VOLUME V
WATER LEVEL MONITORING, GROUNDWATER SEEPS AND WATER QUALITY MONITORING REPORT

CALUMET AREA
CITY OF CHICAGO, COOK COUNTY, ILLINOIS

(DATA: JULY 2003 - JULY 2004)

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1.0 INTRODUCTION

V3 has prepared the following report on behalf of the City of Chicago, Department of Environment (DOE). The report addresses the documentation and presentation of data collected from the water level monitoring network, and water quality and seep investigation components of the Calumet Area Hydrologic Master Plan (Tasks 201, 203 and 205). The scope of work documented within this report was developed in part as a result of the hydrologic data gaps identified during the development of the Calumet Area Ecological Management Strategy (EMS). In particular, the report documents and presents the following related to Phase 1 EMS sites:

- Installation and development of staff gage and groundwater monitoring stations
- Characterization of observed groundwater seeps within the study area
- A one year record of monitored water levels within the study area
- Implementation of multi-parameter water quality monitoring in conjunction with the water level monitoring network
- Plots of monitored water levels and water quality data on an area wide and site-specific basis

Overall, the surface water elevations of the Calumet water bodies tend to be controlled by water control structures and overflow weirs. The sites did not have large annual fluctuations, on average the water bodies fluctuated approximately 1.5 feet during the monitoring period. Heron Pond, Indian Ridge Marsh side pools and the Conservation Area were the least fluctuating water bodies over the course of the monitoring period.

Baseline water quality data from this study shows that water temperatures were measured as low as 33.2 F to 84.5 F over the course of the monitoring period. Anoxic dissolved oxygen conditions were measured at the Big Marsh outlet channel, Heron Pond and Deadstick Pond. North Indian Ridge Marsh recorded the most optimal dissolved oxygen conditions of all monitoring sites. Water quality was also assessed with pH and no acidic conditions were detected during the course of the monitoring program, basic pH is a common condition in the monitoring sites. Specific conductance values measured in water bodies indicate that certain water bodies such as Indian Ridge Marsh Northeast side pool have low levels of dissolved minerals in the water. Dissolved mineral rich water bodies such as Deadstick Pond indicate that there may be a strong level of groundwater connectivity.

Groundwater evaluations within this study indicated that the larger water bodies and pools are influenced and fed by groundwater for at least parts of the year. Groundwater monitoring results show that gross permeable conditions exist at Big Marsh and likely is a prevalent condition of the Calumet Area. The seepage investigation of this report indicates that seepage does likely occur at notable rates at most water bodies, however its occurrence is primarily below surface water elevations.

The Calumet water bodies monitored during this study are individually unique and diverse with respect to water level fluctuations, water quality and groundwater influences. An approach to study each individual water body would be the next step in developing further detailed understandings.

1.1 Monitoring Scope of Work

Following a review of data sources and the approval of the *Water Level Monitoring Network Implementation Plan* by DOE and Calumet EMS partners in 2002, V3 executed the installation of eight (8) automatic staff gages, nine (9) manual staff gages, and two (2) monitoring wells (piezometers). In addition two (2) existing monitoring wells (ASW2, ASW3) were included in the water level monitoring network. The locations of these installations were chosen based upon correspondence with EMS partners and advisors, review of LIDAR topography, site reconnaissance and the overall requirement to obtain data to evaluate the relationships between primary water bodies, pools, side pools and outlet structures.

The network of automatic staff gages, manual staff gages and monitoring wells (piezometers) were observed monthly for a period of one year (starting June 2003). While the automatic stations were programmed to record water elevations at 15 minute intervals, their data was uploaded during monthly visits. Water quality constituents (pH, conductivity, dissolved oxygen, temperature and oxidation-reduction potential) were monitored at select monitoring network stations on a monthly basis. Supplemental data sources utilized for this investigation include O'Brien Lock and Dam – Calumet River water elevations (Army Corps of Engineers), Lake Michigan water levels (USGS) and local Calumet Area Precipitation Data (ISWS).

1.2 Monitoring Report Objectives

While documenting the nature and performance of HMP monitoring, the primary objective of this monitoring report is to present the data collected at Phase I EMS sites in a manner that allows various study area stakeholders to obtain a greater understanding of the hydrologic behavior of individual sites, as well as, the hydrologic relationships and influences between study area sites. In doing so the data within the report has been presented in two ways: area wide plots and multi-parameter site-specific plots. The objective of this report is not, however, to provide an in depth analysis and interpretation of collected data. This data can be used for site specific analysis.

In general, the report contains the following:

- Compilation and presentation of collected surface water and limited groundwater elevation data for the key areas of interest related to Phase I EMS sites, both on an area wide and site-specific basis.

- A discussion of observed groundwater seeps.

- Compilation and presentation of monthly water quality data collected at the water level monitoring sites, both on a area wide and site-specific basis.

While reviewing the presented data is a first step in evaluating Calumet Area hydrology and the relationships between the water bodies of the area, the raw data itself can be utilized in the future for direct and developed watershed model inputs, and for watershed model calibration for flow, stage and potentially water quality. The compiled data can also be used to assist the analysis and consideration of water control structures at Phase I EMS sites. Further, available water elevation data provides a means to infer horizontal gradients between pools and groundwater interactions at specific Phase I EMS water bodies which can be incorporated into future management decisions and watershed modeling.

2.0 MATERIALS AND METHODS

2.1 Data Collection Station Types

<u>Water Level Monitoring</u>: The monitoring station network monitors surface water elevations, and groundwater elevations. Three types of stations have been setup for the monitoring network.

1. Automatic Staff Gages (Surface Water Elevations)
2. Manual Staff Gages (Surface Water Elevations)
3. Piezometer/monitoring wells (Groundwater Elevations): manual collection and auto-recording sites

The following describes the general equipment and specifications for each type of installation:

1. <u>Automatic Staff Gages (ASG)</u>: These consist of 2” diameter PVC stilling wells secured to steel fence posts. Fence posts are secured to existing outlet structures or driven into pool / channel bottoms in open water areas. Each stilling well consists of PVC riser pipe and PVC slotted screen. On average the screened (submerged) interval is typically 3 feet in length with PVC riser completing the surface expression of each stilling well. Filter socks are attached to each screened interval to reduce the quantity of fines (silts and clays) in contact with the down-hole recording equipment. Each installation is completed with a locking and vented well cap.

   The water level recording equipment utilized for each automatic staff gage includes an InSitu Inc. miniTROLL self-contained pressure transducer / data logger. The 0.72-inch diameter probes are installed within each installation by cable suspension. The probes are programmed to read water levels at 15 minute intervals. Data was uploaded monthly directly from the miniTROLL using a Compaq Pocket PC and Pocket-Situ software.

2. <u>Manual Staff Gages (MSG)</u>: The monitoring network includes nine (9) traditional staff gages. The manual gages are secured to steel fence posts driven into pool and/or channel bottoms.

   Manual water levels were observed once per month during the 1 year monitoring period by V3 staff.

3. <u>Piezometers (P)</u>: Piezometer construction consists of typical 2” diameter PVC riser and slotted screen. The piezometers (P1 and P2) are completed within the shallow zone of interest using 5 foot screen length. The void above the screen of each piezometer is backfilled with bentonite. The installations were completed with stick up PVC riser, and a locking metal protective casing. The piezometers were surged and bailed following installation to ensure appropriate removal of caked and smeared fines, and to ensure natural groundwater recharge at the screen.

   Water levels from two (2) piezometers P1 and P2 were manually collected once per month during the 1 year monitoring period by V3 staff.

4. Existing Monitoring Wells: An existing shallow groundwater monitoring well along the east side of Big Marsh (ASW2) was used as a auto-recording site, as well as existing shallow ISWS Well #21 (used to obtain data in vicinity of Hegewisch Marsh for future evaluation of this area). An additional existing well (ISWS Well #48) had been planned for manual measurements but could not be field located and thus was dropped from the network.

   Water levels from the two (2) existing wells ASW2 and ASW3 were obtained automatically using InSitu Inc. miniTROLL self-contained pressure transducer / data loggers. These units were programmed to record water levels at 15 minute intervals.

Water Quality Multi-parameter Measurements: Basic water quality parameters were measured monthly at selected automatic and manual staff gage locations. Temperature, pH, conductivity, dissolved oxygen (DO) and oxidation-reduction potential (ORP) were the parameters measured using an In Situ Inc. Multi-Parameter Troll 9000. Water quality was not obtained for any groundwater locations.

2.2 Monitoring Network Locations and Detail

Data collected as a result of this network (see Figure 1) includes:

- surface water elevations within primary pools, side pools and certain outlet channels,
- groundwater elevations from existing shallow wells and installed piezometers, and
- water quality parameters (pH, DO, Conductivity, Temperature and ORP) measured monthly at all automatic staff gage locations (except ASG 1) and at three (3) manual staff gage locations (MSG 1, MSG 6, MSG 9).

In addition, existing daily Calumet area precipitation data has been compiled from Gage 18 (aka Ingersoll property) of the Illinois State Water Survey Calumet area rain gage network (ISWS Westcott). Calumet River water level elevations are derived from the O'Brien Lock and Dam facility maintained by the Army Corps of Engineers (ACOE), which is approximately 1.5 miles south (downstream) of Lake Calumet. It is important to note that this gage was decommissioned in June 2005. Additionally, this gage location was located downstream of the lock. Lake Michigan water levels were downloaded from the USGS website for the entire monitoring period. The Lake Michigan water levels are measured on the lakeside of Chicago Lock.

The following descriptions provide the locations and general objectives for staff gages installed as part of the monitoring plan; refer to Figure 1 for the location of each station.

Conservation Area

One automatic staff gage, ASG 1 was installed within Conservation Area near the outlet to Lake Calumet (Figure 1). This location and data provides water level data useful for future watershed model calibration and as an initial assessment of seasonal / precipitation event fluctuations. No water quality data was obtained from this location.

Lake Calumet

Two (2) manual staff gages were installed in Lake Calumet. MSG 2 was located south of the Conservation Area and MSG 3 is located in the northeast arm of Lake Calumet, west of the Big Marsh outlet (Figure 1); MSG 3 was installed in an area considered less subject to potential “fetch”. It is important to note that MSG 2 is no longer standing. No water quality data was obtained from these locations.

Big Marsh

Two (2) automatic staff gages were installed to evaluate Big Marsh. ASG 2 was installed along Stony Island Avenue to monitor water level fluctuations in the main pool for Big Marsh (Figure 1). ASG 3 was installed immediately upstream of the outlet from Big Marsh to Lake Calumet (Figure 1). The necessity of this second installation was driven by the observed channel gradient from the main pool to the Big Marsh outlet. Several additional monitoring stations were established at Big Marsh:

- One (1) manual staff gage (MSG 1) was installed in the pool southeast of Big Marsh main pool (Figure 1). This gage will provide information regarding the relationship between this pool and the Big Marsh main pool water levels.
- Groundwater was monitored with an auto-recorder at the existing groundwater well labeled ASW 2 (Figure 1). This well is located east of Big Marsh and assists in interpreting connections and general behavior of groundwater as it relates to surface water elevations in Big Marsh.
- ISWS well # 48 (map ID MSW Figure 1) at the northwest portion of Big Marsh was searched for on multiple occasions by V3 staff for implementation into the monitoring network, however, its location was not found.

Deadstick Pond

Two automatic staff gages (ASG 7, ASG 8) were installed in Deadstick Pond (Figure 1). ASG 7 was installed to monitor representative water level fluctuations within the main pool of the pond. ASG 8 was installed immediately upstream of the outlet to the Calumet River at the water control structure. ASG 8 was installed due to the observed channel gradient from the primary pool to the outlet control structure. The combined installations provide the data necessary to correlate conditions within the main pool and outlet channel in association with any temporal changes in site conditions and during runoff events.

Heron Pond

One automatic staff gage, ASG 6 was installed to monitor water level fluctuations within the main pool (Figure 1). Two (2) manual staff gages (MSG 8, MSG 9) were installed in the pools north and southwest of the Heron Pond main pool to evaluate the relationship between these and the main pool water levels (Figure 1). The water level data from these sources could be used to infer gradient and groundwater contribution information to open water areas at the site.

Indian Ridge Marsh – North (IRM North)

One automatic staff gage, ASG 4 was installed adjacent to the outlet control north of 122nd Avenue in the main pool of Indian Ridge Marsh (Figure 1). This station monitors water level fluctuations in the primary pool to determine temporal water level data in Indian Ridge Marsh North. Several additional monitoring stations were established at Indian Ridge Marsh North:

- Four (4) manual staff gages were installed throughout the Indian Ridge Marsh North pools. MSG 4, 5, 6 and 7 (Figure 1) monitor the water levels in the pools north and east of Indian Ridge Marsh main pool. These gages are used to evaluate the relationship between the side pools and the primary pool water levels.
- Two piezometers (P1, P2) were installed on an east-west transect within the upland region of eastern IRM North (see Figure 1). The objective of these piezometers is to assess groundwater water level data for this region to evaluate the general behavior of

groundwater as it responds to seasonal trends and runoff events and their relation to the surface water elevations in IRM North.

Indian Ridge Marsh – South (IRM South)
One automatic staff gage, ASG 5 was installed to monitor the water level fluctuations in the pool south of 122nd Avenue. It may also be used to assess interactions with Indian Ridge Marsh North. In addition, this data can be used with the swale elevation data to infer outflow periods to the Calumet River.

Illinois State Water Survey Well #21 – Hegewisch Marsh
Groundwater was monitored with an auto-recorder at the existing groundwater well labeled ASW 3 (Figure 1). This well is located south of the Calumet River and north of Hegewisch Marsh. Construction activities destroyed this well in March of 2005.

2.3 Equipment Calibration/Maintenance

The automatic data loggers (In Situ mini Trolls) were visited monthly and operational maintenance was conducted according to the manufacturers instructions and field based observations. These tasks included clearing the hard drive, replacing or checking battery power, making sure o-rings were intact, identifying if mini-Troll would be susceptible to water freezing damage and noting any damage or movement of the stilling well or equipment. At each monthly field visit, the mini-Trolls were evaluated for measurement drift using a water level indicator.

Temperature, pH, conductivity, dissolved oxygen (DO) and oxidation-reduction potential (ORP) were measured using an In Situ Inc. Multi-Parameter Troll 9000 water quality probe. The regular manufacturer recommended maintenance schedule was adapted by V3 and followed for the water quality program. Prior to each sampling event, the probe was calibrated using Troll 9000 Calibration solution, and air for dissolved oxygen. The probe was not used for measurements until all instrument parameters were calibrated.

3.0 RESULTS AND DISCUSSION

This section introduces and summarizes the water elevation, water quality and seep data for all of the Calumet EMS Phase I sites within the monitoring program. The following describes the primary figures prepared to present study findings:

- Figure 2 provides a map of the HMP study area that contains a "snapshot" (April 21, 2004) of water elevations within the various study sites and groundwater monitoring points. This map was developed to provide the reader a sense for the relationships between the various study area sites themselves, as well as the potential tail water and receiving waters (e.g., Lake Calumet and Calumet River).

- Figures 3 and 4 provide a graphical representation of water elevations from surface water and groundwater. While the figure is busy, all sites are plotted together to provide a glimpse of the relationships between monitoring locations.

- Figures 5 through 9 graphically present the water quality measurements. Each water quality parameter is represented on an individual plot that contains data from each monitoring station. This allows a comparison of the variability between sites, and allows the reader to seek trends within the data between sites.

- Figures 10.1 through 10.5 graphically present all measured parameters together on an individual site basis. The plots include the precipitation record (ISWS Westcott) for the monitoring period. These plots allow an evaluation of data and the development of insights relative to the behavior of individual water bodies within the study area. These sheets provide a valuable tool for assessing and analyzing water bodies on an individual basis.

3.1 Surface Water Elevations

The Calumet area water level monitoring network explained in Section 2.0 was utilized to develop one year hydrographs for each monitored water body (July 2003-July 2004). Figure 1 shows the locations of each automatic and manual staff gage location within the monitoring program. The water level elevations were derived following a survey of all monitoring station gages (NAVD 88 DATUM). A total of twelve (12) monthly readings from manual staff gages and continuous (15 minute interval) readings from automatic staff gages comprise the data base of water level data.

Table 1 shows the monthly recorded elevations from each gage and a description of each gage location. A statistical breakdown of the water surface elevations in each water body can be found in Table 3. Figure 3 shows the annual hydrograph of all monitored water bodies including existing daily precipitation data from the Ingersoll Property (ISWS Westcott) and water levels of Lake Michigan (USGS) and the Calumet River (ACOE). Figure 3 also illustrates the correlation between water levels and precipitation events. Figure 2 shows a conceptual diagram of Calumet Area water surface elevations on April 21, 2004 to depict the relationship between water bodies at a date within the growing season.

Mean water surface elevations within the monitoring program range from 578.24' (Lake Calumet) to 587.90' (Heron Pond west pool). Lake Calumet, and the Heron Pond west and Southwest side pools had water elevations that fluctuated over two (2) feet during the monitoring period (Table 3). The least fluctuating water bodies included Heron Pond, Indian Ridge Marsh East side pool and the Conservation area; these water bodies showed fluctuation of one (1) foot or less (Figure 3, Table 3). On average, the water bodies monitored within this program had an annual water elevation fluctuation of 1.5 feet during the monitoring period.

Surface water elevations within the monitored water bodies are primarily controlled by water control structures and overflow weirs (manmade or earthen dams); Figure 3 shows the locations of all outlets, with a legend briefly describing each.

Supplemental water level data extending the available period of record (October 27, 2004 through September 20, 2005) has been provided by the Illinois State Water Survey (ISWS). This data is presented in Appendix B and includes ASGs 2, 4, 5, 6, 7 and 8 representing Big Marsh, Indian Ridge Marsh, Heron Pond and Deadstick Pond. This data is not included within the statistical summaries in Table 3 and is not plotted in the primary figures.

3.2 Surface Water Quality

To gain some initial insight relative to conditions and spatial and temporal trends within select Calumet area Phase I EMS sites, a basic water quality monitoring program was combined with the monitoring stations established for water level monitoring (Section 2.0). In this case basic water quality monitoring refers to the collection of pH, DO, Conductivity, Temperature and ORP measurements monthly from July 2003 thru July 2004 at all automatic staff gage locations (except ASG 1) and at three (3) manual staff gage locations (MSG 1, MSG 6, MSG 9).

These results are graphically presented in Figures 5-9. Further, Figures 10.1 through 10.5 provide the compiled results for all monitoring parameters on an individual site basis, along with their relationship to the water levels and precipitation records for this period. The water quality measurements were collected during the monthly collection of water level elevations. The monthly data from each water body is shown in Table 2, and a statistical breakdown of the one (1) year water quality record for each site is provided in Table 4.

<u>Dissolved Oxygen</u>
Dissolved oxygen provides an indication of the amount of oxygen within the water. This concentration of oxygen is directly influenced by the temperature of the water, the movement of water, the amount of respiration and the amount of photosynthesis from algae and other aquatic plants. In addition, dissolved oxygen concentrations can be higher during the peak daylight hours and lower during the night. DO levels are considered the most important and commonly employed measurement of water quality, an indicator of a water body's ability to support desirable aquatic life. Levels above 5 milligrams per liter (mg /L) are considered optimal and most fish cannot survive for prolonged periods at levels below 3 mg /L. Levels below 1 mg /L are often referred to as hypoxic, and when oxygen is totally absent anoxic.

Figure 5 and Table 2 show the monthly dissolved oxygen readings at all monitored sites; its trend is correlative with temperature data. Table 4 shows the annual statistics relative to DO concentrations for each water body. As expected the highest DO readings at each site occurred during the winter months. The Illinois Pollution Control Board has a general use standard water quality standard for dissolved oxygen of 5 mg/l; this standard is referenced simply for comparative purposes. Multiple measurements at different sites were below this standard. However, the only location with an observed DO median that falls below 5.0 mg/l is the

Deadstick Pond outlet channel (ASG 8); this site recorded a median of 3.9 mg/l, a low value of 0.3 mg/l and a high of 13.6 mg/l indicating a high variability (Table 4). Indian Ridge Marsh North outlet and the pool east of Indian Ridge Marsh main pool (ASG 4, MSG 6 respectively) have the highest median values of 9.5 mg/l.

Although median concentrations typically exceeded 5 mg/l, low DO concentrations were recorded throughout the water bodies during the monitoring period. Concentrations indicating anoxic conditions were measured within the Big Marsh outlet channel (ASG 3), Heron Pond (ASG 6), the pool southwest of Heron Pond main pool (MSG 9) and at the Deadstick Pond outlet channel (ASG 8). These concentrations were noted to be unusually low which may represent environmental conditions, a naturally variable anoxic pocket and/or potential equipment error.

Percent dissolved oxygen saturation was calculated using temperature measurements and the assumption of no salinity, these calculated values are provided for reference in Table 2.

<u>pH</u>

pH is the measurement of alkalinity or acidity of water. The value of seven (7) indicates the neutral level above which is termed alkaline and below which termed acidic. In aquatic systems pH is primarily controlled by the geology (amount of carbonates in the system) and the carbon dioxide cycle within the water body. Carbon dioxide is created within the water system through decomposition and respiration and it is withdrawn from the system under photosynthesis. Within the Calumet area, it has been determined that water in contact with slag can increase alkalinity of the water (Roadcap and Kelly, 1994).

There were no acidic readings measured during this monitoring program (Figure 6), the lowest pH value recorded was 6.8, just below neutral at Indian Ridge Marsh South channel (ASG 5) in December of 2003 (Tables 2, 4). The most basic pH occurred at the pool east of the Indian Ridge Marsh main pool (MSG 6), where the annual median was 9.0 and the highest reading was 10.5.

<u>Oxidation-Reduction Potential (ORP)</u>

The ORP is proportional to the equivalent free energy change of electrons associated with a given reduction. The potential is large and positive in strongly oxidizing solutions. The oxidation potential has been found to remain fairly high and positive at all depths in a water body as long as the water is not near anoxic conditions (lack of dissolved oxygen) (Wetzel 1975). As the oxygen conditions approach zero and anoxic conditions appear, the ORP decreases dramatically. Generally, within the sediments at the bottom of water body, reducing conditions prevail and the ORP reaches zero and negative values within a few milliliters of the sediment-water interface.

Figure 7 graphically illustrates the measured ORP values and Deadstick Pond stands out having the lowest ORP. The Deadstick Pond main pool and outlet medians read 17.5 and 36.0 mV respectively (Table 4). These ORP values correlate with Deadstick Pond having low DO concentrations. Throughout the monitoring period the Deadstick Pond main pool (ASG 7) had a maximum of 101 mV and a minimum of -67mV. The pond outlet (ASG 8) had a maximum of 105 mV and a minimum of -211 mV (Table 4). These data, along with DO data suggests that Deadstick Pond has the most oxygen deficient water of all the monitored sites.

The highest ORP medians are at the Indian Ridge Marsh North outlet (ASG4), Indian Ridge Marsh South channel (ASG 5), and at the pool southeast of Big Marsh main pool (MSG 1). These medians were 70, 94 and 107 mV respectively. It is important to note that the other two locations of Big Marsh recorded medians of 40 and 46 mV during the same time frame. In addition, the isolated pools of Indian Ridge Marsh had much lower ORP values than the main pool.

Conductivity (Specific Conductance)

Specific Conductance measurements provide information regarding the capacity of water to convey electric current; hence, this measurement can be utilized to quantify the dissolved minerals in the water. This parameter is important in that it can help decipher groundwater from runoff, as groundwater would have high conductivity due to the water's access to available minerals to weather. Specific conductance values are shown in Table 2 and statistically summarized in Table 4. Figure 8 plots the monthly readings of specific conductance for each water body.

The highest specific conductance median was 1649 –uS/cm at Deadstick Pond main pool (ASG 7) and the lowest median was 216.4 –uS/cm at the pool east of Indian Ridge Marsh main pool (MSG 6). Looking at table 4, the medians and averages of all sites exceed 1000 –uS/cm except for the pool southeast of Big Marsh main pool (MSG 1), the Indian Ridge Marsh North outlet (ASG 4) and the pool east of Indian Ridge Marsh main pool (MSG 6).

The low conductance values at the pool east of Indian Ridge Marsh main pool may be attributed to a water budget dominated by runoff, additionally this water body has the highest water level elevation of all Indian Ridge Marsh pools (Figures 3, 10.4). As a result it may be that this water body is the least connected to groundwater of all the monitored sites.

One explanation for high conductance values is that Deadstick Pond may have one of the strongest groundwater connections of the monitored sites. However, Deadstick Pond is located directly adjacent to the Calumet River and its water levels are an average of seven (7) feet higher than the river (Figures 3, 10.2).

It is impossible to tell to what extent groundwater drives the EMS water systems by conductivity measurements alone. But the high conductivity medians throughout the monitoring sites suggest that groundwater is more significant to the water budgets in the larger and lower elevated pools.

Temperature

Water temperature is an important parameter as it directly affects biologic activity, growth and chemical reactions within a water system. Figure 9 graphically illustrates recorded temperatures which ranged from as low as 33.2 F in the winter at Heron Pond main pool (ASG 6), and reached a high of 84.5 F at the pool east of Indian Ridge Marsh main pool represented by MSG 6 (Tables 2, 4). On an average basis, the pool east of Indian Ridge Marsh main pool (MSG 6) had the highest average annual temperature and the pool southwest of Heron Pond main pool had the lowest (Table 4). Figure 9 shows the monthly temperature ranges at all monitored sites, its trend is as expected with seasonal climate changes.

3.3 Surface Water and Groundwater Interactions

A general sense for the interaction between groundwater and study area surface waters can be obtained using the surface water elevation data, groundwater elevation data from four (4) monitored wells, and the compiled water quality data. It is important to note that the limited network of groundwater monitoring can support only generalized observations.

Due to the heterogeneity of the Calumet area, establishing a comprehensive groundwater monitoring network would be a significant and extensive undertaking. However, general groundwater observations of value can be obtained with a limited number of monitoring points. Therefore, groundwater was monitored at four (4) locations in the Calumet Area. ASW 2 is located to the Southeast of Big Marsh and monitors shallow groundwater. P1 and P2 are located north of Indian Ridge Marsh main pool. Surface water and groundwater interactions can be briefly displayed and discussed for Indian Ridge Marsh and Big Marsh.

At Big Marsh, the shallow groundwater table elevation (ASW 2) was always similar to the surface water elevations at the pool southeast of Big Marsh main pool represented by MSG 1 (Figure 10.3). This pool is located approximately 300 feet northeast of ASW 2. Additionally, the figure shows that the groundwater is very responsive to precipitation events, almost as responsive as the surface water outlet of Big Marsh (ASG 3). This suggests significant gross permeability within this area of Big Marsh, and corroborates prior studies in this area.

Table 3 shows on average the water table at ASW 2 is approximately 1.75 feet higher than the main pool at Big Marsh (ASG 2) and over two (2) feet higher than the Big Marsh outlet channel location (ASG 3). This implies that groundwater is flowing east to west. This groundwater data also suggests that one can infer groundwater gradients between surface water pools in this area and that the main pools of Big Marsh were fed by groundwater throughout the entire monitoring period.

At Indian Ridge Marsh, the two piezometers screen the shallow sand northeast of the main pools (Figure 1). Water levels within this shallow water bearing sand fluctuated approximately 3.5 feet during the monitoring period, which was seasonally influenced (Table 3, Figure 10.4). The water table responded to the winter and early spring months by rising three feet; the winter elevations were higher than all Indian Ridge Marsh surface water elevations (Figure 10.4). During the summer months, the water table elevation dropped significantly below all Indian Ridge Marsh pools. This seasonal trend indicates that Indian Ridge Marsh pools are likely susceptible to groundwater inflow and seepage more during the winter and spring months. It is also reasonable to assume that the main pool of Indian Ridge Marsh (ASG 4) would have the highest influence with groundwater and the isolated pools are better armored from groundwater influence.

At Deadstick Pond there was no groundwater monitoring conducted, however, the specific conductance values described in section 3.2 relative to the Phase I EMS sites monitored indicate that groundwater may play a significant role in the water budget at Deadstick Pond (Table 3).

ASW 3, which is located south of the Calumet River on the north side of Hegewisch Marsh, has groundwater elevation data illustrated in Figure 4. Figure 4 shows that groundwater at ASW 3 grades to the Calumet River. Hence the Calumet River provides the hydrogeologic low point of the shallow groundwater in the Calumet area.

Overall, in the areas monitored it appears that the larger water bodies and pools are influenced and fed by groundwater during at least part of the year. It is not clear how the isolated pools are influenced, but it is likely less significant.

3.4 Seep Investigation

A comprehensive seep investigation was conducted by V3 during the one year period of monitoring (summer 2003-summer 2004). An initial thorough field investigation of all monitored Phase I EMS sites was conducted in August of 2003, and additional monthly seep searches and monitoring of identified seeps was performed.

The initial seep field reconnaissance investigated locations previously identified by George Roadcap (ISWS), and an assessment of the physical settings and topography of each monitored Phase I EMS site. This investigation did not identify any significant seepage above the water body levels of any of the monitored Phase I EMS sites. However, three small seep locations were identified and monitored throughout the sampling year. Two locations are located on the west bank of South Indian Ridge Marsh (SP 1 and SP 2) and one monitored location was on the west bank of Deadstick Pond, just north of ASG 7 (SP 3).

Appendix A provides photographs of all three (3) seeps monitored in this summary. IRM Seep 1 was identified as "piping" occurring within a localized seam of sand. The pore water pressure created in the soil due to the water piping created a small un-stable scarp and exposed the seep detail. At the initial visit on August 12, 2003 the seep was moister than the surrounding soil, but a measurable discharge was not noted. A water collection pit was dug beneath the seep, to allow for water collection and returning seven (7) hours later amounted to no measurable amount of water. Upon consecutive monthly visits, the collection pit was destroyed and no observable or measurable discharge could be indicated (Appendix A shows the pictures of this seep).

Indian Ridge Marsh Seep 2 (Appendix A) was identified as a small eroded depressional area adjacent to Indian Ridge Marsh South. Seams of coarse grained soil (sandy loam, sandy clay loam) contributed to very moist soil conditions; however, during all field visits no measurable or observed discharges were indicated. V3 believes that the seepage activity that occurs at this location is deeper in the soil column and is closer to the water level of Indian Ridge Marsh South. The pore pressure that is induced by this seepage probably reduced the stability of the land creating the identified depressional area.

The Deadstick Pond seep location (SP 3) (Appendix A) was initially suspected to be a seep due to soil moisture, however no saturated water conditions were ever monitored at this site and digging around the area did not identify any soil conditions related to seepage at this location.

The HMP seep investigation only identified three (3) seep locations within the monitored Phase I EMS sites and the seeps identified had insignificant discharges. Vegetation was a limitation during all of our seep investigation periods; at most Phase I EMS sites investigated the banks were fully vegetated and disguised the banks. As a result, micro–topography and the identification of hydric plants provided an essential criterion during our field analysis of seep locations.

It is likely and probable that seepage occurs at notable rates into the Phase I EMS Sites. However, it is believed that most of the seepage activity would be at or below surface water elevations and disguised by the water levels in the water bodies.

4.0 DATA INFLUENCES, LIMITATIONS AND COMPLICATIONS

Field monitoring and site visits that occurred from June 2003 through July 2004 provided opportunity for the field observation of conditions that may influence the water levels reported within this report. Through the course of data collection, numerous anthropogenic and natural factors were observed that create limitations and complications to the overall water levels record. These factors are identified below and should be referred to during data analysis and interpretation. Further, Table 1 and 2 provide reasons for the data gaps present at some monitoring station locations.

<u>Overall Site-Wide Complications</u>

1. Site access to Port Authority property was difficult to facilitate. Port Authority access was required for Lake Calumet gages (MSG 2 and MSG 3) and the Conservation Area gage (ASG 1). As a result manual water level readings and data upload from ASG 1 was unobtainable during some months (Table 1). In addition, MSG 2 was never surveyed into the project datum due to access constraints. The access agreement with the Port Authority did not allow for the collection of water quality parameters from the Lake Calumet and Conservation area gage locations (ASG 1, MSG 2 and MSG 3).

2. Ice heave was a concern at all staff gage locations. Field observations noted ice up to 3 inches thick during the winter months of the monitoring period. The expansion and movement of ice overlying the water bodies may have accounted for shifting of the gages and hence slight changes in their elevations. MSG 2 located on the Port Authority property in Lake Calumet was permanently damaged by ice flow or boating activity prior to December 22, 2004.

3. Construction activities and site modifications are of concern throughout the monitored area. For instance, a tile installation between the pool east of Indian Ridge Marsh main pool (represented by MSG 7) and the Indian Ridge Marsh main pool. This construction was observed as being recent on July 16, 2004.

   The demolition and roadway construction at 130th Street and Torrence Avenue destroyed ASW 3 (ISWS Well #21). The automatic water level recorder installed in the well was recovered, however, the data record ends in February of 2004.

4. Beaver and debris accumulations at water body outlet weirs and structures promoted water body storage and increased water elevations. They also provided for rapid drawdown events when debris was cleared during periodic maintenance. The areas identified to be most vulnerable to debris accumulation and beaver damming are the Big Marsh Outlet (ASG 3), the Indian Ridge Marsh outlet north of 122nd Avenue (ASG 4), the Indian Ridge Marsh spillway weir that drains to the Calumet River (ASG 5) and the Deadstick Pond outlet structure (ASG 8).

5. Wave action was noted as a concern in larger water bodies; wave action and fetch may influence recorded water levels during certain windy periods. Conservation Area was noted with significant wave action during installation of ASG 1 in June 2003. The other water body with the most significant wave action is Lake Calumet (MSG 2 and MSG 3).

6. Adjustable water control structures throughout the monitoring area are of concern, primarily at Conservation Area (ASG 1). A control structure exists along the embankment between Conservation Area and Lake Calumet. Conservation Area water is higher than that of Lake Calumet. The control structure is equipped with removable stop logs. During the monitoring period Harborside Golf Course maintenance crews adjusted stop logs and water levels to facilitate various wetland mitigation efforts on-going at Conservation Area. Unfortunately, a schedule of stop log installations or removals is un-available. V3 attempted to gain information from the Harborside Golf Course regarding stop log activity, however, the only information obtained was that stop logs were removed from the beginning of September 2003 through October 2003 for grading and an irrigation system installation at the mitigation area adjacent to Harborside.

Instrument and Data Recording Complications

1. As mentioned above, MSG 2 was permanently destroyed by ice flow or boating activities prior to December 22, 2004. Additionally, this gage was never surveyed into the project datum—so no elevation data exists for this gage. However, fortunately MSG3, also located in Lake Calumet, has survived and had been surveyed into the project datum.

2. At the Big Marsh outlet (represented by ASG 3) there are two data gaps observed in the annual data set (Figures 3, 10.3). The first data gap lasted for nearly one month and was attributed to a transducer data logger error. The second data gap exists, because staff decided to remove the transducer for the winter to prevent ice damage. This was done because the water was shallow at this location and the likelihood was high that the entire water column would freeze and possibly damage the equipment.

3. At Heron Pond (represented by ASG 6) there is a data gap in November and December 2004 due to transducer data logger error (Figures 3, 10.1).

4. Winter conditions during the monitoring period created complications with observing manual staff gage water levels at ASG 4, ASG 5, ASG 6, ASG 7 and ASG 8. Water levels from these gages during January and February 2004 were unobtainable due to ice accumulation, and the hazard of working through ice to obtain water levels (Tables 1 , 2).

5.0 CONCLUSION

This initial phase of the Calumet Area Hydrologic Master Plan and associated data collection provides an initial introduction to the behavior of each water body, including pool interactions, groundwater interactions, general water quality characteristics, and pool responses to precipitation events. The data presented in this report will be used as an essential tool assisting stakeholders as they develop ecological management and rehabilitation plans for the Calumet area EMS sites. Future use of the data may include model development and calibration, optimization of water levels to support diverse wetland communities, invasive species management, and the assessment of effective water control structures. Although data gaps may remain at the conclusion of this work, the data contained within this report and as part of the HMP will assist rehabilitation planning and will help assess what further information may be required.

6.0 REFERENCES

Roadcap, G.S., and Kelly, W.R. 1994. *Shallow Ground-Water Quality and Hydrogeology of the Lake Calumet Area, Chicago, Illinois*. Interim Report. Illinois State Water Survey.

USGS and Army Corps of Engineers (ACOE). O'Brien Lock and Dam Gage Data. http://il.water.usgs.gov/annual_report/data/manuipts/05536358.htm.

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Westcott., N.E. 2004. *Continued Operation of a 25-Raingage Network for Collection, Reduction, and Analysis of Precipitation Data for Lake Michigan Diversion Accounting: Water Year 2003* Illinois State Water Survey Contract Report 2004-03.

GLOSSARY

Automatic Staff Gage (ASG) : Apparatus installed to collect sufrace water elevations of water bodies at 15 minute intervals.

Anoxic : Water that contains little to no dissolved oxygen.

Conveyance Capacity : The maximum amount of water that can be transported downstream by a pipe or channel.

Discharge : The rate of water flowing out of a site.

Dredging : Process of removing sediment accumulation from lake and river bottoms.

Equality Formation : Tongues of glacial lake deposits that consist of silts, clays and sands.

Evapotranspiration : Proportion of waterbudget that is returned to the air through evaporation and transpiration (plant uptake).

Glacio-fluvial : Sediment or lithified sequence deposited from meltwater streams flowing from or within glaciers.

Glacio-lacustrine : Sediment or lithified sequence deposited within a glacial lake.

Gradient : Slope of a surface, generally pertaining to groundwater surfaces in these texts.

Headwater : The depth of water at the upstream end of a control structure or pipe.

HEC-RAS : Hydraulic Engineering Center – River Analysis System. A computation program widely used for developing water surface profiles for streams and ditches.

Hummock : Micro-topographic mounds that usually form from soil consolidation and poor surface water drainage.

Hydraulics : The determination of water surface elevations through relationships of flow and physical geography.

Hydrology : The determination of stormwater runoff rates and volumes for a study area based on rainfall data and physical geography.

Hydroperiod : A simulated or measured time duration of water elevations.

Infiltration : The downward movement of water through pores or small openings in soil or rock.

Inudation : Standing surface water.

Manual Staff Gage (MSG) : Apparatus installed within surface water body to visually observe surface water elevations (observations conducted once per month).

*All words are not necessarily referred to in text.

Mottles : Soil discolorations usually caused by chemical interactions between water and chemicals/minerals within the soil.

Orifice : A control structure ; a small opening, usually in a metal plate or wall, used to restrict the amount of water discharging from a site.

Permeability : The capacity of rock or sediment for transmitting fluid flow under unequal pressure.

Piezometer : A well installed into the ground that penetrates an underground water bearing unit – in which the groundwater elevation can be monitored along with its associated head.

Reduction : The removal of oxygen from soil or water.

Slag : Iron and steel manufacturing by-product. Waste material resulting from the impurities of mineral ore and ash from coke.

Stage-Discharge Rating Curve : A curve illustrating discharge rates for water leaving a site at given stages or elevations.

Seep : A location where groundwater discharges to the surface.

Stop Logs : Removable planks used to block water from leaving a site. The top stop log will set the normal pool level for a basin.

Stormwater Control Structure : A device, usually an orifice or a weir, used to regulate water discharge from a site.

Stratigraphy : The arrangement of rock and or soil types in chronologic order of sequence.

Submerged : Located entirely underwater.

Tailwater : The depth of water at the downstream end of a control structure or pipe.

Watershed : The area the drains to a similar point location or water body.

Weir : A control structure that prevents discharge from a site until the headwater exceeds the overflow elevation.

*All words are not necessarily referred to in text.

FIGURES

LEGEND

- ASG - AUTO-RECORDING STAFF GAGE
- MSG - MANUAL STAFF GAGE
- ASW - AUTO-RECORDING (EXISTING) SHALLOW WELL
- P - PIEZOMETER (MANUAL READINGS)
- MSW - MANUAL SHALLOW WELL (EXISTING)
- SP - SEEP

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NO.	DATE	DESCRIPTION

PROJ. NO.: 98216HMP	DESIGNED BY: RKB
FILE NAME: FIGmonitoring	DRAWN BY: KJW
DATE: 11/16/05	CHECKED BY: JKA
SCALE: 1"=1600'	PROJ. MAN.: KRO

HMP MONITORING NETWORK & SEEP LOCATIONS

CALUMET AREA HYDROLOGIC MASTER PLAN

CHICAGO ILLINOIS

DRAWING NO. 1

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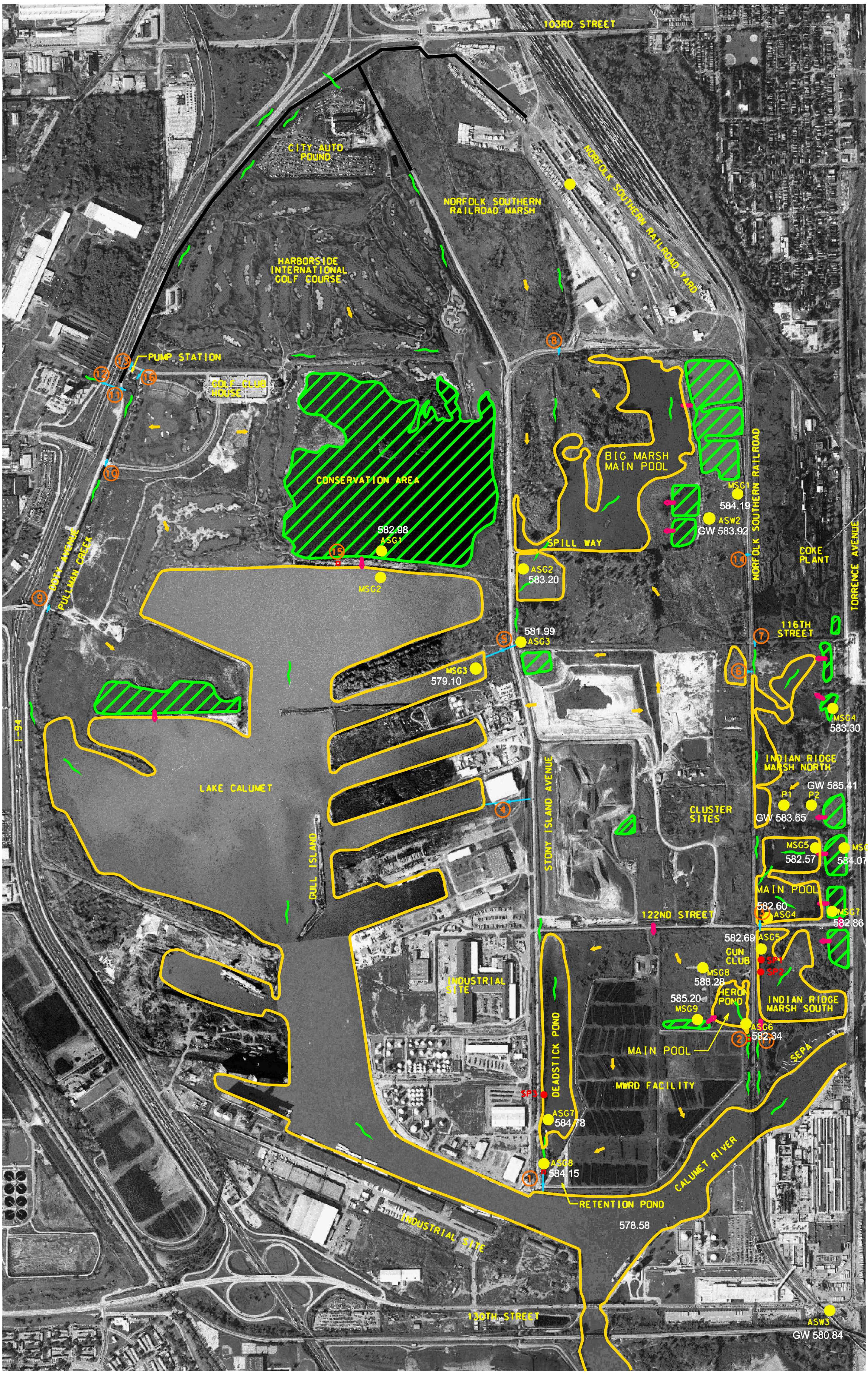


LEGEND

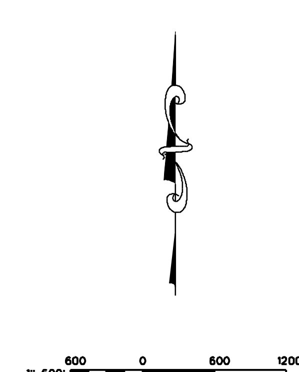
(black line)	WATERSHED BASIN
(yellow arrow)	RUNOFF
(magenta arrow)	LOCAL OVERFLOW
(green line)	DITCH OR STREAM FLOW
(red square)	INLET
(blue arrow)	CULVERT
(green hatched outline)	ISOLATED POND
(yellow outline)	LAKE OR OPEN WATER
(circled number)	STRUCTURE NUMBER

STRUCTURE NOTES

1. DROP INLET DRAINS DEADSTICK POND TO CALUMET RIVER.
2. ABANDONED WEIR STRUCTURE IN HERON POND'S OUTFALL DITCH.
3. 24" CMP CULVERT UNDER 122ND STREET.
4. STORM SEWER OUTFALL IDENTIFIED BY ROSS (1988) (HAS NOT BEEN VERIFIED IN THE FIELD).
5. DROP INLET DRAINS BIG MARSH TO LAKE CALUMET.
6. ABANDONED CULVERTS UNDER RAILROAD.
7. CMP CULVERT UNDER 116TH STREET.
8. CULVERT UNDER RAILROAD.
9. DOUBLE CORRUGATED METAL PIPE ARCH CULVERT IN PULLMAN CREEK.
10. DOUBLE CORRUGATED METAL PIPE ARCH CULVERT IN PULLMAN CREEK.
11. BOX CULVERT UNDER DOTY AVENUE.
12. BOX CULVERT UNDER I-94.
13. CMP CULVERT UNDER ACCESS ROAD TO GOLF CLUB HOUSE.
14. CULVERT 12" CMP FROM COKE PLANT TO BIG MARSH.
15. DROP INLET DRAINS CONSERVATION AREAS TO LAKE CALUMET.
16. 42" STORM SEWER FROM HARBORSIDE INTERNATIONAL GOLF COURSE.
17. OUTLET CHANNEL FROM INDIAN RIDGE MARSH SOUTH TO CALUMET RIVER.

LEGEND

- ASG - AUTO-RECORDING STAFF GAGE
- MSG - MANUAL STAFF GAGE
- ASW - AUTO-RECORDING (EXISTING) SHALLOW WELL
- P - PIEZOMETER (MANUAL READINGS)
- MSW - MANUAL SHALLOW WELL (EXISTING)
- SP - SEEP



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PROJ. NO.: 98216HMP	DESIGNED BY: RKB
FILE NAME: FIGmonitoring	DRAWN BY: KJW
DATE: 11/16/05	CHECKED BY: JKA
SCALE: 1"=1600'	PROJ. MAN.: KRO

HMP STUDY AREA WATER ELEVATIONS APRIL 21, 2004

CALUMET AREA HYDROLOGIC MASTER PLAN

CHICAGO ILLINOIS

DRAWING NO. 2

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Figure 3: HMP Monitoring Network Water Elevations: 07/11/03 - 07/27/04
***See Section 4.0 for additional information that influences data**

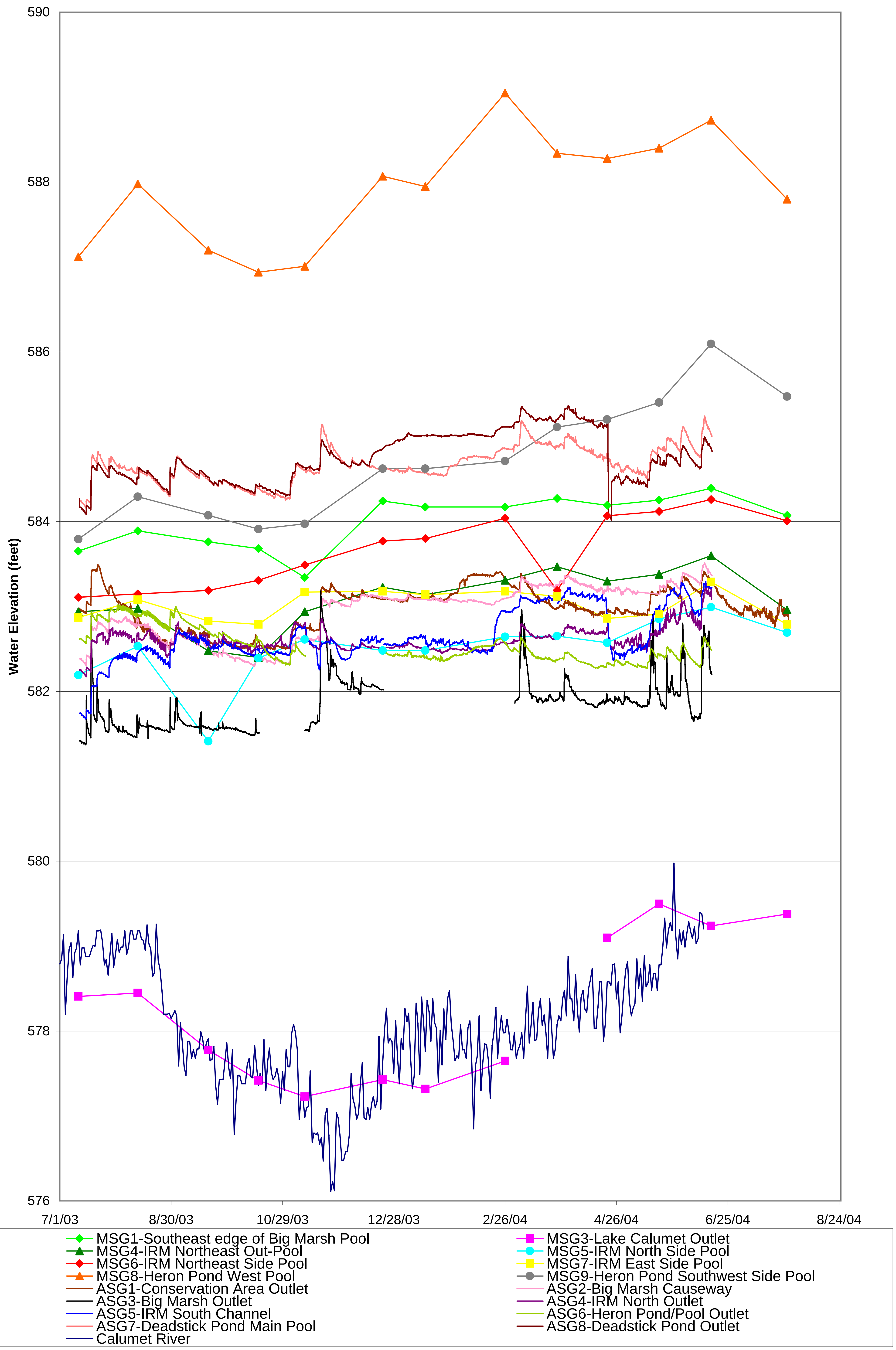


Figure 4: Groundwater Elevations vs. L. Michigan and Calumet River

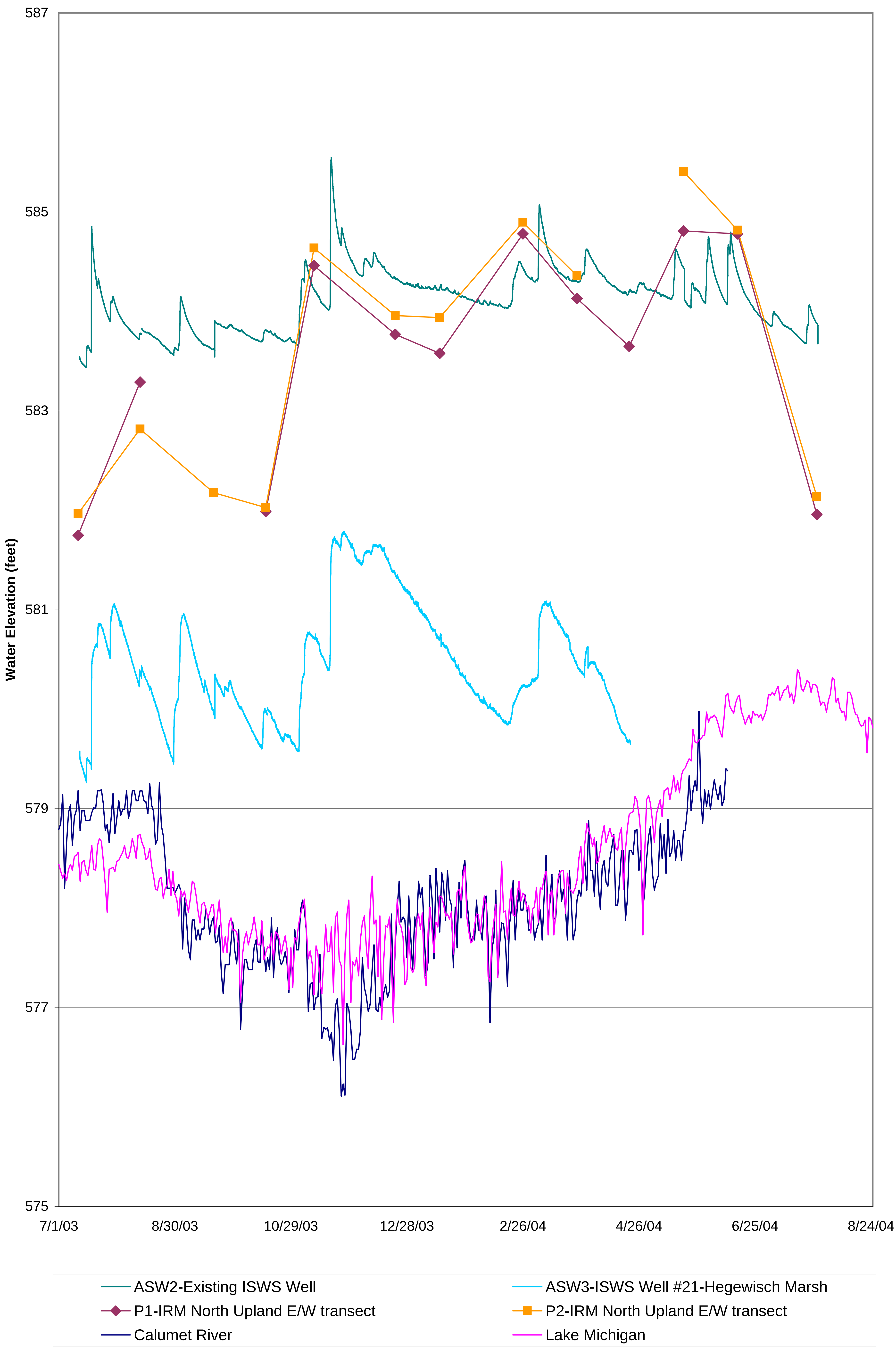


Figure 5: HMP Study Area - Dissolved Oxygen

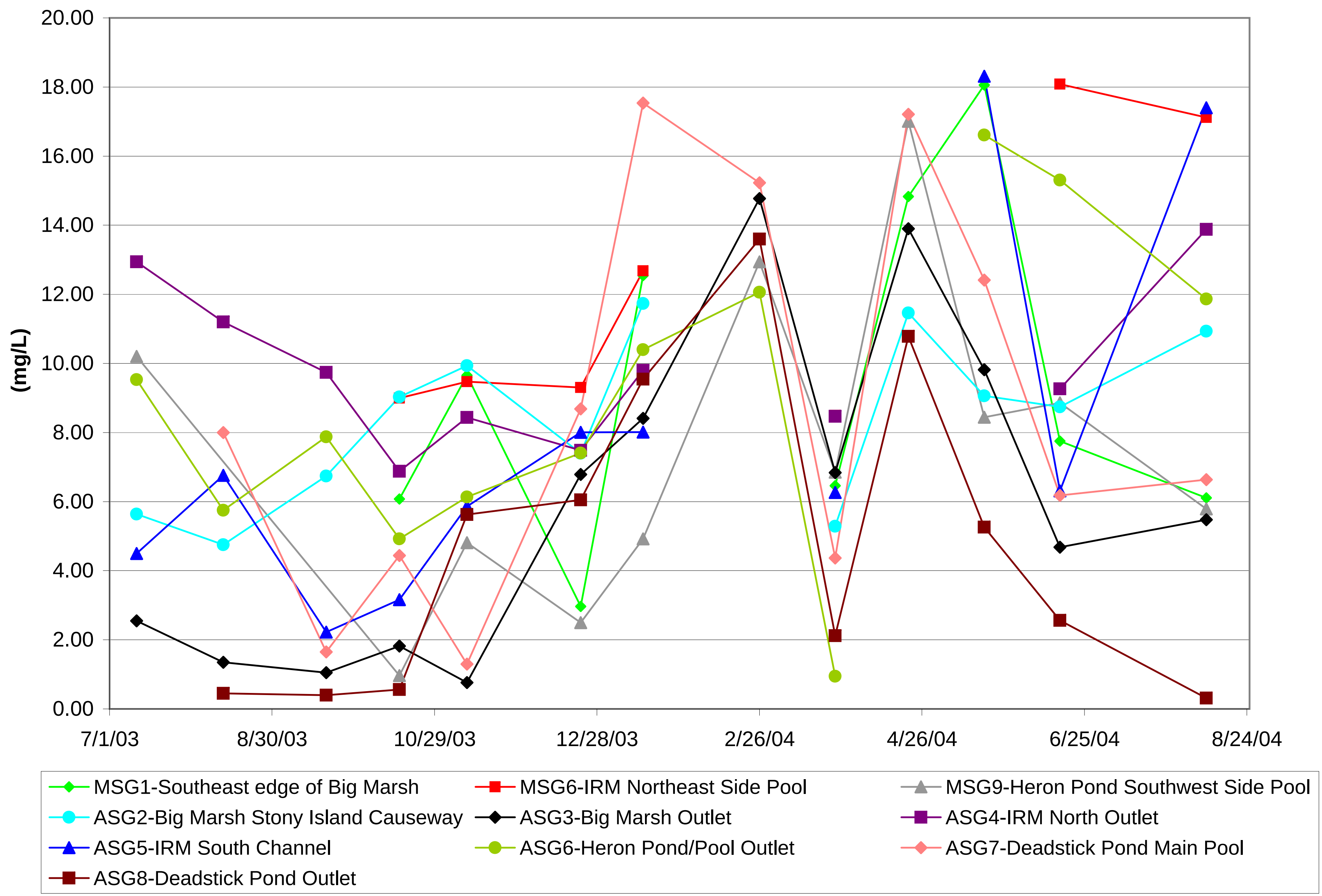


Figure 6: HMP Study Area - pH

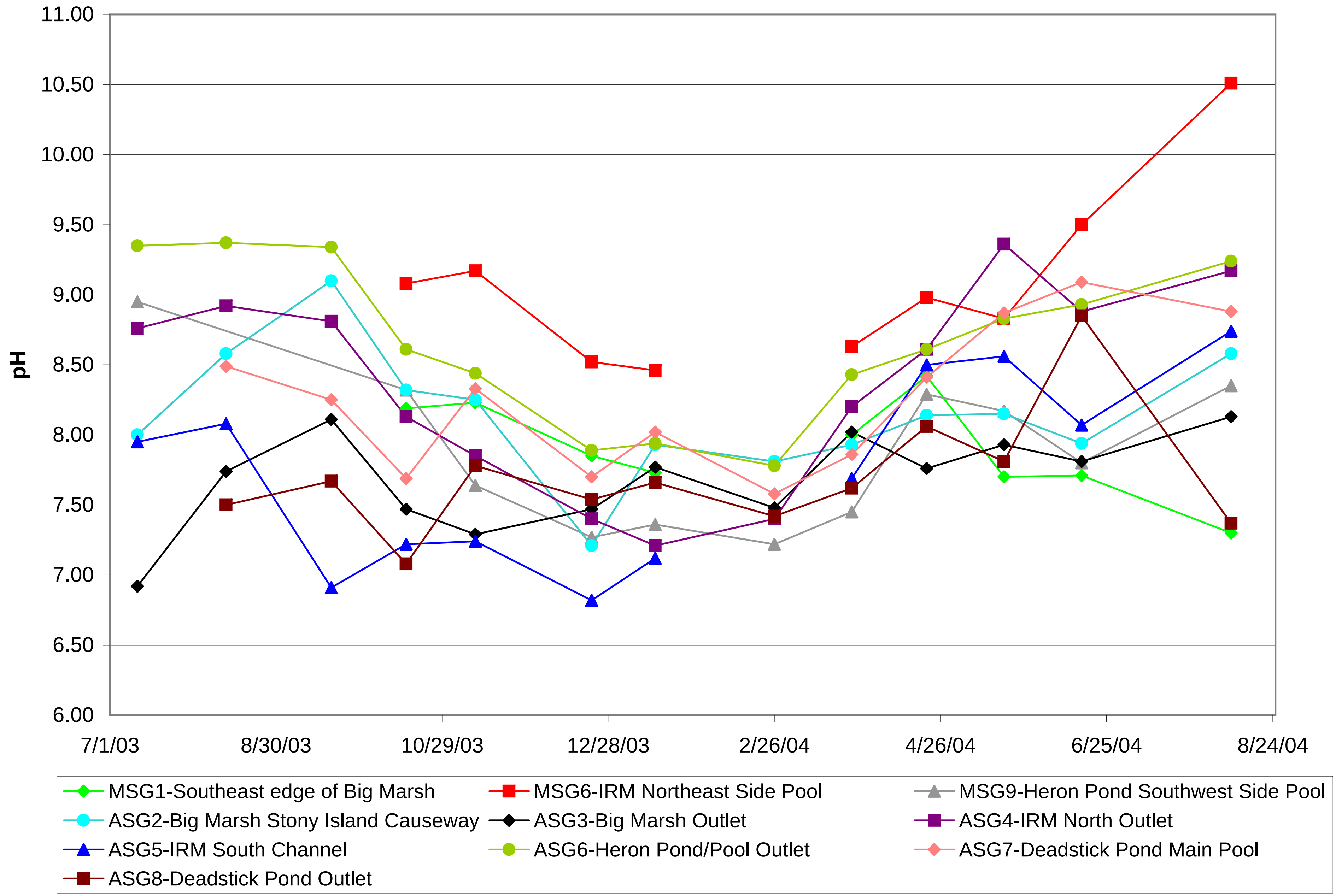


Figure 7: HMP Study Area - Oxidation-Reduction Potential

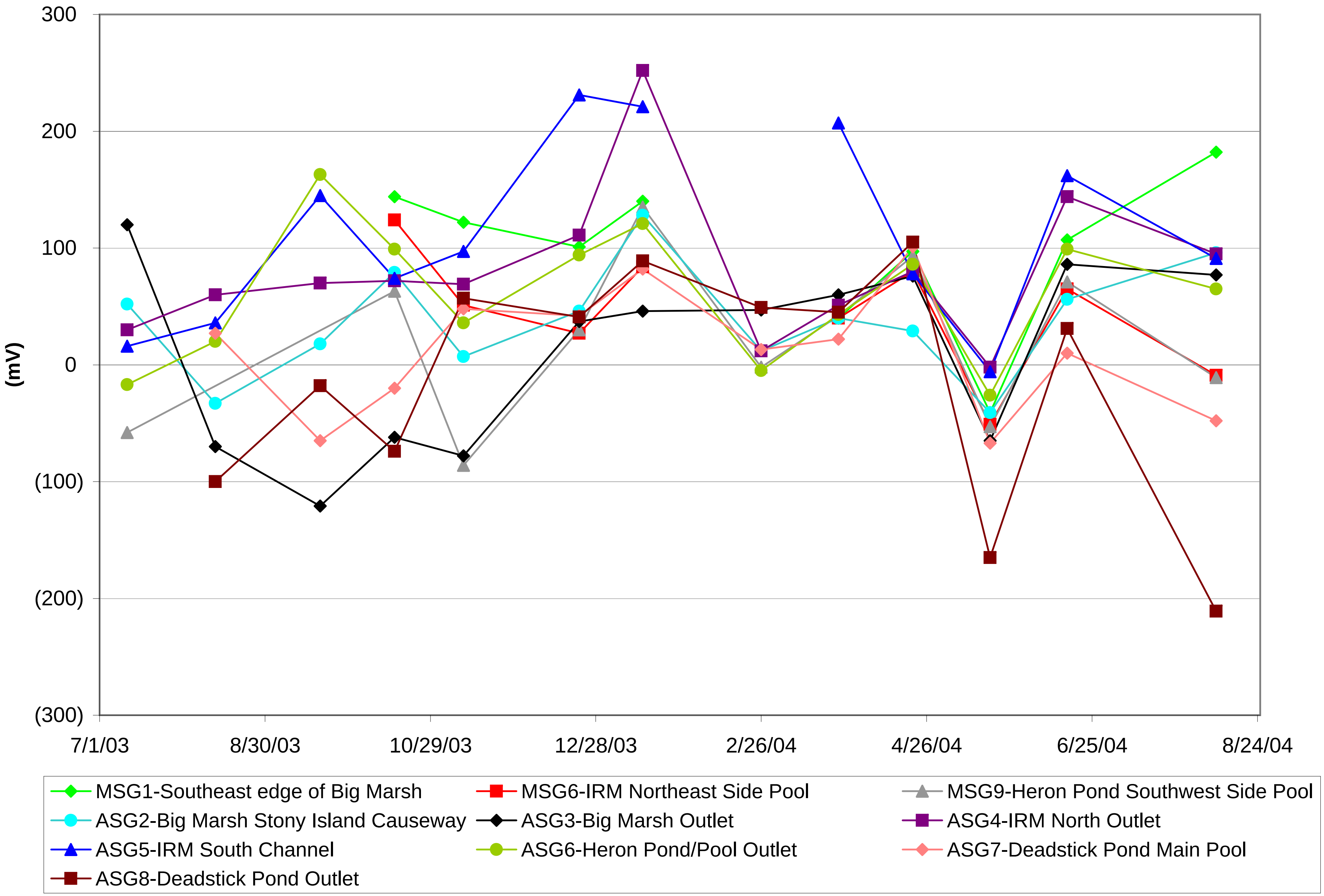


Figure 8: HMP Study Area - Conductivity (Specific Conductance)

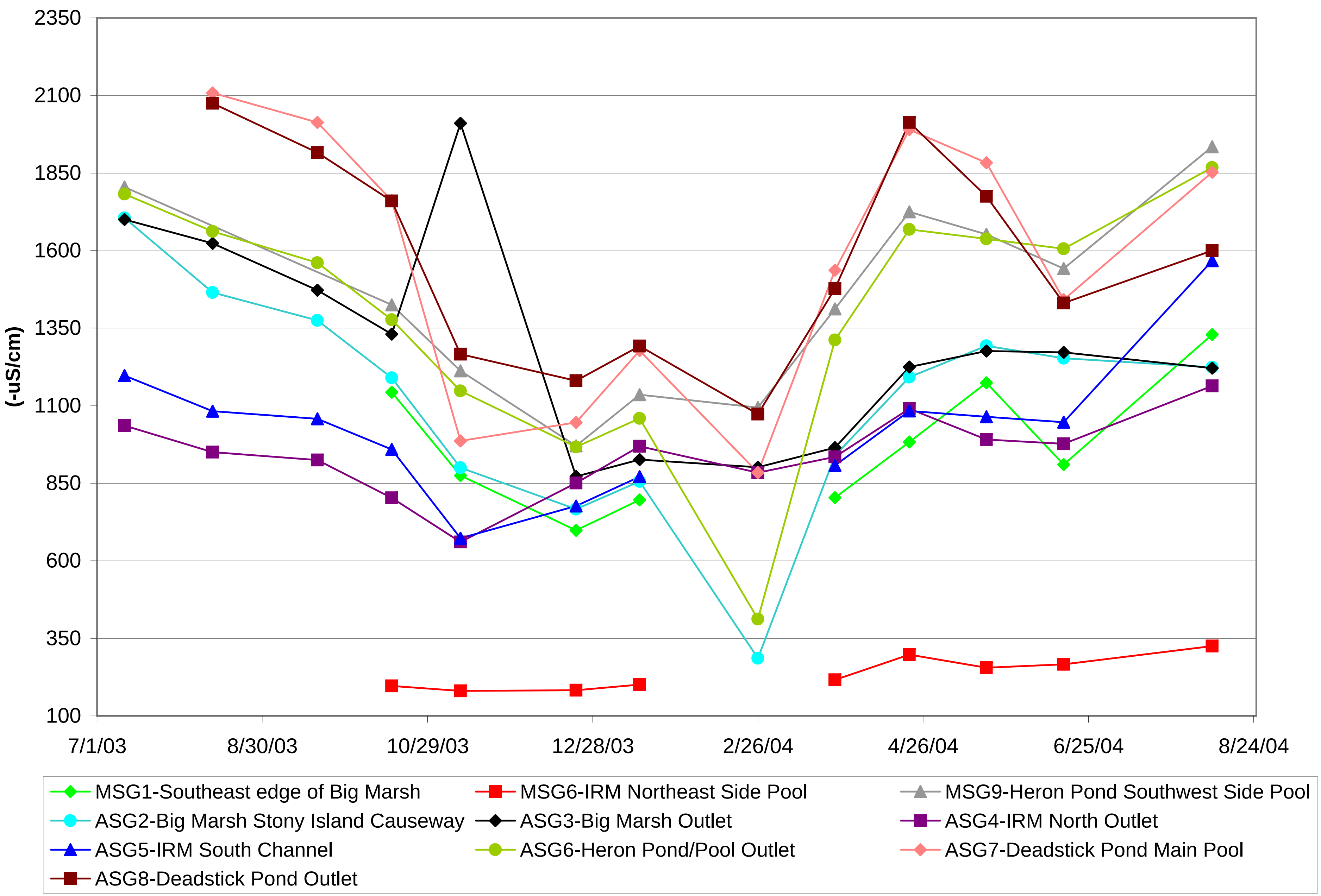


Figure 9: HMP Study Area - Temperature Graph

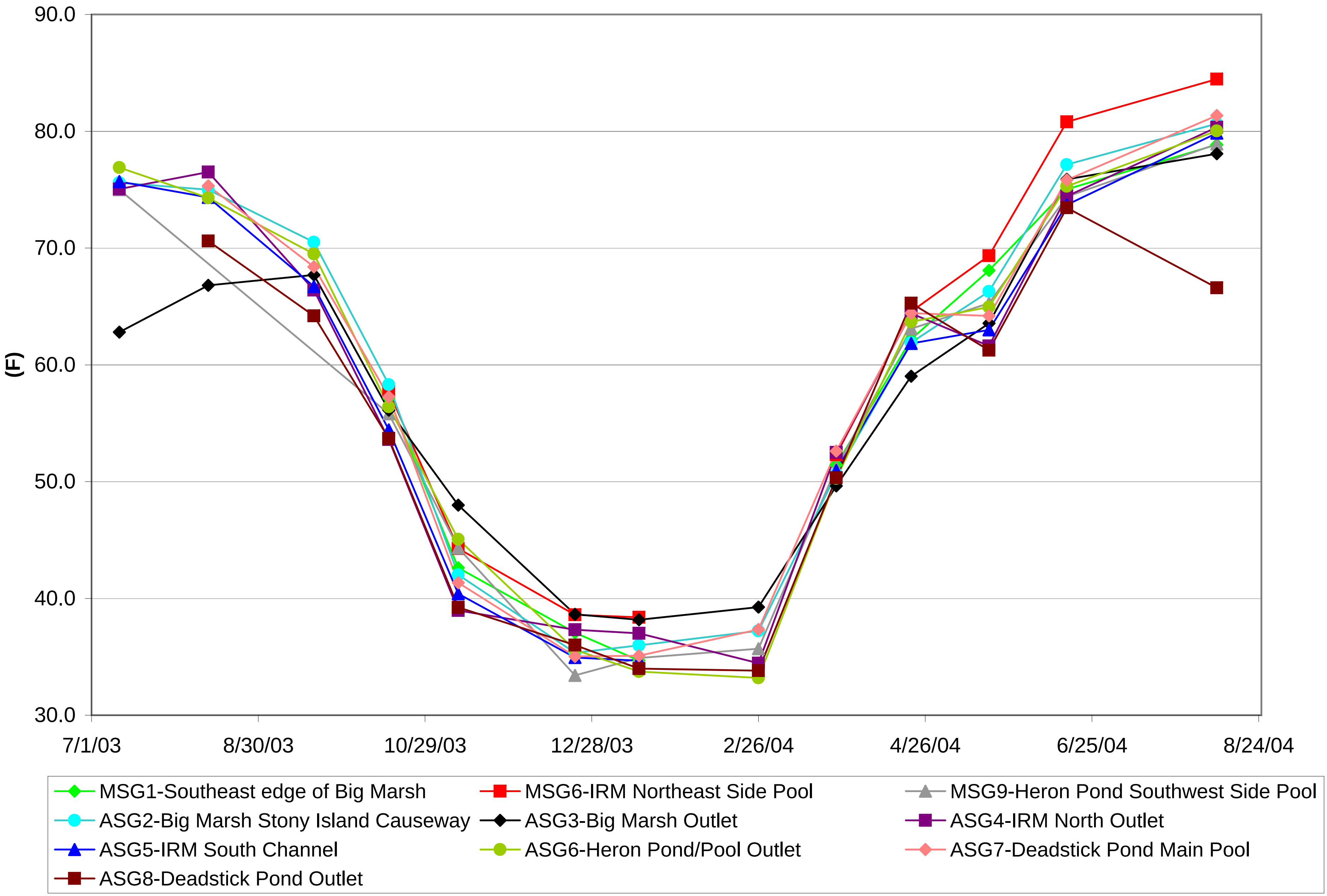
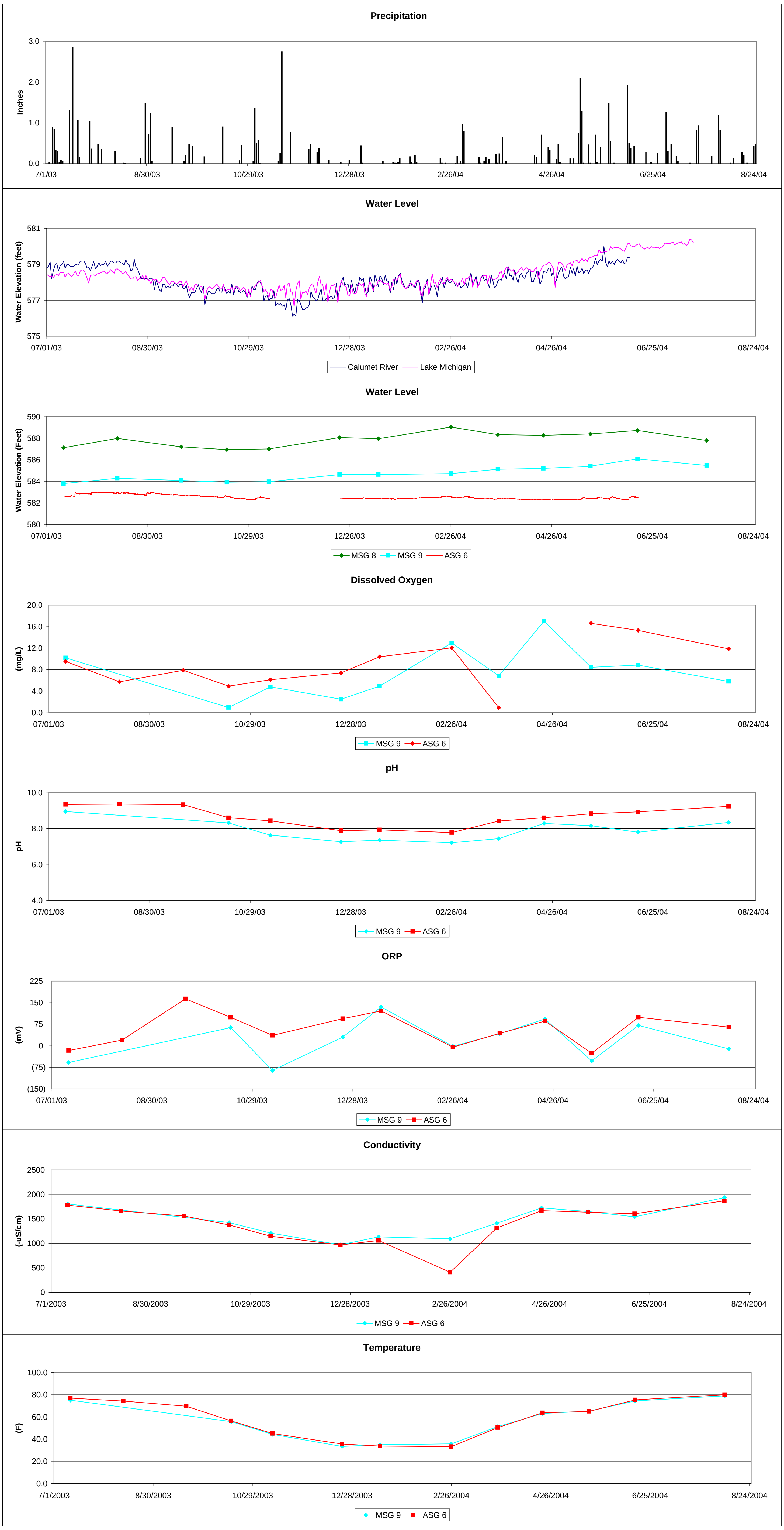
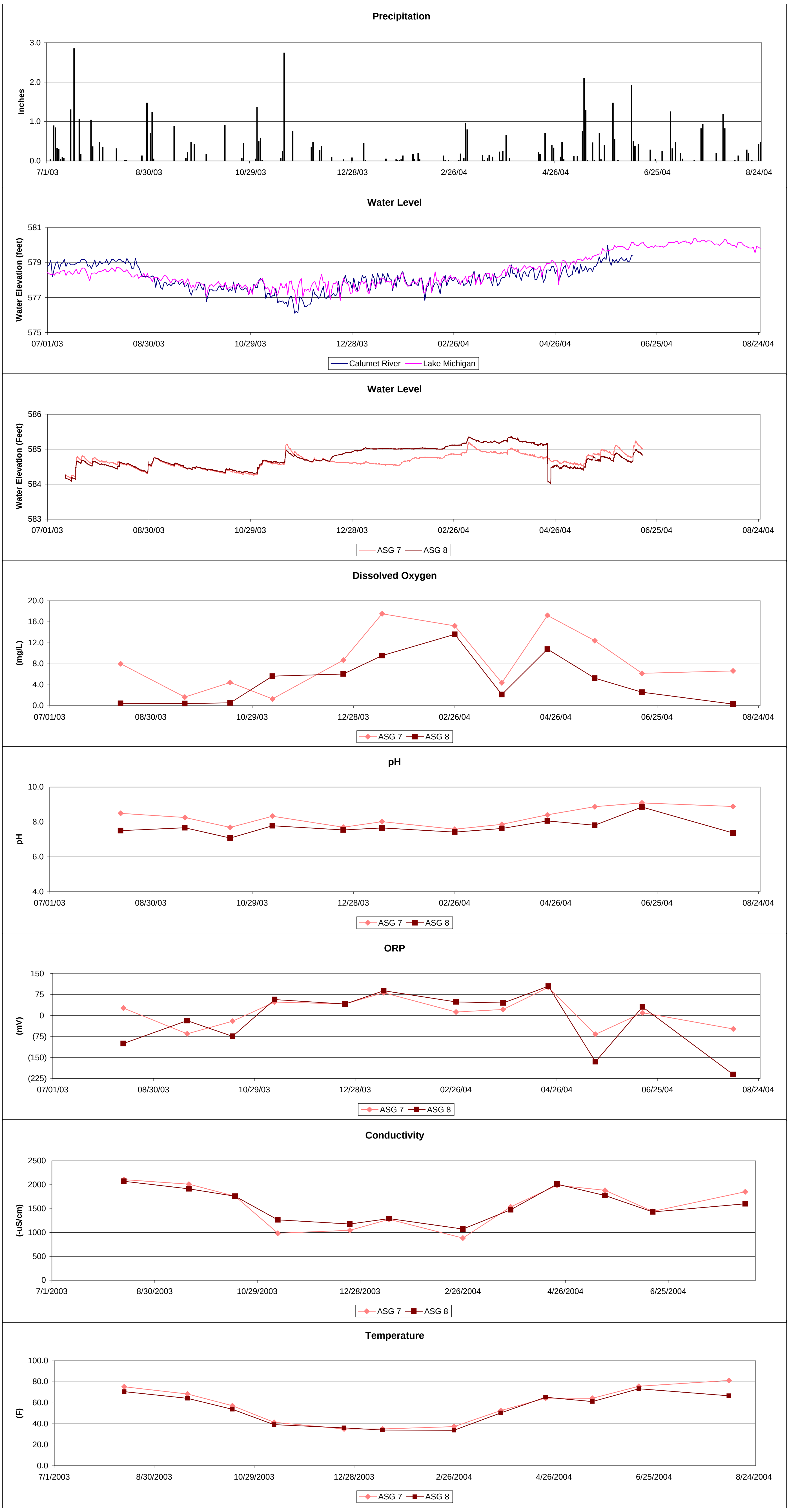


Figure 10.1: Heron Pond Measured Parameters



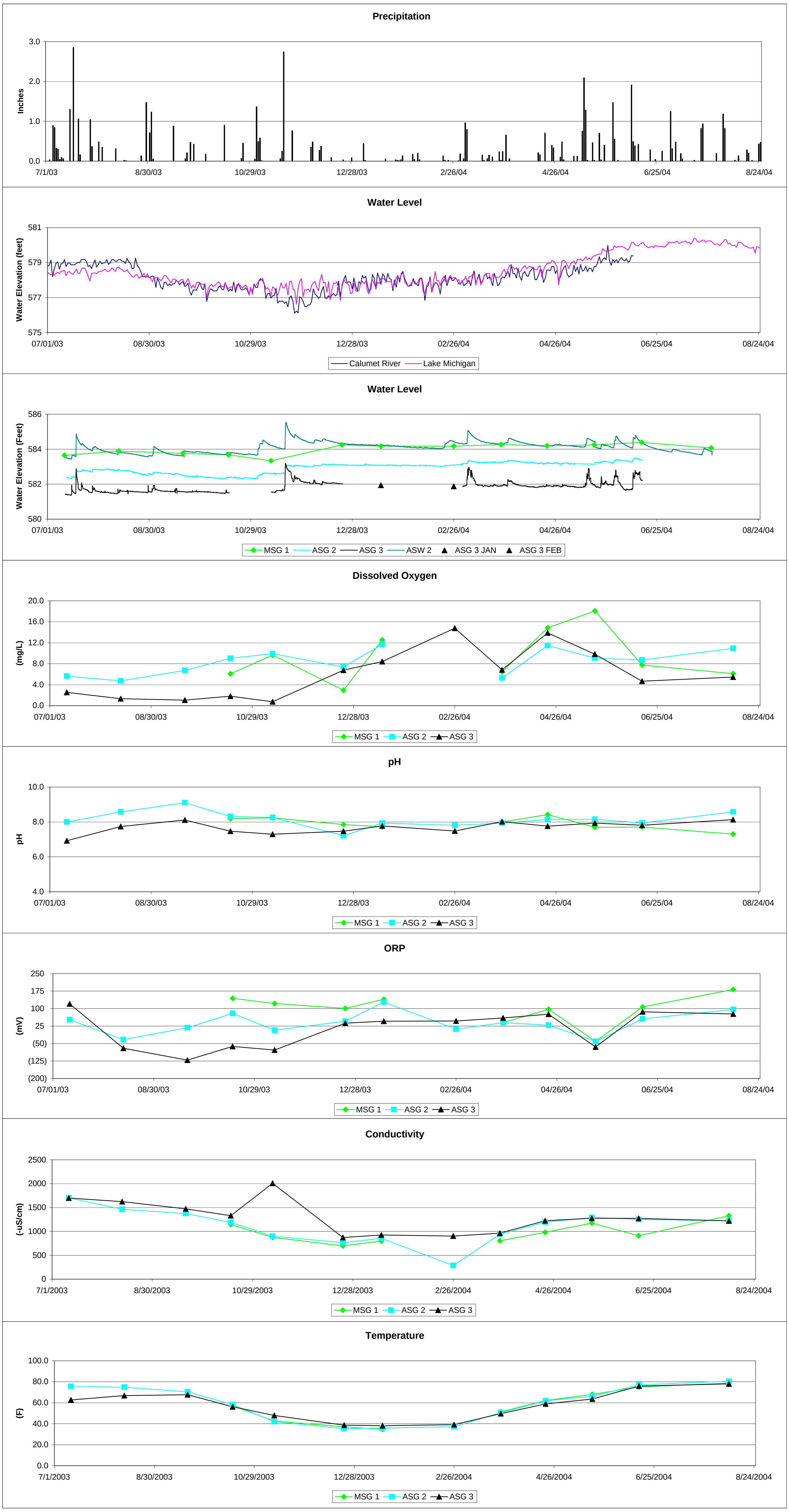
MSG 8 - Heron Pond West Pool **MSG 9 -** Heron Pond Southwest Side Pool **ASG 6 -** Heron Pond/Pool Outlet

Figure 10.2: Deadstick Pond Measured Parameters



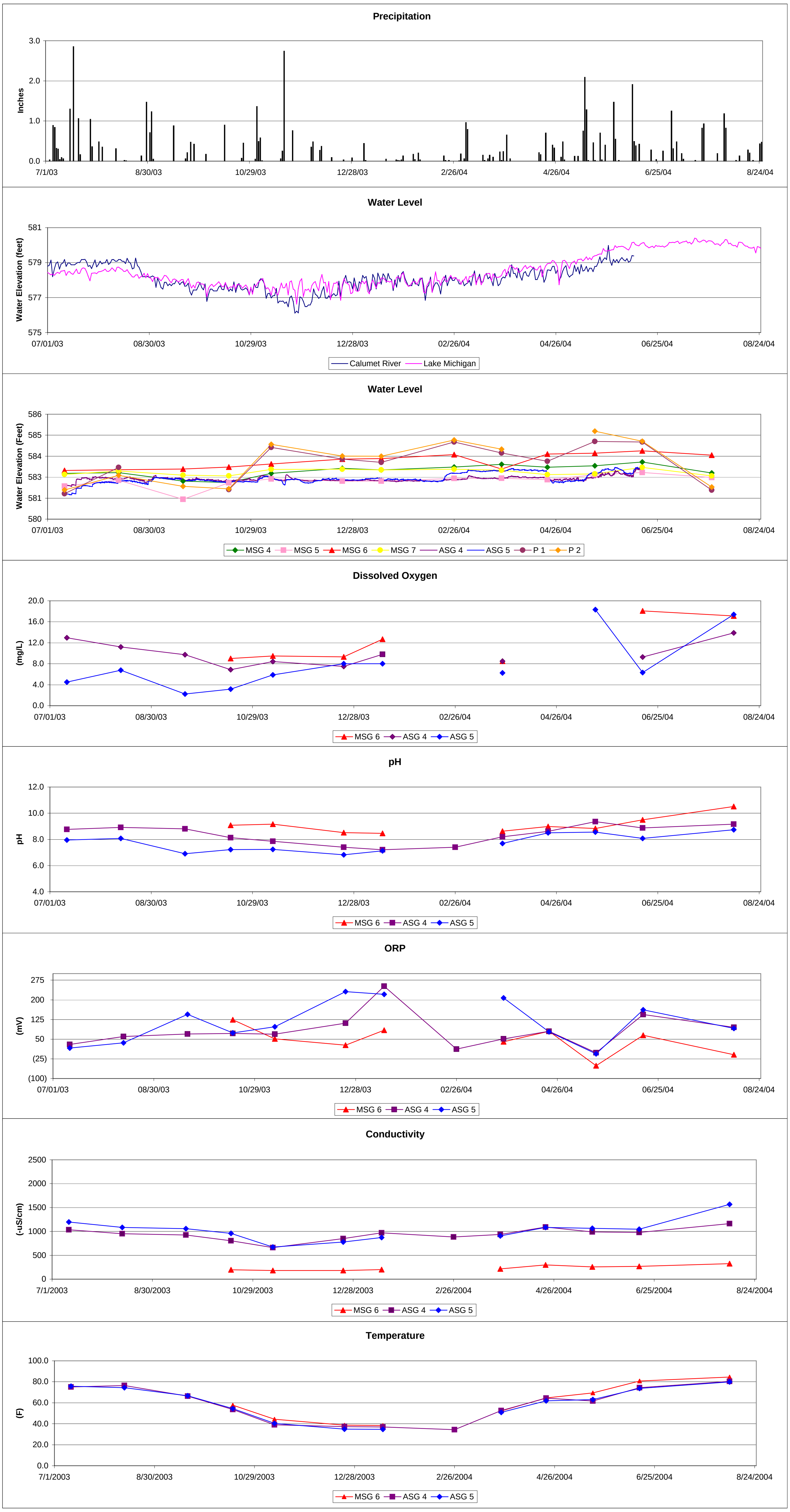
ASG 7 - Deadstick Pond Main Pool **ASG 8 -** Deadstick Pond Outlet

Figure 10.3: Big Marsh Measured Parameters



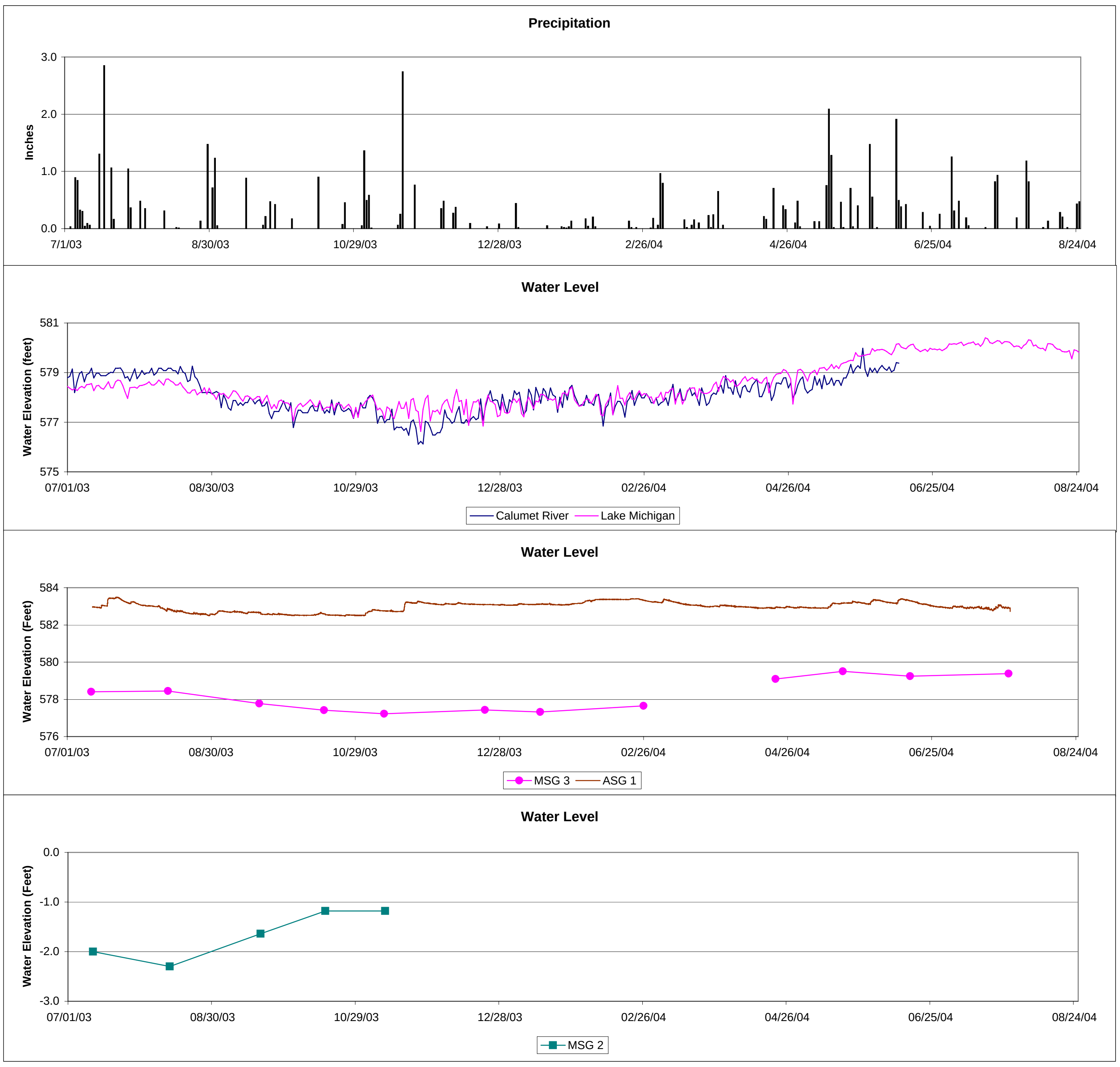
MSG 1 - Southeast edge of Big Marsh Pool **ASG 2 -** Big Marsh Causeway **ASG 3 -** Big Marsh Outlet **ASW 2 -** Existing ISWS Well

Figure 10.4: Indian Ridge Measured Parameters



MSG 4 - IRM Northeast Out-Pool **MSG 5 -** IRM North Side Pool **MSG 6 -** IRM Northeast Side Pool **MSG 7 -** IRM East Side Pool
ASG 4 - IRM North Outlet **ASG 5 -** IRM South Channel **P1 & P2 -** IRM North Upland E/W Transect

Figure 10.5: Lake Calumet-Conservation Area Measured Parameters



MSG 2 - Lake Calumet/Conservation Area Outlet **MSG 3 -** Lake Calumet at Big Marsh Outlet **ASG 1 -** Conservation Area Outlet

TABLES

Table 1 - HMP Monitoring Station Descriptions and Water Level Data

Location	SampleID	Station Description	12-Jun-03	15-Jun-03	11-Jul-03	12-Aug-03	19-Sep-03	16-Oct-03	10-Nov-03	22-Dec-03
Big Marsh	ASW2	Existing ISWS well		584.06	583.70	583.83	583.54	583.42	583.82	583.94
	MSG1	Southeast edge of Big Marsh pool	583.82		583.65	583.89	583.76	583.68	583.34	584.24
	ASG2	Big Marsh Causeway			582.39	582.79	582.48	582.41	582.60	583.11
	ASG3	Big Marsh Outlet			581.42	581.62	581.54	581.49	581.54	582.02
Conservation Area	ASG1	Conservation Area Outlet			582.96		582.56	582.55	582.75	583.09
Lake Calumet	MSG2	Lake Calumet/Conservation Area Outlet			-2.00	-2.30	-1.64	-1.18	-1.18	
	MSG3	Lake Calumet at Big Marsh Outlet			578.41	578.45	577.78	577.42	577.23	577.43
Indian Ridge Marsh North	MSG4	IRM Northeast Out-Pool	583.69		582.94	582.98	582.48	582.40	582.94	583.23
	MSG5	IRM North Side Pool	582.58		582.19	582.53	581.41	582.39	582.61	582.48
	MSG6	IRM Northeast Side Pool	583.32		583.11	583.15	583.19	583.31	583.49	583.77
	MSG7	IRM East Side Pool	583.46		582.87	583.08	582.83	582.79	583.17	583.18
	P1	IRM North Upland E/W transect		585.29	581.75	583.29		581.99	584.46	583.77
	P2			583.27	581.97	582.82	582.18	582.03	584.64	583.96
	ASG4	IRM North Outlet			582.55	582.62	582.53	582.49	582.68	582.51
Indian Ridge Marsh South	ASG5	IRM South Channel			582.14	582.46	582.52	582.49	582.71	582.53
Heron Pond	MSG8	Heron Pond West Pool	587.78		587.12	587.98	587.20	586.94	587.01	588.07
	MSG9	Heron Pond Southwest Side Pool	584.09		583.79	584.29	584.07	583.91	583.97	584.62
	ASG6	Heron Pond/Pool Outlet			582.62	582.89	582.69	583.03	582.43	582.45
Deadstick Pond	ASG7	Deadstick Pond Main Pool			584.55	584.60	584.60	584.39	584.60	584.60
	ASG8	Deadstick Pond Outlet			584.61	584.62	584.52	584.44	584.63	584.62
South of Calumet River	ASW3	ISWS Well #21 - Hegewisch Marsh		581.83	581.16	581.75	581.50	581.07	581.76	582.38

Notes:
Elevations shown in the table are from manual readings obtained during the monrthy site visits.
Elevations are referenced to vertical datum NAVD88
The system numbers both automatic and manual staff gages in their order from the North; for example, the Northernmost automatic staff gage would be ASG1.

- Data not available
- Not accesible, ice accumulation
- Damaged manual staff gage
- No water in well
- Sampling well damaged

Table 1 - HMP Monitoring Station Descriptions and Water Level Data

14-Jan-04	26-Feb-04	25-Mar-04	21-Apr-04	19-May-04	16-Jun-04	27-Jul-04	Survey Elev. USFeet (Oct. 2003)	height of gage (total depth)	MiniTROLL installation date	Location
584.21		583.96	583.92	584.11	584.36	583.83	591.8637	7.95	7/11/2003	Follow Torrence Avenue north to smaller road on west, just past residential. Continue west to barricade (no key available), beyond which are the railroad tracks. Cross the tracks and go through gate (need key). Head north ~200 meters towards wetland area. A 2" PVC riser should be seen approximately 100 meters west of the railroad tracks.
584.17	584.17	584.27	584.19	584.25	584.39	584.07	585.5325	3.65		From ASW 2 head northeast towards the railroad tracks. A large 6" pipe sticking out of the ground should be noted. Gage is located east of the pipe and about 10 meters from the railroad tracks.
		583.23	583.20	583.25	583.38	582.77	583.9904	5.56	7/11/2003	North of ASG 3 and in Big Marsh. Location can be seen from fisherman's berm, but access is easier cutting through plants along the western edge of water body.
581.94	581.87	581.96	581.89	581.91	582.14	581.72	586.8717	7.5	7/11/2003	Located at the north end of the landfill along Stony Island Avenue and attached to water control structure.
			582.98	583.18	583.25	582.81	585.2285	5.09	7/11/2003	Located directly north of MSG 2 within the Conservation Area.
				0.00	0.00	0.00	0.00 - No Elevation Available TOC datum assumed 0.00	4.2		Located in the Port Authority property within Lake Calumet. Follow road to northern edge of Lake Calumet. Location should be just east of a small pullout area.
577.32	577.65		579.10	579.50	579.24	579.38	580.3388	3.5		Located in the Port Authority property. Easiest access is through the Port's northeast gate (across from ASG 3). Heading north, follow road a little ways (~20 meters) after entering gate. MSG 3 will be to the west in the drainage channel.
583.14	583.31	583.47	583.30	583.38	583.60	582.96	585.789	4.29		Head south on Torrence and near the third power post after the north road (116th), park at the entrance to a grown in road. Head directly west. Head to the marsh.
582.48	582.64	582.65	582.57	582.85	582.99	582.69	584.1829	3.85		Park on Torrence, north of the red fire hydrant. Head west along the northern edge of the wetland (along an old road and west of the berm in the tree line-hard to find). Head south between the two wetlands to the gage in the western wetland (eastern edge).
583.80	584.04	583.19	584.07	584.12	584.26	584.01	584.8697	4.24		Park close to the red fire hydrant (along Torrence). Gage should be obvious from the road.
583.14	583.18	583.12	582.86	582.91	583.29	582.79	586.9899	6		Located off of 122nd street (near Torrence Avenue). Will be found on the southwest side of the wetland. (Walk in along the tree line's east side and find the gage. Note fallen tree in the marsh.)
583.58	584.78	584.13	583.65	584.81	584.78	581.96	591.2886	15.5		Located ~200 meters west of P2.
583.94	584.90	584.36		585.41	584.82	582.14	589.6668	11		Heading south on Torrence, park at the 3rd billboard from the northern road (Billboard # 001906). Located approximately 15 feet south and approximately 500 feet directly west of the billboard.
		582.67	582.60	582.67	583.04	582.72	584.9718	5.5	7/11/2003	Located across 122nd, north of ASG 5. (Northeast of culvert along the north side of road by the mini island/pile.)
		583.01	582.69	582.93	583.16	582.24	584.5135	5.14	7/11/2003	Located along 122nd street and just east of the railroad tracks. Park in pullout on south side of road next to tracks. Head south next to tracks a little ways and find location on the western edge of water body. (Can see location when looking down channel from the road)
587.95	589.05	588.34	588.28	588.40	588.73	587.80	590.8870	4.95		club, follow the grown in road southwest until you come across another grown in road (runs north-south) and head north and take an almost immediate left into the wetland (northern most wetland located west of the gun club)
584.62	584.71	585.11	585.20	585.40	586.09	585.47	587.1134	4.92		After MSG 8, follow the north-south grown in road heading south until it ends. Staff gage is located directly west of the southern edge of Heron Pond inside a small wetland.
		582.38	582.34	582.44	582.46	582.12	584.7068	5.3	7/11/2003	Head west on 122nd street, just past railroad tracks there should be an entrance (probably has wire across blocking entrance). Follow this heading south until you come to old gun club building. Climb up hill and follow railroad tracks south from gun club. Gage is located a little ways north of the southeastern edge of Heron Pond and is *not* visible from the railroad tracks
		584.90	584.78	584.87	585.04	584.55	586.9987	4.55	7/11/2003	Enter from western property gate, you will need key to enter (off of Stony Island Ave). Head south for 30 meters.
		584.65	584.15	584.67	584.80	584.30	588.5468	4.95	7/11/2003	Recommend driving through facility to far southwestern corner and parking near gate. Head north along fence to water control structure.
581.80							590.5305	8.95	7/11/2003	Located near the southwest corner of 130th Street and Torrence Avenue. Park in the back of the former "China King" restaurant. Well is located west of the parking lot.

*Locations are provided but approval from land owner is required to access the sites.

Table 2: HMP Study Area - Water Quality Data

Location	Identifier	Station	Date	D.O (mg/L)	% Saturation	pH	ORP (mV)	Conductivity (-uS/cm)	Temp(F)
Big Marsh	ASG2-Big Marsh Stony Island Causeway	ASG 2	7/11/2003	5.64	72%	8.00	52	1705	75.6
			8/12/2003	4.75	60%	8.58	(33)	1465	75.0
			9/19/2003	6.74	80%	9.10	18	1375	70.5
			10/16/2003	9.03	91%	8.32	79	1190	58.3
			11/10/2003	9.93	79%	8.25	7	900	42.0
			12/22/2003	7.40	54%	7.21	46	767	35.4
			1/14/2004	11.73	86%	7.93	128	856	36.0
			2/26/2004			7.81	12	286	37.2
			3/25/2004	5.29	48%	7.93	40	939	50.6
			4/21/2004	11.46	121%	8.14	29	1192	61.9
			5/19/2004	9.06	101%	8.15	(41)	1293	66.3
			6/16/2004	8.74	114%	7.94	56	1253	77.2
			8/9/2004	10.94	149%	8.58	96	1224	80.6
	ASG3-Big Marsh Outlet	ASG 3	7/11/2003	2.55	27%	6.92	120	1700	62.8
			8/12/2003	1.35	15%	7.74	(70)	1623	66.8
			9/19/2003	1.05	12%	8.11	(121)	1472	67.7
			10/16/2003	1.82	18%	7.47	(62)	1331	56.1
			11/10/2003	0.76	7%	7.29	(78)	2010	48.0
			12/22/2003	6.79	52%	7.47	37	872	38.6
			1/14/2004	8.41	63%	7.77	46	926	38.2
			2/26/2004	14.78	113%	7.48	47	901	39.3
			3/25/2004	6.84	61%	8.02	60	965	49.6
			4/21/2004	13.90	141%	7.76	76	1225	59.0
			5/19/2004	9.82	106%	7.93	(65)	1276	63.6
			6/16/2004	4.68	60%	7.81	86	1272	75.9
			8/9/2004	5.47	72%	8.13	77	1221	78.1
	MSG1-Southeast edge of Big Marsh	MSG 1	10/16/2003	6.08	60%	8.19	144	1143	57.1
			11/10/2003	9.66	78%	8.23	122	875	42.6
			12/22/2003	2.97	22%	7.85	101	698	37.1
			1/14/2004	12.54	90%	7.73	140	796	34.7
			2/26/2004						
			3/25/2004	6.46	59%	8.00	40	804	51.4
			4/21/2004	14.83	157%	8.42	97	983	62.2
			5/19/2004	18.06	207%	7.70	(41)	1174	68.1
			6/16/2004	7.75	98%	7.71	107	910	75.0
			8/9/2004	6.11	81%	7.30	182	1329	78.8
N. Indian Ridge Marsh	ASG4-IRM North Outlet	ASG4	7/11/2003	12.94	163%	8.76	30	1036	75.1
			8/12/2003	11.20	144%	8.92	60	950	76.5
			9/19/2003	9.74	109%	8.81	70	925	66.4
			10/16/2003	6.88	65%	8.13	72	803	53.6
			11/10/2003	8.43	64%	7.85	69	661	39.0
			12/22/2003	7.48	56%	7.40	111	851	37.3
			1/14/2004	9.80	73%	7.21	252	969	37.0
			2/26/2004			7.40	12	884	34.5
			3/25/2004	8.47	78%	8.20	51	935	52.5
			4/21/2004			8.61	80	1090	64.4
			5/19/2004			9.36	(2)	991	61.6
			6/16/2004	9.27	116%	8.88	144	977	74.4
			8/9/2004	13.88	189%	9.17	95	1164	80.3
	MSG6-IRM Northeast Side Pool	MSG 6	10/16/2003	9.00	90%	9.08	124	197	57.7
			11/10/2003	9.47	78%	9.17	51	180	44.3
			12/22/2003	9.30	71%	8.52	27	183	38.6
			1/14/2004	12.68	96%	8.46	84	201	38.4
			2/26/2004						
			3/25/2004	8.49	78%	8.63	40	216	52.3
			4/21/2004			8.98	80	298	64.6
			5/19/2004			8.83	(51)	256	69.3
			6/16/2004	18.08	247%	9.50	65	266	80.8
			8/9/2004	17.12	247%	10.51	(9)	325	84.5
S. Indian Ridge Marsh	ASG5-IRM South Channel	ASG5	7/11/2003	4.50	57%	7.95	16	1197	75.7
			8/12/2003	6.76	84%	8.08	36	1082	74.3
			9/19/2003	2.23	25%	6.91	145	1058	66.7
			10/16/2003	3.16	30%	7.22	74	959	54.4
			11/10/2003	5.86	46%	7.24	97	673	40.4
			12/22/2003	8.00	58%	6.82	231	777	34.9
			1/14/2004	8.01	57%	7.12	221	871	34.7
			2/26/2004						
			3/25/2004	6.27	57%	7.69	207	908	50.9
			4/21/2004			8.50	78	1083	61.8
			5/19/2004	18.31	196%	8.56	(6)	1064	63.0
			6/16/2004	6.31	78%	8.07	162	1047	73.7
			8/9/2004	17.40	235%	8.74	91	1567	79.8

Table 2: HMP Study Area - Water Quality Data

Location	Identifier	Station	Date	D.O (mg/L)	% Saturation	pH	ORP (mV)	Conductivity (-uS/cm)	Temp(F)
Heron Pond	ASG6-Heron Pond/Pool Outlet	ASG 6	7/11/2003	9.53	123%	9.35	(17)	1782	76.9
			8/12/2003	5.75	72%	9.37	20	1662	74.3
			9/19/2003	7.88	92%	9.34	163	1561	69.5
			10/16/2003	4.92	48%	8.61	99	1377	56.4
			11/10/2003	6.13	51%	8.44	36	1148	45.1
			12/22/2003	7.40	54%	7.89	94	967	35.6
			1/14/2004	10.40	73%	7.94	121	1059	33.7
			2/26/2004	12.06	85%	7.78	(5)	412	33.2
			3/25/2004	0.94	8%	8.43	43	1312	50.3
			4/21/2004			8.61	86	1668	63.7
			5/19/2004	16.61	183%	8.83	(26)	1638	65.0
			6/16/2004	15.30	194%	8.93	99	1606	75.3
			8/9/2004	11.87	160%	9.24	65	1868	80.0
	MSG9-Heron Pond Southwest Side Pool	MSG 9	7/11/2003	10.20	129%	8.95	(58)	1805	75.0
			10/16/2003	0.97	9%	8.32	63	1425	55.8
			11/10/2003	4.81	40%	7.64	(86)	1212	44.3
			12/22/2003	2.50	18%	7.27	30	970	33.4
			1/14/2004	4.92	35%	7.36	135	1135	34.9
			2/26/2004	12.94	94%	7.22	(2)	1094	35.7
			3/25/2004	6.85	62%	7.45	42	1412	51.2
			4/21/2004	17.01	182%	8.29	93	1725	63.1
			5/19/2004	8.44	93%	8.17	(53)	1652	65.3
			6/16/2004	8.86	111%	7.80	71	1542	74.4
			8/9/2004	5.79	77%	8.35	(11)	1935	78.9
Deadstick Pond	ASG7-Deadstick Pond Main Pool	ASG 7	8/12/2003	8.00	101%	8.49	27	2108	75.3
			9/19/2003	1.65	19%	8.25	(65)	2013	68.4
			10/16/2003	4.44	44%	7.69	(20)	1761	57.3
			11/10/2003	1.30	10%	8.33	48	987	41.4
			12/22/2003	8.68	63%	7.70	42	1046	35.0
			1/14/2004	17.54	126%	8.02	82	1278	35.1
			2/26/2004	15.23	113%	7.58	13	884	37.3
			3/25/2004	4.37	41%	7.86	22	1537	52.6
			4/21/2004	17.21	188%	8.41	101	1990	64.4
			5/19/2004	12.41	135%	8.87	(67)	1883	64.2
			6/16/2004	6.18	79%	9.09	10	1442	75.8
			8/9/2004	6.63	91%	8.88	(48)	1853	81.4
	ASG8-Deadstick Pond Outlet	ASG 8	8/12/2003	0.45	5%	7.50	(100)	2075	70.6
			9/19/2003	0.40	4%	7.67	(18)	1916	64.2
			10/16/2003	0.56	5%	7.08	(74)	1760	53.7
			11/10/2003	5.63	43%	7.78	57	1266	39.2
			12/22/2003	6.05	44%	7.54	41	1180	36.0
			1/14/2004	9.54	68%	7.66	89	1292	34.0
			2/26/2004	13.60	96%	7.42	49	1073	33.8
			3/25/2004	2.12	19%	7.62	45	1477	50.3
			4/21/2004	10.78	119%	8.06	105	2013	65.3
			5/19/2004	5.26	55%	7.81	(165)	1775	61.3
			6/16/2004	2.56	32%	8.85	31	1431	73.5
			8/9/2004	0.32	4%	7.37	(211)	1600	66.59

(cyan)	Sampling not performed due to adverse conditions
(light green)	Reading could not be stablized

Notes

Begin sampling at locations MSG1, MSG6 and MSG9 during the month of October

TABLE 3: HMP Monitoring Stations - Water Level Statistics (July 2003-July 2004)

Surface Water Elevation Statistics

	Lake Calumet	Conservation Area	Big Marsh			Indian Ridge Marsh						Heron Pond			Deadstick Pond		
	MSG 3 -Big Marsh Outlet	ASG 1 - Conservation Area Outlet	ASG 2 - Main Pool at Causeway	ASG 3 - Outlet	MSG 1 - Southeast pool	ASG 4 - North pool outlet	ASG 5 - South channel	MSG 4 - Northeast out pool	MSG 5 - North side pool	MSG 6 - Northeast side pool	MSG 7 - East side pool	ASG 6 - Main Pool/outlet	MSG 8 - West pool	MSG 9 - Southwest side pool	ASG 7 - Main Pool	ASG 8 (outlet)	
Mean	578.24	582.98	582.94	581.85	583.99	582.61	582.65	583.13	582.51	583.63	583.05	582.55	587.90	584.67	584.67	584.76	**Mean**
Median	578.09	583.02	583.07	581.85	584.12	582.58	582.57	583.18	582.58	583.63	583.10	582.49	587.96	584.62	584.65	584.69	**Median**
Minimum	577.23	582.49	582.30	581.37	583.34	582.17	581.68	582.40	581.41	583.11	582.79	582.27	586.94	583.79	584.16	584.02	**Minimum**
Maximum	579.50	583.49	583.51	583.18	584.39	583.27	583.29	583.69	582.99	584.26	583.46	583.02	589.05	586.09	585.24	585.36	**Maximum**
Range	2.27	1.00	1.22	1.81	1.05	1.10	1.62	1.29	1.58	1.15	0.68	0.75	2.11	2.30	1.09	1.35	**Range**
Standard Deviation	0.88	0.25	0.32	0.31	0.30	0.14	0.30	0.38	0.37	0.42	0.21	0.20	0.65	0.70	0.21	0.30	**Standard Deviation**
Count	12.00	36678.00	32697.00	23520.00	14.00	32697.00	32692.00	14.00	14.00	14.00	14.00	26361.00	14.00	14.00	32722.00	32726.00	**Count**

Groundwater Elevation Statistics

	Indian Ridge Marsh Groundwater		Big Marsh Groundwater	Groundwater (ISWS #21)
	P1	P2	ASW 2	ASW 3
Mean	583.71	583.57	584.12	580.48
Median	583.77	583.94	584.15	580.38
Minimum	581.75	581.97	583.44	579.26
Maximum	585.29	585.41	585.55	581.79
Range	3.54	3.44	2.11	2.53
Standard Deviation	1.18	1.24	0.31	0.59
Count	13.00	13.00	36657.00	27345.00

TABLE 4: HMP Monitoring Stations - Water Quality Statistics (July 2003-July 2004)

			D.O. (mg/L)				pH			ORP (mV)				Conductivity (-uS/cm)				Temperature (F)			
Location	Identifier	Station	Mean	Median	Min	Max	Median	Min	Max	Mean	Median	Min	Max	Mean	Median	Min	Max	Mean	Median	Min	Max
Big Marsh	ASG 2 - Big Marsh Stony Island Causeway	ASG 2	8.4	8.9	4.8	11.7	8.1	7.2	9.1	37.6	40.0	-41.0	128.0	1111.1	1192.0	286.1	1705.0	59.0	61.9	35.4	80.6
	ASG 3 - Big Marsh Outlet	ASG 3	6.0	5.5	0.8	14.8	7.8	6.9	8.1	11.8	46.0	-121.0	120.0	1291.8	1272.0	871.8	2010.0	57.2	59.0	38.2	78.1
	MSG 1 - Southeast Edge of Big Marsh	MSG 1	9.4	7.8	3.0	18.1	7.9	7.3	8.4	99.1	107.0	-41.0	182.0	968.0	910.3	698.1	1329.0	56.3	57.1	34.7	78.8
Indian Ridge Marsh	ASG 4 - IRM North Outlet	ASG 4	9.8	9.5	6.9	13.9	8.6	7.2	9.4	80.3	70.0	-2.0	252.0	941.1	950.0	660.6	1164.0	57.9	61.6	34.5	80.3
	MSG 6 - IRM Northeast Side Pool	MSG 6	12.0	9.5	8.5	18.1	9.0	8.5	10.5	45.7	51.0	-51.0	124.0	235.8	216.4	180.3	325.3	58.9	57.7	38.4	84.5
	ASG 5 - IRM South Channel	ASG 5	7.9	6.3	2.2	18.3	7.8	6.8	8.7	112.7	94.0	-6.0	231.0	1023.8	1052.5	673.0	1567.0	59.2	62.4	34.7	79.8
Heron Pond	ASG 6 - Heron Pond/Pool Outlet	ASG 6	9.0	8.7	0.9	16.6	8.6	7.8	9.4	59.8	65.0	-26.0	163.0	1389.2	1561.0	412.2	1868.0	58.4	63.7	33.2	80.0
	MSG 9 - Heron Pond Southwest Side Pool	MSG 9	7.6	6.9	1.0	17.0	7.8	7.2	9.0	20.4	30.0	-86.0	135.0	1446.1	1425.0	970.3	1935.0	55.6	55.8	33.4	78.9
DeadStick Pond	ASG 7 - Deadstick Pond Main Pool	ASG 7	8.6	7.3	1.3	17.5	8.3	7.6	9.1	12.1	17.5	-67.0	101.0	1565.1	1649.0	883.8	2108.0	57.4	60.7	35.0	81.4
	ASG 8 - Deadstick Pond Outlet	ASG 8	4.8	3.9	0.3	13.6	7.6	7.1	8.9	-12.6	36.0	-211.0	105.0	1571.5	1538.5	1073.0	2075.0	54.0	57.5	33.8	73.5

APPENDICES

APPENDIX A: PHOTO LOGS

- MONITORING STATION LOCATIONS
- SEEP LOCATIONS

ASG 1

ASG 1
6/13/03

ASG 1
9/19/03

ASG 1
10/16/03

ASG 1
11/10/03

ASG 1
12/22/03

ASG 1
01/14/04

ASG 1 cont'd

ASG 1
02/26/04

ASG 1
4/21/04

ASG 1
5/19/04

ASG 2

ASG 2
6/13/03

ASG 2
8/12/03

ASG 2
9/19/03

ASG 2
10/16/03

ASG 2
11/10/03

ASG 2
12/22/03

ASG 2 cont'd

ASG 2
1/14/04

ASG 2
2/26/04

ASG 2
3/25/04

ASG 2
5/19/04

ASG 3

ASG 3
8/12/03

ASG 3
8/12/03

ASG 3
9/19/03

ASG 3
10/16/03

ASG 3
11/10/03

ASG 3
12/22/03

ASG 3 cont’d

ASG 3
1/14/04

ASG 3
2/26/04

ASG 3
3/25/04

ASG 3
4/21/04

ASG 3
5/19/04

ASG 4

ASG 4
8/12/03

ASG 4
8/12/03

ASG 4
9/19/03

ASG 4
10/16/03

ASG 4
11/10/03

ASG 4
12/22/03

ASG 4 cont'd

ASG 4
1/14/04

ASG 4
2/26/04

ASG 4
3/25/04

ASG 4
4/21/04

ASG 4
5/19/04

ASG 5

ASG 5
8/12/03

ASG 5
9/19/03

ASG 5
10/16/03

ASG 5
11/10/03

ASG 5
12/22/03

ASG 5
1/14/04

ASG 5 cont'd

ASG 5
2/26/04

ASG 5
3/25/04

ASG 5
4/21/04

ASG 5
5/19/04

ASG 6

ASG 6
8/12/03

ASG 6
8/12/03

ASG 6
9/19/03

ASG 6
10/16/03

ASG 6
11/10/03

ASG 6
12/22/03

ASG 6 cont'd

ASG 6
1/14/04

ASG 6
2/26/04

ASG 6
3/25/04

ASG 6
4/21/04

ASG 6
5/19/04

ASG 7

ASG 7
8/12/03

ASG 7
9/19/03

ASG 7
10/16/03

ASG 7
11/10/03

ASG 7
12/22/03

ASG 7
1/14/04

ASG 7 cont'd

ASG 7
2/26/04

ASG 7
3/25/04

ASG 7
4/21/04

ASG 7
5/19/04

ASG 8

ASG 8
8/12/03

ASG 8
9/19/03

ASG 8
10/16/03

ASG 8
11/10/03

ASG 8
12/22/03

ASG 8
1/14/04

ASG 8 cont'd

ASG 8
2/26/04

ASG 8
3/25/04

ASG 8
4/21/04

ASG 8
5/19/04

ASW 3

ASW 3
8/12/03

ASW 3
3/25/04

ASW 3
3/25/04

ASW 3
3/25/04

ASW 3
3/25/04

ASW 3
4/22/04

ASW 3 cont’d

ASW 3
4/22/04

MSG 1

MSG 1
8/12/03

MSG 1
9/19/03

MSG 1
10/16/03

MSG 1
11/10/03

MSG 1
12/22/03

MSG 1
1/14/04

MSG 1 cont’d

MSG 1
2/26/04

MSG 1
3/25/04

MSG 1
4/21/04

MSG 1
5/19/04

MSG 2

MSG 2
9/19/03

MSG 2
10/16/03

MSG 2
11/10/03

MSG 2
12/22/03

MSG 2
1/14/04

MSG 3

MSG 3
10/16/03

MSG 3
11/10/03

MSG 3
12/22/03

MSG 3
1/14/04

MSG 3
2/26/04

MSG 3
4/21/04

MSG 3 cont’d

MSG 3
5/19/04

MSG 4

MSG 4
9/19/03

MSG 4
10/16/03

MSG 4
11/10/03

MSG 4
12/22/03

MSG 4
1/14/04

MSG 4
2/26/04

MSG 4 cont'd

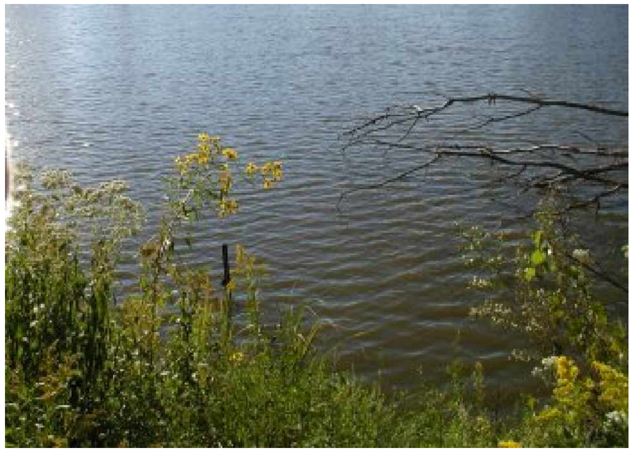
MSG 4
3/25/04

MSG 4
4/21/04

MSG 4
5/19/04

MSG 5

MSG 5
8/12/03



MSG 5
9/19/03

MSG 5
10/16/03

MSG 5
11/10/03

MSG 5
12/22/03

MSG 5
1/14/04

MSG 5 cont'd

MSG 5
2/26/04

MSG 5
3/25/04

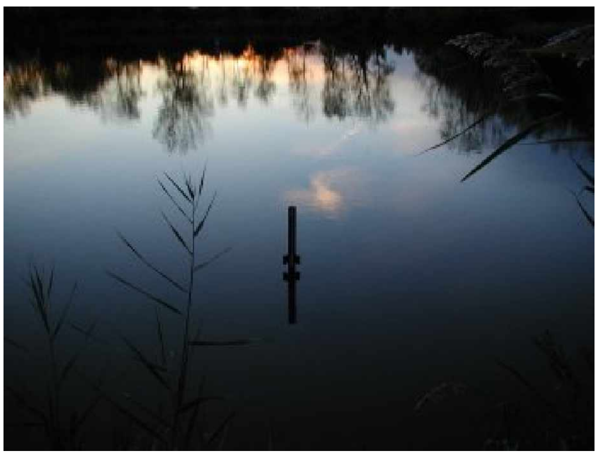
MSG 5
4/21/04

MSG 5
5/19/04

MSG 6

MSG 6
8/12/03

MSG 6
9/19/03



MSG 6
10/16/03

MSG 6
11/10/03

MSG 6
12/22/03

MSG 6
1/14/04

MSG 6 cont'd

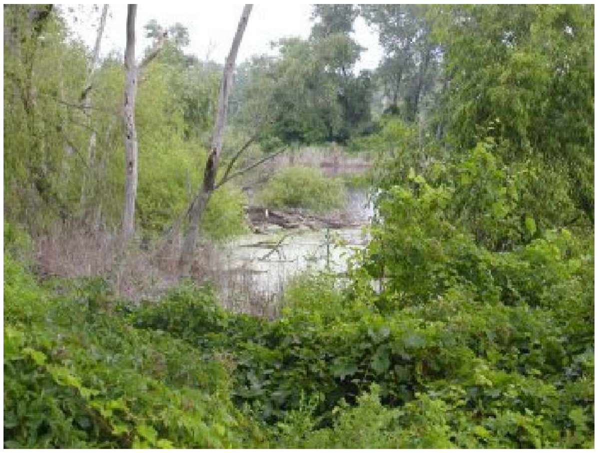
MSG 6
2/26/04

MSG 6
3/25/04

MSG 6
4/21/04

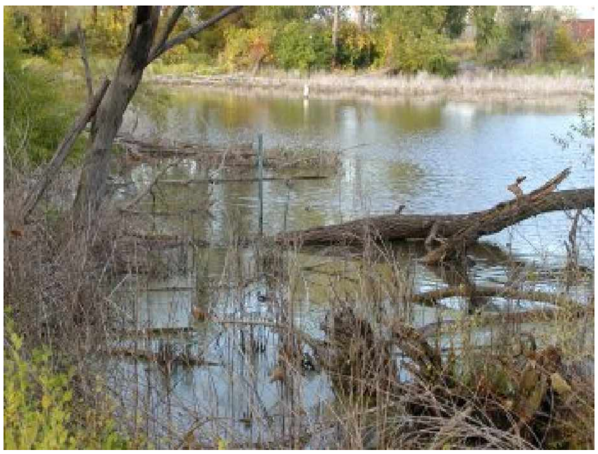
MSG 6
5/19/04

MSG 7



MSG 7
8/12/03

MSG 7
9/19/03



MSG 7
10/17/03

MSG 7
11/10/03

MSG 7
12/22/03

MSG 7
1/14/04

MSG 7 cont'd

MSG 7
2/26/04

MSG 7
3/25/04

MSG 7
4/21/04

MSG 7
5/19/04

MSG 8

MSG 8
8/12/03

MSG 8
9/19/03

MSG 8
11/10/03

MSG 8
12/22/03

MSG 8
1/14/04

MSG 8
2/26/04

MSG 8 cont’d

MSG 8
3/25/04

MSG 8
5/19/04

MSG 9

MSG 9
8/12/03

MSG 9
9/19/03

MSG 9
10/16/03

MSG 9
11/10/03

MSG 9
12/22/03

MSG 9
1/14/04

MSG 9 cont'd

MSG 9
2/26/04

MSG 9
3/25/04

MSG 9
4/21/04

MSG 9
5/19/04

Indian Ridge Marsh Seeps

Seep#1 (SP1) located along the southwest bank of South Indian Ridge Marsh. Seep appears to be about 2-2½ feet in diameter. *(Located at 7th T-pole from 122nd street)*

8/12/03

8/12/03

Seep#2 (SP2) located along the southwest bank of South Indian Ridge Marsh. Possible seep *(Located at 10th T-pole from 122nd street)*

8/12/03

8/12/03
View of path from possible seep to marsh.

Indian Marsh Seeps cont'd

Seep #1 possibly more erosion has occurred, but basically the same.

9/19/03

10/16/03

11/10/03

Deadstick Pond Seeps

Seep #3 (SP 3) located along the west bank of South Indian Ridge Marsh. Seep appears to be about 1 foot in diameter. *(Located just north of ASG 7)*

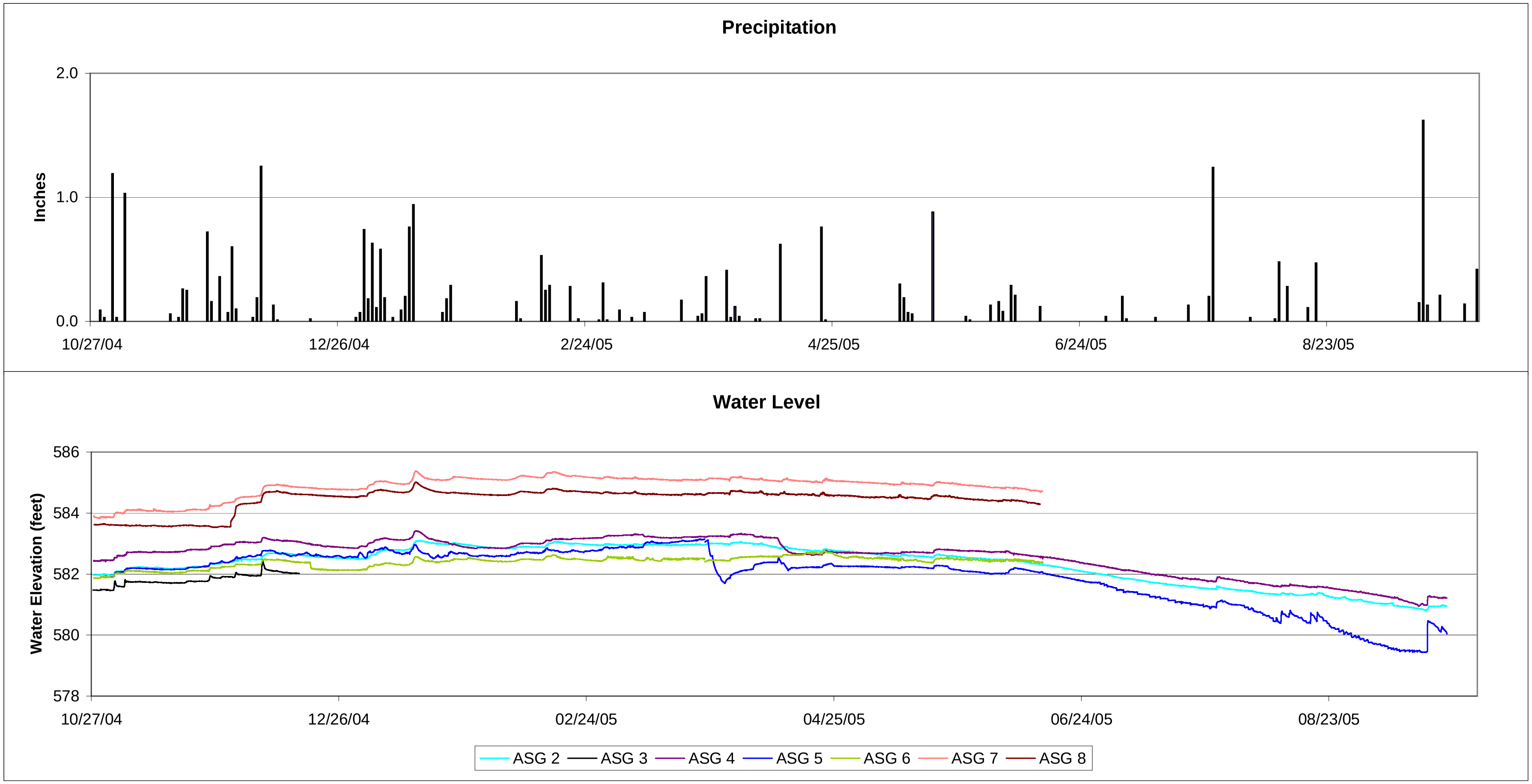
10/16/03

11/16/03

APPENDIX B:

SUPPLEMENTAL WATER LEVEL DATA (ISWS)

Supplemental Water Level Data (ISWS) 10/27/04 - 09/20/05



ASG 2 - Big Marsh Stony Island Causeway **ASG 3 -** Big Marsh Outlet **ASG 4 -** IRM North Outlet **ASG 5 -** IRM South Channel
ASG 6 - Heron Pond/Pool Outlet **ASG 7** - Deadstick Pond Main Pool **ASG 8** - Deadstick Pond Outlet