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Metropolitan Water Reclamation District of Greater Chicago

***RESEARCH AND DEVELOPMENT
DEPARTMENT***

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SALT CREEK PHOSPHORUS REDUCTION DEMONSTRATION

PROJECT INTERIM REPORT:

PRE-PHOSPHORUS REDUCTION CONDITIONS

May 2007

Metropolitan Water Reclamation District of Greater Chicago
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PROJECT INTERIM REPORT:
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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.

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. There are 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 at least until February 2008 (one year after P reduction went on-line). Subsequently, the District will generate a report to summarize the findings from the Project.

Notable findings from 2005–2006 pre-reduction monitoring on Salt Creek were as follows:

- Mean TP concentrations were lowest at Busse Lake Dam (0.3 and 0.2 mg/L during 2005 and 2006, respectively). The mean TP concentrations at JFK Boulevard were 2.76 and 2.20 mg/L, while at Thorndale Avenue; they measured 2.51 and 2.12 mg/L TP.
- 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.
- Diel fluctuations of DO, characteristic of elevated algae concentrations, occurred at all three stations.
- Chlorophyll *a* concentrations in the water column were highest upstream of the Egan WRP outfall, and were diluted by Egan WRP effluent.

- 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 in the downstream direction, although numbers of several game fish were observed to be greater at JFK Boulevard downstream of the Egan WRP than they were at Busse Lake Dam upstream of the Egan WRP.

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 and uncertainty regarding appropriate nutrient standards, the District agreed to conduct a large-scale phosphorus removal demonstration project at its Egan WRP.

Scope of Project

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). Mean TP concentration of 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. 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 in 2005 and again in 2006. Phosphorus removal by ferric chloride chemical treatment at Egan WRP went on-line on February 5, 2007. All monitoring activities are ongoing and will be performed throughout 2007 for comparison.

Study Location

Sampling Stations. 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.

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 final effluent composite samples from the Egan WRP were analyzed for total suspended solids (TSS), biochemical oxygen demand (BOD₅), carbonaceous biochemical oxygen demand (CBOD₅), TP, total Kjeldahl nitrogen (TKN), ammonia-nitrogen (NH₃-N), nitrite-nitrogen (NO₂-N), and nitrate-nitrogen (NO₃-N) at the Egan Analytical Laboratory. An aliquot of the 24-hour final effluent composite 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, and April, May, and August of 2006.

Algal Growth Test. Water samples from the three Salt Creek sampling stations and an Egan WRP effluent grab sample were analyzed quarterly in 2005 using the *Selenastrum capricornutum* Printz Algal Assay Bottle Test (AGT) as described by USEPA (EPA-600/9-78-018, 1978). In 2006, the AGT was performed once per month in January, April, June, and August–December. This algal bioassay assesses the concentration of biologically available P.

Sediment Samples

Sediment samples were collected once each summer during 2005 and 2006 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 put on ice before delivery to the laboratory for analysis. Chemical constituents measured in sediments were as follows: total solids (TS), total volatile solids (TVS), NH₃-N, NO₃-N and NO₂-N, TKN, and TP.

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

| 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 <i>a</i> | Spectrophotometric | SM 10200-H |
| pH | Electrode ^a | SM 4500-H B |
| Dissolved Oxygen | Iodometric ^b | SM 4500-O C |
| Algal Growth Test | <i>Selenastrum</i> Algal Assay | EPA-600/9-78-018 |

^aField measurement taken during water sampling events and continuously monitored since installation of water quality monitor.

^bMethod 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 and 2006. At JFK Boulevard and Thorndale Avenue fishing began at the street bridge, and at Busse Lake Dam 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.

Benthic Invertebrates. Benthic invertebrate communities were assessed during the summers of 2005 and 2006 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 due to concerns over vandalism. 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 invertebrates to species (when possible), with the exception of oligochaetes, which were counted by trained AEWQ personnel.

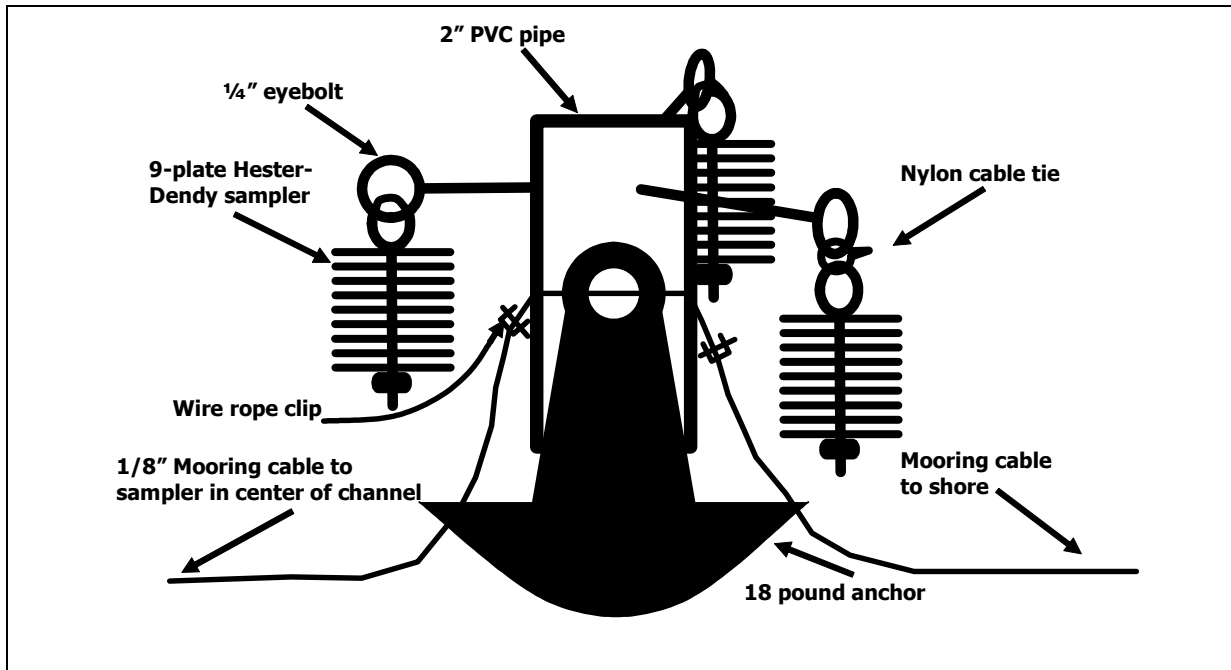
Physical Habitat

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 monitoring (hourly) DO at JFK Boulevard and Thorndale Avenue since August of 2005

FIGURE 2: CONFIGURATION OF HESTER DENDY LARVAL PLATE SAMPLER



**FIGURE 3 (Continued): METROPOLITAN WATER RECLAMATION DISTRICT OF
GREATER CHICAGO PHYSICAL HABITAT ASSESSMENT**

| | | | | | |
|---|---|--------------------------|----------------------------|-----------|-----------------------------|
| | | | | | Station Number _____ |
| Sediment Composition | 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 | <small>(circle one)</small> |
| Embeddedness | NONE | NORMAL | MODERATE | EXTENSIVE | <small>(circle one)</small> |
| Sinuosity | NONE | LOW | MODERATE | HIGH | <small>(circle one)</small> |
| 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 _____

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 the Deep-Draft Chicago Waterway System During 2005” (Minarik *et al.*, 2006).

RESULTS AND DISCUSSION

Water Quality

Average and range values for water quality constituents measured during scheduled sampling events in 2005 and 2006 are shown in [Tables 2](#) and [3](#), respectively.

Rain Event Sampling. Water quality data from rain event sampling in 2005 are displayed in [Tables 4–7](#), and 2006 rain event data are compiled in [Tables 8–11](#). At JFK Boulevard and Thorndale Avenue, TP and ortho-phosphate both tended to increase with each sequential sampling day, after the rain events.

Algal Growth Test. At the Busse Lake Dam sampling station, the *Selenastrum capricornutum* bioassay indicated a low or non-detectable concentration of P that was biologically available for uptake by algae, which was consistent with this station having the lowest TP concentration ([Tables 2 and 3](#)). However, the chlorophyll a concentration was highest at this location, suggesting that most of the available P had already been assimilated by the algae. Biologically available P was estimated to be highest in water samples from the Egan WRP effluent, presumably since it had yet to be taken up by plants or algae. JFK Boulevard and Thorndale Avenue had lower bioavailable concentrations of P than the Egan WRP effluent, according to the bioassay. Mean bioavailable P was approximately 50 to 70 percent lower than mean ortho-phosphate concentrations at JFK Boulevard, Thorndale Avenue, and in the Egan WRP effluent.

Dissolved Oxygen. At the Busse Lake Dam sampling station, there were no DO readings below the IPCB standard of 5.0 mg/L between October (when the continuous DO monitor was installed) and December 2005. During 2006, 97.6 percent of the hourly readings showed compliance with the standard at Busse Lake Dam. JFK Boulevard had 92.8 percent compliance with the 5.0 mg/L standard between August (when the continuous DO monitors were installed at JFK Boulevard and Thorndale Avenue) and December 2005, and Thorndale Avenue showed 92.7 percent compliance. Compliance during 2006 was 100 percent and 98.6 percent at JFK Boulevard and Thorndale Avenue, 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 sestonic (water column) algae. Examples from August of 2006 are provided in [Figures 4–6](#). [Figure 5](#) shows DO conditions upstream of Egan WRP at Busse Lake Dam, where nighttime concentrations fall below the standard. Diel flux also occurs to a lesser magnitude during the winter months as displayed in [Figure 7](#). While most of the diel fluctuations do not result in the nighttime DO concentrations falling below the IPCB standard, there are indications that 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). Theoretically, decreasing P to a point in which it begins to limit algae growth would lower the magnitude of diel DO flux, however, mean ortho-phosphate and bioavailable phosphorus levels were well below 0.07 mg/L at Busse Lake Dam and large diel DO flux was still observed to occur.

TABLE 2: SUMMARY OF WATER QUALITY BEFORE PHOSPHORUS REMOVAL IN SALT CREEK AT BUSSE LAKE DAM, JFK BOULEVARD, AND THORNDALE AVENUE BETWEEN FEBRUARY AND DECEMBER OF 2005*

| Sampling Station | Constituents ^a | Range | Average |
|------------------|-------------------------------------|-----------------|---------|
| Busse Lake Dam | Water Temperature (°C) ^b | 1.9 – 33.5 | 18.4 |
| | pH (units) ^b | 7.1 – 8.4 | 7.8 |
| | TSS | <3 – 34 | 14 |
| | VSS | <3 – 23 | 8 |
| | Turbidity (NTU) | 5 – 23 | 12 |
| | Dissolved Oxygen (DO) | 3.7 – 13.5 | 8.6 |
| | BOD ₅ | <2 – 8 | 4 |
| | CBOD ₅ | <2 – 5 | 4 |
| | COD | 25 – 55 | 37 |
| | TP | <0.05 – 3.15 | 0.25 |
| | Ortho-Phosphate | 0.005 – 2.727 | 0.263 |
| | TKN | 0.70 – 1.47 | 1.11 |
| | Ammonia-N | <0.02 – 0.34 | 0.13 |
| | NO ₃ -N | <0.005 – 11.436 | 0.762 |
| | NO ₂ -N | <0.005 – 0.047 | 0.014 |
| | TN | 0.739 – 12.796 | 1.881 |
| | Chlorophyll <i>a</i> (µg/L) | 7 – 63 | 29 |
| | AGT (mg P/L) ^c | <0.01 – 0.05 | 0.03 |
| JFK Boulevard | Water Temperature (°C) ^b | 1.1 – 28.1 | 17.8 |
| | pH (units) ^b | 7.1 – 8.0 | 7.6 |
| | TSS | <3 – 26 | 8 |
| | VSS | <3 – 11 | 4 |
| | Turbidity (NTU) | 3 – 16 | 6 |
| | Dissolved Oxygen (DO) | 5.5 – 11.8 | 8.1 |
| | BOD ₅ | <2 – 4 | 3 |
| | CBOD ₅ | <2 – 6 | 3 |
| | COD | 17 – 43 | 28 |
| | TP | 0.88 – 4.64 | 2.76 |
| | Ortho-Phosphate | 0.720 – 4.280 | 2.587 |
| | TKN | 0.77 – 1.66 | 1.21 |
| | Ammonia-N | <0.02 – 0.43 | 0.14 |
| | NO ₃ -N | 4.678 – 20.832 | 12.466 |
| | NO ₂ -N | 0.005 – 0.072 | 0.026 |
| | TN | 5.710 – 22.214 | 13.700 |
| | Chlorophyll <i>a</i> (µg/L) | 3 – 29 | 10 |
| | AGT (mg P/L) ^c | 0.83 – 1.29 | 1.06 |

TABLE 2 (CONTINUED): SUMMARY OF WATER QUALITY BEFORE PHOSPHORUS REMOVAL IN SALT CREEK AT BUSSE LAKE DAM, JFK BOULEVARD, AND THORNDALE AVENUE BETWEEN FEBRUARY AND DECEMBER OF 2005*

| Sampling Station | Constituents ^a | Range | Average |
|---------------------------|-------------------------------------|-----------------|---------|
| Thorndale Avenue | Water Temperature (°C) ^b | 4.9 – 28.5 | 17.6 |
| | pH (units) ^b | 7.0 – 8.4 | 7.7 |
| | TSS | <3 – 24 | 13 |
| | VSS | <3 – 18 | 5 |
| | Turbidity (NTU) | 3 – 20 | 9 |
| | Dissolved Oxygen (DO) | 4.8 – 12.6 | 7.2 |
| | BOD ₅ | <2 – 11 | 3 |
| | CBOD ₅ | <2 – 4 | 3 |
| | COD | 21 – 40 | 29 |
| | TP | <0.05 – 4.45 | 2.51 |
| | Ortho-Phosphate | 0.04 – 4.47 | 2.38 |
| | TKN | 0.94 – 1.73 | 1.28 |
| | Ammonia-N | 0.040 – 0.350 | 0.183 |
| | NO ₃ -N | 0.041 – 19.642 | 11.156 |
| | NO ₂ -N | <0.005 – 0.087 | 0.035 |
| | TN | 1.01 – 20.90 | 12.47 |
| | Chlorophyll <i>a</i> (µg/L) | 3 – 34 | 11 |
| AGT (mg P/L) ^c | 0.81 – 1.51 | 1.16 | |
| John E. Egan Outfall | TSS | <2 – 2 | 2 |
| | Turbidity (NTU) | <1 – 3 | 1 |
| | BOD ₅ | <2 – 2 | 2 |
| | CBOD ₅ | <2 – 2 | 2 |
| | TP | 1.87 – 5.23 | 3.41 |
| | Ortho-Phosphate | 2.130 – 4.712 | 3.249 |
| | TKN | 0.82 – 2.16 | 1.22 |
| | Ammonia-N | <0.04 – 0.240 | 0.098 |
| | NO ₃ -N | 13.063 – 20.770 | 16.576 |
| | NO ₂ -N | <0.005 – 0.111 | 0.020 |
| | TN | 13.92 – 23.01 | 17.82 |
| AGT (mg P/L) ^c | 1.05 – 1.60 | 1.43 | |

*During scheduled sampling. Not including rain event data.

^aExpressed in mg/L except where noted.

^bField measurement.

^cAnalyzed quarterly.

TABLE 3: SUMMARY OF WATER QUALITY BEFORE PHOSPHORUS REMOVAL IN SALT CREEK AT BUSSE LAKE DAM, JFK BOULEVARD, AND THORNDALE AVENUE BETWEEN JANUARY AND DECEMBER OF 2006*

| Sampling Station | Constituents ^a | Range | Average |
|------------------|-------------------------------------|----------------|---------|
| Busse Lake Dam | Water Temperature (°C) ^b | 3.6 – 30.1 | 15.9 |
| | pH (units) ^b | 7.1 – 8.7 | 8.1 |
| | TSS | <3 – 35 | 13 |
| | VSS | <3 – 24 | 8 |
| | Turbidity (NTU) | 8 – 41 | 16 |
| | Dissolved Oxygen (DO) ^c | 0.3 – 17.6 | 10.6 |
| | BOD ₅ | <2 – 6 | 4 |
| | CBOD ₅ | <2 – 6 | 3 |
| | COD | 16 – 46 | 30 |
| | TP | 0.02 – 0.87 | 0.18 |
| | Ortho-Phosphate | 0.003 – 0.158 | 0.026 |
| | TKN | 0.97 – 1.92 | 1.33 |
| | Ammonia-N | <0.02 – 0.33 | 0.09 |
| | NO ₃ -N | <0.005 – 5.673 | 0.541 |
| | NO ₂ -N | <0.004 – 0.039 | 0.016 |
| | TN | 1.15 – 6.83 | 1.89 |
| | Chlorophyll <i>a</i> (µg/L) | 15 – 82 | 30 |
| | AGT (mg P/L) ^d | <0.01 – 0.04 | 0.02 |
| JFK Boulevard | Water Temperature (°C) ^b | 5.6 – 25.2 | 16.5 |
| | pH (units) ^b | 6.9 – 8.0 | 7.6 |
| | TSS | 3 – 32 | 10 |
| | VSS | <3 – 18 | 6 |
| | Turbidity (NTU) | 3 – 41 | 11 |
| | Dissolved Oxygen (DO) ^c | 5.1 – 13.5 | 9.1 |
| | BOD ₅ | <2 – 6 | 3 |
| | CBOD ₅ | <2 – 5 | 3 |
| | COD | 18 – 36 | 28 |
| | TP | 0.22 – 5.49 | 2.20 |
| | Ortho-Phosphate | 0.099 – 4.663 | 1.728 |
| | TKN | 1.07 – 1.70 | 1.32 |
| | Ammonia-N | <0.02 – 0.19 | 0.09 |
| | NO ₃ -N | 0.936 – 19.945 | 8.085 |
| | NO ₂ -N | 0.006 – 0.071 | 0.021 |
| | TN | 2.07 – 21.66 | 9.43 |
| | Chlorophyll <i>a</i> (µg/L) | 2 – 42 | 16 |
| | AGT (mg P/L) ^d | 0.04 – 1.06 | 0.55 |

TABLE 3 (Continued): SUMMARY OF WATER QUALITY BEFORE PHOSPHORUS REMOVAL IN SALT CREEK AT BUSSE LAKE DAM, JFK BOULEVARD, AND THORNDALE AVENUE BETWEEN JANUARY AND DECEMBER OF 2006*

| Sampling Station | Constituents ^a | Range | Average |
|---------------------------|-------------------------------------|-----------------|---------|
| Thorndale Avenue | Water Temperature (°C) ^b | 4.8 – 25.3 | 16.2 |
| | pH (units) ^b | 6.7 – 7.9 | 7.5 |
| | TSS | 3 – 32 | 13 |
| | VSS | <3 – 13 | 6 |
| | Turbidity (NTU) | 5 – 40 | 12 |
| | Dissolved Oxygen (DO) ^c | 2.8 – 16.0 | 9.2 |
| | BOD ₅ | <2 – 5 | 3 |
| | CBOD ₅ | <2 – 5 | 3 |
| | COD | 19 – 40 | 29 |
| | TP | 0.27 – 5.30 | 2.12 |
| | Ortho-Phosphate | 0.145 – 4.506 | 1.713 |
| | TKN | 1.01 – 1.96 | 1.35 |
| | Ammonia-N | <0.02 – 0.34 | 0.08 |
| | NO ₃ -N | 1.992 – 18.849 | 8.132 |
| | NO ₂ -N | 0.009 – 0.036 | 0.022 |
| | TN | 3.30 – 20.52 | 9.50 |
| | Chlorophyll <i>a</i> (µg/L) | 3 – 42 | 17 |
| AGT (mg P/L) ^d | <0.01 – 0.88 | 0.45 | |
| John E. Egan Outfall | TSS | <2 – 2 | 2 |
| | Turbidity (NTU) | <1 – 3 | 1 |
| | BOD ₅ | <2 – 2 | 2 |
| | CBOD ₅ | <2 – 2 | 2 |
| | TP | 1.52 – 5.61 | 3.70 |
| | Ortho-Phosphate | 1.443 – 5.256 | 3.397 |
| | TKN | 0.98 – 1.63 | 1.31 |
| | Ammonia-N | <0.04 – 0.13 | 0.07 |
| | NO ₃ -N | 11.207 – 19.842 | 15.566 |
| | NO ₂ -N | <0.005 – 0.038 | 0.013 |
| | TN | 12.49 – 21.25 | 16.70 |
| | AGT (mg P/L) ^d | 0.82 – 1.21 | 1.04 |

* 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.

^d Analyzed eight times in 2006.

TABLE 4: WATER QUALITY DATA AT BUSSE LAKE DAM IN SALT CREEK DURING 2005 RAIN EVENTS

| Constituents ^a | 2005 Rain Event Dates | | | |
|-------------------------------------|-----------------------|-----------------|-----------------|-----------------|
| | <u>7/26/05</u> | <u>7/27/05</u> | <u>7/28/05</u> | <u>7/29/05</u> |
| Water Temperature (°C) ^b | 27.2 | 25.3 | 25.6 | 25.3 |
| pH (units) ^b | 6.5 | 7.5 | 8.2 | 7.6 |
| TSS | 16 | 22 | 16 | 19 |
| VSS | 8 | 9 | 6 | 16 |
| Turbidity (NTU) | 13 | 21 | 16 | 15 |
| Dissolved Oxygen (DO) | 5.2 | 5.7 | 6.5 | 7.1 |
| BOD ₅ | <2 | 3 | 3 | 5 |
| CBOD ₅ | <2 | <2 | <2 | 4 |
| COD | 49 | 49 | 47 | 47 |
| TP | 0.06 | 0.11 | 0.01 | 0.07 |
| Ortho-Phosphate | 0.028 | 0.141 | 0.075 | 0.048 |
| TKN | 0.88 | 1.36 | 1.06 | 1.24 |
| Ammonia-N | 0.04 | 0.05 | 0.03 | 0.14 |
| NO ₃ -N | 0.048 | <0.005 | <0.005 | 0.010 |
| NO ₂ -N | 0.005 | 0.016 | 0.010 | 0.010 |
| TN | 0.93 | 1.38 | 1.07 | 1.26 |
| Chlorophyll <i>a</i> (µg/L) | 38 | 51 | 50 | 61 |
| | <u>10/25/05</u> | <u>10/26/05</u> | <u>10/27/05</u> | <u>10/28/05</u> |
| Water Temperature (°C) ^b | 10.9 | 10.5 | 10.8 | 10.0 |
| pH (units) ^b | 8.1 | 8.1 | 7.5 | 7.6 |
| TSS | 18 | 21 | 21 | 17 |
| VSS | 9 | 5 | 7 | 9 |
| Turbidity (NTU) | 17 | 17 | 16 | 16 |
| Dissolved Oxygen (DO) | 10.0 | 6.3 | 10.0 | 9.7 |
| BOD ₅ | 3 | 3 | 6 | 3 |
| CBOD ₅ | 4 | 4 | 4 | 3 |
| COD | 36 | 34 | 40 | 40 |
| TP | 0.01 | 0.06 | 0.06 | 0.05 |
| Ortho-Phosphate | 0.009 | 0.011 | 0.065 | 0.006 |
| TKN | 1.04 | 1.14 | 1.11 | 1.07 |
| Ammonia-N | 0.03 | <0.02 | 0.07 | 0.04 |
| NO ₃ -N | 0.043 | 0.040 | 0.044 | 0.022 |
| NO ₂ -N | 0.014 | 0.010 | 0.009 | 0.011 |
| TN | 1.10 | 1.19 | 1.16 | 1.10 |
| Chlorophyll <i>a</i> (µg/L) | 38 | 42 | 40 | 37 |

^aExpressed in mg/L except where noted.

^bField measurement.

TABLE 5: WATER QUALITY DATA AT JFK BOULEVARD IN SALT CREEK DURING 2005 RAIN EVENTS

| Constituents ^a | 2005 Rain Event Dates | | | |
|-------------------------------------|-----------------------|-----------------|-----------------|-----------------|
| | <u>7/26/05</u> | <u>7/27/05</u> | <u>7/28/05</u> | <u>7/29/05</u> |
| Water Temperature (°C) ^b | 24.8 | 23.6 | 23.2 | 22.7 |
| pH (units) ^b | 6.3 | 7.5 | 7.6 | 7.5 |
| TSS | 7 | 12 | 11 | 5 |
| VSS | 4 | 4 | <3 | 5 |
| Turbidity (NTU) | 6 | 8 | 7 | 7 |
| Dissolved Oxygen (DO) | 6.6 | 7.0 | 7.4 | 7.5 |
| BOD ₅ | 3 | 3 | <2 | 3 |
| CBOD ₅ | 3 | <2 | <2 | <2 |
| COD | 45 | 38 | 40 | 34 |
| TP | 2.17 | 2.15 | 2.64 | 3.17 |
| Ortho-Phosphate | 1.870 | 1.751 | 2.181 | 2.585 |
| TKN | 1.46 | 1.48 | 1.43 | 1.25 |
| Ammonia-N | 0.32 | 0.09 | 0.05 | 0.16 |
| NO ₃ -N | 8.366 | 8.580 | 10.214 | 12.893 |
| NO ₂ -N | 0.080 | 0.027 | 0.022 | 0.025 |
| TN | 9.91 | 10.09 | 11.67 | 14.17 |
| Chlorophyll <i>a</i> (µg/L) | 17 | 28 | 27 | 21 |
| | <u>10/25/05</u> | <u>10/26/05</u> | <u>10/27/05</u> | <u>10/28/05</u> |
| Water Temperature (°C) ^b | 15.9 | 17.2 | 17.6 | 11.0 |
| pH (units) ^b | 7.5 | 7.8 | 7.2 | 7.4 |
| TSS | 41 | 7 | 3 | 3 |
| VSS | 13 | 4 | <3 | <3 |
| Turbidity (NTU) | 14 | 5 | 7 | 7 |
| Dissolved Oxygen (DO) | 7.6 | 8.3 | 8.0 | 7.8 |
| BOD ₅ | <2 | <2 | <2 | <2 |
| CBOD ₅ | <2 | 3 | <2 | <2 |
| COD | 45 | 27 | 23 | 28 |
| TP | 3.73 | 4.82 | 5.07 | 5.31 |
| Ortho-Phosphate | 3.361 | 3.855 | 4.008 | 4.172 |
| TKN | 1.76 | 1.20 | 1.27 | 1.09 |
| Ammonia-N | 0.08 | 0.03 | 0.25 | 0.08 |
| NO ₃ -N | 16.118 | 19.593 | 19.929 | 19.830 |
| NO ₂ -N | 0.020 | 0.013 | 0.014 | 0.015 |
| TN | 17.90 | 20.81 | 21.21 | 20.94 |
| Chlorophyll <i>a</i> (µg/L) | 15 | 3 | 3 | 2 |

^aExpressed in mg/L except where noted.

^bField measurement.

TABLE 6: WATER QUALITY DATA AT THORNDALE AVENUE IN SALT CREEK DURING 2005 RAIN EVENTS

| Constituents ^a | 2005 Rain Event Dates | | | |
|-------------------------------------|-----------------------|-----------------|-----------------|-----------------|
| | <u>7/26/05</u> | <u>7/27/05</u> | <u>7/28/05</u> | <u>7/29/05</u> |
| Water Temperature (°C) ^b | 23.9 | 23.4 | 22.6 | 23.8 |
| pH (units) ^b | 6.3 | 7.5 | 7.7 | 7.6 |
| TSS | 13 | 17 | 21 | 14 |
| VSS | 5 | 5 | 5 | 4 |
| Turbidity (NTU) | 9 | 11 | 11 | 12 |
| Dissolved Oxygen (DO) | 5.6 | 6.2 | 7.1 | 6.4 |
| BOD ₅ | 3 | 3 | <2 | 3 |
| CBOD ₅ | <2 | <2 | <2 | <2 |
| COD | 38 | 49 | 40 | 36 |
| TP | 2.86 | 2.14 | 2.44 | 3.23 |
| Ortho-Phosphate | 2.364 | 1.689 | 1.932 | 2.652 |
| TKN | 1.46 | 1.55 | 1.56 | 1.36 |
| Ammonia-N | 0.25 | 0.14 | 0.06 | 0.06 |
| NO ₃ -N | 10.475 | 8.393 | 9.582 | 12.064 |
| NO ₂ -N | 0.062 | 0.034 | 0.028 | 0.032 |
| TN | 12.00 | 9.98 | 11.17 | 13.46 |
| Chlorophyll <i>a</i> (µg/L) | 16 | 33 | 36 | 24 |
| | <u>10/25/05</u> | <u>10/26/05</u> | <u>10/27/05</u> | <u>10/28/05</u> |
| Water Temperature (°C) ^b | 14.3 | 15.4 | 15.4 | 10.2 |
| pH (units) ^b | 7.7 | 7.7 | 7.5 | 7.5 |
| TSS | 26 | 12 | 14 | 8 |
| VSS | 20 | <3 | <3 | <3 |
| Turbidity (NTU) | 7 | 8 | 7 | 6 |
| Dissolved Oxygen (DO) | 7.2 | 7.2 | 7.8 | 6.6 |
| BOD ₅ | <2 | <2 | <2 | <2 |
| CBOD ₅ | 3 | 2 | 2 | 2 |
| COD | 25 | 25 | 23 | 23 |
| TP | 3.58 | 4.58 | 4.89 | 5.11 |
| Ortho-Phosphate | 3.224 | 3.765 | 4.087 | 4.407 |
| TKN | 1.26 | 1.25 | 1.36 | 1.00 |
| Ammonia-N | 0.04 | 0.04 | 0.26 | 0.12 |
| NO ₃ -N | 15.150 | 18.104 | 18.628 | 19.503 |
| NO ₂ -N | 0.025 | 0.027 | 0.024 | 0.023 |
| TN | 16.44 | 19.38 | 20.01 | 20.53 |
| Chlorophyll <i>a</i> (µg/L) | 3 | 3 | 3 | 4 |

^aExpressed in mg/L except where noted.

^bField measurement.

TABLE 7: WATER QUALITY DATA FROM JOHN E. EGAN WATER RECLAMATION PLANT EFFLUENT DISCHARGED TO SALT CREEK DURING 2005 RAIN EVENTS

| Constituents ^a | 2005 Rain Event Dates | | | |
|---------------------------|-----------------------|-----------------|-----------------|-----------------------------|
| | <u>7/26/05</u> | <u>7/27/05</u> | <u>7/28/05</u> | <u>7/29/05^b</u> |
| TSS | 2 | 3 | 2 | ND |
| Turbidity (NTU) | 1 | 2 | 2 | ND |
| BOD ₅ | 2 | 2 | <2 | ND |
| CBOD ₅ | <2 | <2 | <2 | ND |
| TP | 3.25 | 3.51 | 3.65 | ND |
| Ortho-Phosphate | 3.22 | 3.19 | 3.28 | ND |
| TKN | 1.66 | 1.21 | 1.07 | ND |
| Ammonia-N | 0.39 | 0.14 | 0.09 | ND |
| NO ₃ -N | 16.242 | 17.245 | 16.787 | ND |
| NO ₂ -N | 0.091 | 0.021 | 0.009 | ND |
| TN | 17.99 | 18.48 | 17.87 | ND |
| | <u>10/25/05</u> | <u>10/26/05</u> | <u>10/27/05</u> | <u>10/28/05^b</u> |
| TSS | <2 | <2 | <2 | ND |
| Turbidity (NTU) | <1 | 1 | 3 | 1 |
| BOD ₅ | <2 | <2 | <2 | ND |
| CBOD ₅ | <2 | <2 | <2 | ND |
| TP | 3.94 | 4.84 | 5.29 | ND |
| Ortho-Phosphate | 3.94 | 4.44 | 5.04 | 4.53 |
| TKN | 1.55 | 1.53 | 1.63 | ND |
| Ammonia-N | 0.08 | 0.17 | 0.15 | ND |
| NO ₃ -N | 18.832 | 19.729 | 22.054 | ND |
| NO ₂ -N | <0.005 | 0.005 | 0.006 | ND |
| TN | 20.39 | 21.26 | 23.69 | ND |

^aExpressed in mg/L except where noted.

^b24-hour composite samples not analyzed on weekends.

ND = No Data.

TABLE 8: WATER QUALITY DATA AT BUSSE LAKE DAM IN SALT CREEK DURING 2006 RAIN EVENTS

| Constituents ^a | 2006 Rain Event Dates | | | |
|-------------------------------------|-----------------------|----------------|----------------|----------------|
| | <u>4/04/06</u> | <u>4/05/06</u> | <u>4/06/06</u> | <u>4/07/06</u> |
| Water Temperature (°C) ^b | 9.1 | 10.0 | 12.1 | 10.4 |
| pH (units) ^b | 8.3 | 8.3 | 8.2 | 8.1 |
| TSS | 18 | 21 | 16 | 26 |
| VSS | 6 | 8 | 5 | 12 |
| Turbidity (NTU) | 19 | 17 | 21 | 16 |
| Dissolved Oxygen (DO) ^c | ND | ND | ND | ND |
| BOD ₅ | 2 | 4 | 5 | 4 |
| CBOD ₅ | 3 | 4 | 5 | 3 |
| COD | 40 | 48 | 44 | 35 |
| TP | 0.08 | 0.11 | 0.08 | 0.10 |
| Ortho-Phosphate | 0.019 | 0.022 | 0.022 | 0.032 |
| TKN | 1.22 | 1.20 | 1.31 | 1.33 |
| Ammonia-N | 0.19 | 0.33 | 0.05 | 0.04 |
| NO ₃ -N | 0.906 | 0.869 | 0.829 | 0.816 |
| NO ₂ -N | 0.032 | 0.028 | 0.026 | 0.027 |
| TN | 2.16 | 2.10 | 2.17 | 2.17 |
| Chlorophyll <i>a</i> (µg/L) | 30 | 29 | 26 | 33 |
| | <u>5/02/06</u> | <u>5/03/06</u> | <u>5/04/06</u> | <u>5/05/06</u> |
| Water Temperature (°C) ^b | 14.9 | 16.6 | 16.6 | 15.8 |
| pH (units) ^b | 8.5 | 8.5 | 8.3 | 9.1 |
| TSS | 17 | 21 | 13 | 19 |
| VSS | 10 | 11 | 10 | 9 |
| Turbidity (NTU) | 18 | 15 | 10 | 11 |
| Dissolved Oxygen (DO) ^c | ND | ND | ND | ND |
| BOD ₅ | 4 | 4 | 6 | 7 |
| CBOD ₅ | 3 | 4 | 5 | 6 |
| COD | 38 | 35 | 44 | 57 |
| TP | 0.11 | 0.19 | 0.14 | 0.10 |
| Ortho-Phosphate | 0.013 | 0.042 | 0.036 | 0.120 |
| TKN | 1.56 | 1.39 | 1.62 | 1.36 |
| Ammonia-N | 0.04 | 0.02 | 0.02 | 0.02 |
| NO ₃ -N | 0.032 | 0.058 | 0.017 | 0.015 |
| NO ₂ -N | 0.009 | 0.008 | 0.004 | 0.004 |
| TN | 1.60 | 1.46 | 1.64 | 1.38 |
| Chlorophyll <i>a</i> (µg/L) | 61 | 60 | 63 | 59 |

TABLE 8 (Continued): WATER QUALITY DATA AT BUSSE LAKE DAM IN SALT CREEK DURING 2006 RAIN EVENTS

| Constituents ^a | 2006 Rain Event Dates | | | |
|-------------------------------------|-----------------------|----------------|----------------|----------------|
| | <u>8/29/06</u> | <u>8/30/06</u> | <u>8/31/06</u> | <u>9/01/06</u> |
| Water Temperature (°C) ^b | 22.9 | 20.8 | 22.5 | 22.0 |
| pH (units) ^b | 7.9 | 8.1 | 8.0 | 8.2 |
| TSS | 17 | 16 | 18 | 18 |
| VSS | 4 | 12 | 11 | 3 |
| Turbidity (NTU) | 20 | 19 | 21 | 26 |
| Dissolved Oxygen (DO) ^c | ND | ND | ND | ND |
| BOD ₅ | 2 | 2 | 2 | 3 |
| CBOD ₅ | 2 | 2 | 2 | 2 |
| COD | 20 | 24 | 26 | 26 |
| TP | 0.13 | 0.11 | 0.11 | 0.27 |
| Ortho-Phosphate | 0.013 | 0.017 | 0.016 | 0.016 |
| TKN | 1.49 | 1.35 | 1.36 | 1.51 |
| Ammonia-N | 0.43 | 0.43 | 0.21 | 0.23 |
| NO ₃ -N | 0.045 | 0.044 | 0.052 | 0.067 |
| NO ₂ -N | 0.012 | 0.004 | 0.016 | 0.020 |
| TN | 1.55 | 1.39 | 1.43 | 1.60 |
| Chlorophyll <i>a</i> (µg/L) | 39 | 33 | 32 | 32 |

^aExpressed in mg/L except where noted.

^bField measurement.

^cContinuous monitoring data implemented in 2006. No grab sample taken for DO.

TABLE 9: WATER QUALITY DATA AT JFK BOULEVARD IN SALT CREEK
DURING 2006 RAIN EVENTS

| Constituents ^a | 2006 Rain Event Dates | | | |
|-------------------------------------|-----------------------|----------------|----------------|----------------|
| | <u>4/04/06</u> | <u>4/05/06</u> | <u>4/06/06</u> | <u>4/07/06</u> |
| Water Temperature (°C) ^b | 10.0 | 10.2 | 11.1 | 11.1 |
| pH (units) ^b | 8.0 | 7.9 | 8.1 | 7.8 |
| TSS | 13 | 18 | 13 | 18 |
| VSS | 7 | 10 | 3 | 4 |
| Turbidity (NTU) | 15 | 13 | 12 | 12 |
| Dissolved Oxygen (DO) ^c | ND | ND | ND | ND |
| BOD ₅ | 3 | 4 | 5 | 3 |
| CBOD ₅ | 2 | 4 | 4 | 3 |
| COD | 31 | 27 | 33 | 31 |
| TP | 0.39 | 0.57 | 0.73 | 0.96 |
| Ortho-Phosphate | 0.238 | 0.361 | 0.594 | 0.779 |
| TKN | 1.37 | 1.28 | 1.13 | 1.36 |
| Ammonia-N | 0.21 | 0.27 | 0.04 | 0.06 |
| NO ₃ -N | 3.019 | 3.887 | 4.832 | 5.605 |
| NO ₂ -N | 0.029 | 0.024 | 0.019 | 0.023 |
| TN | 4.42 | 5.19 | 5.98 | 6.99 |
| Chlorophyll <i>a</i> (µg/L) | 28 | 22 | 21 | 23 |
| | <u>5/02/06</u> | <u>5/03/06</u> | <u>5/04/06</u> | <u>5/05/06</u> |
| Water Temperature (°C) ^b | 15.2 | 17.7 | 16.4 | 16.8 |
| pH (units) ^b | 8.1 | 8.0 | 7.8 | 8.1 |
| TSS | 21 | 23 | 9 | 7 |
| VSS | 6 | 9 | 9 | 7 |
| Turbidity (NTU) | 16 | 17 | 8 | 10 |
| Dissolved Oxygen (DO) ^c | ND | ND | ND | ND |
| BOD ₅ | 2 | 5 | 6 | 7 |
| CBOD ₅ | 2 | 4 | 5 | 6 |
| COD | 33 | 55 | 38 | 42 |
| TP | 0.63 | 1.00 | 0.99 | 1.52 |
| Ortho-Phosphate | 0.453 | 0.745 | 0.820 | 1.215 |
| TKN | 1.67 | 1.83 | 1.32 | 1.62 |
| Ammonia-N | 0.05 | 0.02 | 0.02 | 0.02 |
| NO ₃ -N | 2.785 | 4.136 | 4.086 | 6.613 |
| NO ₂ -N | 0.010 | 0.013 | 0.007 | 0.015 |
| TN | 4.47 | 5.98 | 5.41 | 8.25 |
| Chlorophyll <i>a</i> (µg/L) | 46 | 44 | 64 | 38 |

TABLE 9 (Continued): WATER QUALITY DATA AT JFK BOULEVARD IN SALT CREEK DURING 2006 RAIN EVENTS

| Constituents ^a | 2006 Rain Event Dates | | | |
|-------------------------------------|-----------------------|----------------|----------------|----------------|
| | <u>8/29/06</u> | <u>8/30/06</u> | <u>8/31/06</u> | <u>9/01/06</u> |
| Water Temperature (°C) ^b | 22.3 | 21.7 | 20.3 | 21.5 |
| pH (units) ^b | 7.7 | 7.9 | 7.7 | 7.5 |
| TSS | 16 | 12 | 9 | 10 |
| VSS | 3 | 3 | 7 | 10 |
| Turbidity (NTU) | 12 | 17 | 10 | 9 |
| Dissolved Oxygen (DO) ^c | ND | ND | ND | ND |
| BOD ₅ | 2 | 2 | 2 | 2 |
| CBOD ₅ | 2 | 3 | 2 | 2 |
| COD | 26 | 16 | 20 | 13 |
| TP | 1.88 | 2.66 | 3.11 | 4.04 |
| Ortho-Phosphate | 1.693 | 2.418 | 2.897 | 3.583 |
| TKN | 1.55 | 1.37 | 1.38 | 1.32 |
| Ammonia-N | 0.42 | 0.28 | 0.11 | 0.07 |
| NO ₃ -N | 5.221 | 5.100 | 8.355 | 10.943 |
| NO ₂ -N | 0.012 | 0.011 | 0.013 | 0.014 |
| TN | 6.78 | 6.48 | 9.75 | 12.28 |
| Chlorophyll <i>a</i> (µg/L) | 28 | 22 | 17 | 13 |

^aExpressed in mg/L except where noted.

^bField measurement.

^cContinuous monitoring data implemented in 2006. No grab sample taken for DO.

TABLE 10: WATER QUALITY DATA AT THORNDALE AVENUE IN SALT CREEK DURING 2006 RAIN EVENTS

| Constituents ^a | 2006 Rain Event Dates | | | |
|-------------------------------------|-----------------------|----------------|----------------|----------------|
| | <u>4/04/06</u> | <u>4/05/06</u> | <u>4/06/06</u> | <u>4/07/06</u> |
| Water Temperature (°C) ^b | 9.4 | 10.1 | 10.1 | 10.7 |
| pH (units) ^b | 8.1 | 8.1 | 8.1 | 7.9 |
| TSS | 18 | 16 | 15 | 13 |
| VSS | 6 | 14 | 6 | 4 |
| Turbidity (NTU) | 19 | 13 | 12 | 14 |
| Dissolved Oxygen (DO) ^c | ND | ND | ND | ND |
| BOD ₅ | 3 | 4 | 4 | 3 |
| CBOD ₅ | 3 | 4 | 4 | 3 |
| COD | 40 | 31 | 29 | 35 |
| TP | 0.37 | 0.44 | 0.66 | 0.86 |
| Ortho-Phosphate | 0.182 | 0.298 | 0.534 | 0.649 |
| TKN | 1.44 | 1.59 | 1.40 | 1.38 |
| Ammonia-N | 0.18 | 0.31 | 0.02 | 0.06 |
| NO ₃ -N | 2.619 | 3.581 | 4.520 | 5.067 |
| NO ₂ -N | 0.031 | 0.026 | 0.020 | 0.030 |
| TN | 4.09 | 5.20 | 5.94 | 6.48 |
| Chlorophyll <i>a</i> (µg/L) | 27 | 24 | 22 | 23 |
| | <u>5/02/06</u> | <u>5/03/06</u> | <u>5/04/06</u> | <u>5/05/06</u> |
| Water Temperature (°C) ^b | 14.4 | 18.8 | 16.2 | 16.3 |
| pH (units) ^b | 8.1 | 8.1 | 7.6 | 8.0 |
| TSS | 25 | 20 | 16 | 12 |
| VSS | 11 | 12 | 7 | 6 |
| Turbidity (NTU) | 18 | 14 | 10 | 8 |
| Dissolved Oxygen (DO) ^c | ND | ND | ND | ND |
| BOD ₅ | 4 | 5 | 4 | 6 |
| CBOD ₅ | 3 | 4 | 4 | 5 |
| COD | 31 | 40 | 42 | 44 |
| TP | 0.60 | 0.82 | 0.95 | 1.51 |
| Ortho-Phosphate | 0.404 | 0.613 | 0.765 | 1.140 |
| TKN | 1.93 | 1.77 | 1.28 | 1.29 |
| Ammonia-N | 0.05 | 0.08 | 0.02 | 0.02 |
| NO ₃ -N | 2.461 | 3.449 | 4.090 | 6.938 |
| NO ₂ -N | 0.012 | 0.010 | 0.011 | 0.069 |
| TN | 4.40 | 5.23 | 5.38 | 8.30 |
| Chlorophyll <i>a</i> (µg/L) | 42 | 47 | 41 | 36 |

TABLE 10 (Continued): WATER QUALITY DATA AT THORNDALE AVENUE IN SALT CREEK DURING 2006 RAIN EVENTS

| Constituents ^a | 2006 Rain Event Dates | | | |
|-------------------------------------|-----------------------|----------------|----------------|----------------|
| | <u>8/29/06</u> | <u>8/30/06</u> | <u>8/31/06</u> | <u>9/01/06</u> |
| Water Temperature (°C) ^b | 22.1 | 21.1 | 21.8 | 21.1 |
| pH (units) ^b | 7.6 | 7.8 | 7.6 | 7.6 |
| TSS | 28 | 17 | 90 | 10 |
| VSS | 3 | 5 | 24 | 3 |
| Turbidity (NTU) | 23 | 16 | 11 | 14 |
| Dissolved Oxygen (DO) ^c | ND | ND | ND | ND |
| BOD ₅ | 2 | 2 | 3 | 2 |
| CBOD ₅ | 2 | 2 | 2 | 2 |
| COD | 18 | 18 | 22 | 18 |
| TP | 1.89 | 3.14 | 3.25 | 3.38 |
| Ortho-Phosphate | 1.690 | 2.595 | 2.933 | 3.022 |
| TKN | 1.51 | 1.65 | 1.49 | 1.48 |
| Ammonia-N | 0.21 | 0.32 | 0.10 | 0.08 |
| NO ₃ -N | 6.075 | 5.792 | 8.019 | 9.547 |
| NO ₂ -N | 0.024 | 0.018 | 0.020 | 0.019 |
| TN | 7.61 | 7.46 | 9.53 | 11.05 |
| Chlorophyll <i>a</i> (µg/L) | 24 | 22 | 23 | 18 |

^aExpressed in mg/L except where noted.

^bField measurement.

^cContinuous monitoring data implemented in 2006. No grab sample taken for DO.

TABLE 11: WATER QUALITY DATA FROM JOHN E. EGAN WATER RECLAMATION PLANT EFFLUENT DISCHARGED TO SALT CREEK DURING 2006 RAIN EVENTS

| Constituents ^a | 2006 Rain Event Dates | | | |
|---------------------------|-----------------------|----------------|----------------|----------------------------|
| | <u>4/04/06</u> | <u>4/05/06</u> | <u>4/06/06</u> | <u>4/07/06</u> |
| TSS | 3 | 2 | 2 | ND |
| Turbidity (NTU) | <1 | 2 | 2 | 1 |
| BOD ₅ | 3 | 2 | 2 | ND |
| CBOD ₅ | 2 | 2 | 2 | ND |
| TP | 1.28 | 1.75 | 1.50 | ND |
| Ortho-Phosphate | 1.209 | 1.474 | 2.026 | 2.430 |
| TKN | 0.97 | 0.99 | 0.08 | ND |
| Ammonia-N | 0.04 | 0.07 | 0.04 | ND |
| NO ₃ -N | 10.724 | 12.934 | 14.376 | ND |
| NO ₂ -N | 0.021 | 0.010 | 0.032 | ND |
| TN | 11.72 | 13.93 | 14.49 | ND |
| | <u>5/02/06</u> | <u>5/03/06</u> | <u>5/04/06</u> | <u>5/05/06^b</u> |
| TSS | 2 | 2 | 2 | ND |
| Turbidity (NTU) | 3 | 1 | 1 | <1 |
| BOD ₅ | 2 | 2 | 2 | ND |
| CBOD ₅ | 2 | 2 | 2 | ND |
| TP | 2.30 | 2.96 | 3.36 | ND |
| Ortho-Phosphate | 2.182 | 2.207 | 2.960 | 3.265 |
| TKN | 1.43 | 1.51 | 1.50 | ND |
| Ammonia-N | 0.04 | 0.04 | 0.06 | ND |
| NO ₃ -N | 11.573 | 13.064 | ND | ND |
| NO ₂ -N | 0.005 | 0.005 | ND | ND |
| TN | 13.01 | 14.58 | ND | ND |
| | <u>8/29/06</u> | <u>8/30/06</u> | <u>8/31/06</u> | <u>9/1/06^b</u> |
| TSS | 2 | 2 | 2 | ND |
| Turbidity (NTU) | 1 | 1 | 2 | <1 |
| BOD ₅ | 2 | 2 | 2 | ND |
| CBOD ₅ | 2 | 2 | 2 | ND |
| TP | ND | ND | ND | ND |
| Ortho-Phosphate | 7.400 | 7.982 | 6.028 | 7.047 |
| TKN | 1.35 | 1.22 | 1.59 | ND |
| Ammonia-N | 0.06 | 0.04 | 0.08 | ND |
| NO ₃ -N | 16.242 | 16.925 | 17.450 | ND |
| NO ₂ -N | 0.005 | 0.010 | 0.008 | ND |
| TN | 17.60 | 18.16 | 19.05 | ND |

^aExpressed in mg/L except where noted.

^b24-hour composite samples not analyzed on weekends.

ND = No Data.

FIGURE 4: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT BUSSE LAKE DAM IN SALT CREEK AUGUST 1, 2006 THROUGH AUGUST 31, 2006

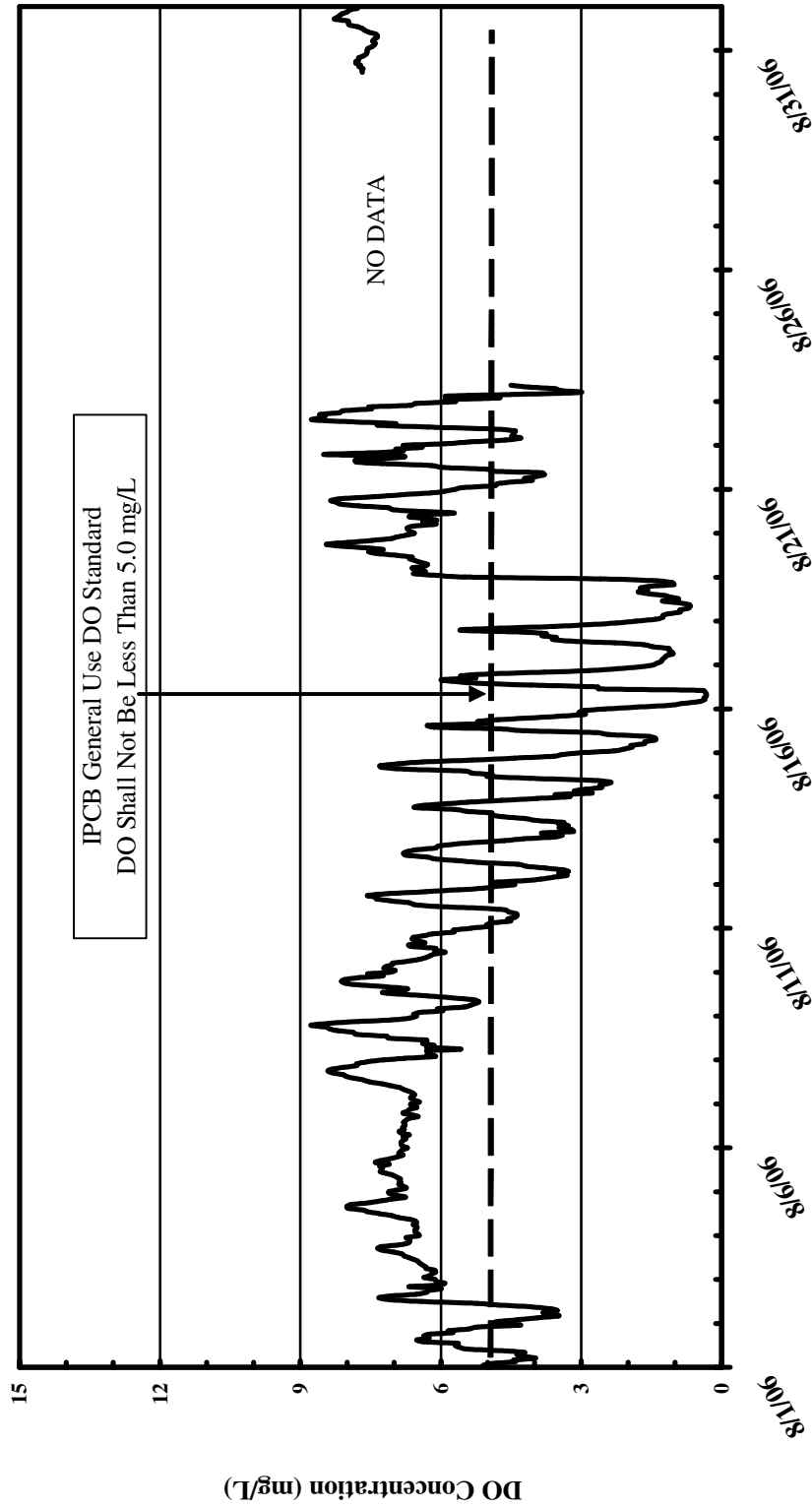


FIGURE 5: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT JFK BOULEVARD IN SALT CREEK AUGUST 1, 2006 THROUGH AUGUST 31, 2006

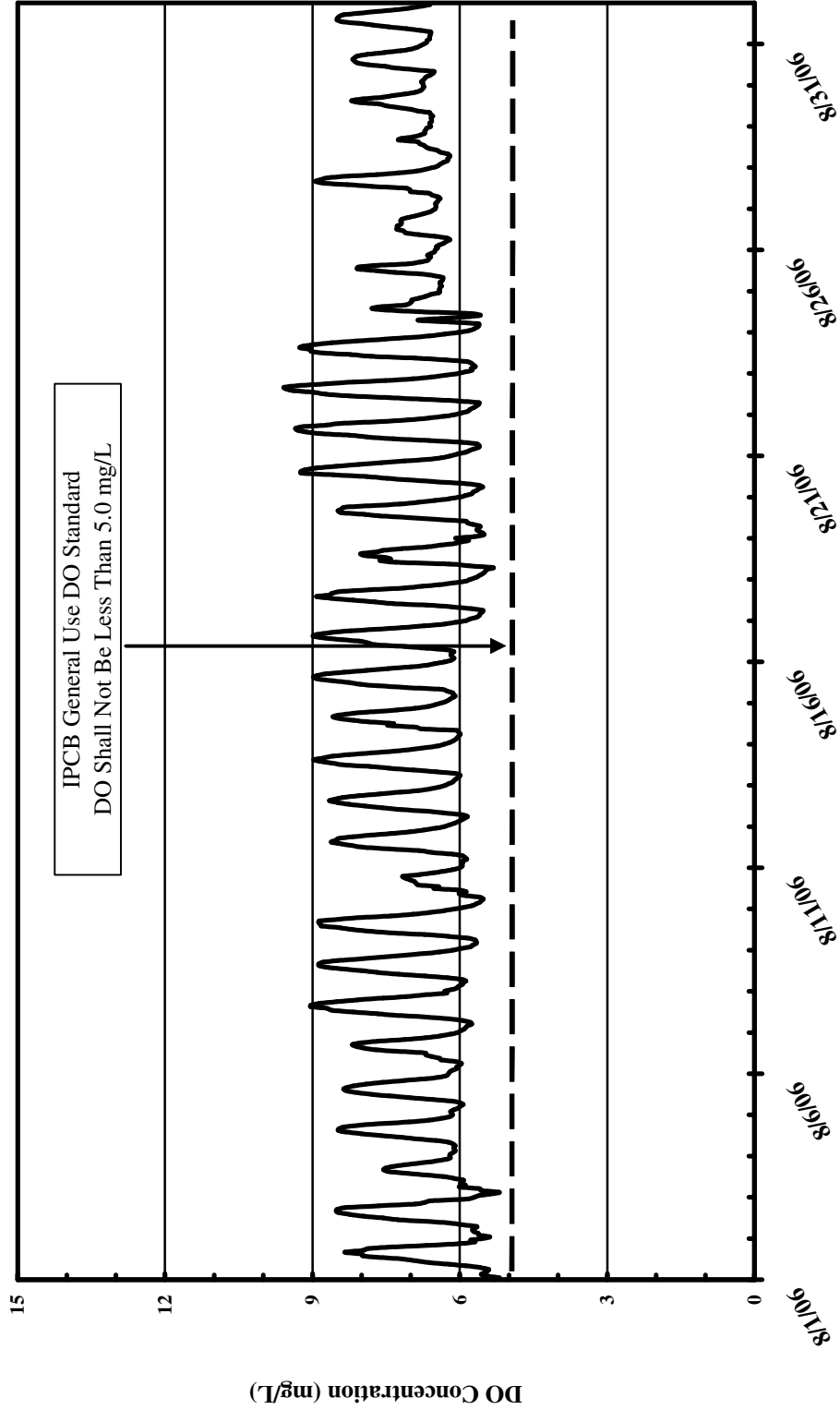


FIGURE 6: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT THORNDALE AVENUE IN SALT CREEK AUGUST 1, 2006 THROUGH AUGUST 31, 2006

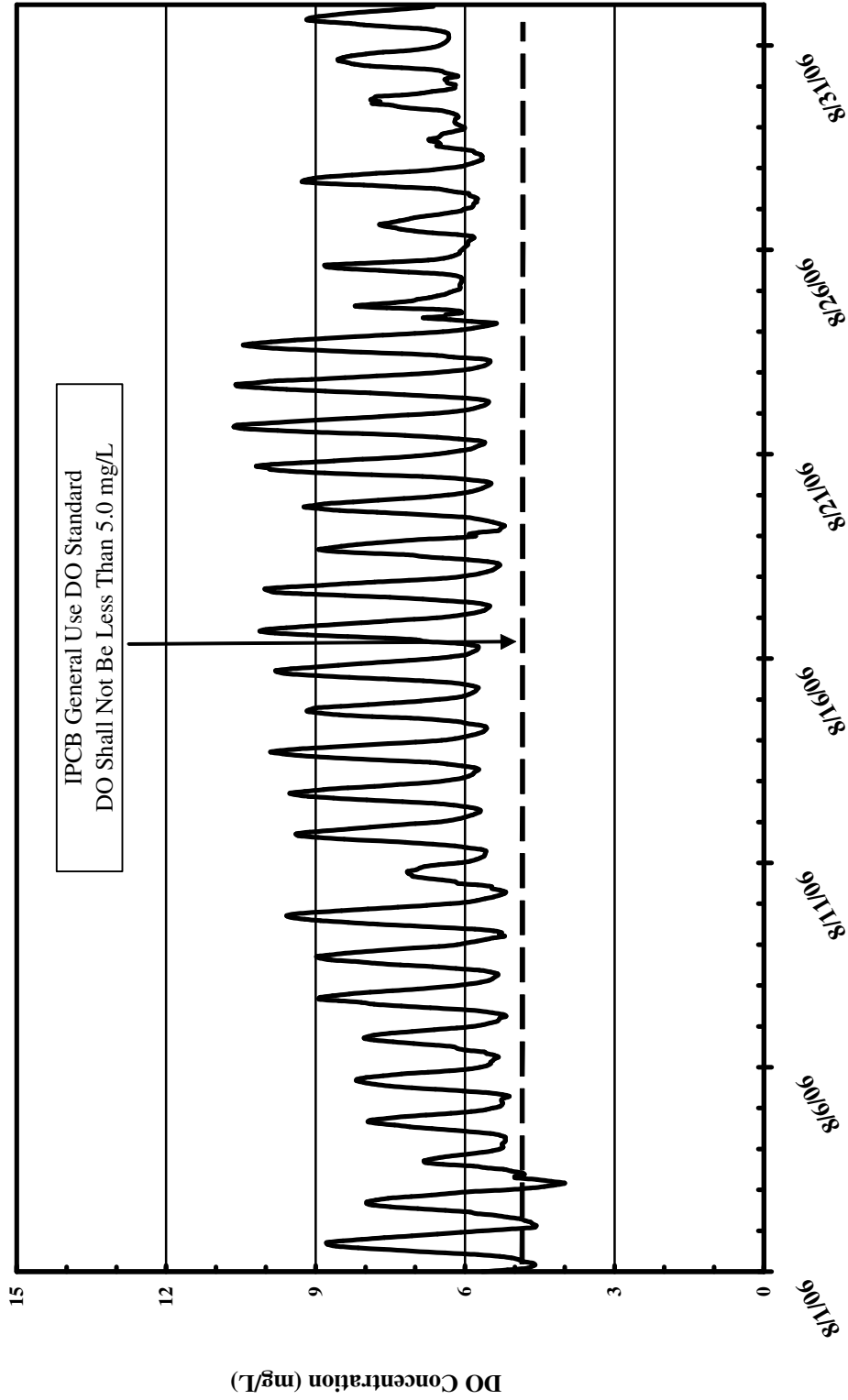
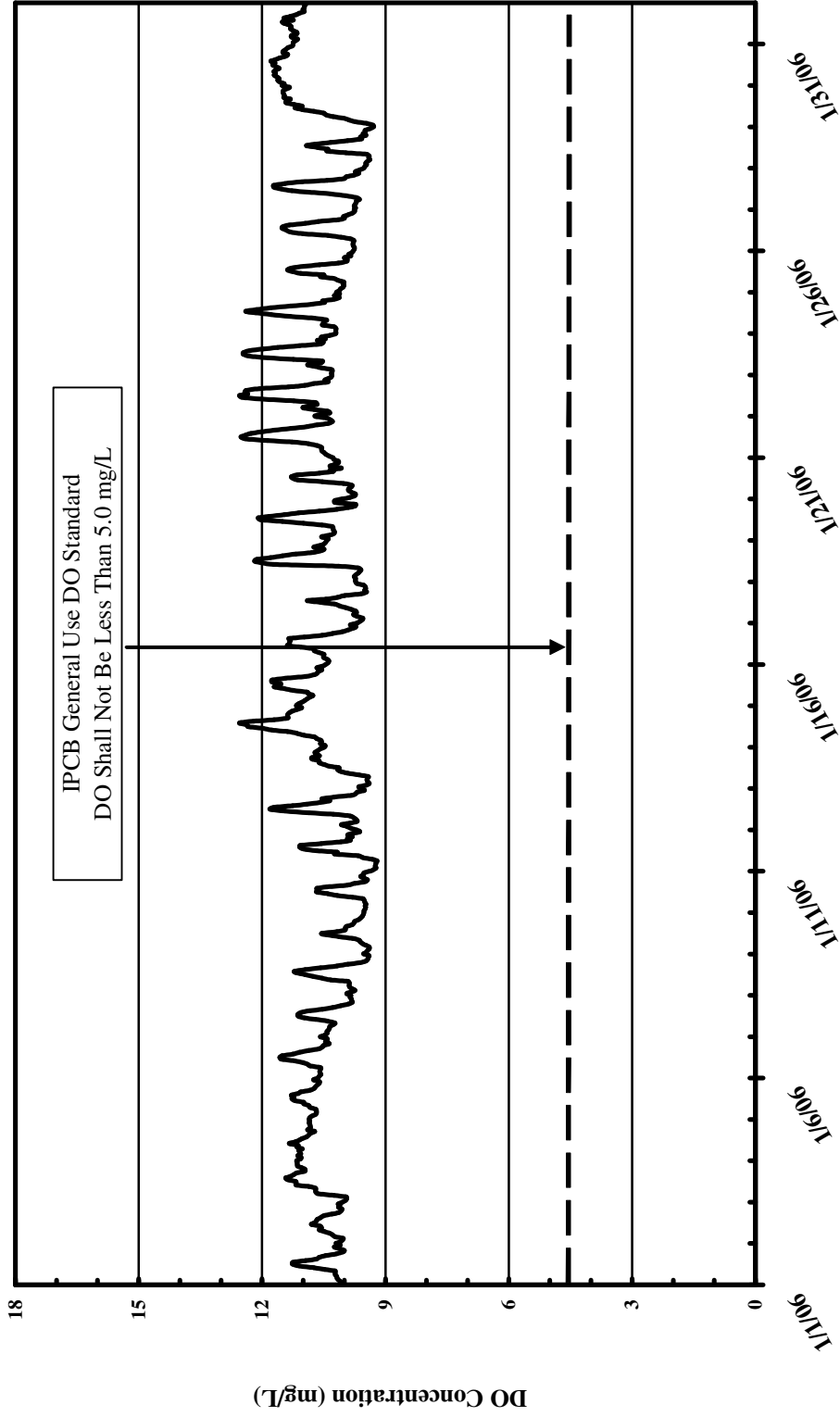


FIGURE 7: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT JFK BOULEVARD IN SALT CREEK JANUARY 1, 2006 THROUGH JANUARY 31, 2006



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 2–11). Chlorophyll *a* concentrations were highest upstream of the Egan WRP at the Busse Lake Dam sampling station, with means of 29 and 30 µg/L for 2005 and 2006, 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, chlorophyll *a* mean concentrations were 10 and 16 µg/L during 2005 and 2006, and 11 and 17 µg/L, respectively, at Thorndale Avenue. The decreased values at JFK Boulevard represent dilution by Egan WRP effluent discharge to Salt Creek.

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 and Stevenson, 2006).

Sediment Quality

Sediment chemistry from the three sampling stations during 2005–2006 is shown in Table 12.

Biological Quality

Fish. Table 13 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 decreased in the downstream direction from Busse Lake Dam to Thorndale Avenue. Despite this general trend, larger numbers of green sunfish, largemouth bass, orange spotted sunfish, and yellow bullhead were collected downstream of the Egan WRP effluent outfall at JFK Boulevard than upstream of the Egan WRP effluent at the Busse Lake Dam. Along the sampling reach, a total of 402 fish were collected, consisting of 13 species during the pre-reduction study period. Studies have shown a negative correlation between TP and Index of Biotic Integrity (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.

Benthic Invertebrates. Benthic invertebrates collected during 2005–2006 are currently being identified.

TABLE 12: CHEMICAL CHARACTERISTICS OF SEDIMENT COLLECTED AT BUSSE LAKE DAM, JFK BOULEVARD, AND THORNDALE AVENUE IN SALT CREEK DURING 2005 AND 2006 PRIOR TO PHOSPHORUS REMOVAL

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

TABLE 13: NUMBER OF FISH COLLECTED (N) AND SPECIES PERCENTAGE COMPOSITION (%) FROM SALT CREEK DURING 2005 AND 2006

| Fish Species | Salt Creek Sample Stations | | | | | | | | | |
|------------------------------------|----------------------------|------|---------------|------|--------------|------|----------------|------|-------------------|------|
| | Busse Lake Dam | | JFK Boulevard | | Devon Avenue | | Thorndale Road | | Total Collections | |
| | N | % | N | % | N | % | N | % | N | % |
| Black bullhead | 1 | 0.7 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 0.2 |
| Black crappie ¹ | 2 | 1.4 | 0 | 0.0 | 2 | 2.4 | 0 | 0.0 | 4 | 1.0 |
| Blackstripe topminnow | 37 | 26.6 | 1 | 0.9 | 1 | 1.2 | 25 | 40.3 | 64 | 15.9 |
| Bluegill ¹ | 45 | 32.4 | 29 | 24.8 | 23 | 27.4 | 12 | 19.4 | 109 | 27.1 |
| Bluntnose minnow | 0 | 0.0 | 7 | 6.0 | 1 | 1.2 | 0 | 0.0 | 8 | 2.0 |
| Carp | 2 | 1.4 | 0 | 0.0 | 6 | 7.1 | 0 | 0.0 | 8 | 2.0 |
| Green sunfish ¹ | 15 | 10.8 | 53 | 45.3 | 30 | 35.7 | 22 | 35.5 | 120 | 29.9 |
| Largemouth bass ¹ | 3 | 2.2 | 4 | 3.4 | 2 | 2.4 | 1 | 1.6 | 10 | 2.5 |
| Orangespotted sunfish ¹ | 5 | 3.6 | 13 | 11.1 | 0 | 0.0 | 0 | 0.0 | 18 | 4.5 |
| Pumpkinseed sunfish ¹ | 3 | 2.2 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 3 | 0.7 |
| Spotfin shiner | 25 | 18.0 | 6 | 5.1 | 13 | 15.5 | 0 | 0.0 | 44 | 10.9 |
| Yellow bullhead ¹ | 1 | 0.7 | 3 | 2.6 | 6 | 7.1 | 2 | 3.2 | 12 | 3.0 |
| White sucker | 0 | 0.0 | 1 | 0.9 | 0 | 0.0 | 0 | 0.0 | 1 | 0.2 |
| Total Fish | 139 | | 117 | | 84 | | 62 | | 402 | |
| Total Species | 11 | | 9 | | 9 | | 5 | | 13 | |

¹Game fish.

Physical Habitat. 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, and immediate shore cover consisted of grasses, shrubs, and trees. Bank erosion throughout the study reach was moderate to severe. 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 0.1 foot on the east bank close to the dam, to 2.8 feet in the center of the creek at the end of the sampling reach. 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 duckweed covered about 75 percent of the sampling area in August of 2005, whereas, field investigation in July of 2006 indicated a coverage of approximately 45 percent, with a large proportion of green filamentous algae. There was little canopy cover and immediate shore cover consisted of maintained grass. Bank erosion throughout the study reach was slight to severe. Riparian land use in the area is urban residential. Depth of fines in the streambed sediment ranged from 0.1 foot on the east bank close to the bridge, to 2.9 feet in the center of the creek at the end of the sampling reach. Sediment was comprised mostly of sand, with cobble, silt, and clay in localized areas, and 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 1–3 feet under normal conditions, and would be characterized as a “run” stream habitat. Eurasian watermilfoil and leafy pondweed covered approximately 35 percent of the sampling area in August of 2005, and <20 percent in July of 2006. Canopy cover throughout the reach was open to partially shaded, and immediate shore cover consisted of grasses, shrubs, and trees. Bank erosion throughout the study reach was moderate to severe. Riparian land use in the area is primarily urban industrial. Depth of fines in the streambed sediment ranged from 0.3–2.0 feet in the sampling reach. Sediment was comprised mostly of sand and silt, with some gravel and plant debris, and normal embeddedness.

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