Metropolitan Water Reclamation District of Greater Chicago

RESEARCH AND DEVELOPMENT DEPARTMENT

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SALT CREEK PHOSPHORUS REDUCTION DEMONSTRATION PROJECT INTERIM REPORT: COMPARISON OF PRE- AND POST-PHOSPHORUS REDUCTION CONDITIONS DURING 2005 – 2007

August 2008

Metropolitan Water Reclamation District of Greater Chicago
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SALT CREEK PHOSPHORUS REDUCTION DEMONSTRATION PROJECT INTERIM REPORT:

COMPARISON OF PRE- AND POST-PHOSPHORUS REDUCTION CONDITIONS DURING 2005 – 2007

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DISCLAIMER

Mention of proprietary equipment and chemicals in this report does not constitute endorsement by the Metropolitan Water Reclamation District of Greater Chicago.

SUMMARY

In order to study the effects of phosphorus (P) reduction at the John E. Egan Water Reclamation Plant (Egan WRP), the Metropolitan Water Reclamation District of Greater Chicago (District) is conducting the Salt Creek Phosphorus Reduction Demonstration Project (Project). The mean total phosphorus (TP) concentration in Egan WRP final effluent during 2005 (from daily 24-hour composite samples) was 3.3 mg/L, with a range of 1.0–5.9 mg/L and 3.7 mg/L in 2006, ranging from 0.9–8.22 mg/L. Ferric chloride chemical treatment has been employed since February 5, 2007, in order to reduce the final effluent P concentration to approximately 0.5 mg/L. The mean TP concentration between February 6 - December 31, 2007 in Egan WRP final effluent was 0.35 mg/L.

Water and sediment quality, biological, and physical habitat data were collected from Salt Creek during 2005 and 2006 to assess pre-phosphorus reduction conditions, and to be used as a baseline for subsequent comparisons. These data were similarly collected in 2007 following P reduction at Egan. There were three monitoring stations along Salt Creek, one upstream of the Egan WRP outfall (Busse Lake Dam) and two downstream (J. F. Kennedy [JFK] Boulevard and Thorndale Avenue). Water quality was assessed once per month during the winter and twice per month for the rest of the year. Hourly measurements of dissolved oxygen (DO), temperature, pH, turbidity, and conductivity were logged by continuous water quality monitors installed at the three stations. Biological collections of fish and macroinvertebrates, as well as sediment chemistry and physical habitat assessments, took place once each summer.

Data collection will continue in this same manner through February, 2009 (two years after P reduction went on-line). Subsequently, the District will generate a final report to summarize the findings from the Project.

Notable findings from 2005–2007 monitoring on Salt Creek were as follows:

- Mean TP concentrations were lowest at Busse Lake Dam (0.25, 0.18, and 0.11 mg/L during 2005, 2006, and 2007, respectively). The annual mean TP concentrations at JFK Boulevard were 2.76 and 2.20 mg/L prior to Egan P reduction and 0.29 mg/L in 2007, post P reduction. At Thorndale Avenue, mean TP measured 2.51 and 2.12 mg/L during 2005 and 2006, and 0.30 mg/L during 2007.

- During 2006, continuous DO monitoring indicated that 2.4 and 1.4 percent of hourly measurements at Busse Lake Dam and Thorndale Avenue, respectively, were below the Illinois Pollution Control Board (IPCB) Water Quality Standard of 5.0 mg/L. There were no violations of the IPCB standard for DO at JFK Boulevard during 2006. During 2007, 2.1, 1.3, and 1.6 percent of hourly DO measurements were below 5.0 mg/L at Busse Lake Dam, Thorndale Avenue, and JFK Boulevard, respectively.

- Diel fluctuations of DO, characteristic of elevated algae concentrations, occurred at all three stations, before and after the P reduction.

- During all three years, chlorophyll *a* concentrations in the water column were highest upstream of the Egan WRP outfall, and were diluted by Egan WRP effluent.

- Before and after Egan P reduction, algae in this system did not appear to be limited by nutrient concentrations, but rather by habitat conditions such as light availability and residence time.

- Total number of fish collected, as well as number of fish species collected, were highest upstream of the Egan WRP and decreased at downstream stations. Index of Biotic Integrity (IBI) scores were variable between stations and from year to year, but were generally in the "fair" range.

- There is no apparent stream response to lower P in the water column.

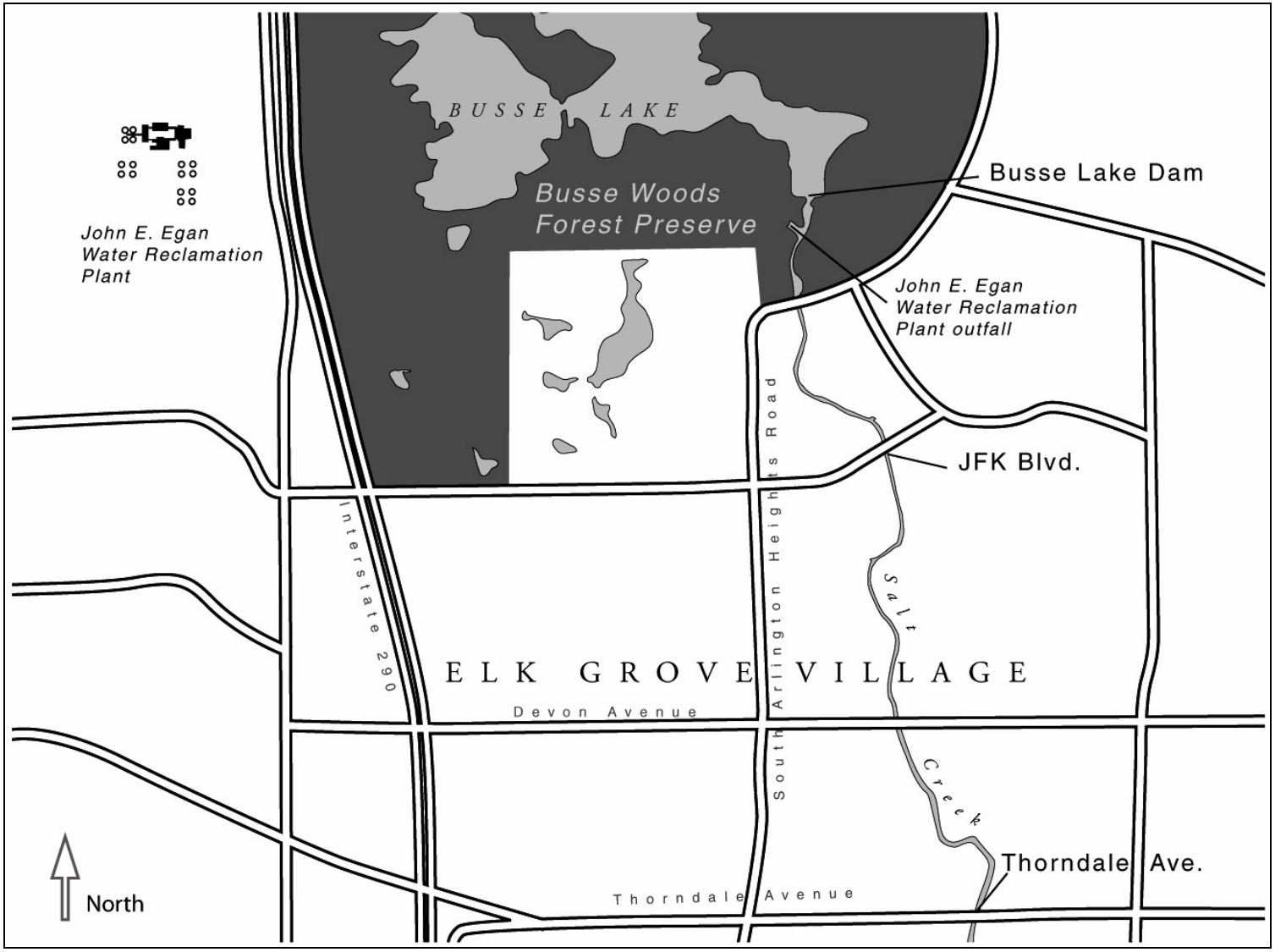
INTRODUCTION

In 1998, the United States Environmental Protection Agency (USEPA) established a national strategy for the development and promulgation of regional water quality criteria for nutrients. In response to communications with the Illinois Environmental Protection Agency (IEPA) and uncertainty regarding appropriate nutrient standards, the District agreed to conduct a large-scale P removal demonstration project at its Egan WRP.

Mean TP concentration of Egan WRP final effluent during 2005 (from all 24-hour effluent composite samples) was 3.26 mg/L, with a range of 0.98 – 5.87 mg/L, and 3.72 mg/L in 2006, ranging from 0.92 – 8.22 mg/L. The goal of this study is to enhance understanding of the effects of P reduction to 0.5 mg/L at Egan WRP on water and sediment chemistry and aquatic communities in Salt Creek (the receiving stream for Egan WRP effluent). Effluent TP concentrations of 0.5 mg/L were thought to be attainable using ferric chloride dosing to perform chemical P removal. Phosphorus removal by ferric chloride chemical treatment at Egan WRP went online on February 5, 2007. Subsequently, the mean TP concentration of Egan WRP final effluent during 2007 (between February and December) was 0.35 mg/L. The range during this time period was from 0.06 – 1.77 mg/L.

Comprehensive water quality monitoring was implemented in Salt Creek in February 2005 in order to assess baseline conditions prior to P removal. In addition, macroinvertebrate, fish, and sediment samples were assessed once each summer during 2005, 2006, and 2007. Three monitoring stations were chosen on Salt Creek (Figure 1). Station 1 at Busse Reservoir Dam is approximately 0.1 mile upstream of the Egan WRP effluent outfall, Station 2 at JFK Boulevard is approximately 0.7 mile downstream of the outfall, and Station 3 at Thorndale Avenue is approximately 2.4 miles downstream of the outfall. In addition, a 24-hour composite sample of the final effluent from the Egan WRP was collected and analyzed Monday – Friday. Additional water quality and biological data were collected on Salt Creek downstream of the Egan WRP at the District's Ambient Water Quality Monitoring (AWQM) Program sampling stations, including Devon Avenue, Wolf Road, and Brookfield Avenue. However, this report will focus specifically on data from the three Salt Creek Nutrient Demonstration Project stations. All monitoring activities are ongoing and will be performed throughout 2008 for further comparison.

FIGURE 1: SALT CREEK PHOSPHORUS REDUCTION DEMONSTRATION PROJECT SAMPLING STATIONS



MATERIALS AND METHODS

Water Samples

Water grab samples were taken in a rinsed bucket from the center of the waterway. Samples were poured off into appropriate containers and kept in a dark, ice-packed cooler immediately after collection until delivery to the Analytical Laboratory Division login area. Water quality constituents measured, as well as analytical methods utilized, are listed in Table 1.

Twenty-four hour composite samples of final effluent from the Egan WRP were analyzed for total suspended solids (TSS), biochemical oxygen demand (BOD_5), carbonaceous biochemical oxygen demand ($CBOD_5$), TP, total Kjeldahl nitrogen (TKN), ammonia-nitrogen (NH_3-N), nitrite-nitrogen (NO_2-N), and nitrate-nitrogen (NO_3-N) at the Egan Analytical Laboratory. An aliquot of the 24-hour composite final effluent sample was obtained from the Egan WRP the day after each scheduled Salt Creek stream sampling event and analyzed for ortho-phosphate and turbidity at the Stickney WRP Analytical Laboratory. During wet weather sampling events that ended on Friday, Egan WRP final effluent grab samples were obtained for ortho-phosphate and turbidity analysis. However, data for the other constituents were not available for Egan effluent on these days (composite samples are not analyzed on the weekends).

Sampling Frequency. Stream water sampling occurred once per month during December through March and twice per month during April through November. In addition, wet weather event sampling was conducted for four consecutive days following major rain events in July and October of 2005, April, May, and August of 2006, and April-May, June, and August of 2007.

Sediment Samples

Sediment samples were collected once each summer during 2005-2007 using a 6- X 6-inch petite ponar grab sampler. Samples were taken from the side and center of Salt Creek at each station and homogenized before being scooped into a glass quart bottle. Bottles were kept on ice before delivery to the Stickney Analytical Laboratory for analysis. Chemical constituents measured in sediments were as follows: total solids (TS), total volatile solids (TVS), NH_3-N, NO_3-N and NO_2-N, TKN, and TP.

TABLE 1: SALT CREEK NUTRIENT DEMONSTRATION PROJECT WATER QUALITY CONSTITUENTS MEASURED AND ANALYTICAL METHODS USED

Water Quality Constituent	Analytical Method	Method Reference
Water Temperature	Electrode[a]	SM 2550 B
Total Phosphorus	Colorimetric	EPA 365.4
Ortho-Phosphate	Colorimetric	EPA 365.1
Ammonia-Nitrogen	Colorimetric	EPA 350.1
Nitrate-Nitrogen	Colorimetric	EPA 353.2
Nitrite-Nitrogen	Colorimetric	EPA 353.2
Total Kjeldahl Nitrogen	Colorimetric	EPA 351.2
Turbidity	Nephelometric[b]	SM 2130 B
Carbonaceous BOD_5	Membrane Electrode	SM 5210 B
Chemical Oxygen Demand	Colorimetric	SM 5220 D
Total Suspended Solids	Gravimetric	SM 2540 D
Volatile Suspended Solids	Gravimetric	SM 2540 E
Chlorophyll *a*	Spectrophotometric	SM 10200-H
pH	Electrode[a]	SM 4500-H B
Dissolved Oxygen	Iodometric[b]	SM 4500-O C

[a]Field measurement taken during water sampling events and continuously monitored since installation of water quality monitors.
[b]Method used prior to continuous water quality monitoring installation.

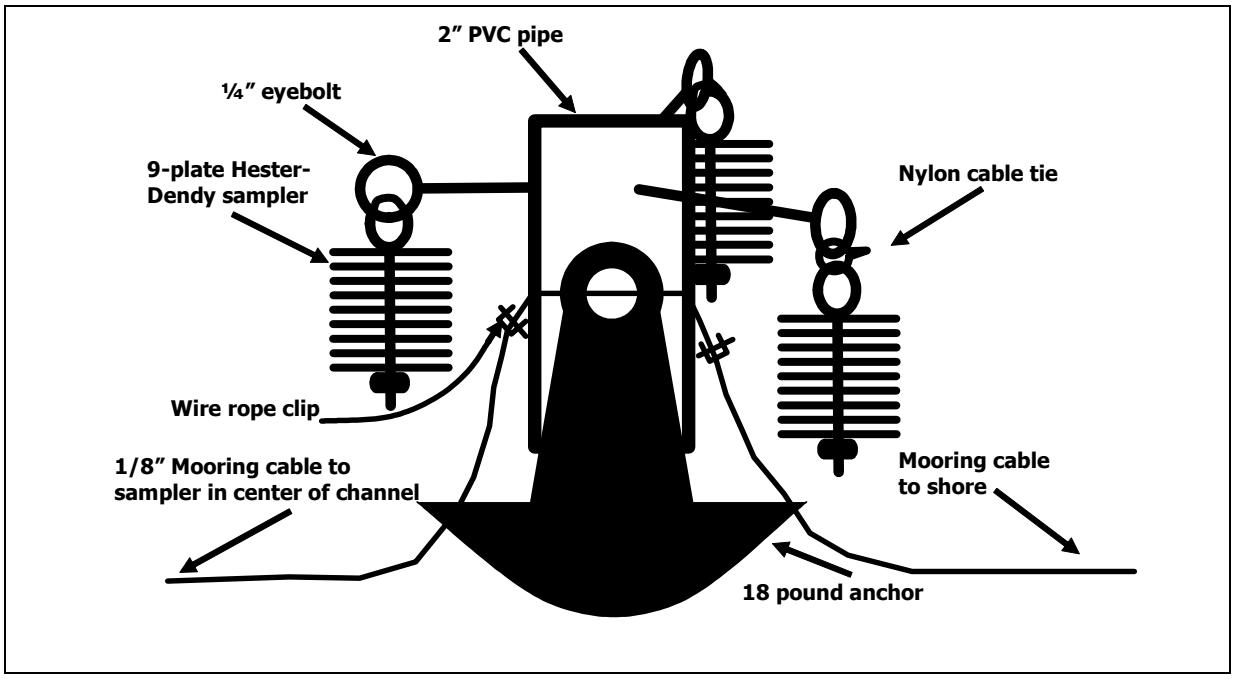
Biological Parameters

Fish. Backpack electrofishing and seining were performed in the upstream direction along a 40-meter stretch on each bank of the three sampling stations during 2005-2007. At JFK Boulevard and Thorndale Avenue fishing began at the street bridge; at Busse Lake Dam the fishing range was downstream of the dam. A Smith-Root LR-24 model backpack electrofisher and a 15-foot seine net with a 3-foot nylon bag and 3/16-inch mesh were employed. Whenever possible, fish were identified, weighed, and measured in the field by an Aquatic Ecology and Water Quality Section (AEWQ) Biologist and subsequently released. Minnows and unique specimens were fixed in 10 percent formalin and brought back to the laboratory for identification and measurement. All fish were checked for abnormalities and diseases, which were recorded on field data sheets.

Index of Biotic Integrity. Biological integrity of aquatic ecosystems has been defined as the ability to support and maintain a balanced, integrated, and adaptive community having a species composition, diversity, and a functional organization comparable to that of a natural habitat (Karr et al., 1986). Karr's 1986 IBI was used to analyze fish data from Salt Creek. The limitations of using this tool when catch numbers are very low should be recognized. Karr's IBI integrates information from 12 fish community metrics that fall into three major categories: (1) species richness and composition; (2) trophic composition; and (3) fish abundance and condition. Each metric is scored as a 1, 3, or 5 based on whether its evaluation deviates strongly, deviates somewhat, or approximates expectations, respectively, as compared to an undisturbed site located in a similar geographical region and on a stream of comparable size. Individual metrics are added to calculate a total IBI score. A high IBI indicates high biological integrity or health and low disturbance or lack of perturbations. A low IBI indicates low biological integrity and high disturbance or degradation. Separate IBI metric scores were determined based on the relative abundance of fish collected with each fishing gear. IBI categories of good (IBI 41-60), fair (IBI 21-40) or poor (IBI <21), as derived by the IEPA (IEPA, 1996) were determined and reported.

Benthic Invertebrates. Benthic invertebrate communities were assessed during the summers of 2005, 2006, and 2007 using grab sediment samples as well as Hester Dendy larval plate samples. Three samples were taken from the side and center of the waterway with a 6- X 6-inch petite ponar grab sampler and sieved in buckets with #60 screens. The remaining sample was collected in a plastic gallon bottle, filled with river water, and fixed to a final concentration of 10 percent formalin and bicarbonate. Hester Dendy larval plates were assembled and attached to an 18-pound river anchor (Figure 2). Sample set-ups were located in the side and center of the waterway and attached to on-shore trees by a cable. Samplers remained in place for at least 6 weeks before being removed from the anchor and placed in a leak-proof gallon container (filled with river water and fixed to final concentration of 10 percent formalin and bicarbonate). Hester Dendy larval samplers were not installed at the JFK Boulevard station because of previous vandalism at that site. Larval invertebrate community data from the Devon Avenue AWQM Program station, which is approximately one mile downstream of JFK Boulevard, were substituted. During the summer of 2005, Hester Dendy larval samplers were stolen from the Busse Lake Dam site. Contractual services were obtained for taxonomic identification of benthic

FIGURE 2: CONFIGURATION OF HESTER DENDY LARVAL PLATE SAMPLER



invertebrates to species (when possible), with the exception of oligochaetes, which were counted by trained AEWQ personnel.

Physical Habitat

Field data sheets describing physical habitat conditions at the stations were completed once each year concurrent with the fish sampling (Figure 3). Data sheets were completed for the side and center of the waterway at the beginning and end of the fishing area (40-meter stretch). Algal and macrophytic coverage was assessed at this time, along with sediment composition, riparian coverage, erosion conditions, canopy coverage, and other physical characterizations.

Continuous Dissolved Oxygen Monitoring

YSI Model 6920 or Model 6600 water quality monitors have been installed and continuously monitor (hourly) DO at JFK Boulevard and Thorndale Avenue since August of 2005, and at Busse Lake Dam since October of 2005. Prior to continuous monitoring, grab water samples were analyzed for DO in accordance with the aforementioned water-sampling schedule. Water quality monitors also measured turbidity, conductivity, water temperature, and pH. Field monitors were replaced weekly with calibrated, cleaned, and serviced monitors. Monitor maintenance and data review followed an approved quality assurance project plan (QAPP) and are outlined in the report entitled "Continuous Dissolved Oxygen Monitoring in Chicago Area Wadeable Streams During 2006" (Minarik *et al*., 2007).

FIGURE 3: METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO PHYSICAL HABITAT ASSESSMENT

Date _____ **Time** _____ **Station Number** _____

Station Name _____ **Latitude** _____

Waterbody _____ **Longitude** _____

Assessment Observer (s) _____

Weather Conditions SUNNY CLOUDY RAIN (circle one)

Stream Order _____ **Assessment Location** BEGINNING END (circle one)

Assessment Location Facing Upstream LEFT CENTER RIGHT (circle one)

Channel Habitat POOL RUN RIFFLE (circle one)

Water Depth (ft) _____ **Channel Width** (ft) _____

Water Level LOW NORMAL HIGH FLOODED (circle one)

Man-made Structures DAM RIPRAP BRIDGE LEVEE ISLAND OUTFALL SHEET PILING OTHER _____ (Specify) (circle all applicable)

Channelization YES NO (circle one)

Bank Erosion NONE SLIGHT MODERATE SEVERE (circle one)

Floatable Materials YES NO (circle one)
If YES, characterize (circle all applicable)
STREET LITTER SANITARY SEWAGE VEGETATIVE MATERIAL

Aquatic Vegetation YES NO (circle one)
If YES, is vegetation (circle all applicable)
ROOTED EMERGENT ROOTED SUBMERGENT ROOTED FLOATING
ATTACHED ALGAE FLOATING ALGAE OTHER _____ (Specify)

Instream Cover for Fish (circle all applicable)
AQUATIC VEGETATION BOULDERS BRUSH-DEBRIS JAMS LOGS
SUBMERGED TREE ROOTS SUBMERGED TERRESTRIAL VEGETATION
UNDER CUT BANK ROCK LEDGE OTHER _____ (Specify)

Canopy Cover OPEN PARTLY SHADED SHADED (circle one)

Immediate Shore Cover		**Riparian Land Use**	
DENUDED	_____ %	GRASSLAND	_____ %
GRASSES	_____ %	URBAN RESIDENTIAL	_____ %
SHRUBS	_____ %	URBAN COMMERCIAL/INDUSTRIAL	_____ %
TREES	_____ %	WETLAND	_____ %
OTHER (Specify)		FOREST	_____ %
_____	_____ %	ROW CROPS	_____ %
		OTHER _____ (Specify)	_____ %

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FIGURE 3 (Continued): METROPOLITAN WATER RECLAMATION DISTRI
GREATER CHICAGO PHYSICAL HABITAT ASSESSMENT

Station Number

Sediment Compostion	Plant Debris	_____	%
	Clay	_____	%
	Inorganic Silt	_____	%
	Organic Sludge	_____	%
	Sand (0.06 mm to 2 mm diameter)	_____	%
	Gravel (>2 mm to 64 mm diameter)	_____	%
	Cobble (>64 mm to 256 mm diameter)	_____	%
	Boulder (>256 mm diameter)	_____	%
	Bedrock or Concrete	_____	%

Sediment Color _____ **Sediment Odor** _____

Oil in Sediment NONE LIGHT MODERATE HEAVY

Embeddedness NONE NORMAL MODERATE EXTENSIV

Sinuosity NONE LOW MODERATE HIGH

Depth of Fines (In feet using 1 inch diameter probe) _____

Photo Numbers Looking Upstream _____ Looking Downstream

Site Location/Map (Draw a map of the site and indicate the area assessed)

Additional Remarks _____

(Complete both sides of page)

RESULTS AND DISCUSSION

Water Quality

Average and range values for water quality constituents measured during scheduled sampling events in 2005-2007 are shown in Tables 2-5. Upstream of the Egan WRP at Busse Lake Dam, high TP and ortho-phosphate values on August 17 caused the 2005 means to be much higher than in 2006 and 2007. Eliminating this outlier concentration would result in mean TP and ortho-phosphorus concentrations of 0.08 and 0.118 mg/L, respectively.

During 2005, several samples from Busse Lake Dam and, to a lesser extent the other two sampling stations, exhibited higher ortho-phosphorus than TP concentrations. This was likely due to the fact that in August of 2005 the Stickney Analytical Laboratory at the District began using more sensitive equipment to analyze these parameters. Prior to this time, there was a higher method detection limit, resulting in a higher analytical error.

Rain Event Sampling. Water quality data from rain event sampling in 2007 are displayed in Tables 6-9. Rain Event data from 2005 and 2006 were compiled in R&D report number 07-24 (Wasik, 2007).

Dissolved Oxygen. During 2006 and 2007, 97.6 and 97.9 percent of the hourly readings, respectively, showed compliance with the standard at Busse Lake Dam. The JFK Boulevard station was in 100 percent compliance with the 5.0 mg/L DO standard during 2006 and 98.7 percent compliance during 2007. Hourly DO readings from Thorndale Avenue were in compliance 98.6 and 98.4 percent of the time with the standard during 2006 and 2007, respectively.

Continuous DO monitoring has revealed that all three Salt Creek monitoring stations are prone to wide diel DO fluctuations, which is a signature response to algae or aquatic plants, since they photosynthesize during the day and respire at night. Examples from July of 2007 are provided in Figures 4–6 for Busse Dam, JFK, and Thorndale, respectively. Example DO graphs from 2006 are available in the previous R&D interim report (Wasik, 2007). At each of the stations, some nighttime DO values fell below the standard during July, 2007. Upstream of the Egan WRP at Busse Lake Dam (Figure 4), DO fluctuations were less uniform and there were some daytime concentrations which also fell below the DO standard. Diel flux occurred to a lesser magnitude during the winter months at the JFK Boulevard and Thorndale Avenue sampling stations. For example, Figure 7 displays the hourly DO concentrations at JFK Boulevard during January of 2007 that is typical for both sites in the winter.

The continuous DO monitoring results were similar during 2006 and 2007, pre and post P reduction. Tables 10-12 show the number and percentage of total observations in which DO fluctuation (DO maximum – DO minimum within 24 hours) was less than 2, between 2-3, between 3-4, between 4-5, or greater than 5 mg/L before and after P reduction at each of the three sampling stations. Theoretically, if P enrichment is the cause of algal blooms, decreasing P to a point in which it begins to limit algae growth would, in turn, lower the magnitude of diel DO flux.

TABLE 2: SUMMARY OF WATER QUALITY AT BUSSE LAKE DAM DURING 2005 – 2007*

Constituents[a]	Feb – Dec 2005 Range	Feb – Dec 2005 Average	Jan – Dec 2006 Range	Jan – Dec 2006 Average	Feb – Dec 2007 Range	Feb – Dec 2007 Average
Water Temperature (ºC)[b]	1.9 – 33.5	18.4	3.6 – 30.1	15.9	1.2 – 32.7	15.6
pH (units)[b]	7.1 – 8.4	7.8	7.1 – 8.7	8.1	7.1 – 8.6	8.0
TSS	<3 – 34	14	<3 – 35	13	2 – 33	18
VSS	<3 – 23	8	<3 – 24	8	<2 – 13	6
Turbidity (NTU)	5 – 23	12	8 – 41	16	9 – 33	17
Dissolved Oxygen (DO)[c]	3.7 – 13.5	8.6	0.3 – 17.6	10.6	1.2 – 18.3	10.4
BOD_5	<2 – 8	4	<2 – 6	4	<2 – 10	4
$CBOD_5$	<2 – 5	4	<2 – 6	3	<2 – 6	3
COD	25 – 55	37	16 – 46	30	17 – 66	34
TP	<0.05 – 3.15	0.25	0.02 – 0.87	0.18	0.06 – 0.36	0.11
Ortho-Phosphate	0.005 – 2.727	0.263	0.003 – 0.158	0.026	<0.005 – 0.022	0.011
TKN	0.70 – 1.47	1.11	0.97 – 1.92	1.33	0.81 – 1.86	1.17
Ammonia-N	<0.02 – 0.34	0.13	<0.02 – 0.33	0.09	<0.02 – 0.38	0.07
NO_3-N	<0.005 – 11.436	0.762	<0.005 – 5.673	0.541	<0.005 – 0.701	0.166
NO_2-N	<0.005 – 0.047	0.014	<0.004 – 0.039	0.016	<0.004 – 0.052	0.012
TN	0.739 – 12.796	1.881	1.15 – 6.83	1.89	0.96 – 2.25	1.35
Chlorophyll *a* (µg/L)	7 – 63	29	15 – 82	30	11 – 78	31

*During scheduled sampling. Not including rain event data.
[a]Expressed in mg/L except where noted.
[b]Field measurement.
[c]From hourly continuous monitoring data.

TABLE 3: SUMMARY OF WATER QUALITY AT JOHN F. KENNEDY BOULEVARD DURING 2005 – 2007*

Constituents[a]	Feb – Dec 2005 Range	Feb – Dec 2005 Average	Jan – Dec 2006 Range	Jan – Dec 2006 Average	Feb – Dec 2007 Range	Feb – Dec 2007 Average
Water Temperature (°C)[b]	1.1 – 28.1	17.8	5.6 – 25.2	16.5	4.8 – 24.4	16.2
pH (units)[b]	7.1 – 8.0	7.6	6.9 – 8.0	7.6	7.2 – 7.8	7.5
TSS	<3 – 26	8	3 – 32	10	2 – 20	10
VSS	<3 – 11	4	<3 – 18	6	<2 – 11	4
Turbidity (NTU)	3 – 16	6	3 – 41	11	3 – 16	10
Dissolved Oxygen (DO)[c]	5.5 – 11.8	8.1	5.1 – 13.5	9.1	3.1 – 13.9	9.0
BOD_5	<2 – 4	3	<2 – 6	3	<2 – 5	2
$CBOD_5$	<2 – 6	3	<2 – 5	3	<2 – 5	2
COD	17 – 43	28	18 – 36	28	12 – 50	25
TP	0.88 – 4.64	2.76	0.22 – 5.49	2.20	0.10 – 0.76	0.29
Ortho-Phosphate	0.720 – 4.280	2.587	0.099 – 4.663	1.728	0.013 – 0.668	0.182
TKN	0.77 – 1.66	1.21	1.07 – 1.70	1.32	0.86 – 1.36	1.13
Ammonia-N	<0.02 – 0.43	0.14	<0.02 – 0.19	0.09	<0.02 – 0.25	0.07
NO_3-N	4.678 – 20.832	12.466	0.936 – 19.945	8.085	3.408 – 16.940	8.676
NO_2-N	0.005 – 0.072	0.026	0.006 – 0.071	0.021	<0.004 – 0.027	0.013
TN	5.710 – 22.214	13.700	2.07 – 21.66	9.43	4.73 – 18.17	9.82
Chlorophyll *a* (µg/L)	3 – 29	10	2 – 42	16	2 – 38	13

*During scheduled sampling. Not including rain event data.
[a]Expressed in mg/L except where noted.
[b]Field measurement.
[c]From hourly continuous monitoring data.

TABLE 4: SUMMARY OF WATER QUALITY AT THORNDALE AVENUE DURING 2005 – 2007*

Constituents[a]	Feb – Dec 2005 Range	Feb – Dec 2005 Average	Jan – Dec 2006 Range	Jan – Dec 2006 Average	Feb – Dec 2007 Range	Feb – Dec 2007 Average
Water Temperature (°C)[b]	4.9 – 28.5	17.6	4.8 – 25.3	16.2	5.0 – 25.6	16.0
pH (units)[b]	7.0 – 8.4	7.7	6.7 – 7.9	7.5	7.1 – 8.0	7.5
TSS	<3 – 24	13	3 – 32	13	6 – 24	15
VSS	<3 – 18	5	<3 – 13	6	<2 – 14	6
Turbidity (NTU)	3 – 20	9	5 – 40	12	5 – 18	10
Dissolved Oxygen (DO)[c]	4.8 – 12.6	7.2	2.8 – 16.0	9.2	1.4 – 15.7	9.2
BOD_5	<2 – 11	3	<2 – 5	3	<2 – 9	2
$CBOD_5$	<2 – 4	3	<2 – 5	3	<2 – 4	2
COD	21 – 40	29	19 – 40	29	12 – 42	25
TP	<0.05 – 4.45	2.51	0.27 – 5.30	2.12	0.10 – 0.97	0.30
Ortho-Phosphate	0.04 – 4.47	2.38	0.145 – 4.506	1.713	0.012 – 0.840	0.196
TKN	0.94 – 1.73	1.28	1.01 – 1.96	1.35	0.87 – 1.35	1.15
Ammonia-N	0.040 – 0.350	0.183	<0.02 – 0.34	0.08	<0.02 – 0.26	0.08
NO_3-N	0.041 – 19.642	11.156	1.992 – 18.849	8.132	3.370 – 15.677	8.357
NO_2-N	<0.005 – 0.087	0.035	0.009 – 0.036	0.022	0.001 – 0.0831	0.017
TN	1.01 – 20.90	12.47	3.30 – 20.52	9.50	4.70 – 16.85	9.52
Chlorophyll *a* (µg/L)	3 – 34	11	3 – 42	17	2 – 33	14

*During scheduled sampling. Not including rain event data.
[a]Expressed in mg/L except where noted.
[b]Field measurement.
[c]From hourly continuous monitoring data.

TABLE 5: SUMMARY OF WATER QUALITY AT JOHN E. EGAN OUTFALL DURING 2005 – 2007*

Constituents[a]	Feb – Dec 2005 Range	Feb – Dec 2005 Average	Jan – Dec 2006 Range	Jan – Dec 2006 Average	Feb – Dec 2007 Range	Feb – Dec 2007 Average
TSS	<2 – 2	2	<2 – 2	2	<2 – 2	<2
Turbidity (NTU)	<1 – 3	1	<1 – 3	1	<0.2 – 3	1
BOD_5	<2 – 2	2	<2 – 2	2	<2 – <2	<2
$CBOD_5$	<2 – 2	2	<2 – 2	2	<2 – <2	<2
TP	1.87 – 5.23	3.41	1.52 – 5.61	3.70	0.14 – 0.93	0.37
Ortho-Phosphate	2.130 – 4.712	3.249	1.443 – 5.256	3.397	0.057 – 0.883	0.303
TKN	0.82 – 2.16	1.22	0.98 – 1.63	1.31	0.12 – 1.18	0.79
Ammonia-N	<0.04 – 0.240	0.098	<0.04 – 0.13	0.07	<0.03 – 0.17	0.09
NO_3-N	13.063 – 20.770	16.576	11.207 – 19.842	15.566	13.845 – 18.884	16.322
NO_2-N	<0.005 – 0.111	0.020	<0.005 – 0.038	0.013	0.003 – 0.063	0.013
TN	13.92 – 23.01	17.82	12.49 – 21.25	16.70	14.41 – 20.05	17.12

*Statistics only include Egan effluent data from regularly scheduled Salt Creek sampling days; not all daily samples.
[a]Expressed in mg/L except where noted.

TABLE 6: WATER QUALITY DATA AT BUSSE LAKE DAM IN SALT CREEK DURING 2007 RAIN EVENTS

Constituents[a]	2007 Rain Event Dates			
	4/30/07	**5/1/07**	**5/2/07**	**5/3/07**
Water Temperature (°C)[b]	16.5	15.9	17.1	16.2
pH (units)[b]	8.5	8.0	8.7	7.2
TSS	13	14	18	15
VSS	4	7	7	6
Turbidity (NTU)	8	11	12	11
Dissolved Oxygen (DO)[c]	ND	ND	ND	ND
BOD_5	4	3	5	4
$CBOD_5$	4	3	4	4
COD	28	28	26	11
TP	0.08	0.08	0.10	0.12
Ortho-Phosphate	0.007	0.006	0.011	0.010
TKN	1.57	1.82	1.19	1.29
Ammonia-N	0.04	0.02	0.07	0.05
NO_3-N	0.181	0.138	0.074	0.038
NO_2-N	0.012	0.013	0.012	0.014
TN	1.76	1.97	1.28	1.34
Chlorophyll *a* (µg/L)	40	43	44	55
	6/05/07	**6/6/07**	**6/7/07**	**6/8/07**
Water Temperature (°C)[b]	21.8	20.8	21.2	22.3
pH (units)[b]	8.3	8.1	8.1	8.2
TSS	17	22	33	21
VSS	2	7	6	15
Turbidity (NTU)	21	23	31	19
Dissolved Oxygen (DO)[c]	ND	ND	ND	ND
BOD_5	4	<2	3	3
$CBOD_5$	3	<2	3	<2
COD	34	38	36	34
TP	0.12	0.15	0.12	0.08
Ortho-Phosphate	0.006	0.012	0.012	0.010
TKN	1.41	1.15	1.16	1.20
Ammonia-N	<0.02	0.06	0.15	0.12
NO_3-N	0.008	0.023	0.025	0.003
NO_2-N	0.005	0.003	0.004	0.007
TN	1.42	1.18	1.19	1.21
Chlorophyll *a* (µg/L)	33	15	16	24

TABLE 6 (Continued): WATER QUALITY DATA AT BUSSE LAKE DAM IN SALT CREEK DURING 2007 RAIN EVENTS

Constituents[a]	2007 Rain Event Dates			
	8/7/07	**8/8/07**	**8/9/07**	**8/10/07**
Water Temperature (°C)[b]	23.2	27.0	26.7	26.7
pH (units)[b]	7.8	7.7	7.7	7.9
TSS	17	23	21	16
VSS	2	4	4	7
Turbidity (NTU)	18	29	28	24
Dissolved Oxygen (DO)[c]	ND	ND	ND	ND
BOD_5	3	3	3	3
$CBOD_5$	2	3	2	4
COD	27	32	32	29
TP	0.10	0.11	0.11	0.15
Ortho-Phosphate	0.009	0.005	0.012	0.004
TKN	1.27	1.16	1.20	1.24
Ammonia-N	0.19	0.24	0.21	0.08
NO_3-N	0.064	0.226	0.283	0.287
NO_2-N	0.014	0.029	0.030	0.031
TN	1.35	1.42	1.51	1.56
Chlorophyll *a* (µg/L)	32	30	27	55

ND=No Data
[a]Expressed in mg/L except where noted.
[b]Field measurement.
[c]Continuous monitoring data implemented in 2005. No grab sample taken for DO.

TABLE 7: WATER QUALITY DATA AT JFK BOULEVARD IN SALT CREEK DURING 2007 RAIN EVENTS

Constituents[a]	2007 Rain Event Dates			
	4/30/07	**5/1/07**	**5/2/07**	**5/3/07**
Water Temperature (°C)[b]	18.4	15.7	16.4	15.6
pH (units)[b]	7.9	8.0	8.2	8.1
TSS	12	10	14	12
VSS	2	5	5	4
Turbidity (NTU)	13	10	7	8
Dissolved Oxygen (DO)[c]	ND	ND	ND	ND
BOD_5	3	3	3	3
$CBOD_5$	3	3	3	3
COD	50	22	20	4
TP	0.14	0.12	0.15	0.18
Ortho-Phosphate	0.018	0.017	0.017	0.023
TKN	1.13	1.45	1.13	1.09
Ammonia-N	0.05	0.03	0.10	0.08
NO_3-N	3.408	3.940	4.708	6.215
NO_2-N	0.009	0.007	0.009	0.011
TN	4.55	5.40	5.85	7.32
Chlorophyll *a* (µg/L)	23	27	24	29
	6/05/07	**6/6/07**	**6/7/07**	**6/8/07**
Water Temperature (°C)[b]	18.0	19.9	20.8	21.0
pH (units)[b]	7.8	7.9	7.7	7.7
TSS	13	21	19	13
VSS	4	8	4	7
Turbidity (NTU)	12	17	18	13
Dissolved Oxygen (DO)[c]	ND	ND	ND	ND
BOD_5	3	3	3	0
$CBOD_5$	<2	2	3	<2
COD	29	36	29	34
TP	0.19	0.18	0.24	0.28
Ortho-Phosphate	0.098	0.066	0.108	0.141
TKN	1.56	1.24	1.26	1.33
Ammonia-N	0.04	0.05	0.12	0.05
NO_3-N	3.666	2.851	4.487	6.679
NO_2-N	0.007	0.002	0.005	0.007
TN	5.23	4.09	5.75	8.02
Chlorophyll *a* (µg/L)	16	11	13	13

TABLE 7 (Continued): WATER QUALITY DATA AT JFK BOULEVARD IN SALT CREEK DURING 2007 RAIN EVENTS

Constituents[a]	2007 Rain Event Dates			
	8/7/07	**8/8/07**	**8/9/07**	**8/10/07**
Water Temperature (°C)[b]	25.3	26.7	26.2	26.3
pH (units)[b]	7.4	7.7	7.5	7.7
TSS	32	22	19	15
VSS	13	4	4	5
Turbidity (NTU)	27	26	23	21
Dissolved Oxygen (DO)[c]	ND	ND	ND	ND
BOD_5	19	3	3	3
$CBOD_5$	15	3	<2	4
COD	60	27	25	27
TP	0.82	0.14	0.14	0.14
Ortho-Phosphate	0.365	0.021	0.042	0.031
TKN	4.29	1.24	1.12	1.23
Ammonia-N	1.79	0.20	0.19	0.10
NO_3-N	2.007	0.831	1.159	1.548
NO_2-N	0.076	0.024	0.027	0.028
TN	6.37	2.10	2.31	2.81
Chlorophyll *a* (µg/L)	19	29	30	35

ND=No Data
[a]Expressed in mg/L except where noted.
[b]Field measurement.
[c]Continuous monitoring data implemented in 2005. No grab sample taken for DO.

TABLE 8: WATER QUALITY DATA AT THORNDALE AVENUE IN SALT CREEK DURING 2007 RAIN EVENTS

Constituents[a]	2007 Rain Event Dates			
	4/30/07	**5/1/07**	**5/2/07**	**5/3/07**
Water Temperature (ºC)[b]	19.9	15.4	16.1	16.5
pH (units)[b]	7.7	7.6	7.8	8.6
TSS	18	17	13	20
VSS	5	8	3	8
Turbidity (NTU)	12	13	6	6
Dissolved Oxygen (DO)[c]	ND	ND	ND	ND
BOD_5	4	3	3	3
$CBOD_5$	3	3	2	3
COD	26	24	22	6
TP	0.14	0.14	0.13	0.17
Ortho-Phosphate	0.021	0.012	0.015	0.018
TKN	1.18	1.16	1.14	1.12
Ammonia-N	0.12	0.04	0.14	0.11
NO_3-N	3.835	3.270	4.857	6.016
NO_2-N	0.011	0.0008	0.010	0.013
TN	5.03	4.44	6.01	7015
Chlorophyll *a* (µg/L)	22	27	20	21
	6/05/07	**6/6/07**	**6/7/07**	**6/8/07**[b]
Water Temperature (ºC)[b]	21.0	20.4	21.5	21.3
pH (units)[b]	7.4	7.8	7.6	7.5
TSS	21	28	26	21
VSS	5	8	8	8
Turbidity (NTU)	17	19	20	16
Dissolved Oxygen (DO)[c]	ND	ND	ND	ND
BOD_5	4	<2	4	5
$CBOD_5$	4	<2	3	<2
COD	32	27	36	34
TP	0.21	0.18	0.23	0.23
Ortho-Phosphate	0.097	0.060	0.102	0.127
TKN	1.37	1.25	1.43	1.26
Ammonia-N	0.08	0.05	0.28	0.09
NO_3-N	3.102	2.371	4.130	6.101
NO_2-N	0.015	0.004	0.007	0.012
TN	4.49	3.63	5.57	7.37
Chlorophyll *a* (µg/L)	15	13	15	13

TABLE 8 (Continued): WATER QUALITY DATA AT THORNDALE AVENUE IN SALT CREEK DURING 2007 RAIN EVENTS

Constituents[a]	2007 Rain Event Dates			
	8/7/07	**8/8/07**	**8/9/07**	**8/10/07**[b]
Water Temperature (ºC)[b]	24.5	26.7	26.0	26.3
pH (units)[b]	7.5	7.6	7.5	7.5
TSS	42	19	23	22
VSS	10	8	8	7
Turbidity (NTU)	22	23	23	24
Dissolved Oxygen (DO)[c]	ND	ND	ND	ND
BOD_5	3	5	3	<2
$CBOD_5$	<2	3	<2	3
COD	32	32	25	23
TP	0.21	0.24	0.14	0.19
Ortho-Phosphate	0.096	0.025	0.046	0.042
TKN	1.58	1.31	1.22	1.30
Ammonia-N	0.22	0.17	0.19	0.11
NO_3-N	2.545	0.778	0.969	1.592
NO_2-N	0.014	0.025	0.031	0.028
TN	4.14	2.11	2.22	2.92
Chlorophyll *a* (µg/L)	35	44	32	38

ND=No Data.
[a]Expressed in mg/L except where noted.
[b]Field measurement.
[c]Continuous monitoring data implemented in 2005. No grab sample taken for DO.

TABLE 9: WATER QUALITY DATA FROM JOHN E. EGAN WATER RECLAMATION PLANT EFFLUENT DISCHARGED TO SALT CREEK DURING 2007 RAIN EVENTS

Constituents[a]	2007 Rain Event Dates			
	4/30/07	**5/1/07**	**5/2/07**	**5/3/07**
TSS	2	2	<2	<2
Turbidity (NTU)	0.43	0.31	0.5	0.05
BOD_5	<2	<2	<2	<2
$CBOD_5$	<2	<2	<2	<2
TP	0.15	0.18	0.17	0.25
Ortho-Phosphate	0.099	0.095	0.101	0.117
TKN	1.17	1.13	0.66	1.06
Ammonia-N	0.07	0.07	0.03	0.04
NO_3-N	12.381	13.626	14.624	15.403
NO_2-N	0.006	0.004	0.002	0.001
TN	13.56	14.76	15.29	16.46
	6/05/07	**6/6/07**	**6/7/07**	**6/8/07**[b]
TSS	<2	3	<2	ND
Turbidity (NTU)	1.02	1.94	1.6	0.77
BOD_5	<2	<2	<2	ND
$CBOD_5$	<2	<2	<2	ND
TP	0.37	0.40	0.41	ND
Ortho-Phosphate	0.337	0.325	0.359	0.399
TKN	1.22	0.57	0.79	ND
Ammonia-N	0.24	0.11	0.07	ND
NO_3-N	11.353	12.773	14.896	ND
NO_2-N	0.019	0.007	0.009	ND
TN	12.59	13.35	15.70	ND
	8/7/07	**8/8/07**	**8/9/07**	**8/10/07**[b]
TSS	3	<2	2	ND
Turbidity (NTU)	1.5	0.77	0.89	0.79
BOD_5	<2	<2	<2	ND
$CBOD_5$	<2	<2	<2	ND
TP	0.47	0.34	0.38	ND
Ortho-Phosphate	0.388	0.262	0.294	0.281
TKN	1.07	0.85	1.13	ND
Ammonia-N	0.11	0.08	0.06	ND
NO_3-N	11.927	9.793	9.389	ND
NO_2-N	0.025	0.028	0.006	ND
TN	13.02	10.67	10.53	ND

[a]Expressed in mg/L except where noted.
[b]24-hour composite samples not analyzed on weekends.
ND = No Data.

FIGURE 4: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT BUSSE LAKE DAM IN SALT CREEK JULY 1, 2007 THROUGH JULY 31, 2007

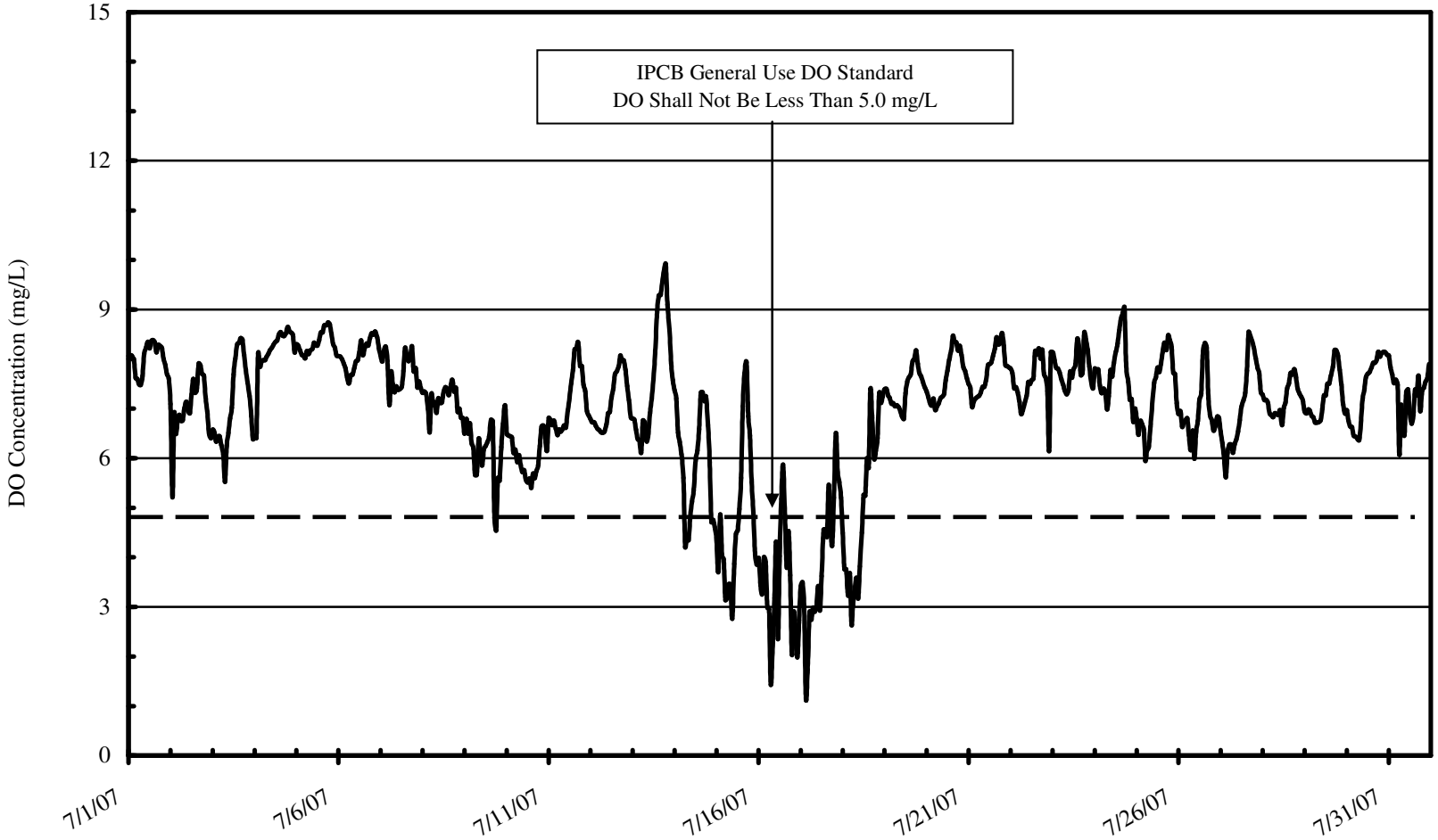

FIGURE 5: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT JFK BOULEVARD IN SALT CREEK JULY 1, 2007 THROUGH JULY 31, 2007

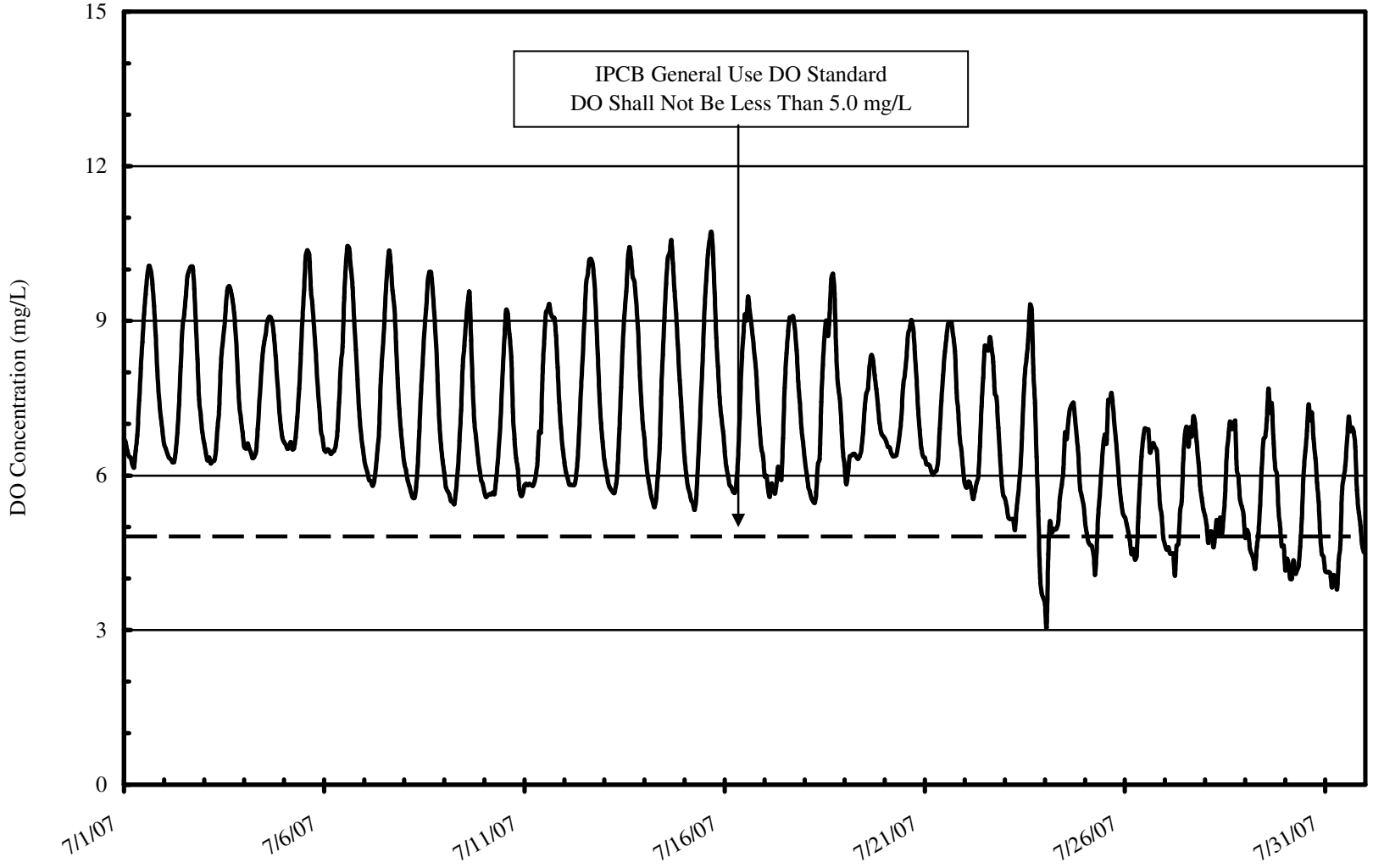

FIGURE 6: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT THORNDALE AVENUE IN SALT CREEK JULY 1, 2007 THROUGH JULY 31, 2007

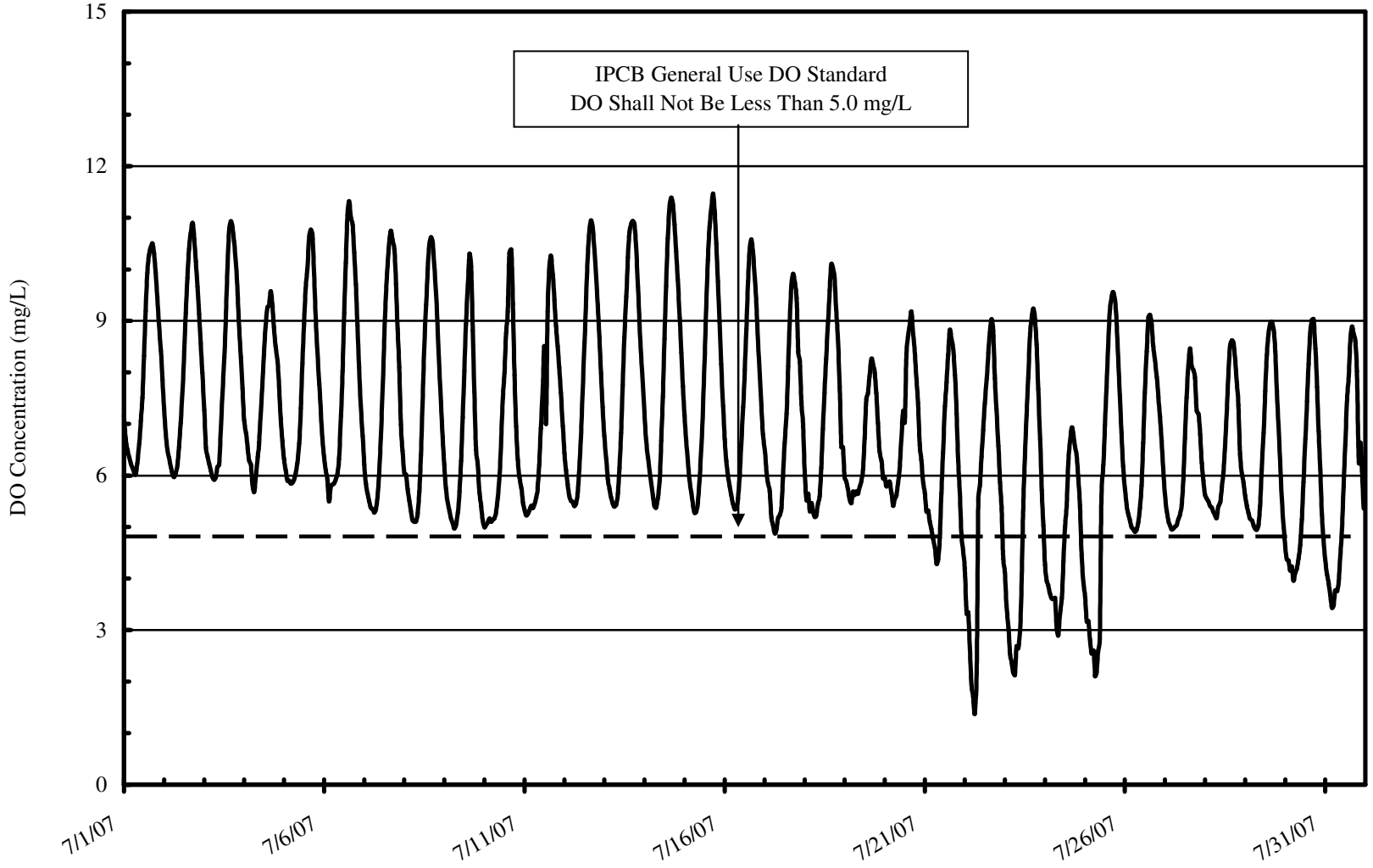

FIGURE 7: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JFK BOULEVARD IN SALT CREEK JANUARY 1, 2007 THROUGH JANUARY 31, 2007

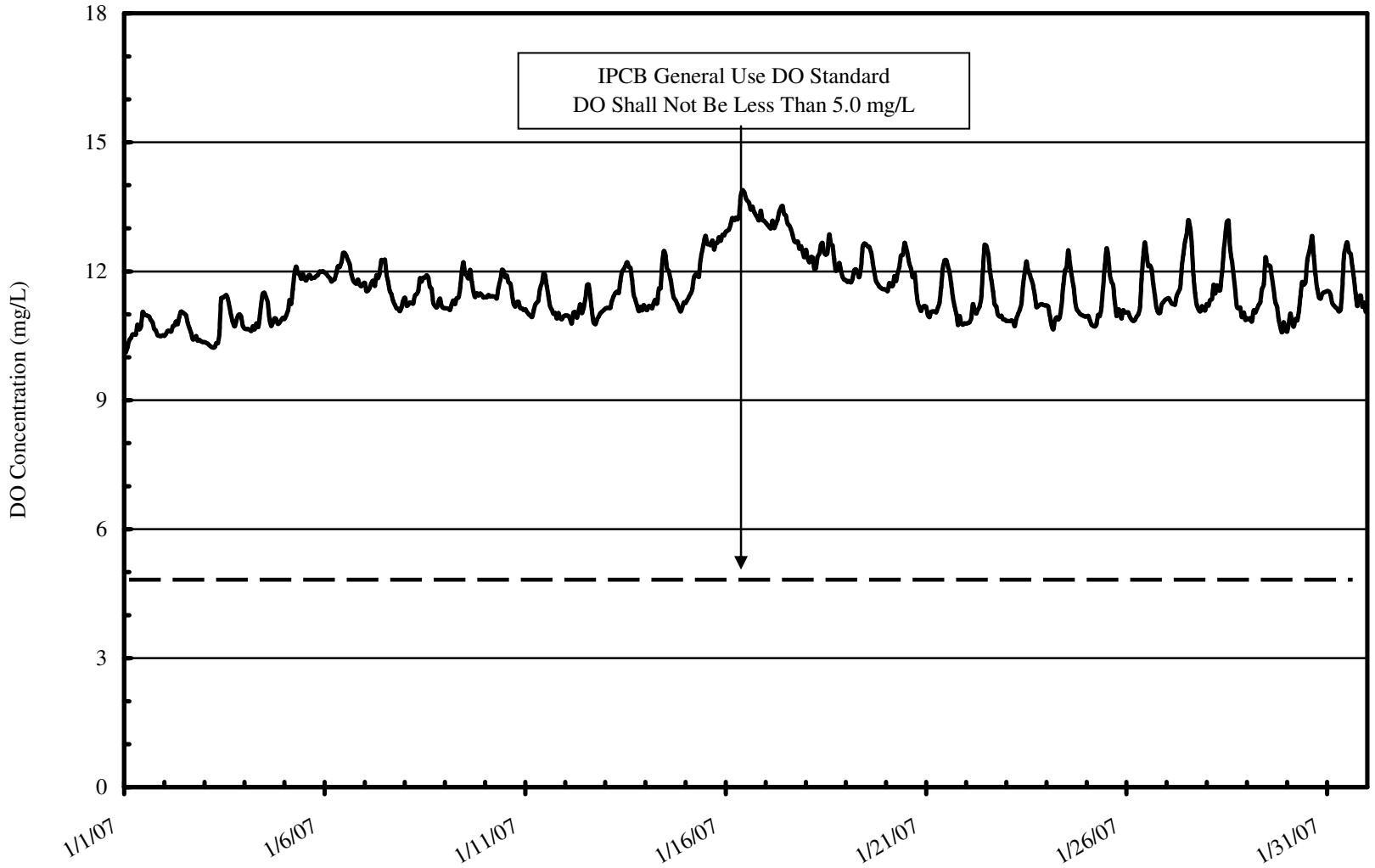

TABLE 10: DISSOLVED OXYGEN FLUCTUATION AT BUSSE LAKE DAM BEFORE AND AFTER PHOSPHORUS REDUCTION AT THE JOHN E. EGAN WRP

Dissolved Oxygen Fluctuation in 24 Hour Period	February 2006 Through January 2007		February 2007 Through January 2008	
	No. of Observations	Percentage of total	No. of Observations	Percentage of total
< 2	321	89.4	315	88.0
2 - <3	22	6.1	27	7.5
3 - <4	8	2.2	7	2.0
4 - <5	6	1.7	6	1.7
>= 5	2	0.6	3	0.8
Total of all Intervals	359	100	358	100

TABLE 11: DISSOLVED OXYGEN FLUCTUATION AT JFK BOULEVARD BEFORE AND AFTER PHOSPHORUS REDUCTION AT THE JOHN E. EGAN WRP

Dissolved Oxygen Fluctuation in 24 Hour Period	February 2006 Through January 2007		February 2007 Through January 2008	
	No. of Observations	Percentage of total	No. of Observations	Percentage of total
< 2	192	52.6	220	60.3
2 - <3	99	27.1	83	22.7
3 - <4	54	14.8	35	9.6
4 - <5	15	4.1	17	4.7
>= 5	5	1.4	10	2.7
Total of all Intervals	365	100	365	100

TABLE 12: DISSOLVED OXYGEN FLUCTUATION AT THORNDALE AVENUE BEFORE AND AFTER PHOSPHORUS REDUCTION AT THE JOHN E. EGAN WRP

Dissolved Oxygen Fluctuation in 24 Hour Period	February 2006 Through January 2007		February 2007 Through January 2008	
	No. of Observations	Percentage of total	No. of Observations	Percentage of total
< 2	96	30.8	121	35.7
2 - <3	60	19.2	96	28.3
3 - <4	62	19.9	49	14.5
4 - <5	46	14.7	28	8.3
>= 5	48	15.4	45	13.3
Total of all Intervals	312	100	339	100

Decreasing P to 0.5 mg/L in Egan WRP effluent did not eliminate diel DO fluctuation at the downstream stations in Salt Creek, nor did it appear to have a dampening effect on the magnitude of these fluctuations. Notably, mean ortho-phosphate concentration (estimate of bioavailable P level) was 0.011 mg/L at Busse Lake Dam during 2007 and large diel DO fluctuations still occurred.

While most of the diel fluctuations throughout the year did not result in the nighttime DO concentrations falling below the IPCB standard, there are studies that suggest the sheer magnitude of a daily DO flux may have a negative impact on stream biota, irrespective of the DO minima (Heiskary, 2007 and Miltner, 2007). However, the causal mechanisms of these observations are unknown.

Biological Quality

Chlorophyll and Algae. Sestonic algae or phytoplankton, is estimated by analyzing the chlorophyll *a* concentration in the water column. These data are included in the water quality tables (Tables 2–8). Chlorophyll *a* concentrations were highest upstream of the Egan WRP at the Busse Lake Dam sampling station, with means of 29, 30, and 31 µg/L for 2005, 2006, and 2007, respectively. These elevated concentrations were likely due to the high residence time and slow-moving water in the wide upstream area of Busse Lake. At JFK Boulevard, mean chlorophyll *a* concentrations were 10, 16, and 13 µg/L during 2005, 2006, and 2007, respectively. Similarly, mean concentrations were 11, 17, and 14 µg/L, respectively, at Thorndale Avenue. The evident decrease in algae between Busse Lake Dam and JFK Boulevard represent dilution by the Egan WRP effluent discharged into Salt Creek.

A statistical comparison of data show there was no difference in water column chlorophyll *a* concentrations pre and post P reduction at Egan, despite the substantial decrease in stream P (Table 13).

Generally, algae are limited by either nutrients (N or P), light, or habitat (substrate in the case of periphyton). In Illinois, analyses of several water quality surveys have failed to show a significant correlation between any form of nutrients and chlorophyll *a* measured either in the water column or extracted from a substrate (Terrio, 2007). This indicates the lack of nutrient limitation in most Illinois streams, and suggests that phytoplankton are light limited since nutrients are generally available in high concentrations. Various threshold concentrations for TP limitation of algae have been reported in the literature, some as low as 0.05 mg/L (Dodds *et al*. 2000, Stevenson 2006, and Hill et al. 2007).

Fish. Table 14 identifies the number of fish collected and species percentage composition for each station, as well as for Devon Avenue on Salt Creek. Fish sampling is performed annually at Devon Avenue as part of the District's AWQM Program. Both total number of fish collected and number of species collected were highest at Busse Lake Dam and lowest at Devon Avenue. Along the sampling reach, a total of 348 fish were collected, consisting of 13 species during 2007, following Egan WRP P reduction. During 2005 and 2006 combined, 402 fish were collected of 13 species. Detailed fish data for the pre P reduction sampling period is included in R&D Report number 07-24 (Wasik 2007).

TABLE 13: STATISTICAL COMPARISON OF CHLOROPHYLL *A* VALUES AT BUSSE LAKE DAM, JFK BOULEVARD, AND THORNDALE AVENUE BEFORE (PRE) AND AFTER (POST) PHOSPHORUS REDUCTION AT THE JOHN E. EGAN WRP

Station	Statistics						Significance Probability*			
	No. of Obs		**Mean**		**Standard Deviation**		**H_0: Normal**		**H_0: $\sigma_1=\sigma_2$**	**H_0: $\mu_1=\mu_2$**
	Pre	Post	Pre (ug/L)	Post (ug/L)	Pre s_1	Post s_2	Pre p_1	Post p_2		
Busse Lake Dam	56	31	34.3	31.4	16.1	17.4	0.422	0.544	0.301	0.437
JFK Boulevard	57	31	17.0	16.4	13.1	10.6	0.442	0.665	0.102	0.827
Thorndale Avenue	57	31	17.3	17.7	12.4	11.0	0.390	0.766	0.238	0.881

*Significance probability greater than 0.05 indicates that the null hypothesis (H_0) should be accepted, the means and standard deviations are not significantly different.

TABLE 14: NUMBER OF FISH COLLECTED (N) AND SPECIES PERCENTAGE COMPOSITION (%) FROM SALT CREEK DURING 2007

Fish Species	Salt Creek Sample Stations								Total Collections	
	Busse Lake Dam		JFK Boulevard		Devon Avenue		Thorndale Road			
	N	%	N	%	N	%	N	%	N	%
Black crappie[1]	6	2.3	0	0.0	0	0.0	0	0.0	6	1.7
Blackstripe topminnow	1	0.4	0	0.0	0	0.0	4	12.9	5	1.4
Bluegill[1]	48	18.6	1	2.6	0	0.0	1	3.2	50	14.4
Bluntnose minnow	0	0.0	0	0.0	4	20.0	0	0.0	4	1.1
Carp	1	0.4	0	0.0	0	0.0	1	3.2	2	0.6
Golden shiner	3	1.2	0	0.0	0	0.0	0	0.0	3	0.9
Green sunfish[1]	12	4.7	22	56.4	12	60.0	19	61.3	65	18.7
Green sunfish x Bluegill[2]	1	0.4	0	0.0	0	0.0	0	0.0	1	0.3
Largemouth bass[1]	67	26.0	1	2.6	1	5.0	0	0.0	69	19.8
Orangespotted sunfish[1]	12	4.7	12	30.8	0	0.0	0	0.0	24	6.9
Pumpkinseed sunfish[1]	10	3.9	1	2.6	0	0.0	0	0.0	11	3.2
Spotfin shiner	97	37.6	0	0.0	0	0.0	1	3.2	98	28.2
Yellow bullhead[1]	0	0.0	1	2.6	3	15.0	5	16.1	9	2.6
White sucker	0	0.0	1	2.6	0	0.0	0	0.0	1	0.3
Total Fish	258		39		20		31		348	
Total Game fish	155		38		16		25		234	
Total Species	11		7		4		6		13	

[1]Game fish.
[2]Hybrid species not included in total species count.

IBI scores (Karr et al. 1986) for sample collections at each of the stations between 2005-2007 can be found in Table 15. However, with such small numbers of fish collected, scores calculated using this index can be misleading. For instance, if only 1 fish is collected in a particular sampling haul and an IBI is computed, as long as the fish was non-diseased and not a green sunfish (tolerant species), these metrics will receive the highest score. Therefore, the score may be artificially higher than another station where more individuals were caught and the incidence of disease, as well as the proportion of green sunfish was higher. For this reason, it may be prudent to avoid using IBI scores when there are a low number of individuals caught.

Since the Salt Creek fish collection methods almost always result in a catch number of less than 50 individuals, this might preclude using the IBI for these sampling stations. Rather than exclude the use of the IBI altogether, Table 15 reports the number of fish caught using each sampling method along with the IBI scores so that this issue can be considered. For the most part, IBI scores for Salt Creek during 2005-2007 were in the "fair" range of the narrative IBI classifications set forth by IEPA (IEPA 1996).

Studies have shown a negative correlation between TP and IBI, and a positive correlation with tolerant taxa (Miltner and Rankin, 1998 and Robertson et al. 2006). The threshold for TP affecting fish IBI was reported to be as low as 0.06 mg/L (Robertson et al. 2006). However, the causal mechanism between the correlation is unclear from this study. Theoretically, the effect on fish would be mediated through algal effects on DO. Since DO has not been affected by the P reduction at the Egan WRP, any variation in fish data between pre and post year collections is not expected to have resulted from the decreased stream TP concentration.

Benthic Invertebrates. Benthic invertebrates collected during 2006 and 2007 are currently being identified and will be discussed in the final report, after the demonstration project is completed.

Sediment Quality

Sediment chemistry from the three sampling stations during 2005-2007 is shown in Table 16. Chemical constituents in the sediment, including P, were extremely variable between stations and years. This variability can be expected from grab sediment samples since contaminants are not uniformly distributed throughout the channel bed, and there can be "hot spots," or areas with higher concentrations of deposited contaminants.

Physical Habitat Quality

Busse Lake Dam is located approximately 500 feet upstream of the Egan WRP outfall. The dam marks the end of a wide, slow-moving, 2-mile segment of Salt Creek known as Busse Lake. Water depth within the 130-foot sampling reach at Busse Lake Dam was between 1–2 feet under normal conditions, and would be characterized as "run" stream habitat. Aquatic macrophytes such as Eurasian watermilfoil, leafy pondweed, and water grasses covered approximately 20 percent of the sampling area. Canopy cover ranged from completely shaded to wide open,

TABLE 15: CATCH NUMBERS, INDEX OF BIOTIC INTEGRITY (IBI) SCORES AND CATEGORIES FOR BUSSE LAKE DAM, JFK BOULEVARD, DEVON AVENUE, AND THORNDALE AVENUE IN SALT CREEK DURING 2005, 2006, AND 2007

Location	Year	Sampling Gear	Number of Individuals in Catch	IBI Score	IBI Category
Busse Lake Dam	2005	BP	49	34	Fair
		Seine	56	30	Fair
	2006	BP	34	30	Fair
		Seine	ND	ND	ND
	2007	BP	52	22	Fair
		Seine	206	46	Good
Devon Avenue	2005	BP	33	24	Fair
		Seine	16	34	Fair
	2006	BP	63	24	Fair
		Seine	1	28	Fair
	2007	BP	20	20	Poor
		Seine	0	NA	NA
JFK Boulevard	2005	BP	22	26	Fair
		Seine	15	32	Fair
	2006	BP	103	22	Fair
		Seine	33	30	Fair
	2007	BP	36	28	Fair
		Seine	3	34	Fair
Thorndale Avenue	2005	BP	31[a]	30	Fair
		Seine	3	28	Fair
	2006	BP	31[a]	26	Fair
		Seine	7	28	Fair
	2007	BP	31[a]	22	Fair
		Seine	0	NA	NA

BP = Backpack Electrofisher
NA = No fish were caught so IBI could not be calculated.
ND = No seine haul due to unfavorable conditions.
[a]Coincidently, 31 fish were caught at Thorndale Avenue with the backpack electrofisher each of the three years.

TABLE 16: CHEMICAL CHARACTERISTICS OF SEDIMENT COLLECTED AT BUSSE LAKE DAM, JFK BOULEVARD, AND THORNDALE AVENUE IN SALT CREEK DURING 2007, POST PHOSPHORUS REDUCTION AT THE JOHN E. EGAN WRP

Station Name	Location in Waterway	Sample Date	Constituents (Expressed on a dry weight basis)							
			Total Solids (%)	Total Volatile Solids (% of Total)	Total Phos-phorus (mg/kg)	Ammonia Nitrogen (mg/kg)	Total Kjeldahl Nitrogen (mg/kg)	Nitrite + Nitrate Nitrogen (mg/kg)	Total Cyanide (mg/kg)	Phenols (µg/kg)
Busse Lake Dam	Center	8/04/05	72	2	84	5	217	2	0.012	37.5
Busse Lake Dam	Side	8/04/05	68	3	141	5	223	1	0.015	80.7
Busse Lake Dam	Center	6/28/06	80	2	46	2	86	6	<0.003	21.2
Busse Lake Dam	Side	6/28/06	75	2	94	2	244	5	0.013	14.6
Busse Lake Dam	Center	6/25/07	77	3	4	9	8	5	0.006	34.9
Busse Lake Dam	Side	6/25/07	76	3	6	5	8	6	0.007	24.9
JFK Boulevard	Center	8/03/05	81	2	218	4	238	4	0.022	41.7
JFK Boulevard	Side	8/03/05	84	2	222	16	423	3	<0.003	33.5
JFK Boulevard	Center	7/06/06	69	2	37	6	65	2	<0.003	31.8
JFK Boulevard	Side	7/06/06	78	2	11	1	27	8	<0.003	113.3
JFK Boulevard	Center	6/27/07	65	3	382	7	655	3	0.035	210.2
JFK Boulevard	Side	6/27/07	63	4	705	7	895	4	0.086	66.9
Thorndale Avenue	Center	8/04/05	30	14	1,205	14	1,255	4	0.170	143.1
Thorndale Avenue	Side	8/04/05	69	2	460	3	282	3	0.014	69.3
Thorndale Avenue	Center	7/05/06	76	1	11	<1	24	7	0.013	43.2
Thorndale Avenue	Side	7/05/06	68	4	42	3	266	3	0.007	35.1
Thorndale Avenue	Center	6/27/07	75	2	336	2	471	5	0.056	72.2
Thorndale Avenue	Side	6/27/07	68	3	557	11	1,017	8	0.041	69.5

and immediate shore cover consisted of grasses, shrubs, and trees. Bank erosion throughout the study reach during 2007 was slight. Riparian land use in the area is "forest," managed by the Forest Preserve District of Cook County. Depth of fines in the streambed sediment ranged from 0.4-2.8 feet, with deeper sediment in the center of the creek. Sediment was comprised of sand, gravel, and silt, with a normal amount of embeddedness.

The JFK Boulevard sampling station is located approximately 0.7 mile from the Egan WRP outfall. Water depth within the 130-foot sampling reach was between 1–2 feet under normal conditions, and would be characterized as "pool" stream habitat near the JFK Boulevard Bridge, and "run" stream habitat upstream of the bridge. Eurasian watermilfoil, leafy pondweed, and filamentous algae covered about 50 percent of the sampling area in June of 2007. There was little canopy cover and the immediate shore cover consisted of maintained grass. Bank erosion is controlled throughout the study reach with inter-locking concrete bank stabilizers. Riparian land use in the area is urban residential. Depth of fines in the streambed sediment was as deep as 5 feet near the JFK Boulevard Bridge in the side and center of the creek. Sediment was comprised mostly of sand, with silt, plant debris, gravel, and boulders in localized areas, and there was a normal amount of embeddedness.

The Thorndale Avenue sampling station is located approximately 2.4 miles from the Egan WRP outfall. Water depth within the 130-foot sampling reach was between 1–2 feet under normal conditions, and would be characterized as a "run" stream habitat. Eurasian watermilfoil and leafy pondweed covered approximately 10 percent of the sampling area in June of 2007. Canopy cover throughout the reach was open to shaded, and immediate shore cover consisted of grasses, shrubs, and trees. Bank erosion throughout the study reach was moderate and riparian land use in the area was primarily urban industrial. Depth of fines in the streambed sediment ranged from 0.8–2.0 feet in the sampling reach. Sediment was comprised mostly of sand, with silt, gravel and plant debris, and normal embeddedness.

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