depth may not be possible at the shallow(west) end, so take the measurement at the lowest depth]. Also collect six, one-gallon water samples (5-foot depth and 20-foot depth at the east, center, and west ends of the reservoir) for chemical analysis. At locations where there is less than 20 feet of depth, collect liquid samples at the lowest depth. Water samples will be analyzed for BOD₅, NH₄-N, TSS, and VSS. Water samples will only be collected on weekdays.

In addition, conduct daily odor monitoring surveys along the entire upper perimeter of the reservoir using subjective odor assessments by two trained individuals, and measure H₂S using a meter. The odor monitoring will be conducted in the early afternoon by R&D staff. M&O staff at Kirie will be notified each day as to the presence of R&D staff at the reservoir.

Continue this monitoring for seven days unless a strong odor is detected emanating from the reservoir. If a strong odor is detected, inform M&O and R&D supervisory staff immediately. M&O Dept. staff will then make an assessment of the severity of the odor, and if deemed necessary by M&O, the experiment will be terminated, and M&O will begin draining the reservoir immediately.

During draining, do not turn the aerators on, as this may worsen the spread of the odors.

If no strong odors are detected, begin draining the reservoir after seven days to an elevation of approximately 18 feet of water depth at the deep end of the reservoir. At this depth, the seven most easterly surface aerators can be activated. The remaining two surface aerators will be off. Turn on the seven aerators in order to resuspend some of the settled solids and begin monitoring for odors (it is understood that the surface aerators will not have enough input energy to thoroughly mix the sediment layer). Continue odor monitoring every hour for 4 hours. Then **turn off the aerators** and completely drain the reservoir.

After the reservoir is empty, measure the depth of the settled solids at six evenly spaced locations on the reservoir floor, and collect samples of the sediments for total solids and total volatile solids analysis. Also determine the wet density of the settled solids by weighing a measured volume of collected sediment at each of the six locations. This may be done using the small plastic pans which M&O has agreed to install on the bottom of the reservoir.

Then have the private contractor clean the bottom of the reservoir.

For experiments that end early (before seven days of storage) due to odors, also collect sediment samples after the reservoir has been completely drained. However, for a case where the reservoir is being drained due to odors, do not conduct the resuspension part of the experiment. Just drain the reservoir as fast as possible.

Experiment 2

Repeat the above Experiment 1, except for this test fill the reservoir with 90 million gallons of combined sewage (approximately 27 feet of liquid depth at the deep end).

Since 90 million gallons is a significant liquid volume, it is understood that M&O will have the authority to terminate this experiment and begin draining the reservoir in the middle of the test, in the event that a rainstorm is forecast. M&O will notify R&D if the decision is made to drain the reservoir in the middle of a test. It is estimated by M&O that it would take approximately 24 to 36 hours to empty the reservoir and be ready for a predicted significant rain event.

If no significant odors are detected at the end of seven days, an attempt will be made to measure the sediment oxygen demand (SOD) of the settled solids before the reservoir is completely drained. This will require draining the reservoir to a liquid depth of approximately 16 feet at the deep end, and launching a small R&D boat over the water surface. It will take approximately six hours to conduct the SOD measurements. At the end of the SOD measurements, the reservoir would be completely drained, sampled, and cleaned as described for Experiment 1.

Due to logistical considerations, only one set of SOD measurements will be attempted during this entire study. M&O and R&D will work together to coordinate this extra SOD determination and address any safety issues. It is understood that SOD measurements will not be made until all safety issues have been resolved.

It should also be noted that SOD measurements cannot be made when initial dissolved oxygen levels near the sediment/water interface are less than 2 mg/l.

Experiment 3

Repeat the above Experiment 1, except for this test wait 30 days before beginning to empty the reservoir. After the first 7 days, reduce dissolved oxygen monitoring to once per week, but continue daily odor monitoring by R&D staff in the early afternoon, except for weekends. M&O staff will check the reservoir for odors on weekends and holidays.

It is noted that the private contractor cleaning the reservoir may incur larger than normal costs when required to clean the reservoir bottom after this long storage time, as the settled solids may have objectionable characteristics.

Experiment 4

Repeat the above Experiment 2, except for this test wait 30 days before beginning to empty the reservoir. Use the same monitoring schedule as for the above Experiment 3.

Further Man-made Experiments

Review the results of the above four experiments, and then design additional modifications of the experimental plan as appropriate.

II. Natural Fill Event

When the reservoir fills due to a natural storm event, institute the same experimental protocol as described for Experiment 3 above, i.e., a 30-day holding period with no aeration, if possible.

Evaluate all data at the end of 2002, and decide if experiments should continue in 2003.

If any experiment is in progress, and a significant rainfall is predicted in the near future, M&O will have the discretion to drain the reservoir early to prepare for the anticipated large storm event.

It is understood that the O'Hare CUP Reservoir is an operational component of the District's collection system, and the proposed experiments should not interfere with M&O operational needs.

Groundwater Monitoring Program

During all of the above experiments, follow the existing groundwater monitoring protocol as described in the memorandum, dated February 28, 2000, from Buckley to

Kukielka, with the following exception. For the first experiment with a 7-day holding time and the first experiment with a 30-day holding time, sample the four groundwater monitoring wells on the perimeter of the reservoir daily instead of weekly, and analyze for ammonia and fecal coliform. After evaluating the results, a decision will be made as to whether daily groundwater sampling is needed for all experiments.

Interagency Cooperation

The Army Corps of Engineers has reviewed the experimental plan, and is in agreement with the proposed experiment. The Illinois Environmental Protection Agency will be informed of our plan to conduct this experiment.

APPENDIX AII

RESULTS OF ANALYSES OF COMBINED SEWER OVERFLOW (CSO)
SAMPLES DURING O'HARE CUP RESERVOIR AUGUST 13-14, 2002 AND
AUGUST 22-23, 2002 FILL EVENTS

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-1

RESULTS OF ANALYSES OF COMBINED SEWER OVERFLOW (CSO) GRAB SAMPLES COLLECTED DURING THE O'HARE CUP RESERVOIR AUGUST 13-14, 2002 FILL EVENT

Date	Time Collected (military time)	BOD ₅ mg/L	TSS mg/L	NO ₂ -N mg/L	NO ₃ -N mg/L	NH ₄ -N mg/L
8/13/02	2330	17	52	0.054	0.741	2.08
8/14/02	0030	15	52	0.056	0.895	2.24
8/14/02	0130	16	48	0.077	1.299	2.58
8/14/02	0230	26	46	0.467	0.912	4.96
8/14/02	0330	28	48	1.183	0.152	5.08
8/14/02	0430	27	64	1.022	0.131	4.23
8/14/02	0530	25	32	0.992	0.107	3.75
8/14/02	0630	19	46	0.651	0.108	3.53
8/14/02	0730	19	32	0.469	0.062	3.79
8/14/02	0830	20	46	0.000	0.025	4.16
8/14/02	0930	21	44	0.007	0.021	4.32
8/14/02	1030	18	28	0.027	0.020	4.15
8/14/02	1130	18	32	0.010	0.022	4.34
8/14/02	1230	18	38	0.009	0.137	5.12
8/14/02	1330	22	28	0.011	0.018	4.49
8/14/02	1430	22	30	0.012	0.123	4.79

AII-1

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-1 (Continued)

RESULTS OF ANALYSES OF COMBINED SEWER OVERFLOW (CSO) GRAB SAMPLES COLLECTED DURING THE O'HARE CUP RESERVOIR AUGUST 13-14, 2002 FILL EVENT

Date	Time Collected (military time)	BOD ₅ mg/L	TSS mg/L	NO ₂ -N mg/L	NO ₃ -N mg/L	NH ₄ -N mg/L
8/14/02	1530	25	34	0.012	0.021	5.01
8/14/02	1630	22	32	0.161	0.785	4.60
Minimum		15	28	0.000	0.018	2.08
Mean		21	41	0.290	0.310	4.07
Maximum		28	64	1.183	1.299	5.12

Note: DO and fecal coliform in the sample collected at 2330 hrs on 8/13/02 were 4.8 mg/L and > 6,000 CTS/100 mL, respectively.

AII-2

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-2

RESULTS OF ANALYSES OF COMBINED SEWER OVERFLOW (CSO) GRAB SAMPLES COLLECTED DURING
THE O'HARE CUP RESERVOIR AUGUST 22-23, 2002 FILL EVENT

Date	Time Collected (military time)	BOD ₅ mg/L	TSS mg/L	NO ₂ -N mg/L	NO ₃ -N mg/L	NH ₄ -N mg/L
8/22/02	0530	25	111	0.040	1.624	0.58
8/22/02	0630	21	102	0.065	1.944	0.69
8/22/02	0730	24	76	0.072	2.398	0.79
8/22/02	0830	21	84	0.061	3.048	0.78
8/22/02	0930	*	54	0.062	2.999	0.77
8/22/02	1030	15	64	0.055	3.186	0.83
8/22/02	1130	14	54	0.063	2.936	0.87
8/22/02	1230	12	50	0.060	2.921	1.22
8/22/02	1330	10	34	0.064	3.026	1.09
8/22/02	1430	10	40	0.076	2.881	0.92
8/22/02	1530	9	34	0.075	2.938	1.01
8/22/02	1630	10	46	0.078	3.046	1.08
8/22/02	1730	10	26	0.076	3.107	1.10
8/22/02	1830	10	32	0.083	3.161	1.10
8/22/02	1930	11	28	0.074	3.107	0.87
8/22/02	2030	12	40	0.094	3.181	1.05
8/22/02	2130	13	40	0.090	3.167	0.95
8/22/02	2230	11	32	0.087	2.905	0.90

AII-3

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-2 (Continued)

RESULTS OF ANALYSES OF COMBINED SEWER OVERFLOW (CSO) GRAB SAMPLES COLLECTED DURING
THE O'HARE CUP RESERVOIR AUGUST 22-23, 2002 FILL EVENT

Date	Time Collected (military time)	BOD ₅ mg/L	TSS mg/L	NO ₂ -N mg/L	NO ₃ -N mg/L	NH ₄ -N mg/L
8/22/02	2330	9	34	0.088	2.707	0.95
8/23/02	0030	10	30	0.088	2.707	0.96
Minimum		9	26	0.040	1.624	0.58
Mean		14	51	0.073	2.849	0.93
Maximum		25	111	0.094	3.186	1.22

Note: DO in the sample collected at 0530 hrs on 8/22/02 was 8.0 mg/L.

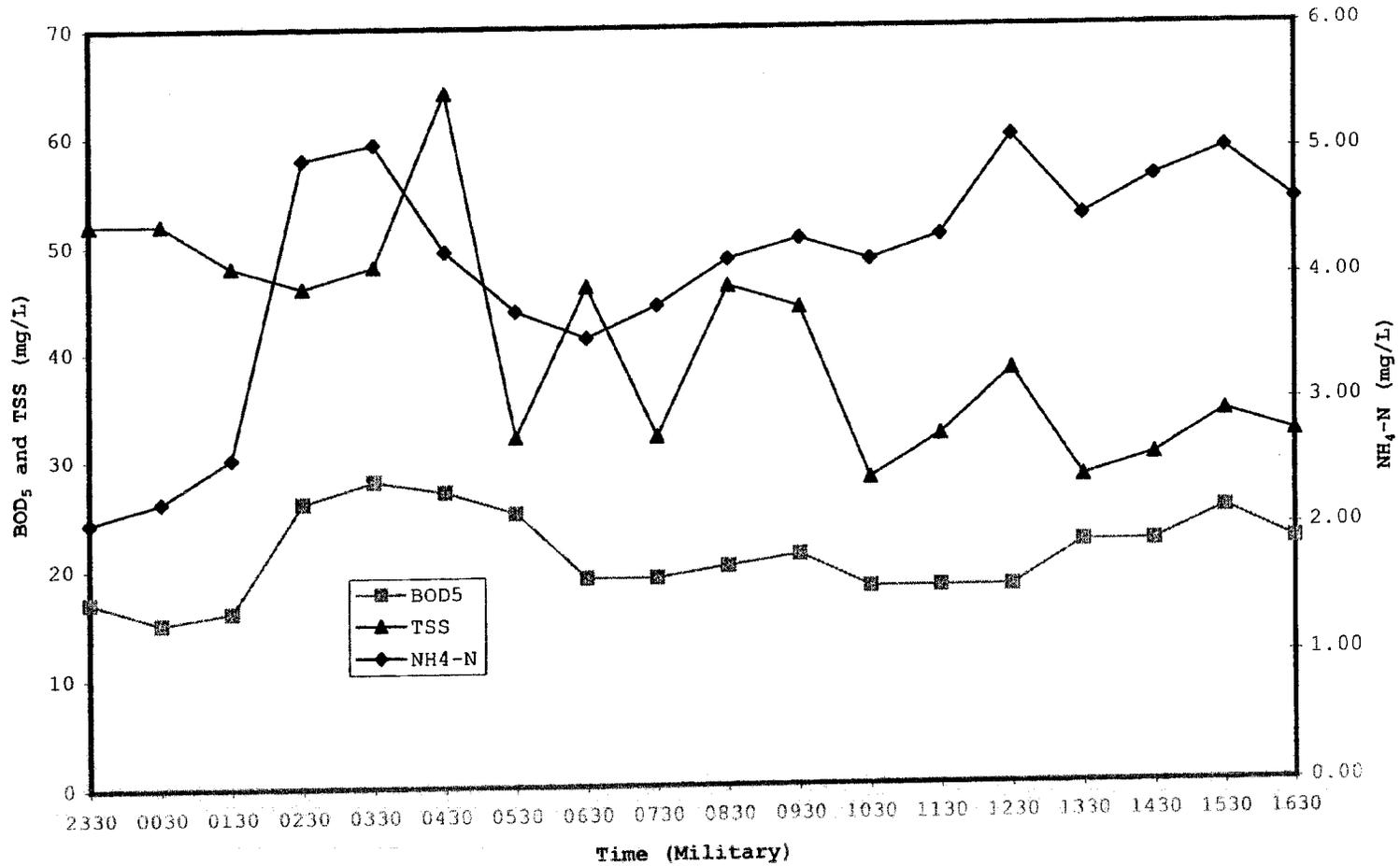
AII-4

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-1

BOD₅, TSS, AND NH₄-N IN HOURLY GRAB SAMPLES COLLECTED DURING THE O'HARE CUP RESERVOIR AUGUST 13-14, 2002 FILL EVENT

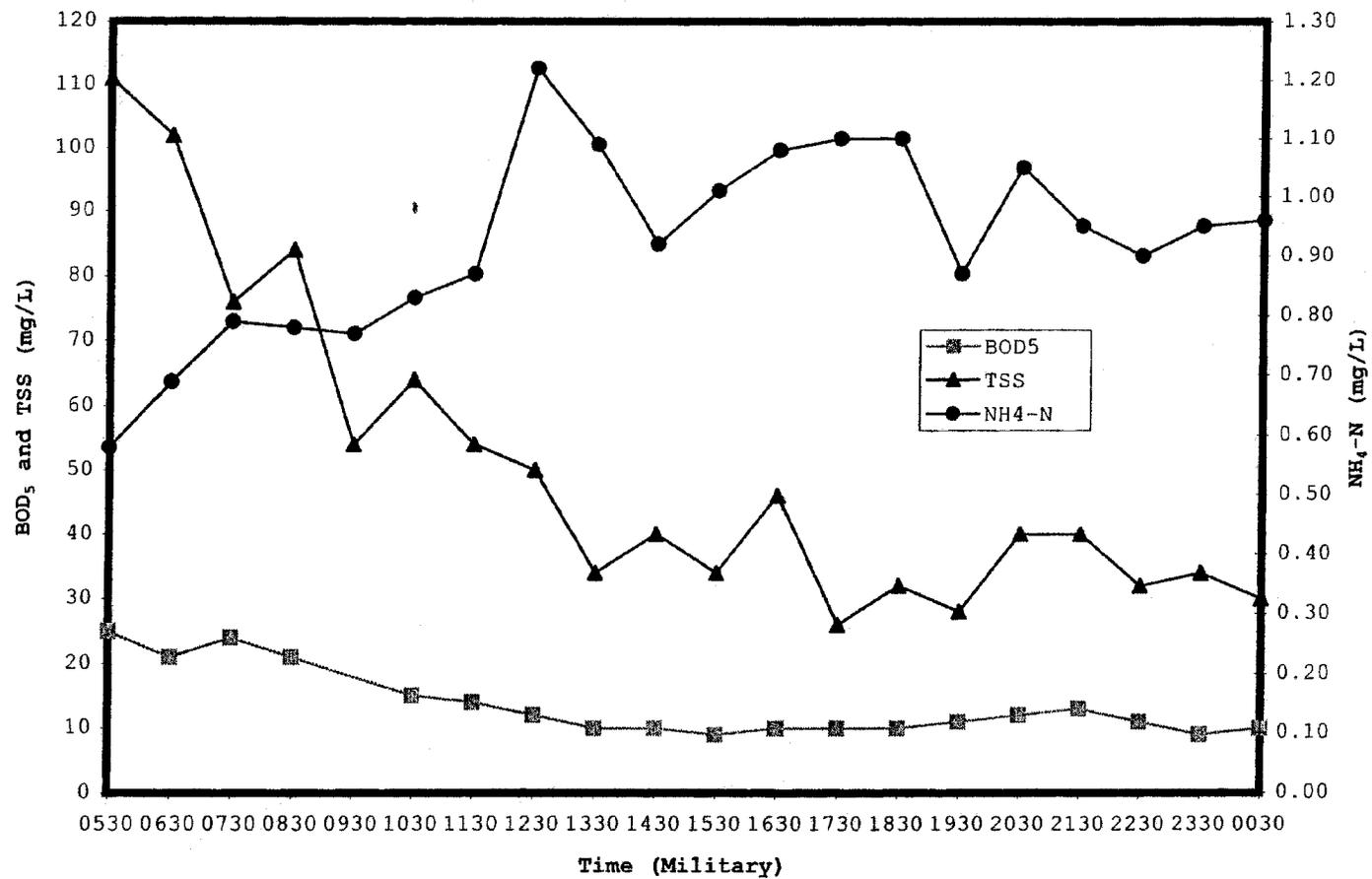
AII-5



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-2

BOD₅, TSS, AND NH₄-N IN HOURLY GRAB SAMPLES COLLECTED DURING THE O'HARE CUP RESERVOIR AUGUST 22-23, 2002 FILL EVENT



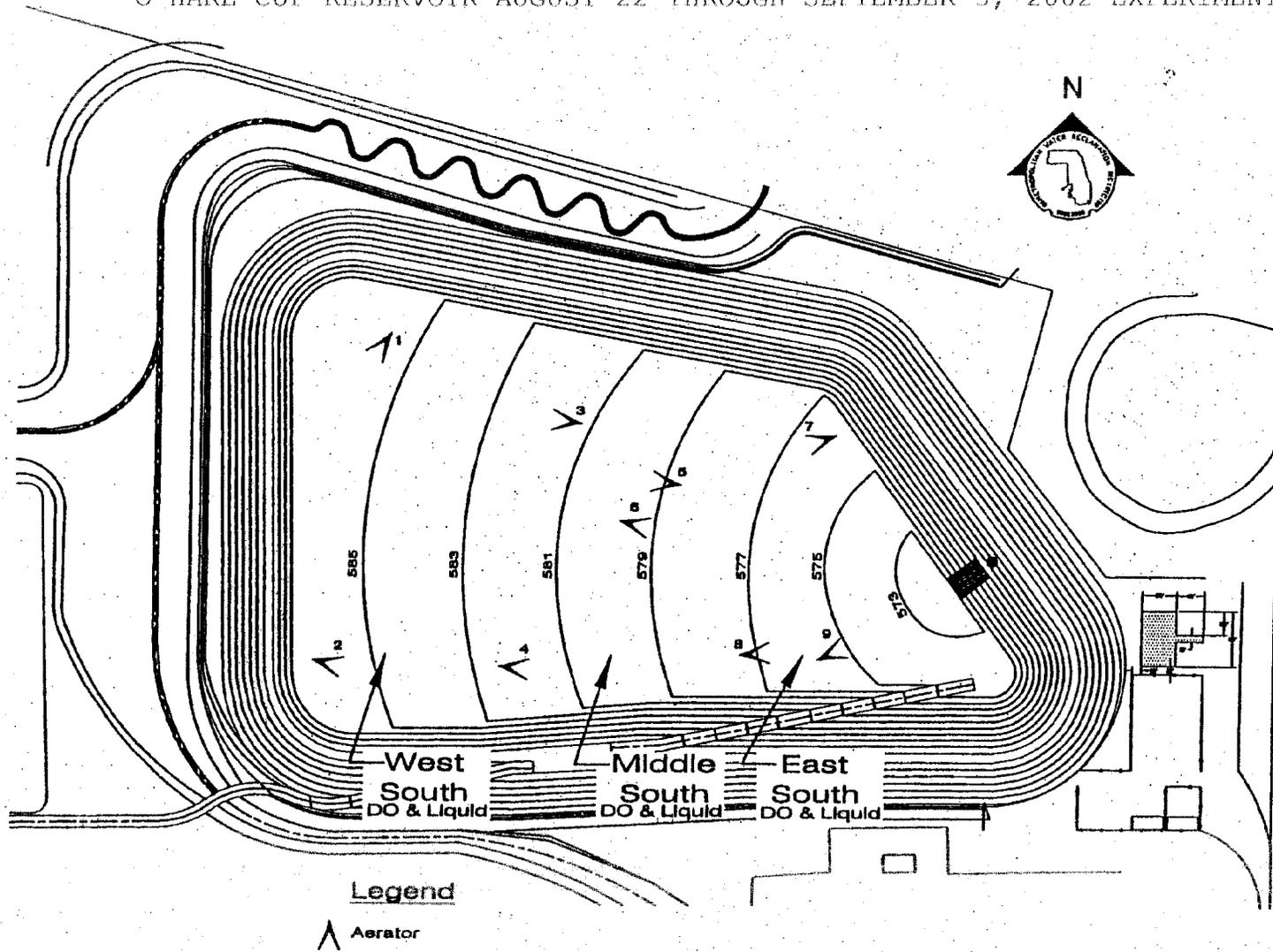
9-IIIV

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-3

LOCATIONS OF LIQUID SAMPLING AND DO MEASUREMENTS
O'HARE CUP RESERVOIR AUGUST 22 THROUGH SEPTEMBER 3, 2002 EXPERIMENT

AII-7



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-3

RESULTS OF IN-SITU SAMPLE ANALYSES FOR BOD₅, NH₄-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE O'HARE CUP RESERVOIR AUGUST 13 - SEPTEMBER 3, 2002 FILL EVENT EXPERIMENT (8/15/02 THROUGH 8/21/02)

Date	East 5*	East 15*	East 20*	Center 5*	Center 10*	Center 15*	West 5*	West 10*
-----BOD ₅ (mg/L)-----								
8/15/02	16	**	20	16	15	****	16	21
8/16/02	17	**	39	17	**	33	18	***
8/19/02	13	22	***	12	25	***	11	***
8/20/02	13	20	***	8	19	***	10	***
8/21/02	8	21	***	9	22	***	10	***
Minimum	8	20	20	8	15	33	10	21
Mean	13	21	30	12	20	33	13	21
Maximum	17	22	39	17	25	33	18	21
-----NH ₄ -N (mg/L)-----								
8/15/02	6.24	**	4.33	3.88	4.04	****	4.15	4.79
8/16/02	4.35	**	4.99	4.31	**	4.60	3.36	***
8/19/02	4.22	4.96	***	4.42	5.33	***	4.20	***
8/20/02	3.92	5.13	***	4.20	5.23	***	3.99	***
8/21/02	3.94	5.49	***	3.83	5.43	***	3.74	***
Minimum	3.92	4.96	4.33	3.83	4.04	4.60	3.36	4.79
Mean	4.53	5.19	4.66	4.13	5.01	4.60	3.89	4.79
Maximum	6.24	5.49	4.99	4.42	5.43	4.60	4.20	4.79

AII-8

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-3 (Continued)

RESULTS OF IN-SITU SAMPLE ANALYSES FOR BOD₅, NH₄-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE O'HARE CUP RESERVOIR AUGUST 13 - SEPTEMBER 3, 2002 FILL EVENT EXPERIMENT (8/15/02 THROUGH 8/21/02)

Date	East 5*	East 15*	East 20*	Center 5*	Center 10*	Center 15*	West 5*	West 10*
-----TSS (mg/L)-----								
8/15/02	92	**	46	48	52	****	82	38
8/16/02	11	**	82	48	**	118	42	***
8/19/02	11	10	***	10	10	***	12	***
8/20/02	14	12	***	14	6	***	6	***
8/21/02	12	16	***	22	28	***	22	***
Minimum	11	10	46	10	6	118	6	38
Mean	28	13	64	28	24	118	33	38
Maximum	92	16	82	48	52	118	82	38
-----VSS (mg/L)-----								
8/15/02	22	**	20	12	6	****	20	12
8/16/02	9	**	30	22	**	36	16	***
8/19/02	7	5	***	6	5	***	2	***
8/20/02	6	0	***	10	2	***	4	***
8/21/02	10	4	***	18	12	***	22	***
Minimum	6	0	20	6	2	36	2	12
Mean	11	3	25	14	6	36	13	12
Maximum	22	5	30	22	12	36	22	12

AII-9

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-3 (Continued)

RESULTS OF IN-SITU SAMPLE ANALYSES FOR BOD₅, NH₄-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE O'HARE CUP RESERVOIR AUGUST 13 - SEPTEMBER 3, 2002 FILL EVENT EXPERIMENT (8/15/02 THROUGH 8/21/02)

Date	East 5*	East 15*	East 20*	Center 5*	Center 10*	Center 15*	West 5*	West 10*
-----Sulfide (mg/L)-----								
8/15/02		0.00	0.00		**	****	0.00	**
8/16/02		**	0.03		**	0.01	**	0.01
8/19/02		0.11	***		0.15	***	0.04	***
8/20/02		0.11	***		0.15	***	0.01	***
8/21/02		0.16	***		0.14	***	0.00	***
Minimum		0.00	0.00		0.14	0.01	0.00	0.01
Mean		0.10	0.02		0.15	0.01	0.01	0.01
Maximum		0.16	0.03		0.15	0.01	0.04	0.01

*Number refers to depth of water column in feet.
 **Sample not taken.
 ***Sample not taken because of water depth constraint.
 ****Sample contaminated with bottom sediments.

AII-10

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-4

RESULTS OF IN-SITU SAMPLE ANALYSES FOR BOD₅, NH₄-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE O'HARE CUP RESERVOIR AUGUST 13 - SEPTEMBER 3, 2002 FILL EVENT EXPERIMENT (8/26/02 THROUGH 8/30/02)

AII-11

Date	East 5*	East 20*	Center 5*	Center 15*	West 5*	West 10*
-----BOD ₅ (mg/L)-----						
8/26/02	3	5	3	4	5	**
8/27/02	3	10	4	4	2	2
8/28/02	10	11	12	3	3	3
8/29/02	2	5	4	5	3	0
8/30/02	4	**	6	6	3	3
Minimum	2	5	3	3	2	0
Mean	4	8	6	4	3	2
Maximum	10	11	12	6	5	3
-----NH ₄ -N (mg/L)-----						
8/26/02	1.06	1.15	1.07	1.22	0.88	1.12
8/27/02	1.01	1.62	0.99	1.26	1.09	1.05
8/28/02	0.32	1.71	0.24	1.22	1.17	1.15
8/29/02	0.98	1.40	0.88	1.28	1.02	1.09
8/30/02	1.06	1.91	0.72	1.52	0.90	1.13
Minimum	0.32	1.15	0.24	1.22	0.88	1.05
Mean	0.89	1.56	0.78	1.30	1.01	1.11
Maximum	1.06	1.91	1.07	1.52	1.17	1.15

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-4 (Continued)

RESULTS OF IN-SITU SAMPLE ANALYSES FOR BOD₅, NH₄-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE O'HARE CUP RESERVOIR AUGUST 13 - SEPTEMBER 3, 2002 FILL EVENT EXPERIMENT (8/26/02 THROUGH 8/30/02)

Date	East 5*	East 20*	Center 5*	Center 15*	West 5*	West 10*
-----TSS (mg/L)-----						
8/26/02	16	18	6	4	4	4
8/27/02	9	6	8	8	16	10
8/28/02	15	8	33	9	9	10
8/29/02	8	8	15	14	12	4
8/30/02	18	21	21	13	21	5
Minimum	8	6	6	4	4	4
Mean	13	12	17	10	12	7
Maximum	18	21	33	14	21	10
-----VSS (mg/L)-----						
8/26/02	12	16	4	2	2	0
8/27/02	8	4	6	7	10	9
8/28/02	14	5	24	4	8	6
8/29/02	7	3	13	12	6	2
8/30/02	9	13	12	5	6	5
Minimum	7	3	4	2	2	0
Mean	10	8	12	6	6	4
Maximum	14	16	24	12	10	9

AII-12

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-4 (Continued)

RESULTS OF IN-SITU SAMPLE ANALYSES FOR BOD₅, NH₄-N, TSS, VSS, AND SULFIDE FROM THE SOUTH SIDE OF THE O'HARE CUP RESERVOIR AUGUST 13 - SEPTEMBER 3, 2002 FILL EVENT EXPERIMENT (8/26/02 THROUGH 8/30/02)

Date	East 5*	East 20*	Center 5*	Center 15*	West 5*	West 10*
-----Sulfide (mg/L)-----						
8/26/02		0.00		0.00		0.00
8/27/02		0.05		0.00		0.00
8/28/02		0.15		0.00		0.00
8/29/02		0.00		0.00		0.00
8/30/02		0.54		0.19		0.00
Minimum		0.00		0.00		0.00
Mean		0.15		0.04		0.00
Maximum		0.54		0.19		0.00

*Number refers to depth of water column in feet.

**Data missing.

AII-13

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-5

RESULTS OF CHLOROPHYLL *a* CONCENTRATION IN $\mu\text{g/L}$ FROM SAMPLES
COLLECTED AT A DEPTH OF 5 FEET IN THE O'HARE CUP RESERVOIR
DURING AUGUST 13 THROUGH SEPTEMBER 3, 2002 FILL EVENTS

Date	East	Center	West
8/14/02	0.999	0.638	1.147
8/21/02	17.035	18.134	37.302
8/28/02	314.163	127.748	41.697

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-6

DISSOLVED OXYGEN AND TEMPERATURE READINGS AT SEVERAL LOCATIONS AND VARIOUS DEPTHS IN THE
O'HARE CUP RESERVOIR
AUGUST 13, 2002 THROUGH SEPTEMBER 3, 2002 FILL-EVENT EXPERIMENT

AII-15

Date	ES1/5		ES1/10		ES1/15		CS2/5		CS2/10		WS3/5	
	DO mg/L	Temp. °C										
8/15/02	0.7	26.1	NS	NS	4.7	27.1	0.0	26.3	0.0	27.9	0.0	26.2
8/16/02	6.7	*	NS	NS	2.3	*	0.0	24.2	NS	NS	0.0	24.2
8/17/02	0.0	23.8	NS	NS	0.0	22.9	0.1	24.6	0.0	23.2	0.0	23.8
8/18/02	0.0	24.1	NS	NS	0.0	23.9	0.0	24.1	NS	NS	0.0	24.0
8/19/02	0.2	23.4	0.1	23.2	6.3	*	0.1	24.3	0.1	23.4	0.1	24.3
8/20/02	1.0	23.7	0.1	23.3	0.0	23.1	0.0	23.6	0.1	23.4	0.0	23.9
8/21/02	0.0	23.9	0.0	23.2	0.1	23.4	0.6	24.2	0.0	23.4	0.5	24.1
8/22/02	Fill Event											
8/26/02	5.7	22.6	3.0	22.3	0.8	22.1	9.3	23.3	4.4	22.1	6.2	22.6
8/27/02	0.1	22.3	0.1	22.1	0.1	22.2	0.2	22.3	0.1	22.1	2.0	23.4
8/28/02	6.0	24.5	1.7	22.1	14.4	22.3	*	*	0.2	22.0	*	*
8/29/02	18.8	24.9	15.7	23.8	12.3	23.8	10.1	30.0	0.0	26.4	6.1	31.8
8/30/02	0.9	27.9	0.7	23.0	0.2	24.5	2.2	29.7	1.0	25.4	4.1	25.3
Minimum	0.0	22.3	0.0	22.1	0.0	22.1	0.0	22.3	0.0	22.0	0.0	22.6
Mean	3.3	24.3	2.7	22.9	3.4	23.5	2.1	25.1	0.6	23.9	1.7	24.9
Maximum	18.8	27.9	15.7	23.8	14.4	27.1	10.1	30.0	4.4	27.9	6.2	31.8

*Data missing.

NS = No sample.

Note: 8/16/02, Meter reading showed error at 12:05.

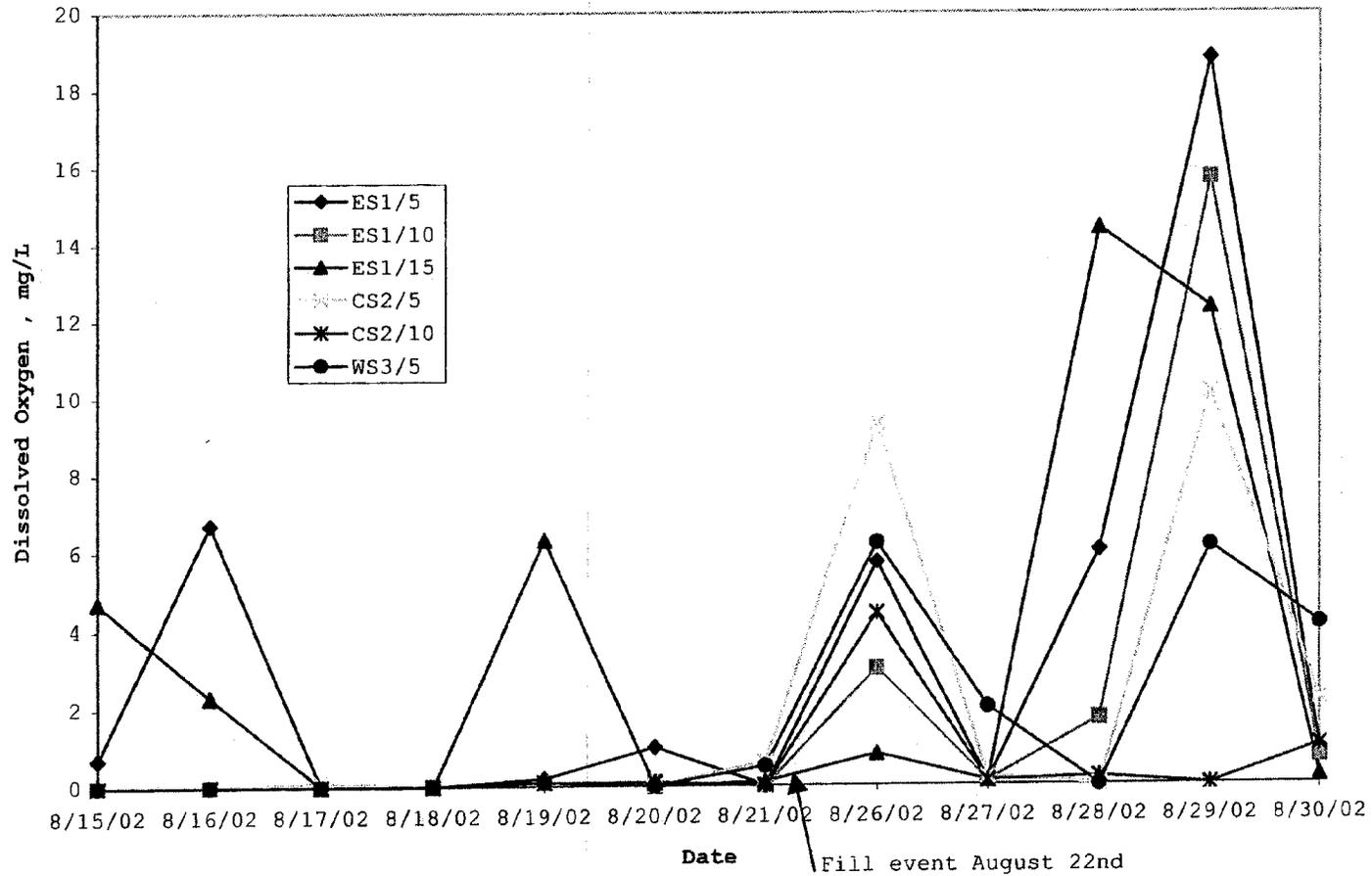
Note: 8/19/02, Probe changed after 10:55 reading.

Note: Oil/grease on probe 8/27/02 (possible lower readings).

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-4

DISSOLVED OXYGEN CONCENTRATIONS IN THE O'HARE CUP RESERVOIR ALONG THE SOUTH SIDE OF THE RESERVOIR AT DIFFERENT LOCATIONS AND DIFFERENT DEPTHS AUGUST 13, 2002 THROUGH AUGUST 30, 2002

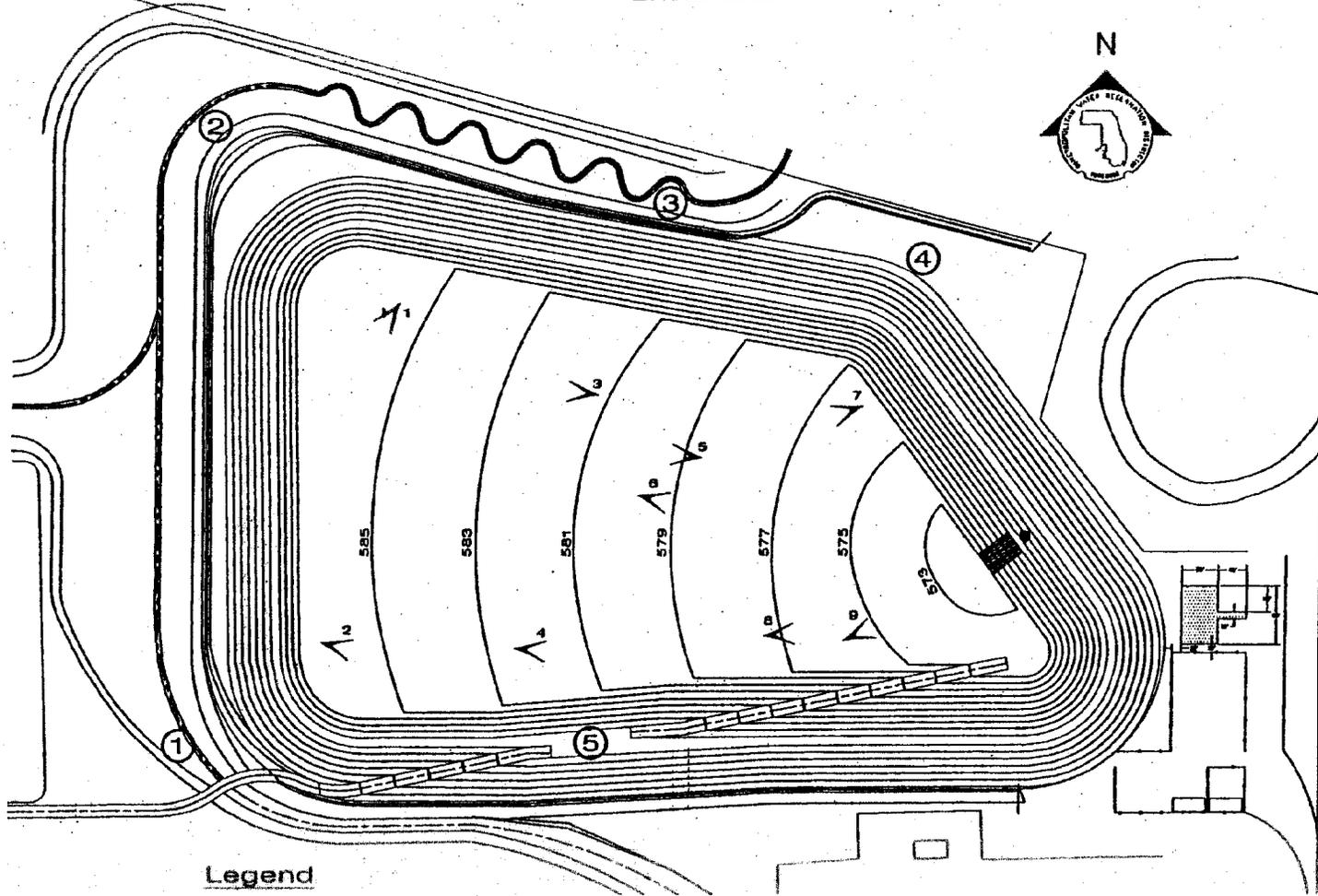


AII-16

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AII-5

ODOR AND H₂S MONITORING LOCATIONS
O'HARE CUP RESERVOIR AUGUST 13, 2002 THROUGH SEPTEMBER 3, 2002 FILL EVENTS
EXPERIMENT



AII-17

Legend

-  Aerator
-  Monitoring Location

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-7

HYDROGEN SULFIDE MONITORING DATA IN PARTS PER BILLION (PPB) AROUND THE O'HARE CUP RESERVOIR AUGUST 13, 2002 THROUGH SEPTEMBER 3, 2002 FILL EVENT EXPERIMENT

Date	Location 1*	Location 2*	Location 3*	Location 4*	Location 5*
8/15/02	7	6	8	8	7
8/16/02	7	6	8	6	15
8/17/02	6	3	5	7	6
8/18/02	6	6	10	6	7
8/19/02	2	5	6	6	12
8/20/02	7	7	7	7	5
8/21/02	10	11	10	10	10
8/21/02	10	11	10	10	10
8/26/02	6	8	6	8	3
8/27/02	8	8	8	8	7
8/28/02	6	8	7	7	7
8/29/02	6	8	9	9	9
8/30/02	12	12	12	11	10
8/31/02	8	8	9	9	7
9/1/02	7	7		10	7
9/2/02	9	11	10	11	11
9/3/02	7	6	6	7	7
Minimum	2	3	5	6	3
Mean	7	8	8	8	8
Maximum	12	12	12	11	15

AII-18

*See Figure AII-5.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AII-8

QUALITATIVE ODOR INTENSITY MONITORING AROUND O'HARE CUP RESERVOIR
AUGUST 13, 2002 THROUGH SEPTEMBER 3, 2002 FILL EVENT EXPERIMENT

Location No.**	Total Number of Observations	Number of Times Odor Perceived with Varying Intensity*					
		No Odor	Very Faint	Faint	Noticeable	Strong	Very Strong
1	19	8	2	2	7	0	0
2	19	15	2	1	1	0	0
3	19	16	2	1	0	0	0
4	18	16	1	0	1	0	0
5	19	5	2	2	10	0	0
Total Number of Readings	94	60	9	6	19	0	0

*A subjective odor intensity as interpreted by the person conducting the monitoring.

**See Figure AII-5.

AII-19

APPENDIX AIII

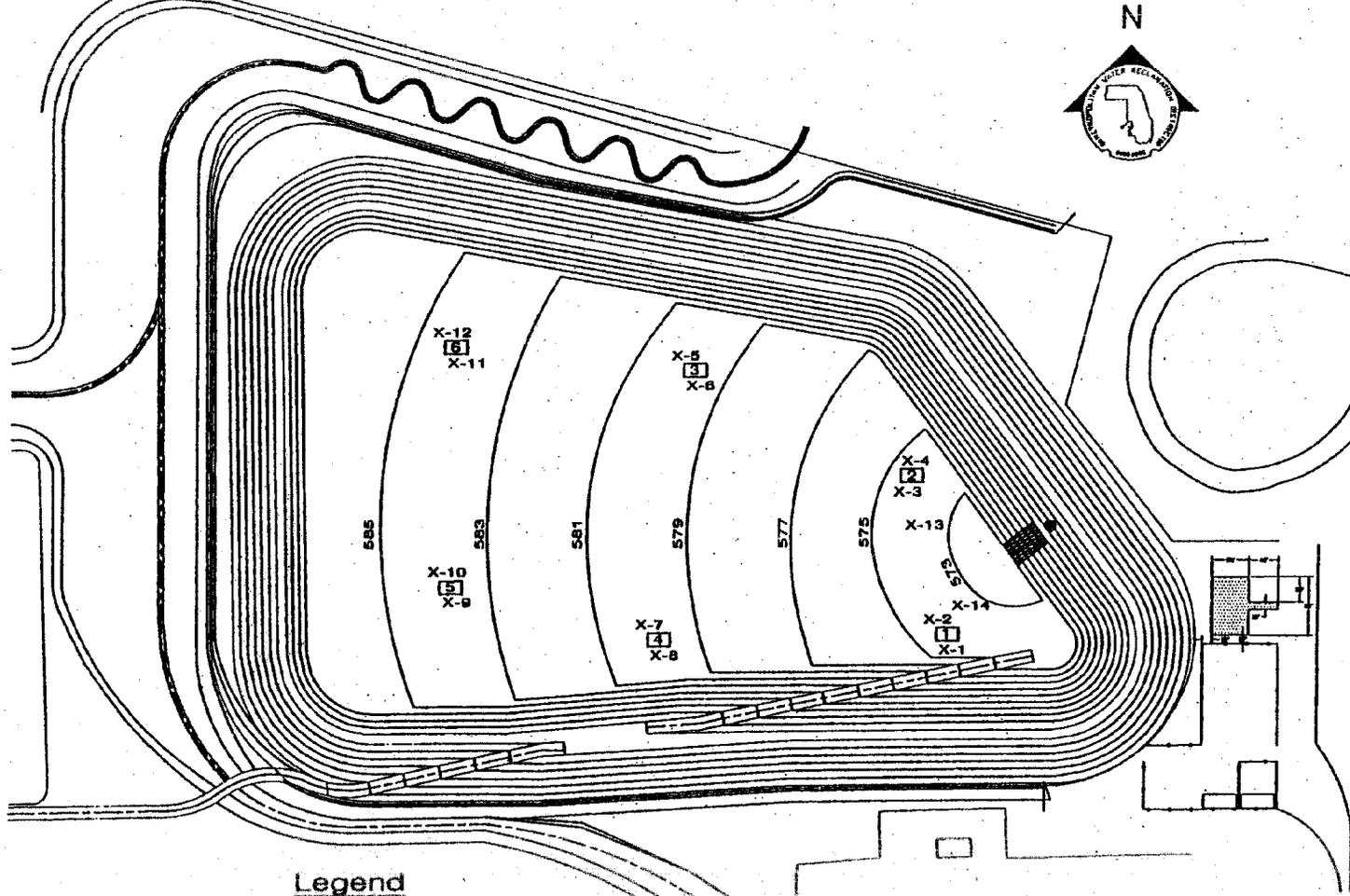
LOCATIONS OF SAMPLING AND RESULTS OF BOTTOM SEDIMENTS
MEASUREMENTS DURING O'HARE CUP RESERVOIR AUGUST 13 -
SEPTEMBER 3, 2002 FILL EVENT EXPERIMENT

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE AIII-1

LOCATIONS OF SEDIMENT DEPTH MEASUREMENTS AT THE BOTTOM OF THE RESERVOIR AND THE SIX PANS INSTALLED FOR THE STUDY
SAMPLES COLLECTED SEPTEMBER 3, 2002

AIII-1



Legend

- x- Sample spot
- Sediment pans

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-1

SEDIMENT DEPTH AND SOLIDS RESULTS FROM THE O'HARE CUP
RESERVOIR SEDIMENTS, SEPTEMBER 3, 2002*

Site*	Depth Inches	Total Solids (TS) Percent	Total Volatile Solids (TVS) Percent of TS
1	2.250	15.00	40.05
2	1.938	16.20	34.67
3	0.188	4.86	27.42
4	0.313	12.77	29.95
5	0.063	14.63	22.83
6	0.063	16.31	22.17
7	0.125	30.84	31.84
8	0.500	15.28	33.65
9	0.063	18.38	30.39
10	0.125	14.72	27.64
11	0.125	20.43	28.94
12	0.125	14.73	24.69
13	0.375	17.42	29.88
14	0.375	33.05	24.10
Min.	0.063	4.86	22.17
Mean	0.473	17.47	29.16
Max.	2.250	33.05	40.05

*See Figure AIII-1.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE AIII-2

SEDIMENT DEPTH AND SOLIDS RESULTS FROM THE O'HARE CUP
RESERVOIR SEDIMENT PANS, SEPTEMBER 3, 2002*

Site*	Depth Inches	Total Solids (TS) Percent	Total Volatile Solids (TVS) Percent of TS
1	1.500	11.83	40.32
2	0.063	6.24	25.53
3	0.063	4.36	23.70
4	0.375	10.90	21.60
5	0.063	10.95	26.18
6	0.063	10.47	23.98
Min.	0.063	4.36	21.60
Mean	0.355	9.13	26.89
Max.	1.500	11.83	40.32

Note: Average wet density is 1.01 g/mL.

*See Figure AIII-1.