Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

RESEARCH AND DEVELOPMENT DEPARTMENT

REPORT NO. 05-17

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

2004

ANNUAL REPORT

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Metropolitan Water Reclamation District of Greater Chicago
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ENVIRONMENTAL MONITORING AND RESEARCH DIVISION 2004 ANNUAL REPORT

Research and Development Department
Richard Lanyon, Director

December 2005

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ACKNOWLEDGMENTS

This 2004 Annual Report is the result of the efforts of not only the scientists and engineers who perform the monitoring and research initiatives of the Department, but also the impressive efforts of support staff and other personnel who contribute their valuable time, energy, and know-how to the production of the report. These individuals deserve special recognition and thanks.

Special thanks are due to Laura Franklin, Rhonda Griffith, Deborah Messina, Joan Scrima, Nancy Urlacher, and Sabina Yarn for their immaculate typing, zealous adherence to Department formatting tradition, responsiveness to turnaround times, and dedication to moving the report forward.

DISCLAIMER

STRUCTURE AND RESPONSIBILITIES OF THE ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

The Environmental Monitoring and Research (EM&R) Division has 70 employees, and is comprised of seven Sections. These are illustrated in Figure 1 with a breakdown of the number of employees. The seven Sections are:

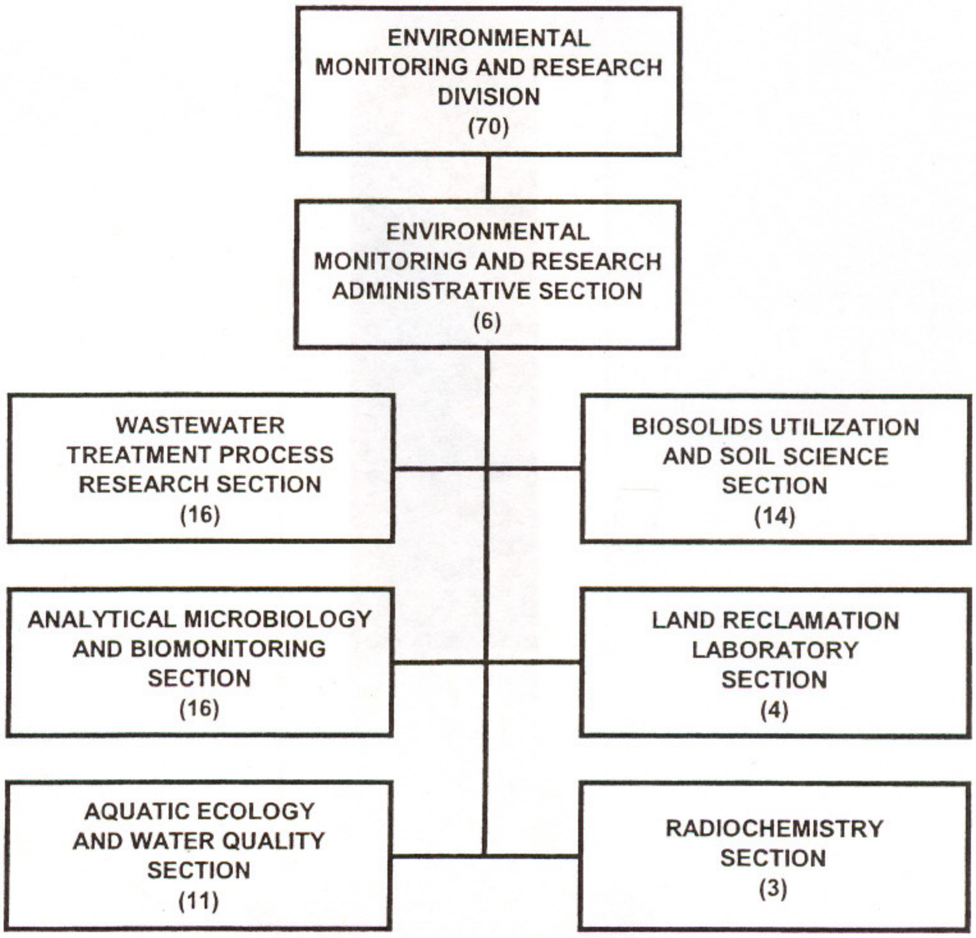
1. Administrative
2. Wastewater Treatment Process Research
3. Biosolids Utilization and Soil Science – Stickney
4. Land Reclamation Laboratory - Fulton County
5. Analytical Microbiology and Biomonitoring
6. Aquatic Ecology and Water Quality
7. Radiochemistry

The major areas of focus of the Division were as follows:

- Monitoring the environmental quality of Lake Michigan, area rivers and canals, and the Illinois River to document the effectiveness of the District's wastewater treatment program.
- Assisting in the resolution of sewage treatment and solids disposal operation problems.
- Providing technical assistance to other departments and agencies with respect to issues related to wastewater treatment; combined sewer overflow management; waterways management; and solids processing, utilization, and marketing.
- Conducting applied and operations research to achieve improvement and cost reductions in District wastewater treatment, waterways management, and solids processing and biosolids utilization activities.
- Assessing the impacts of new or proposed regulations on District activities.
- Generation and transmittal of environmental monitoring reports to regulatory agencies to ensure compliance with requirements of Tunnel and Reservoir Plan (TARP) and biosolids processing and utilization permits.

Figure 1

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION ORGANIZATION CHART (WITH THE NUMBER OF EMPLOYEES)



ADMINISTRATIVE SECTION

The Administrative Section provides technical guidance, scientific review, and administrative support for the work being carried out by the EM&R Division staff. The Section also organizes a monthly seminar series, open to all District employees, that presents information on areas of interest to the wastewater field. In 2004, 1,019 people attended these seminars. A list of the seminar topics is shown in Appendix IV

In addition to the overall administrative and supervisory functions performed by the Administrative Section, the Experimental Design and Statistical Evaluation Group, which is part of the Administrative Section, provided the following support to the rest of the EM&R Division.

Experimental Design and Statistical Evaluation Group

The Experimental Design and Statistical Evaluation Section is responsible for providing assistance in the design of laboratory and full-scale experiments, collection of appropriate data, development of guidelines for data collection methodology, and statistical analyses. Since 1999, section personnel have been performing these tasks using PC computing media. They also developed programs to interconnect Visual Basic Program with SAS, Access, Excel, Outlook, and Power Point software programs. This has enabled the section to produce reports, tables, and texts in suitable designs, and to respond to many requests in a shorter period.

Statistical and Computing Support. During 2004, a Biostatistician and an Associate Statistician provided statistical and computing support to various projects. The following is a description of some of the activities.

1. Statistical support was provided to the Analytical Microbiology & Biomonitoring Section to study the trend of average fecal coliform concentrations in Des Plaines River (91) and Chicago Sanitary and Ship Canal (92) at Lockport for the 2000-2001 period.

2. Statistical support was provided to the Analytical Microbiology & Biomonitoring Section to estimate the *Escherichia coli* to Fecal Coliform ratio in wastewater effluents and ambient waters of the District. The results of the statistical analyses of the project was complete in April 2004.

3. Statistical support was provided to the Biosolids Utilization and Soil Science Section on the study of corn yields and nutrient compositions during long-term biosolids applications to calcareous strip-mine soil. All statistical analyses including stability analyses were completed. The final report on the project is underway.

4. Statistical support was provided to the Analytical Microbiology & Biomonitoring Section of the studies of the project Protecting Lake Michigan Water Quality: Addressing Beach Issues

5. Statistical support was provided to Analytical Microbiology & Biomonitoring Section to study the project Chlorophyll Monitoring in Chicago Area Waterways.

6. Statistical support was provided to the Environmental Monitoring and Research Division to study the ”Characteristics of Stormwater Runoff Discharged to the Chicago Waterways System from Three

Illinois Department of Transportation Pumping Stations."

7. Statistical consulting was provided to the Soil Science section on projects including the USX demonstration project and the St. David Coal refuse reclamation project.

Water Quality Data. Each year, the Section prepares an annual report describing the water quality of the streams and channels within the Districts jurisdiction for the preceding year. Surface water quality data for 2003 were evaluated regarding compliance with water quality standards set by the Illinois Pollution Control Board (IPCB). In 2003, 68 water quality parameters including biochemical oxygen demand; carbonaceous biochemical oxygen demand; dissolved oxygen; temperature; pH; alkalinity (total); chloride; turbidity; total Kjeldahl nitrogen; ammonium nitrogen; unionized ammonia; organic nitrogen; nitrite plus nitrate nitrogen; total solids; total suspended solids; volatile suspended solids; total dissolved solids; sulfate; fats, oils, and greases; total phosphorus; total cyanide; weak acid dissociable cyanide; fluoride; total organic carbon; fecal coliform; *Escherichia coli*; total calcium; total magnesium; hardness; gross alpha radioactivity; gross beta radioactivity; chlorophyll *a*; benzene; ethylbenzene; toluene; xylene; total silver; total arsenic; total barium; total boron; total cadmium; total copper; total chromium; total hexavalent chromium; total iron; total lead; total nickel; total manganese; total mercury; total zinc; total selenium; soluble calcium; soluble magnesium; soluble silver; soluble arsenic; soluble barium; soluble boron; soluble cadmium; soluble copper; soluble chromium; soluble iron; soluble lead; soluble nickel; soluble manganese; soluble mercury; soluble zinc; and soluble selenium were analyzed and reported.

General Use Water. In 2003, 31 water quality parameters (dissolved oxygen, temperature, pH, chloride, ammonium nitrogen, total dissolved solids, phenols, sulfate, weak acid dissociable cyanide, fluoride, fecal coliform, gross beta radioactivity, benzene, ethylbenzene, toluene, xylene, total silver, total barium, total boron, total hexavalent chromium, total manganese, total selenium, soluble arsenic, soluble cadmium, soluble copper, soluble chromium, soluble iron, soluble lead soluble nickel, soluble mercury, and soluble zinc) had IPCB General Use Standard. Benzene and total mercury had IPCB Human Health standards. Twenty-three water quality parameters were in total compliance with the standards in all river systems. They were ammonium nitrogen, phenols, weak acid dissociable cyanide, gross beta radioactivity, benzene, ethylbenzene, toluene, xylene, total silver, total barium, total boron, total hexavalent chromium, total manganese, total selenium, soluble arsenic, soluble cadmium, soluble copper, soluble chromium, soluble iron, soluble lead, soluble nickel, soluble mercury, and soluble zinc. Benzene had total compliance with the Human Health standard in all river systems. Six of the remaining 8 parameters, viz., dissolved oxygen, temperature, pH, chloride, sulfate, and fluoride had compliance rates of greater than 86.5 percent in all river systems. Total dissolved solids had a compliance rate greater than 75.4 percent in all river systems. Fecal coliform had the lowest compliance rate, and it was in the range of 30.1 to 57.8 percent in the Chicago, Calumet, and the Des Plaines River Systems.

Secondary Contact Water. Twenty-three water quality parameters measured in the secondary contact waters during 2003 had applicable IPCB standards. They were dissolved oxygen; temperature; pH; unionized ammonia; total dissolved solids; phenols;

fats, oils, and greases; total cyanide; fluoride; total silver; total arsenic; total barium; total cadmium; total copper; total hexavalent chromium; total iron; total lead; total nickel; total manganese; total mercury; total zinc; total selenium; and soluble iron. Eighteen parameters were in complete compliance with the IPCB standards for the Chicago and the Calumet River Systems in 2003. They were temperature; pH; total dissolved solids; phenols; total cyanide; fluoride; total silver; total arsenic; total barium; total cadmium; total copper; total hexavalent chromium; total nickel; total manganese; total mercury; total zinc; total selenium; and soluble iron. The percent compliance of the remaining 5 parameters (dissolved oxygen; unionized ammonia, fats, oils, and greases; total iron; and total lead), which were not in total compliance in both the river systems varied from 90.0 percent to total compliance.

WASTEWATER TREATMENT PROCESS RESEARCH SECTION

The Wastewater Treatment Process Research (WTPR) Section is responsible for conducting basic, applied, and problem solving research with regard to various wastewater and sludge treatment processes currently utilized by the District. Technical assistance is provided to the Maintenance and Operations (M&O) Department for solving water reclamation plant (WRP) operating problems. This Section also investigates innovative treatment processes for future use.

The work of the WTPR Section originates from several sources. Current operations may be investigated as the result of a WRP problem, or interest in arriving at new knowledge concerning certain aspects of a waste treatment process. Studies of future operations are concerned with maximizing the efficiency of an existing process at the lowest cost, or the development of new processes. Investigations may take the form of surveys, literature reviews, laboratory bench testing, pilot plant studies, full-scale testing, special analyses, or a combination or progression of any or all of the above. Plans and specifications are also reviewed at the request of the Engineering Department for the purpose of optimizing process design criteria.

In 2004, the Section was primarily concerned with studies relating to odor monitoring and control, sludge treatment technologies, oxygen transfer efficiency, ammonia loads to the Stickney WRP, settling and chemical characteristics of combined sewer overflows, reevaluation of pretreatment program local limits, participation in the Stickney and Calumet WRP Master Plans, and the operation of the Tunnel and Reservoir Plan (TARP) System. The main projects performed by the Section are summarized below.

Polymer Testing Program for the District Centrifuge Complexes

In 2004, a comparison of summer and winter polymers used in the centrifugal dewatering of anaerobically digested sludge was carried out at the Stickney WRP. The testing procedure is performed twice at Stickney, once in summer and once in winter, because sludge characteristics change during these seasons at this WRP. Based on these full-scale tests, polymers are switched as appropriate.

Pilot-Scale Grit Testing of Dewatered Grit Overflow at Stickney WRP Using the Grit King Unit

Background. During the course of the 2004 Stickney Master Plan meetings, the subject of pre-centrifuge maintenance was raised, and whether it was related to uncaptured grit that may end up in the preliminary sludge. A preliminary sludge sample collected over a decade ago showed the presence of relatively large size particles. Thus, it was decided to see if it was possible to determine the grit content of Southwest Plant preliminary sludge. The M&O Department was also interested in the overflow from the grit dewatering operation. Hydro International, Inc.'s Grit King mobile unit that had been rented to test the preliminary sludge was then used to determine if there was any grit in the overflow from the Southwest Grit Dewatering Tanks.

Objective. The objective of the pilot-scale test was to evaluate how much grit is carried away in the overflow during grit dewatering at the Southwest Plant at the Stickney WRP, and then to characterize this grit. The captured grit from the Southwest aerated grit tanks is dewatered prior to disposal. Grit in the overflow from the dewatering tanks is operationally undesirable. An attempt to quantify fugitive grit in the overflow will help estimate the grit loading from recycle to the West Side Plant.

Grit Sampling Technique. Grit sampling was conducted using Hydro International, Inc.'s Grit King mobile unit, which was rented by the Engineering Department for use in this study.

The pilot-scale unit was set up by Stickney WRP M&O Department personnel next to the grit dewatering building. The overflow from the dewatering operation was pumped from the open trough that receives the flow over the weirs of the grit dewatering tanks. The grit dewatered overflow was pumped at a constant rate of 180 gpm for three days (October 27 - 29, 2004). The feed to the Grit King unit passes through the vortex cup in which inertia due to centrifugal force separates the relatively heavier material and directs it towards the classifier in the underflow. In the classifier, the heavier material settles at the bottom, where the screw pump picks up the settled material and discharges it into the container. The supernatant from the classifier and the overflow from the vortex unit discharged into a manhole that ends up in the headworks of the West Side Plant.

The total flow that passed through the Grit King unit during the sampling period and the volume of material collected in the container were recorded. Grab samples of the feed, the vortex overflow, and the supernatant from the classifier were collected each hour and composited over the period of operation. The separated grit material was collected in a 5-gallon container over the sampling period. The collected samples were taken to the R&D Laboratory for total solids, volatile solids, grit content and sieve analysis. The sieve analyses were performed by the Biosolids Utilization and Soil Science Section.

Analytical Methods and Procedure for Sieve Analysis of Grit. The methods prescribed in *Standard Methods* were used for the quantitative determination of the total and volatile solids. The inert material that remains after volatilizing at 550°C is considered to be grit and was subjected to sieve analysis.

The distribution of particle sizes was determined by a modified ASTM D 422-63 (Re-Approved 1990) method. The material is first dried at 103°C, and then ignited in a muffle furnace at 550°C until the organic matter is destroyed. The remaining residue is then sieved and each fraction is weighed. The sieved fractions ranged from 1,000 µm (U. S. Sieve #18) to 75 µm (U. S. Sieve #200).

Results and Discussion. The samples were collected on October 27, 28, and 29, 2004. Relative to the total flow processed in a given day, only a very small volume of grit was found. The volume of the grit material collected from the Grit King unit (average of 1.83 gallons) was approximately three-thousandths of a percent of the average sludge flow processed (64,800 gallons). The details on flows processed and material collected are summarized in Table II-1.

Qualitative Observations of the Fresh Grit-Like Samples Collected. The samples collected over the three days were observed for qualitative assessment before analyzing further. All three samples were consistent in appearance and composition. The material collected from the Grit King unit does not look like typical grit. In addition to grit, material collected included soggy wood chips, pieces of leaves, cigarette filters, dark soil-like organic matter, small pieces of tinfoil, and other extraneous material.

Total Solids and Volatile Solids of the Inflow and Outflow Liquid Streams. The total solids of the influent water to the pilot-scale unit averaged 0.09 percent over three days (Table II-2). Total solids in both vortex and classifier overflow averaged 0.09 percent. The fact that the percent total solids of the vortex and classifier overflows were equal, and comparable to the inflow total solids indicates little removal of solids in the vortex cup and the classifier unit. No significant difference in the percent volatile solids values of the vortex and classifier samples was observed. On average, approximately 53 to 55 percent of the liquid stream sample solids were inert, indicating that about 45 to 47 percent of the liquid stream sample solids were organic in nature.

Total and Volatile Solids in the Collected Grit. Total and volatile solids results on the material collected from the grit dewatering overflow are presented in Table II-3. The collected material had approximately 47 percent total solids of which approximately 38 percent was organic in nature leaving 62 percent mass as inert or grit.

An estimate of the volume of actual grit collected was made using the average values of 1.83 gallons of material collected per run, total solids of 46.89 percent, inorganic solids of 61.58 percent and assuming that all of the material solids had a specific gravity of 2.65. Based upon the percentages of water and solids, the specific gravity of the collected material was estimated to be:

$$\frac{53.11(1)+46.89(2.65)}{100}=1.77$$

The volume of the grit portion of the collected material would be:

$$\frac{0.4689\times 0.6158}{1.77}\times 1.83\text{ gal}=0.30\text{ gal of grit}$$

The volume of grit in a million gallons of grit dewatering tank overflow pumped would be:

$$\frac{0.30\times 10^{6}}{64{,}800}=4.63\text{ gal of grit/MG}$$

This is assuming that all of the inorganic matter is classified as grit.

Qualitative Observations of Grit Samples After Incineration of Volatile Solids. The samples collected over three days were observed for qualitative assessment after incinerating in the muffle furnace. As mentioned before, the collected material, before drying, does not look like typical grit in composition, nor did the final material upon incineration in the muffle furnace. All three samples were consistent in appearance and composition and did not look like grit. A portion of the material was tan in color and looked like very fine ash or clay, and there were also some small pieces of tinfoil.

Sieve Analysis of Grit. The incinerated material was subjected to sieve analysis. The sieve analysis results are presented in Table II-4. With respect to a grit particle size cutoff of 150 µm, an average of about 9 percent of the mass is smaller in size than 150 µm. At the higher end of the scale approximately 24 percent of the material was greater than 425 µm in size. The bulk of the material, an average of 67 percent by weight, was in the 150 to 425 µm range.

Summary and Conclusions. The following conclusions could be drawn based on the pilot-scale tests conducted on the Southwest dewatered grit overflow at the Stickney WRP.

1. The grit material collected was approximately three-thousandths of a percent by volume of the average dewatered grit overflow processed by the Grit King unit over the three days.

2. The material collected from the Grit King unit contains approximately 47 percent total solids of which 38 percent is organic (volatile) material and 62 percent is inert or considered to be grit.

3. The material collected from the Grit King unit does not look like typical grit either in composition or appearance. In addition to grit, the material collected included soggy wood chips, pieces of leaves, cigarette filters, dark soil-like organic matter, pieces of tinfoil, and other extraneous material.

4. The estimated grit content of the grit dewatering tank overflow, on a volume basis, is 4.63 gallons of grit per million gallons of overflow.

5. With respect to a grit particle size cutoff of 150 µm, an average of about 9 percent of the mass is smaller in size than 150 µm. This fraction is relatively light, not typical grit. The majority (67 percent) of the grit was between 150 and 425 µm in size, and about 25 percent was 425 µm or larger in size.

6. Based upon this study, an insignificant amount of grit is escaping the dewatering process.

Odor Monitoring Programs

As part of the District's continuing odor surveillance program, the EM&R Division conducts odor monitoring at the Harlem Avenue Solids Management Area (HASMA), Vulcan, the Lawndale Avenue Solids Management Area (LASMA), Marathon Solids Drying Area (SDA), and Calumet SDAs. A similar odor monitoring program was initiated in the spring of 2001 at the Stony Island and the Ridgeland Avenue Solids Management Area (RASMA) SDAs. The programs are a part of the NPDES permits for the solids management areas. Odor monitoring is also conducted at the Calumet WRP, the John E. Egan WRP, the Stickney WRP, the James C. Kirie WRP, and the North Side WRP.

A similar protocol for monitoring odors is used at each location. Either R&D or M&O Department personnel (at some WRPs) visit various stations at each site on a regular basis. Frequency can range from once per week (as with the John E. Egan WRP), or daily (as with the Kirie WRP), depending on the program. The odor monitoring personnel make subjective observations regarding the character and intensity of odors at each of the stations. The odor intensities are ranked on a scale from 0, no odor, to 5, very strong odor. These data are tabulated monthly.

The objective of the program is to collect and maintain a database of odor levels within and around each WRP, and associated solids processing areas. The data are used to study the trends in odor levels associated with WRP operations, and to relate odor levels to changing conditions within the WRP, such as installation of odor control equipment.

Since several residential areas surround the WRPs in the program, the odor monitoring activities also provide early warning of odorous conditions that develop within the WRPs, to allow for corrective action before they become a nuisance to area residents.

Odor Monitoring at the HASMA, Vulcan, and Marathon Solids Drying Areas and the LASMA Solids Processing Area. This odor monitoring program was initiated in 1990. Anaerobically digested solids lagoon-aged for one and one-half years and/or centrifuge cake is dried on paved drying cells to a solids content greater than 60 percent. The solids drying process is enhanced by agitation using auger-equipped tractors. Experience has indicated that agitation is important for reducing odors during the operation.

R&D personnel visited 16 stations throughout the three solids drying areas (HASMA, Vulcan, and Marathon) and the lagoon area (LASMA) at least three times a week. During 2003 additional monitoring locations were added at Vulcan and Marathon.

For each month, average odor intensity data from the 13 stations were calculated. Figure II-1 summarizes the observations of odor monitoring personnel during 2004, presented as percentage of visits at which easily noticeable, strong, and very strong odors were observed. Although there were easily noticeable odor observations, ranging between 10 and 45 percent of the visits during the year, there were no very strong odor observations. The strong odor observations, which occurred over the period of April through September, made up less than 1.0 percent of the total observations for the year.

Odor Monitoring at the Calumet WRP and Calumet Solids Drying Areas. The Calumet WRP odor monitoring program which was initiated in March 1992 is a cooperative effort of the R&D and M&O Departments. The Calumet odor monitoring program involves the daily visitation of 22 stations around the WRP and biosolids processing areas.

Figures II-2 and II-3 summarize the observations of easily noticeable, strong, and very strong odors made during 2004 in terms of frequency of occurrence for the Calumet WRP and the Calumet Drying Areas, respectively. The odors were at generally low levels in 2004, with no very strong odors observed at either the Calumet WRP or Drying Areas. A few instances of strong odor were observed over the year, mainly at the Sludge Concentration Building and Preliminary Tanks at the Calumet WRP. Easily noticeable odor observations varied between 14 and 29 percent of the monthly observations at the Calumet WRP and between 2 and 32 percent (in September) at the Drying Areas. Ten strong odor observations were noted in October 2004.

Odor Monitoring at the RASMA Solids Drying Area. The odor monitoring program at the Ridgeland Solids Management Area was started in May of 2001. R&D Department personnel visit four stations located around the boundary of the drying cells one to two days per week.

A monthly summary of the observations of easily noticeable, strong, and very strong odors made during 2004 is presented in Figure II-4 expressed as frequency of occurrence. No very strong or strong odors were observed. Easily noticeable odors were detected between 0 and 35 percent of the time and were observed mainly during the drying period of August through December 2004.

Odor Monitoring at the Stony Island Solids Drying Area. The odor monitoring program at the Stony Island Solids Management Area was started in June of 2001. R&D Department personnel visit four stations located around the boundary of the drying cells at least once per week.

Figure II-5 summarizes the observations of easily noticeable, strong, and very strong odors made during 2004 in terms of frequency of observation. There were no very strong odor observations. Strong odors were only observed from June through November, and varied between 3 and 9 percent of total monthly observations during that period.

Odor Monitoring at the John E. Egan WRP. The John E. Egan WRP odor monitoring program, initiated in October 1993, is also a joint effort between the R&D and

M&O Departments. Seven stations within the WRP boundaries are visited at least once a week by R&D personnel. For each month, average odor intensity data from the seven stations were calculated. The percentage of observations at which easily noticeable, strong, and very strong odors were observed during 2004 was plotted by month and is presented in Figure II-6. Odor of an easily noticeable intensity was observed from 7 to 25 percent of the monthly observations made at the John E. Egan WRP. No very strong odors or strong odors were observed.

Odor Monitoring at the Stickney WRP. The Stickney WRP odor monitoring program initiated in May 1991 is a cooperative effort between the R&D and M&O Departments. Either R&D or M&O personnel visit each of the 19 established stations within and around the Stickney WRP on five days each week.

The 19 stations are located at treatment process operation sites where potentially odorous activities, such as sludge dewatering and anaerobic digestion, take place. Also included are locations along the perimeter of the WRP where odors might be detected by the public.

Figure II-7 summarizes the observations of odor monitoring personnel during 2004. For each month, average intensity data from the 19 stations were plotted. The percentage of visits at which easily noticeable, strong, and very strong odors were observed are plotted by month in Figure II-7. Easily noticeable odors were observed less than 33 percent of the time during every month of the year. Two very strong odors were observed in April near the Centrifuge Building. Strong odor observations varied from 0.2 to 2.5 percent of the total monthly observations throughout the year.

Odor Monitoring at the James C. Kirie WRP. The James C. Kirie WRP odor monitoring program is a joint effort between the R&D and M&O Departments, and was initiated in September 1996. The program includes monitoring of 15 locations within the WRP boundaries and two locations in the nearby community. R&D Department personnel monitor once a week, and during the summer months M&O Department personnel monitor three times a day, seven days a week.

Figure II-8 summarizes the observations of odor monitoring personnel during 2004. As may be noted from the figure, there were no strong or very strong odors observed in 2004. Easily noticeable odors were detected in less than 1.2 percent of the observations during the summer months.

Odor Monitoring at the North Side WRP. The North Side WRP is located in close proximity to residences and several light industrial facilities. There is little buffer between the WRP, residences, and industrial facilities, particularly along the Howard Street boundary of the WRP.

R&D personnel visited 13 stations within and around the WRP boundaries at least once a week. Figure II-9 summarizes the observations of odor monitoring personnel from January through December 2004. For each month, total odor intensity data from the 13 stations that were monitored was calculated and plotted. The percentage of observations at which easily noticeable, strong, and very strong odors were observed was plotted by month. No very strong odors were observed during the year, and a couple of strong odors were observed in the month of May 2004. The easily noticeable odors ranged from 27 to 44 percent of the monthly observations.

Estimation of Emission of Hazardous Air Pollutants (HAPs)

Under Section 112 of Title I of the Clean Air Act, a publicly owned treatment works (POTW) is considered a major source of HAPs if it emits or has the potential to emit 10 tons per year or more of any HAP or 25 tons per year or more of any combination of HAPs.

Samples of the influent sewage to each of the District's WRPs are collected twice a year and analyzed by the Organic Chemical Analytical Laboratory for 65 of the HAP compounds of concern to POTWs. Estimates of the emissions of these HAPs from the wastewater treatment process units (grit chamber, primary settling tanks, aeration tanks, and secondary settling tanks) are made using the Bay Area Sewage Toxics Emissions (BASTE) computer model developed by CH2M Hill. The average concentration of each HAP detected in the influent sewage was used as an input to the model along with the annual average operating conditions. The physical properties of the individual compounds were taken from the United States Environmental Protection Agency (USEPA) database.

During 2004, influent samples were collected in January and July. The average influent concentrations found are presented in Table II-5 for the three major District WRPs. The estimated emissions of individual HAPs for the three major District WRPs are summarized in Table II-6.

According to the BASTE model, all of the individual HAP emissions were less than the 10 tons/year criterion. Hexane, toluene, and 2,2,4-trimethylpentane were the predominant compounds emitted from the wastewater treatment processes at the Stickney WRP. The Calumet WRP had the most compounds detected, but the emissions were very low, with all less than 1.4 ton/year. The total measured HAP emissions were substantially less than the 25 ton/year threshold at each of the three WRPs. The wastewater treatment process units at the District's WRPs are not a major source of HAPs.

Reevaluation of Local Pretreatment Limits

The EM&R Division and Industrial Waste Division evaluated technology-based pollutant limits for the District's local service area. Local limits are intended to prevent site-specific plant passthrough and interference, caused by industrial wastewater discharge. Site-specific treatment criteria and environmental criteria are required to determine the limit for each pollutant at each plant. A mass balance approach was used to convert standards into allowable headwork loadings at each District location. This approach traces the routes of each pollutant throughout the treatment process, taking into account pollutant removals in each process.

The local limits are intended to protect water quality, biosolids quality, biological integrity of WRPs, worker safety, collection systems, and air emissions. Each of the seven District WRPs was evaluated individually. One objective was to maintain a single limit throughout the District service area for each pollutant. The most stringent limit for each pollutant was used as the limiting concentration for the entire system. The pollutants of concern were identified for each WRP. The data collection strategy, as well as an analysis of data quality was detailed in the final report, Reevaluation of Local Pretreatment Limits Report No. 03-11, April 2003. The District takes into account site-specific conditions including National Pollutant Discharge Elimination System (NPDES) permit compliance, receiving water quality, biosolids quality, worker health and safety, and potential biological inhibition in wastewater treatment. The technically based local limits are based on the Guidance Manual for the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program 1 (1987 Guidance) methodology using maximum allowable headworks loading (MAHL).

The MAHL was determined using 2000 data from all WRPs and industrial users in the District service area. A pollutant required further evaluation when the annual average load exceeded 60 percent of the MAHL or the annual maximum load exceeded 80 percent of the MAHL.

The 2004 influent loads at each WRP were monitored monthly for each pollutant of concern. Monthly load evaluations were initiated to quickly bring awareness to an influent load increase before any problems arose. The 2004 data was compared to the MAHL determined from the 2000 data. Further investigation of a pollutant of concern at a specific WRP was indicated by average MAHL or the maximum MAHL above the guidance recommended levels. An annual summary for the pollutants of concern for each WRP is shown in Tables II-7 through II-14. The pollutants which require further investigation are fluoride at the Egan WRP, cyanide at the Kirie WRP, and copper and fluoride at the Hanover Park WRP. The Industrial Waste Division is studying the fluoride loads at the Egan and Hanover Park WRPs. Cyanide and copper are currently limited in the District's Sewage and Waste Control Ordinance, November 1, 2001. The Stickney (Southwest and West Side), North Side, Calumet, and Lemont WRPs did not have pollutants which required further investigation. The 1987 Guidance recommends the local limits for industrial wastewater be reevaluated every five years. The next reevaluation will be scheduled for 2008.

Reduction of Hydrogen Sulfide Concentration in Collection System Using Calcium Nitrate

The collection system upstream of Upper Des Plaines TARP Drop Shaft 5 (DS5) located in Mount Prospect, Illinois, has been determined to be a source of odors. Previous studies have verified the presence of hydrogen sulfide, a common source of odors in collection systems. In the collection system, bacteria reduce sulfate to hydrogen sulfide during cellular respiration. Sulfate reducing bacteria are cultivated in a "slime layer" that coats the sewer's wetted perimeter. The bacteria use oxygen in the most readily available form: first, from the molecular oxygen; then nitrates, followed by sulfates. As nitrate is not usually available in wastewater, bacteria will reduce sulfate after depleting the molecular oxygen. The resultant bisulfide ions combine with hydrogen to form aqueous hydrogen sulfide ($H_2S(aq)$). At pH 7, nearly half of the bisulfide ions are converted to $H_2S(aq)$. Henry's Law, temperature, pH, and the turbulence of the waste stream govern the rate at which $H_2S(aq)$ is transferred into atmospheric H_2S. High temperature, low pH, and increased turbulence increase the rate of H_2S transfer.

Calcium nitrate, sold under the trade name Bioxide, provides an alternative source of electrons and should inhibit sulfate reduction. Bioxide is 4.52 lb nitrate per gallon and in the present study the influence of dose on odor response was investigated. Solution pH, temperature, sulfide and nitrate concentrations were monitored to understand the dose-response to the calcium nitrate solution additions.

A schematic of the area, including DS5, the Upper Des Plaines 14 Sewer Interceptor (UDP14), the dosing station, and sampling locations are presented in Figure II-10. The sampling location was approximately two and a half miles downstream of the dosing location. The sulfide concentration of the wastewater was measured for three days prior to dosing with calcium nitrate solution. The sampling results are shown in Table II-15. The minimum $H_2S(aq)$ level occurred at around 10 AM on all three days. The pH ranged from 7.17 to 7.21. The increasing sulfide levels correlate with increasing water temperature, as expected.

The calcium nitrate solution dose needed to eliminate odors was evaluated on site in the fall of 2003. A H_2S monitor was located in the airspace of a manhole in the wastestream, directly upstream of DS5. M&O determined a location for a dosing station upstream of DS5 on UDP14. The dosing station was constructed on Kensington Road, east of Wolf Road.

The chemical dosing began July 2, 2004. The weekday dosing of calcium nitrate solution was done using two pumps. Pump 1 was set to 125 gpd from 12 noon until 2 AM. Pump 2 was set to 75 gpd. Pump 1 was turned off on the weekends. Pump 2 was on 24 hours a day. Rain events of one inch or more flush the collection system and reduce the production of hydrogen sulfide. During storms and for one day after, the pumps were turned off to conserve Bioxide.

The nitrate concentration in the wastestream was analyzed to evaluate the calcium nitrate dose. Ideally the wastewater would have a small nitrate residual. If no residual was found the dosage was increased; if a large residual was found the dosage was decreased. Figure II-11 shows the residual nitrate measured in the wastewater compared to the previous day's calcium nitrate dosage.

Hydrogen sulfide concentration in the headspace of the sewer was monitored continuously. The rain, ambient temperature and calcium nitrate effect on hydrogen sulfide production are shown in Figure II-12. The H_2S value given is the daily maximum concentration. The H_2S production pattern shows a weekly minimum on Sundays. The dosing pumps developed mechanical problems which disrupted the dosing schedule resulting in two weeks of inconsistent results. These problems were first noticed on July 26, 2004. The erratic pump operation resulted in an increase in hydrogen sulfide production. The pumps were repaired and calibrated on August 3, 2004. The H_2S production increased throughout the week. The effect of rain can be seen on Figure II-12, where the production is reduced. Rain events greater than one inch occurred on July 3, 2004, and August 28, 2004. The H_2S decreased due to these rain events.

Ambient air monitoring of H_2S was initiated at DS5 because of a concern of odors which may be troubling to neighbors. This monitoring began June 6, 2004, and concluded November 11, 2004. Three locations near DS5 were measured: upwind, downwind, and near the flapgate, located about thirty feet south of DS5. Monitoring was conducted four days a week when possible. The parameters measured were ambient H_2S in parts per billion, temperature, wind speed, wind direction and a qualitative characterization of odor, if present. A summary of the monthly results are shown in Table II-16.

In summary, the calcium nitrate solution dosing was successful in eliminating odor complaints near DS5. The average daily calcium nitrate dose was 95 gpd. An adjustment of the timing on pump 2 to better decrease the hydrogen sulfide peaks will be undertaken in 2005. The monitoring and optimization of nitrate salt dosing will continue in 2005.

Calumet Ambient Hydrogen Sulfide Monitoring

Two hydrogen sulfide monitoring stations operate at the Calumet WRP, monitoring and recording ambient air hydrogen sulfide concentrations. Each station consists of a hydrogen sulfide analyzer in a temperature-controlled shelter. The analyzers measure hydrogen sulfide in the very low parts per billion range, below the odor threshold for the human nose. These stations are intended to detect hydrogen sulfide before it is noticeable to nearby residents. Hydrogen sulfide is used as an indicator, because many odors from wastewater reclamation plants have a hydrogen sulfide component.

The two hydrogen sulfide monitoring stations were set up in October of 2002. The north station is north of the Calumet WRP lagoons and the south station is outside of the plant fence line near 130th Street (Figure II-13). These locations were chosen with the understanding that the wind over the lagoons in the southeastern direction would carry hydrogen sulfide to the south monitoring station, where it would be identified before it moved across 130th Street to the residential neighborhood. The north station was used to confirm the direction of the odor plume generated by the lagoons. The monitors are Zellweger Instrument's Single Point Monitors: Tape impregnated with lead acetate is used as an indicator for the hydrogen sulfide concentration, with a range of zero to ninety parts per billion.

A summary of the 2004 hydrogen sulfide ambient concentration data is shown in Table II-17. The summer months had more peak values than the winter months. The highest mean concentration of hydrogen sulfide occurred in July for both the north and south locations.

The analyzers will continue to run for further evaluation of low level hydrogen sulfide near the Calumet WRP, to provide continuous information regarding hydrogen sulfide emissions at the Calumet WRP.

Calumet Master Plan Project

The District hired the consulting firm of Metcalf & Eddy Inc. to conduct a plant process needs feasibility study and master plan for the Calumet WRP. The consultants assessed the conditions and capacities of existing infrastructure and process at the Calumet WRP, projected changes in future sewage flow, pollutant loadings and regulatory requirements. Modification and addition of infrastructure and processes to meet future needs were identified. Key infrastructure and process upgrade needs were identified for the primary settling tanks and grit removal facilities, and for nutrient removal to comply with pending and future regulations.

The WTPR Section of the R&D Department actively participated in this study. The R&D Department provided plant monitoring data, conducted special sampling, attended workshops, and reviewed documents generated from the study. The District's Engineering, M&O and R&D Departments are currently collaborating with the consulting firm to evaluate alternatives for meeting future needs at the Calumet WRP.

Characteristics of Stormwater Runoff From Three IDOT Pumping Stations

A study was conducted by the R&D Department to collect and analyze stormwater runoff discharged at three Illinois Department of Transportation (IDOT) pumping stations from October 2002 through July 2003. The purpose of the study was to obtain data on pollutant loadings from highway stormwater runoff to the Chicago Waterway System (CWS). The three IDOT pumping stations sampled in this study were IDOT Pumping Stations Number 3 (IDOT PS No. 3), Number 5 (IDOT PS No. 5) and Number 29 (IDOT PS No. 29). These pumping stations collect stormwater runoff from portions of the Edens Expressway (I-94), Eisenhower Expressway (I-290), and Dan Ryan Expressway (I-90). The collected runoff is discharged to the North Branch from IDOT PS No. 3 and to the South Branch of the Chicago River from IDOT PS Nos. 5 and 29.

Stormwater runoff discharged at these locations was sampled by autosamplers whenever discharge flow occurred. In the sampling period of the study, discharges from IDOT Pumping Station Nos. 3, 5 and 29 were sampled in 21, 40 and 41 sampling events, respectively. These sampling events covered the discharges under four different conditions, which are categorized as no rain, snowmelt, light rain (< 0.1 inches) and heavy rain (≥ 0.1 inches). Of the 21 sampling events at IDOT PS No. 3, there were 2 no rain events, 2 snowmelts, 2 light rains, and 15 heavy rains. Of the 40 sampling events at IDOT PS No. 5, there were 4 no rain events, 9 snowmelts, 4 light rains, and 23 heavy rains. Of the 41 sampling events at IDOT PS No. 29, there were 6 no rain events, 5 snowmelts, 5 light rains, and 25 heavy rains. However, the amounts of discharge from these stations in any of the sampling events were unknown.

In each sampling event at each sampling location, one composite sample was collected, with aliquots taken every 15 minutes until the discharge flow stopped. Each sample was analyzed for nine constituents, including carbonaceous BOD_5 ($CBOD_5$), TSS, three forms of nitrogen (NO_2+NO_3-N, NH_3, and TKN) and two forms of phosphorus (TP and Soluble P), chloride and conductivity. The concentration of a pollutant in this composite sample was defined as the event mean concentration (EMC) for the pollutant.

Table II-18 lists the mean values of all EMCs of six major constituents in the stormwater runoff caused by storms with at least 0.1 inches of cumulative rainfall at the three IDOT pumping stations. Among these six stormwater constituents, TSS had the largest variation in individual EMCs and (NO_2+NO_3)-N had the least variation.

At the three locations sampled, the mean values of EMCs of TSS, $CBOD_5$ and TP were not statistically different at the 5 percent level of significance. However, the mean EMC value of (NO_2+NO_3)-N at IDOT PS No. 3 was significantly lower compared to those at the other two locations. The reason for this variability cannot be explained.

In the study, the impact of storm variables, such as cumulative rainfall, storm duration, mean rain intensity and the days since the last rain that had at least 0.1 inches of rainfall, on the EMCs of major stormwater constituents was analyzed. It was found that the days since the last rain had the largest impact on the EMCs of TSS, $CBOD_5$, TN (the sum of TKN and (NO_2+NO_3)-N), and TP at all three locations. One of the conclusions of this study is that the concentrations of these constituents in stormwater runoff increases as the number of days from the previous storm that had at least 0.1 inches of rainfall increases. The correlation between the stormwater constituents and the other three storm variables were generally weak and no pattern was observed (R&D Department Report No. 04-7).

Additional Biosolids Digestion Tests for Calumet WRP

This project was to monitor whether the requirements for vector attraction reduction could be met through anaerobic digestion of biosolids at the Calumet WRP, using Option 2 of Section 503.33(b) of the 40 CFR 503 Regulation. Option 2 states that vector attraction reduction is demonstrated if, after anaerobic digestion of the biosolids, the volatile solids in the biosolids are reduced by less than 17 percent in an additional 40 days bench-scale anaerobic digestion at a temperature between 30° and 37°C. The main reason of employing this option and conducting laboratory bench-scale additional anaerobic digestion tests is that volatile solids reduction of 38 percent cannot be consistently achieved at the Calumet WRP through its two-step anaerobic digestion all year round.

In 2004, the WTPR Section conducted additional anaerobic digestion tests for the Calumet WRP. These tests were conducted once or twice a month in the wastewater treatment research laboratory at the Cecil Lue-Hing Research and Development Complex. The test procedure proposed in Appendix D of the White House Document by USEPA (EPA/625/R-92/013, Revised October 1999) was generally followed in each test. The digester draw sample used in the additional digestion tests was a mixture of the digester draw from the four second step digesters. The tests include 15 replicates of 50-mL digester draw each placed in a 125-mL flask. On Day 0, five replicates were randomly selected and sent to ALD to determine the sample total and volatile solids content, and the remaining ten were further digested in a shaking incubator at a temperature of 35.5°C (about 96°F). On Days 20 and 40, five replicates each were taken out of the incubator, and analyzed for total and volatile solids content. The mean values of each set of five replicates were used in data analysis.

A total of 14 tests were conducted in 2004. The total and volatile solids contents of the Calumet digester draw samples used in the 14 additional digestion tests ranged from 1.68 to 2.80 percent with an average of 2.14 percent and from 47.9 to 60.0 percent with an average of 54.1 percent, respectively. These values were comparable to the plant daily monitoring values for the digester draw. This indicated that the digester draw samples collected for the additional digestion tests were representative of the actual digester draw at the plant. In these tests, the standard error of the replicate samples ranged from 0.14 to 6.10 percent of the corresponding means, with an average of 0.93 percent for total solids and from 0.23 to 5.95 percent with an average of 1.13 percent for total volatile solids. This indicated that the differences among the replicate samples were relatively small.

The volatile solids reduction expected through additional digestion was calculated using both Van Kleeck equation and mass balance method. The 40-day additional volatile solids reduction from the 14 digestion tests calculated using both methods was always less than 17 percent (Table II-19). This indicates that the requirement for vector attraction reduction for the biosolids produced at the Calumet WRP was consistently met in 2004, using Option 2 of the 503 Regulation. These test results were included in the annual 503 report to USEPA for 2004.

GPS-X Process Model for Stickney Master Plan

The Hydromantis GPS-X software has been chosen to model Stickney WRP processes to assist in the development of the Stickney Master Plan. The Engineering Department, M&O, and EM&R were involved in the preliminary input of model needs. The initial data needed for input into the model was collected and evaluated by District personnel in conjunction with Black & Veatch and Greeley and Hansen consulting firms. The input involved new analytical data, as well as historical analytical and operations data.

The EM&R Division was involved in the special sampling needs of the model input. Special sampling consisted of influent, mixed liquor and final effluent analysis for a two week period. The wastewater was characterized using "Methods for Wastewater Characterization in Activated Sludge Modeling" (WERF 2003) research methods. The influent was collected with a flow paced sampler in each of three interceptors, and characterized with respect to chemical oxygen demand (COD), solids, nutrients, alkalinity and pH. The sampling and filtering methods isolated components of COD and nutrients into classes which were used as input to the Stickney Master Plan GPS-X model.

The fractions of COD distinguished between biodegradable and nonbiodegradable components, which were further categorized as particulate or soluble. The readily biodegradable COD fraction of the influent was also determined.

The diurnal flow and concentration patterns were determined for six days of sampling, including three days of dry weather flow and three days of wet weather flow. Influent grab samples were taken every two hours.

The original plan called for three two week sampling periods: One cold weather, one hot weather, and one intermediate temperature scenario. The collection of flow paced samples presented many sampling problems. On some days little to no sample was collected. One of the flow sensors was ripped from its mounting and lost during a rain event. For this reason, the other two sampling events were canceled, and the historical data and two weeks of special sampling data were used for the Stickney Master Plan GPS-X model.

Stickney Master Plan Project

The District hired Black & Veatch and Greeley Hansen consultants to conduct an infrastructure and process needs feasibility study for the Stickney WRP, which is also called Stickney Master Plan Study. In this study, the consultants assessed the conditions and capacities of the existing infrastructure and processes at the Stickney WRP, projected the changes in future sewage flow, pollutant loadings and regulatory requirements, and identified the needs for modification and addition of infrastructure and process(es) to meet the projected needs for the next 40 years. In particular, the following areas were evaluated in this study:

- Preliminary/Primary Treatment and Treatment of the Pumpback from TARP
- Solids Thickening
- Digester Gas Utilization
- Blowers and Process Air Supply System
- Nutrient Control
- Biosolids processing.

The WTPR Section actively participated in the Stickney Master Plan Study with respect to providing some of the plant monitoring data, conducting special sampling for characterizing the sewage, attending workshops and reviewing the documents generated from the study. In the workshops conducted by the consultants in the above-mentioned areas, the alternatives for improving and updating infrastructure and process facilities of the Stickney WRP to meet the future needs were critiqued and discussed by the participants from the District's Engineering, M&O and R&D Departments. In 2004, six reports generated by the consultants resulting from the Stickney Master Plan Study were reviewed and commented on by the WTPR Section.

WERF Study on Nutrient Removal Full Scale Testing at the Egan WRP

This project was a part of the District commitment to the Water Environment Research Foundation (WERF) Research Project No. 02-CTS-1, Sustainable Technology for Achieving Very Low Nitrogen and Phosphorus Effluent. This project involved coordinating, preparing and implementing the experimental plan for a full-scale testing of nutrient removal technologies at the Egan WRP.

One of the aeration batteries, North Aeration Battery, at the Egan WRP was retrofitted a few years ago to include an 88-foot anoxic zone at the beginning of each of the two aeration tanks. These aeration tanks were originally designed to have step feed capability, in which influent is distributed at various locations along the tank. The experimental plan proposed by the principal investigator of the WERF project included the use of a step feed biological nutrient removal (BNR) process for nitrogen removal and chemical precipitation with ferric chloride for phosphorus removal. Therefore, North Aeration Tank 1 of the Egan WRP was chosen for the full-scale nutrient removal test.

The full-scale test could not be conducted in 2004 because the control valves for step feed at the end of Pass 1 and the beginning of Pass 3 of the three-pass aeration tank were in the process of being replaced. However, preparation for the full-scale test began in 2004. A sampling program designed for this study was developed and tested in the summer of 2004. Mixed liquor grab samples along the aeration tank were collected for obtaining nitrogen and phosphorus profiles along the test aeration tank. Figure II-14 presents the DO, NH_3-N and NO_3-N concentrations at various locations of North Aeration Tank 1 of the Egan WRP. During this profiling, the north aeration battery received 20 MGD of sewage and 15 MGD of return sludge flow. The first two data points were taken in the beginning and end of the anoxic zone, respectively. As can be seen, most of the ammonia was converted at the end of Pass 1 and nitrification nearly completed in the middle of Pass 2. This indicates that there should be sufficient amount of nitrate that can be denitrified at the end of Pass 1 if a new anoxic zone is created and a portion of sewage inflow is diverted to this second anaerobic zone.

Unsteady Flow Water Quality Modeling for the Chicago Waterway System

An unsteady flow water quality model for the CWS has been developed by Professor Charles S. Melching of Marquette University who has been retained as a consultant by the District to study the effects of flow and pollutant loading variations on the water quality in the CWS during both dry and wet weather periods. Modeling of CWS includes the North Shore Channel (NSC), North Branch of Chicago River, Chicago River Main Branch, South Branch of Chicago River, Little Calumet River (south and north sections), Calumet-Sag Canal, and Chicago Sanitary and Ship Canal (CSSC) down to Romeoville. The model is built using Duflow Modeling Studio software, which was developed by several Dutch research institutions and universities. This model is capable of simulating dynamic changes of flows and water quality parameters in the CWS in 15 minute intervals with respect to flow and one hour intervals with respect to Dissolved Oxygen (DO), one of the most important water quality parameters in the CWS.

The structural setup of the model was completed by the consultant prior to 2004, and so was the calibration of the hydraulic part of the model, which simulates flow and surface elevation. Preliminary calibration of the model for water quality and verification of the hydraulic part of the model were completed and the draft report on the model preliminary calibration for water quality was submitted to the District for review and comment in early 2004. The WTPR Section, along with other sections and departments involved, reviewed the report. It was found that the verification of the hydraulic part of the model yielded satisfactory results. At six locations within the CWS, mean and median values of the absolute values of the difference between the measured and simulated stages are below 1 percent relative to the depth of the water at all locations. For all the data points, the simulated water depths were within 1 percent difference of the measured water depth for 70 to 96 percent of the values and within 2 percent difference for 89 to 99.8 percent of the values at these six locations. Although the difference between simulated and measured flows at the three upstream boundaries was relatively large, the flow rates at these locations were relatively small compared to the flow rates downstream of the WRPs in the CWS. The effects due to this difference on water quality parameters, particularly DO, appear to be small downstream of the major inflows, such as the discharges from the three large District WRPs to the CWS.

District personnel attended a two-day training session on October 21 and 22, 2004, regarding model use. District personnel from Engineering, M&O and R&D Departments attended the training course. Three case studies were reviewed in the training course. These case studies included the shift of lake diversion, reduction of CBOD loading from combined sewer overflows (CSOs) discharging into the CWS, and increase of supplemental aeration with the purpose of raising DOs in the CWS. Through the training course, it was demonstrated that this model is a useful tool to study the water quality changes after altering the input of flow and/or pollutant loadings to the CWS and to evaluate the alternatives for improving water quality in the CWS. For example, one case involved shifting 20 cfs of lake water from O'Brien Lock and Dam to the Wilmette Pumping Station each day. Simulation results from this case study showed noticeable DO increase in NSC, but little change of DO in the Calumet-Sag Channel. Therefore, shifting part of the lake diversion from O'Brien Lock and Dam to the Wilmette Pumping Station could be a valid option for improving the water quality in NSC without compromising the water quality in the Calumet-Sag Channel.

Tunnel and Reservoir Plan (TARP) Groundwater Study

The District's TARP Groundwater Monitoring Program was implemented in 1976 to assess the impact on groundwater quality and quantity due to operating the TARP tunnels. The TARP tunnels were constructed from 100 to 350 feet underground and function as a part of a region-wide pollution and flood control system, capturing and temporarily storing CSOs. The CSOs are a mixture of raw sewage and storm runoff and are subsequently treated at District WRPs.

During normal dry weather conditions, a small amount of groundwater infiltrates the tunnels due to a naturally higher pressure gradient favoring the groundwater table. During a major storm the tunnels may become full with CSOs, producing an internal pressure that causes exfiltration of small amounts of CSOs into the surrounding groundwater. After the storm subsides and the tunnel has been dewatered, infiltration occurs and small amounts of the surrounding groundwater are drawn into the tunnel. Groundwater monitoring wells have been installed to verify the infiltration/exfiltration process, which may occur in strategic locations of the TARP tunnel operation and verify that the TARP system is not adversely affecting the local groundwater.

The TARP groundwater monitoring program currently includes 128 monitoring wells and 34 observation wells along the Calumet, Mainstream, Des Plaines, and Upper Des Plaines TARP systems, and Chicagoland Underflow Plan (CUP) Reservoir systems anchoring the Upper Des Plaines and Calumet TARP systems (Figure II-15). Of those 128 water quality monitoring wells, 119 are currently being monitored. The remaining wells (QM-51, QM-52, QM-54, QM-55, QM-57, QM-59, QM-60, QM-66, and QC-8.1), are not required to be monitored. Four of the monitoring wells are located around the perimeter of the O'Hare Reservoir, which anchors the Upper Des Plaines (O'Hare) TARP system. Another four monitoring wells were added in 2002 to the perimeter of the Thornton Transitional Reservoir which anchors the Calumet TARP system. Although the Little Calumet leg of the Calumet TARP system (QC-29 through QC-37) has not been completed, water quality wells QC-29 through QC-37 along this segment are being monitored.

The Illinois Environmental Protection Agency (IEPA) gave the District permission to monitor 15 Mainstream TARP System Wells (QM-53, QM-56, QM-58, QM-68, and QM-70 through QM-82 excluding wells QM-72 and QM-81) at a reduced rate of twice per year from six times per year. The same reduced sampling frequency was also granted for nine Calumet TARP system wells (QC-2.2, QC-9, QC-11 through QC-15, QC-17, and QC-18), and eleven Des Plaines TARP system wells (QD-34, QD-39 through QD-45, and QD-47 through QD-49). Also the IEPA gave the District permission to reduce monitoring of the Mainstream observation wells (OM-1 through OM-23) from once every two weeks to once every two months.

The water quality wells are sampled for the following parameters: ammonia nitrogen, chloride, electrical conductivity, fecal coliform bacteria, hardness, pH, sulfate, total organic carbon, and total dissolved solids. Water level elevation is measured at all TARP wells. Data collected from the TARP wells are submitted annually to the IEPA.

The overall results obtained from regularly monitoring and sampling TARP wells indicate that operation of TARP tunnels and reservoirs has had no adverse effect on the local groundwater system.

Pollutants Captured by TARP

The R&D Department has been calculating the removal of certain pollutants, including suspended solids and both carbonaceous and nitrogenous oxygen demanding substances, and flow of CSO by the TARP systems.

The purpose of building the TARP systems was to prevent CSOs from entering Lake Michigan and Chicago area waterways. Calculating pollution removal gives an indication of how well TARP is protecting Chicago area waterways. The pollutants diverted to TARP would have otherwise been discharged into the area waterways.

Tables II-20, II-21, and II-22 contain data pertaining to CSO captured, total suspended solids removed, and oxygen demanding pollutants removed, respectively, by the TARP systems during the period 1982 through 2004. As can be seen from these tables, during 2004 the Stickney WRP treated 28.05 billion gallons of CSO, and removed 62.89 million pounds of suspended solids and 28.22 million pounds of oxygen-demanding substances (both carbonaceous and nitrogenous). The Calumet WRP treated 15.55 billion gallons of CSO, and removed 18.55 million pounds of suspended solids and 16.72 million pounds of oxygen demanding substances (both carbonaceous and nitrogenous) from TARP. The Kirie WRP treated 2.67 billion gallons of CSO, and removed 4.42 million pounds of suspended solids and 5.47 million pounds of oxygen demanding substances (both carbonaceous and nitrogenous).

Again referring to Tables II-20, II-21, and II-22, it can be seen that since TARP has gone on line a total of 787.33 billion gallons of CSO, 1.53 billion pounds of suspended solids, and 797.16 million pounds of oxygen demanding substances (both carbonaceous and nitrogenous) have been diverted to TARP. Broken down by plant, the Stickney WRP has treated a total of 533.35 billion gallons of CSO, the Calumet WRP has treated a total of 192.04 billion gallons of CSO and the Kirie WRP has treated a total of 61.94 billion gallons of CSO. The Stickney WRP removed a total of 1.22 billion pounds of suspended solids, the Calumet WRP removed 242.11 million pounds of suspended solids, and the Kirie WRP has removed a total of 64.86 million pounds of suspended solids. The Stickney WRP has removed a total of 524.29 million pounds of oxygen demanding substances. The Calumet WRP has removed 202.67 million pounds of oxygen demanding substances and the Kirie WRP has removed a total of 70.20 million pounds of oxygen demanding substances.

Sampling to Evaluate Impact of Thornton Transitional Reservoir Leakage to Material Service Corporation (MSC) Clear Water Pond

The IEPA has issued NPDES Permit No. IL0001937 to MSC. The permit authorizes the discharge of process wastewater, non-contact cooling water, pit water, and stormwater runoff from MSC Thornton Quarry–Yard 41 to Thorn Creek.

There is an 8.6-acre settling pond on the Yard 41 site that receives process wastewater, and it subsequently discharges to a larger 15.1-acre clear water pond. As the level increases in the clear water pond, periodically a portion of the clear water pond is pumped up to Thorn Creek. The MWRD Thornton Transitional Reservoir is located on the other side of a railroad pillar (barrier wall) immediately west of the clear water pond. The elevation of the area where the clear water pond has been excavated is lower than that of the Thornton Transitional Reservoir. When a fill event at the Thornton Transitional Reservoir occurs, a through-wall flow of water becomes readily apparent. This flow goes into a channel cut along the wall and over a weir in a box positioned under a protective canopy. The canopy has been constructed by the District near the barrier wall for protection against falling ice and rock. The through-wall flow eventually enters the clear water pond.

MSC has expressed concern to the District about the impact this through-wall flow might be having on the water quality of the clear water pond, and consequently its NPDES-regulated discharge. MSC has asked the District to perform sampling of the through-wall flow prior to and subsequent to a fill event in the Thornton Transitional

Reservoir. In this way the impact of the flow may be assessed.

In response to MSC, the WTPR Section collected samples for comparison from the Thornton Transitional Reservoir weirflow during dry weather and fill event conditions. The results are given in Tables II-23 and II-24. Comparison of results given in Tables II-23 and II-24 for dry weather conditions and fill event conditions, respectively, does not indicate any adverse effect on the quality of MSC 15.1-acre clear water pond resulting from leakage of water from the Thornton Transitional Reservoir. MSC should be able to meet their IEPA-issued NPDES permit for the 15.1-acre clear water pond under dry weather (no fill event) as well as under fill event conditions.

O'Hare CUP Reservoir Fill Event Experiments in 2004

The objective of this project was to provide research assistance, by the District and/or its subcontractors, to the U.S. Army Corps of Engineers (ACOE) to support the design of full scale aeration and wash down systems for the McCook and Thornton Reservoirs. Since the McCook and Thornton Reservoirs will eventually contain CSOs, an assessment of the potential and the impact of the reservoir contents on the ambient air quality was conducted. Meetings were held regularly between the District and ACOE to review the progress of the project.

A full scale experiment was conducted from May 30, 2004, to June 30, 2004, at the O'Hare CUP Reservoir to study the potential for odor formation during the storage of CSOs without mechanical aeration. This was a follow up to three similar full scale experiments that were conducted from May 12 to June, 2002, August 13 to September 3, 2002, and May 1, 2003, through May 21, 2003. As in the three previous experiments conducted in 2002 and 2003 the objective of this experiment was also to collect information and data for use in the evaluation and design of aeration systems of the future McCook and Thornton Reservoirs.

The experiment was run according to the experimental plan dated April 19, 2002. The experimental protocol addressed two scenarios, one a manmade fill event and the other a natural fill event. The fill event for 2004 was a natural fill event.

The O'Hare CUP experimental plan was put into effect during a natural fill event, which occurred on May 30, 2004. This fill event was incorporated into the study and the study was carried out for the entire 30 day period. The O'Hare CUP Reservoir began filling with CSO at 1925 hours (military time) on May 30, 2004, and became static at 1830 hours on May 31, 2004. A total of 83 million gallons of CSO was captured in the reservoir.

The results obtained during this experiment were similar to those of previous experiments. No strong odors were detected, and H_2S readings ranged between 0 and 14 ppb, which is well below the threshold odor concentration of 25 ppb. Odor frequency was perceived as infrequent. Sediment depths measured on the reservoir floor after the reservoir had drained were similar to those taken during the previous experiments.

Thornton Transitional Flood Control Reservoir Fill Events for 2004

According to the IEPA's Scope of Work (SOW) after the reservoir goes on line, event based sampling shall be conducted for the indicator parameters, specified in the IEPA's SOW Table 2 reproduced here as Table II-25, on a weekly basis while floodwater is stored in the reservoir. This will include floodwater stored in the reservoir in addition to samples collected from the groundwater quality monitoring wells (QT-1 through QT-4).

There were a total of two fill events at the Thornton Transitional Flood Control Reservoir during 2004. The events took place on March 5, 2004, and June 1, 2004.

The first fill event took place on March 5, 2004. This fill event resulted in 22.5 million gallons of CSO stored in the reservoir. The second fill event took place on June 1, 2004, and resulted in 93 million gallons of CSO stored in the reservoir.

During both fill events sampling of both the surrounding water quality monitoring wells and the Reservoir was conducted as long as there was water in the Reservoir, per requirements of the SOW.

During the fill event of March 5, 2004, the revised upper 95 percent confidence limits from the background samples occasionally exceeded for certain parameters listed in IEPA's SOW Table 2 for the following wells: QT-1 barium, cadmium, and silver, QT-2 cadmium, QT-3 sulfate and nitrate nitrogen, and QT-4 mercury, sulfate, and cadmium. During the June 1, 2004, fill event, the revised upper 95 percent confidence limits were not exceeded for any of the parameters listed in the IEPA's SOW Table 2.

TABLE II-1: GRIT DEWATERING TANK OVERFLOW SAMPLE DETAILS

Sample Date	Day	Sampling Period	Sample Hours	Flow rate to the Grit King gpm	Total Flow Pumped, gal	Total Grit Material Collected, gal
10/27/2004	Wednesday	9:00–3:00	6	180	64,800	1.98
10/28/2004	Thursday	9:00–3:00	6	180	64,800	1.53
10/29/2004	Friday	9:00–3:00	6	180	64,800	1.98
Average				180	64,800	1.83

TABLE II-2: GRIT DEWATERING TANK OVERFLOW ANALYTICAL RESULTS OF THE LIQUID STREAMS OF THE GRIT KING UNIT

	%TS			%TVS			% Ash (Inorganic)		
Sample Date	Inflow	Vortex	Classifier	Inflow	Vortex	Classifier	Inflow	Vortex	Classifier
10/27/2004	0.09	0.09	0.09	41.08	42.57	34.24	58.92	57.43	65.73
10/28/2004	0.09	0.08	0.09	42.54	42.59	38.36	57.46	57.41	61.64
10/29/2004	0.10	0.10	0.10	53.96	54.74	61.29	46.04	45.26	38.71
Average	0.09	0.09	0.09	45.86	46.63	44.63	54.14	53.37	55.36

TABLE II-3: GRIT DEWATERING TANK OVERFLOW ANALYTICAL RESULTS OF THE COLLECTED GRIT MATERIAL FROM THE GRIT KING UNIT

Sample Date	% TS	% TVS	% Ash (Inorganic)
10/27/2004	52.24	35.42	64.58
10/28/2004	44.80	40.60	59.40
10/29/2004	43.63	39.24	60.76
Average	46.89	38.42	61.58

TABLE II-4: GRIT DEWATERING TANK OVERFLOW SIEVE ANALYSIS RESULTS OF COLLECTED GRIT

Sieve Size µm (No)	Sample Date 10/27/04 Retained		10/28/04 Retained		10/29/04 Retained		Average Retained	
	Retained	Passing	Retained	Passing	Retained	Passing	Retained	Passing
	Percent							
1000 (18)	4.7	95.5	2.1	98.1	1.8	98.4	2.9	97.4
600 (30)	9.0	86.6	5.3	92.8	3.8	94.7	6.0	91.3
425 (40)	20.5	66.0	15.5	77.3	10.5	84.1	15.5	75.8
300 (50)	27.8	38.1	26.4	50.8	19.6	64.4	24.6	51.1
212 (70)	23.0	15.0	27.0	23.8	26.4	38.0	25.5	25.6
150 (100)	9.8	5.3	16.0	7.7	24.0	13.9	16.6	9.0
106 (140)	1.9	3.3	3.5	4.3	6.4	7.5	3.9	5.0
75 (200)	1.0	2.3	1.4	2.9	2.5	5.0	1.6	3.4
Pan	2.3	0.0	2.9	0.0	5.0	0.0	3.4	0.0
Total	100.0		100.1		100.0		100.0	

TABLE II-5: INFLUENT HAZARDOUS AIR POLLUTANT CONCENTRATIONS AT THE DISTRICT'S MAJOR WATER RECLAMATION PLANTS IN 2004

HAP Organic Compound	Concentrations in µg/L[1]		
	Stickney	Calumet	North Side
Dichloromethane	4	7.0	6.5
Chloroform	1.5	1.5	NF
Trichloroethene	NF	2.0	NF
Benzene	NF	1.5	NF
Tetrachloroethene	0.8	11.5	5
Toluene	10.8	16.0	3.5
Ethylbenzene	0.5	NF	NF
Carbon disulfide	NF	1.5	NF
Methyl ethyl ketone	6	34	NF
Styrene	NF	8.5	NF
Xylene (total)	5.5	NF	1.5
Cresol (total)	2	8.5	12
Acetophenone	NF	9.0	NF
Cumene	NF	20	NF
2,2,4-Trimethylpentane	0.75	NF	NF
Hexane	2	NF	NF
Acetaldehyde	21.2	NF	NF

[1]Average results of the two influent samples collected in January and July 2004.
NF = Not found.

TABLE II-6: HAZARDOUS AIR POLLUTANT EMISSIONS FROM THE DISTRICT'S MAJOR WATER RECLAMATION PLANTS IN 2004[1]

HAP Organic Compound	Stickney (tons/yr.)	Calumet (tons/yr.)	North Side (tons/yr.)
Dichloromethane	0.50	0.36	0.34
Chloroform	0.16	0.07	0
Trichloroethene	0	0.12	0
Benzene	0	0.07	0
Tetrachloroethene	0.27	1.37	0.69
Toluene	1.01	0.69	0.12
Ethylbenzene	0.01	0	0
Carbon disulfide	0	0.08	0
Methyl ethyl ketone	0.07	0.15	0
Styrene	0	0.29	0
Xylene (total)	0.53	0	0.06
Cresol (total)	0	0.01	0.02
Acetophenone	0	0.01	0
Cumene	0	0.88	0
2,2,4-Trimethylpentane	0.83	0	0
Hexane	1.81	0	0
Acetaldehyde	0.57	0	0
Total	5.76	4.04	1.23

[1]Emissions estimated using the BASTE model.

TABLE II-7: EVALUATION OF POLLUTANTS OF CONCERN USING 2004 DATA FOR THE CALUMET WRP

Pollutant of Concern	MAHL (2000), lbs/day	Annual Average Load, lbs/day	Annual Maximum Load, lbs/day	Further Investigation Needed for Local Limit[1]
Ammonia	1,536,974	21,360	40,115	No
Arsenic	2,418	10	68	No
Cadmium	843	1	38	No
Chromium, total	36,851	15	117	No
Chromium, hexavalent	2,848	4	7	No
Copper	5,085	68	551	No
Cyanide	3,247	20	128	No
Fats, Oils and Grease	365,563	35,954	73,244	No
Fluoride	NA	1,417	2,053	No
Iron	92,154	4,717	37,989	No
Lead	5,721	8	164	No
Mercury	14	<1	3	No
Nickel	4,774	18	112	No
Phenol	43,138	249	1,793	No
Selenium	4,601	12	59	No
Silver	2,989	3	21	No
Zinc	8,485	299	2,032	No

[1]Local limits should be set where the average actual loading exceeds 60 percent of the MAHL, or where the maximum actual loading exceeds 80 percent of the MAHL.

TABLE II-8: EVALUATION OF POLLUTANTS OF CONCERN USING 2004 DATA FOR THE JOHN E. EGAN WRP

Pollutant of Concern	MAHL (2000), lbs/day	Annual Average Load, lbs/day	Annual Maximum Load, lbs/day	Further Investigation Needed for Local Limit[1]
Ammonia	44,630	3,427	5,176	No
Arsenic	44	2	7	No
Cadmium	14	<1	<1	No
Chromium, total	1,586	1	4	No
Chromium, hexavalent	10	<1	1	No
Copper	89	18	37	No
Cyanide	18	2	5	No
Fats, Oils and Grease	NA	7,150	14,553	No
Fluoride	321	231	348	Yes
Iron	NA	273	709	No
Lead	1,681	1	3	No
Mercury	3	<1	<1	No
Nickel	468	2	5	No
Phenol	NA	7	14	No
Selenium	440	1	1	No
Silver	17	1	2	No
Zinc	664	22	46	No

[1]Local limits should be set where the average actual loading exceeds 60 percent of the MAHL, or where the maximum actual loading exceeds 80 percent of the MAHL.

TABLE II-9: EVALUATION OF POLLUTANTS OF CONCERN USING 2004 DATA FOR THE JAMES C. KIRIE WRP

Pollutant of Concern	MAHL (2000), lbs/day	Annual Average Load, lbs/day	Annual Maximum Load, lbs/day	Further Investigation Needed for Local Limit[1]
Ammonia	48,388	3,559	8,633	No
Arsenic	51	2	19	No
Cadmium	18	<1	3	No
Chromium, total	1,993	4	18	No
Chromium, hexavalent	12	1	2	No
Copper	121	22	89	No
Cyanide	34	3	63	Yes
Fats, Oils and Grease	NA	6,201	10,515	No
Fluoride	NA	265	517	No
Iron	NA	441	4,164	No
Lead	2,157	2	15	No
Mercury	2	<1	1	No
Nickel	36,513	3	19	No
Phenol	NA	11	37	No
Selenium	533	1	7	No
Silver	32	1	4	No
Zinc	694	44	158	No

[1]Local limits should be set where the average actual loading exceeds 60 percent of the MAHL, or where the maximum actual loading exceeds 80 percent of the MAHL.

TABLE II-10: EVALUATION OF POLLUTANTS OF CONCERN USING 2004 DATA FOR THE LEMONT WRP

Pollutant of Concern	MAHL (2000), lbs/day	Annual Average Load, lbs/day	Annual Maximum Load, lbs/day	Further Investigation Needed for Local Limit[1]
Ammonia	1,663,415	253	559	No
Arsenic	9,982	<1	<1	No
Cadmium	3,475	<1	<1	No
Chromium, total	163,085	<1	<1	No
Chromium, hexavalent	11,741	<1	<1	No
Copper	143,402	1	4	No
Cyanide	2,717	NA	NA	No
Fats, Oils and Grease	1,503,597	394	1,513	No
Fluoride	NA	13	28	No
Iron	281,323	19	161	No
Lead	24,385	<1	<1	No
Mercury	853	<1	<1	No
Nickel	19,647	<1	1	No
Phenol	57,154	1	6	No
Selenium	18,965	<1	<1	No
Silver	12,282	<1	<1	No
Zinc	52,595	2	14	No

[1]Local limits should be set where the average actual loading exceeds 60 percent of the MAHL, or where the maximum actual loading exceeds 80 percent of the MAHL.

TABLE II-11: EVALUATION OF POLLUTANTS OF CONCERN USING 2004 DATA FOR THE NORTH SIDE WRP

Pollutant of Concern	MAHL (2000), lbs/day	Annual Average Load, lbs/day	Annual Maximum Load, lbs/day	Further Investigation Needed for Local Limit[1]
Ammonia	129,578	23,374	31,062	No
Arsenic	2,265	16	58	No
Cadmium	771	2	8	No
Chromium, total	701,450	10	126	No
Chromium, hexavalent	2,606	4	8	No
Copper	8,212	93	733	No
Cyanide	522	17	60	No
Fats, Oils and Grease	455,650	52,848	132,718	No
Fluoride	NA	1,703	2,386	No
Iron	68,679	2,474	26,160	No
Lead	5,657	18	208	No
Mercury	12	<1	2	No
Nickel	3,495	15	97	No
Phenol	28,566	58	159	No
Selenium	4,210	7	22	No
Silver	1,720	5	37	No
Zinc	5,601	191	1,434	No

[1]Local limits should be set where the average actual loading exceeds 60 percent of the MAHL, or where the maximum actual loading exceeds 80 percent of the MAHL.

TABLE II-12: EVALUATION OF POLLUTANTS OF CONCERN USING 2004 DATA FOR THE HANOVER PARK WRP

Pollutant of Concern	MAHL (2000), lbs/day	Annual Average Load, lbs/day	Annual Maximum Load, lbs/day	Further Investigation Needed for Local Limit[1]
Ammonia	17,943	1,247	1,964	No
Arsenic	14	1	4	No
Cadmium	4	<1	<1	No
Chromium, total	474	<1	4	No
Chromium, hexavalent	3	<1	<1	No
Copper	21	5	48	Yes
Cyanide	7	1	2	No
Fats, Oils and Grease	NA	2,344	5,443	No
Fluoride	100	52	121	Yes
Iron	NA	78	1,076	No
Lead	488	<1	3	No
Mercury	3	<1	<1	No
Nickel	193	<1	2	No
Phenol	NA	2	6	No
Selenium	138	<1	1	No
Silver	4	<1	3	No
Zinc	215	7	42	No

[1]Local limits should be set where the average actual loading exceeds 60 percent of the MAHL, or where the maximum actual loading exceeds 80 percent of the MAHL.

TABLE II-13: EVALUATION OF POLLUTANTS OF CONCERN USING 2004 DATA FOR THE STICKNEY (SOUTHWEST) WRP

Pollutant of Concern	MAHL (2000), lbs/day	Annual Average Load, lbs/day	Annual Maximum Load, lbs/day	Further Investigation Needed for Local Limit[1]
Ammonia	159,040	51,067	110,330	No
Arsenic	4,170	9	72	No
Cadmium	1,452	7	164	No
Chromium, total	35,163	195	4,048	No
Chromium, hexavalent	4,905	4	19	No
Copper	29,503	498	11,025	No
Cyanide	933	27	67	No
Fats, Oils and Grease	690,118	40,473	254,835	No
Fluoride	2,153	2,416	3,943	No
Iron	204,623	18,499	493,895	No
Lead	7,867	216	7,070	No
Mercury	23	1	4	No
Nickel	8,210	75	1,496	No
Phenol	191,848	231	1,745	No
Selenium	7,922	29	109	No
Silver	5,143	15	133	No
Zinc	23,664	1,351	28,247	No

[1]Local limits should be set where the average actual loading exceeds 60 percent of the MAHL, or where the maximum actual loading exceeds 80 percent of the MAHL.

TABLE II-14: EVALUATION OF POLLUTANTS OF CONCERN USING 2004 DATA FOR THE STICKNEY (WEST SIDE) WRP

Pollutant of Concern	MAHL (2000), lbs/day	Annual Average Load, lbs/day	Annual Maximum Load, lbs/day	Further Investigation Needed for Local Limit[1]
Ammonia	172,294	30,243	80,071	No
Arsenic	4,517	9	31	No
Cadmium	1,572	3	17	No
Chromium, total	38,093	141	884	No
Chromium, hexavalent	5,313	11	327	No
Copper	31,961	204	1,355	No
Cyanide	1,010	45	215	No
Fats, Oils and Grease	747,627	56,982	180,004	No
Fluoride	2,671	2,268	3,823	No
Iron	221,675	5,679	37,816	No
Lead	8,522	68	654	No
Mercury	25	<1	1	No
Nickel	8,895	44	226	No
Phenol	207,835	246	527	No
Selenium	8,583	33	105	No
Silver	5,571	9	137	No
Zinc	25,636	548	3,158	No

[1]Local limits should be set where the average actual loading exceeds 60 percent of the MAHL, or where the maximum actual loading exceeds 80 percent of the MAHL.

TABLE II-15: SULFIDE LEVELS IN WASTEWATER, MEASURED AT DiMUCCI PARK

Date	Temperature, °F	pH	Average Sulfide, mg/L	Maximum Sulfide, mg/L	Minimum Sulfide, mg/L	Standard Deviation, mg/L
4/7/04	58.69	7.17	0.44	0.60	0.20	0.1027
4/21/04	60.44	7.17	0.63	0.70	0.50	0.0951
5/4/04	61.47	7.21	0.74	1.00	0.60	0.1512

TABLE II-16: SUMMARY OF AMBIENT H_2S MONITORING NEAR DROP SHAFT 5

	June 2004	July 2004	August 2004	September 2004	October 2004	November 2004
Mean H_2S, ppb	11	25	10	7	4	4
Maximum H_2S, ppb	81	150	58	14	8	5
Minimum H_2S, ppb	1	3	0	3	2	3
No. of Observations	21	20	20	15	3	2
Ambient Temperature Recorded at Time of Measurement, °F	72	76	71	70	59	51
Wind Speed, mph	3.4	4.3	7.5	5	4.2	5.2

TABLE II-17: SUMMARY OF 2004 CALUMET WRP HYDROGEN SULFIDE CONCENTRATION MONITORING

Month	H_2S at North Monitor, ppb		H_2S at South Monitor, ppb	
	Mean	Maximum	Mean	Maximum
January	0.00	0.04	0.00	1.80
February	0.00	2.50	0.01	9.20
March	0.00	0.00	0.02	24.10
April	0.01	3.20	0.03	14.60
May	0.00	2.20	0.04	33.20
June	0.15	41.80	0.02	33.10
July	0.56	20.50	0.29	14.90
August	0.30	23.00	0.20	12.10
September	0.70	5.00	0.11	6.80
October	0.70	8.50	0.05	10.30
November	0.20	4.30	0.00	7.10
December	0.00	2.80	0.00	3.90

TABLE II-18: MEAN CONCENTRATIONS OF MAJOR CONSTITUENTS IN HIGHWAY STORMWATER RUNOFF DISCHARGED TO CHICAGO WATERWAYS SYSTEM

Location	TSS mg/L	$CBOD_5$ mg/L	TKN mg/L	NH_3-N mg/L	NO_2+NO_3-N mg/L	TP mg/L
IDOT PS No. 3	98.9	9.1	1.74	0.31	0.99	0.25
IDOT PS No. 5	69.3	10.0	1.79	0.30	1.54	0.26
IDOT PS No. 29	87.3	8.3	1.78	0.32	1.53	0.19

TABLE II-19: RESULTS OF ADDITIONAL ANAEROBIC DIGESTION TESTS FOR THE CALUMET WRP PER OPTION 2 OF SECTION 503.33(b) OF THE 40 CFR PART 503 REGULATIONS

Test Start	Before Test		After Test*		Volatile Solids Reduction (%)	
Date	TS (%)	%VTS (%)	TS (%)	%VTS (%)	By Equation**	By Mass
1/16/04	2.10	56.16	1.95	52.40	14.1	13.1
2/25/04	1.68	60.05	1.55	56.68	12.9	13.1
3/18/04	1.85	58.36	1.68	54.25	15.4	15.8
4/23/04	2.14	55.33	1.98	51.80	13.3	13.1
5/14/04	2.12	55.34	1.99	53.07	8.7	9.8
5/28/04	2.19	53.51	2.05	50.13	12.7	12.2
6/11/04	2.48	51.47	2.40	49.45	7.7	7.3
7/2/04	2.80	50.36	2.54	46.17	15.5	16.6
8/5/04	2.40	47.93	2.32	46.63	5.1	5.9
8/20/04	2.25	49.63	2.10	47.17	9.4	11.1
9/1/04	2.37	51.24	2.24	47.81	12.8	11.7
10/7/04	1.93	53.35	1.75	50.80	9.7	13.8
11/17/04	1.88	55.83	1.75	52.01	14.3	13.7
12/2/04	1.76	58.17	1.63	54.74	13.0	12.8

*After 40 days of incubation at 35.5°C in bench-scale reactors.
**The Van Kleeck Equation was used in calculations.

TABLE II-20: COMBINED SEWER OVERFLOWS CAPTURED BY THE TUNNEL AND RESERVOIR SYSTEMS DURING THE PERIOD 1982 THROUGH 2004

Date	Stickney[1] Flow (billion gallons)	Calumet[1] Flow (billion gallons)	Kirie[2] Flow (billion gallons)	Total (billion gallons)
1982-1993[3]	206.20	60.20	37.30	303.70
1994	18.74	7.83	1.44	28.01
1995	22.84	9.08	2.60	34.52
1996	21.54	12.02	2.23	35.79
1997	29.10	8.44	1.50	39.04
1998	34.31	13.23	2.69	50.23
1999	27.20	11.77	3.15	42.12
2000	28.55	11.55	2.14	42.24
2001	48.43	16.34	3.24	68.01
2002	41.17	11.15	1.50	53.82
2003	27.22	14.88	1.48	43.58
2004	28.05	15.55	2.67	46.27
Total	533.35	192.04	61.94	787.33

[1]Stickney and Calumet Data were taken from TARP Pumpback reports.
[2]Kirie data were taken from LIMS KRRAW69 Report. CSO capture was calculated by subtracting the average dry weather flow from the average daily flow. The flow data were provided by the Maintenance and Operations Department (Technical Projects).
[3]Data were supplied by Engineering Department.

TABLE II-21: TOTAL SUSPENDED SOLIDS REMOVED THROUGH THE COMBINED SEWER OVERFLOWS CAPTURED BY THE TUNNEL AND RESERVOIR SYSTEMS DURING THE PERIOD 1982 THROUGH 2004

Date	Mainstream (Million Pounds)	Calumet (Million Pounds)	Kirie (Million Pounds)	Total (Million Pounds)
1982-1993	413.20	69.00	25.20	507.40
1994	41.31	12.60	1.90	55.81
1995	67.75	9.93	3.50	81.18
1996	56.57	12.43	3.30	72.30
1997	62.14	14.28	1.88	78.30
1998	107.02	16.00	3.08	126.10
1999	71.69	15.31	6.63	93.63
2000	114.52	18.59	3.95	137.06
2001	88.78	18.53	5.89	113.20
2002	66.85	13.18	2.68	82.71
2003	67.86	23.71	2.43	94.00
2004	62.89	18.55	4.42	85.86
Total	1,220.58	242.11	64.86	1,527.55

TABLE II-22: OXYGEN DEMANDING POLLUTANTS REMOVED[1] THROUGH COMBINED SEWER OVERFLOWS CAPTURED BY THE TUNNEL AND RESERVOIR SYSTEMS DURING THE PERIOD 1982 THROUGH 2004

Date	Mainstream (Million Pounds)	Calumet (Million Pounds)	Kirie (Million Pounds)	Total (Million Pounds)
1982 through 1993	189.56	59.22	24.68	273.46
1994	15.00	8.46	2.24	25.70
1995	15.77	9.79	3.58	29.14
1996	18.60	12.96	4.14	35.70
1997	26.03	9.16	2.31	37.50
1998	30.86	13.57	4.81	49.24
1999	22.84	13.39	6.36	42.59
2000	35.91	13.61	4.55	54.07
2001	50.67	16.82	5.95	73.44
2002	54.49	12.41	2.96	69.86
2003	36.34	16.56	3.15	56.05
2004	28.22	16.72	5.47	50.41
Total	524.29	202.67	70.20	797.16

[1]CBOD + (Ammonia*4.6), except for Kirie WRP which uses BOD + (Ammonia*4.6). Kirie WRP does not report CBOD.

TABLE II-23: IMPACT OF THORNTON TRANSITIONAL RESERVOIR WEIR FLOW TO THE MSC 15.1-ACRE CLEAR WATER POND SAMPLING DURING DRY WEATHER (NO FILL EVENT) CONDITIONS

Date	FOG (mg/L)	Suspended Solids (mg/L)	pH	Temperature (°C)
Results from Weir Box				
2/19/04	1	2	7.7	1
5/18/04	1	32	8.2	19
8/10/04	3	2	8.2	20
11/10/04	NA	4	7.8	15
Results from Pond*				
2/19/04	1	4	7.7	1
5/18/04	1	10	8.0	15
8/10/04	1	3	8.2	24
11/10/04	NA	2	8.0	14

NA = Sample not analyzed for FOG.
*NPDES Limit: FOG (15 monthly average, 30 daily maximum)
Suspended Solids (35 monthly average, 70 daily maximum)
pH (6.0–9.0)

TABLE II-24: IMPACT OF THORNTON TRANSITIONAL RESERVOIR WEIR FLOW TO THE MSC 15.1-ACRE CLEAR WATER POND
SAMPLING DURING FILL EVENTS OF MARCH 5, 2004, AND JUNE 1, 2004

Date	FOG (mg/L)	Suspended Solids (mg/L)	pH	Temperature (°C)
Results from Weir Box				
3/11/04	2	5	8.2	7
6/1/04	1	5	8.0	22
6/8/04	1	3	8.3	25
6/14/04	3	16	NA	NA
6/21/04	3	4	8.4	18
6/28/04	2	3	8.3	17
Results from Pond*				
3/11/04	2	8	8.2	6
6/1/04	2	5	7.9	20
6/8/04	3	3	8.2	23
6/14/04	2	8	NA	NA
6/21/04	2	4	8.3	22
6/28/04	1	4	8.3	22

NA = Sample not analyzed for pH and temperature.
*NPDES Limit: FOG (15 monthly average, 30 daily maximum)
Suspended Solids (35 monthly average, 70 daily maximum)
pH (6.0–9.0)

TABLE II-25: LIST OF PARAMETERS TO BE ANALYZED ACCORDING TO TABLE 2 FROM THE IEPA'S SCOPE OF WORK FOR MONITORING THORNTON TRANSITIONAL RESERVOIR

Arsenic	Ammonia
Boron	Barium
Chloride	Cadmium
Copper	Chromium
Fecal Coliform	Cyanide
Iron	Fluoride
Lead	Manganese
Mercury	Nickel
Phenols	Silver
Sulfate	Temperature
Total Dissolved Solids	Nitrate
Biochemical Oxygen Demand (5-day and 21-day)	

FIGURE II-1: ODOR OBSERVANCES AT HASMA, VULCAN, AND MARATHON SOLIDS DRYING AREAS AND LASMA SOLIDS PROCESSING SITE—2004

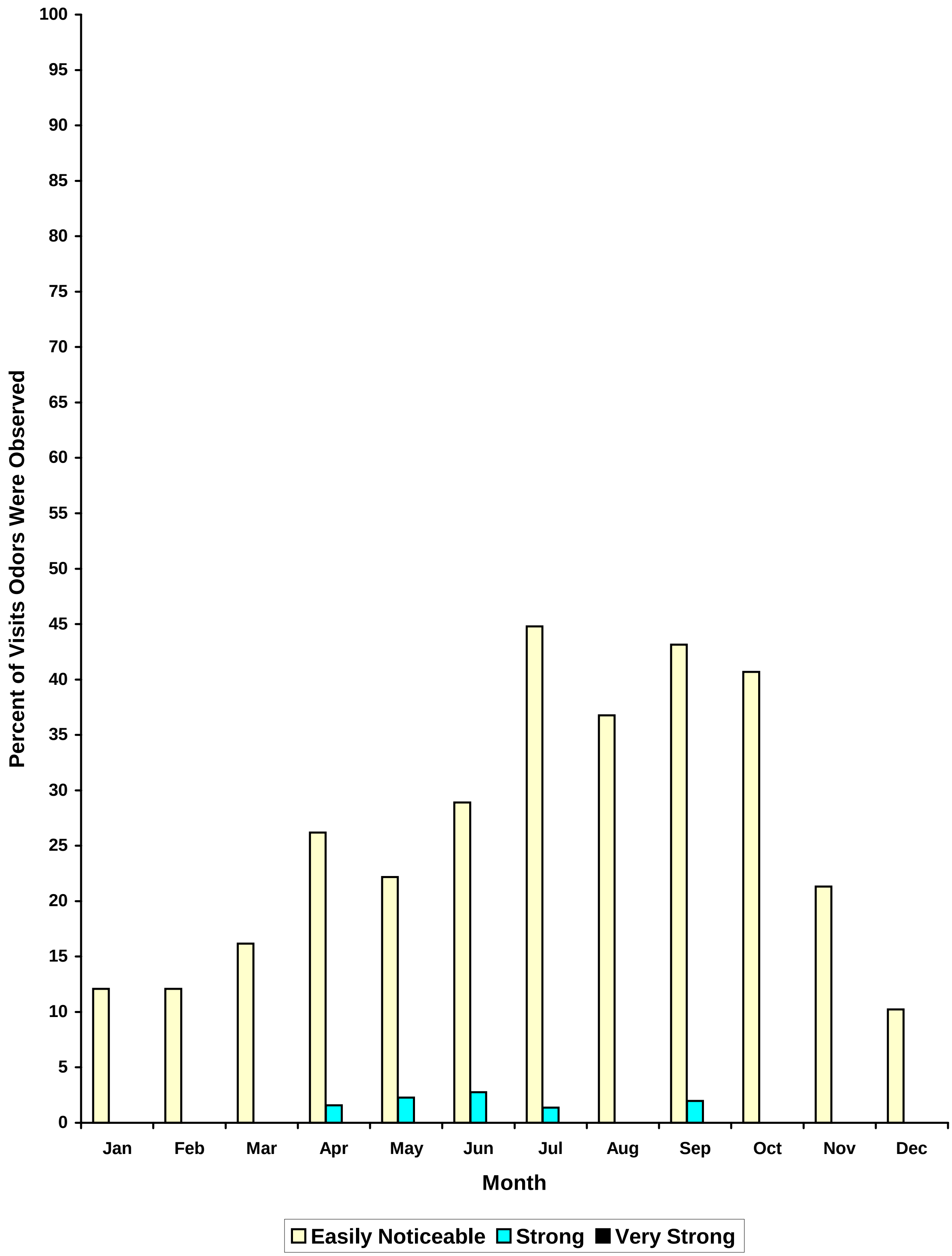


FIGURE II-2: ODOR OBSERVANCES AT CALUMET WRP—2004

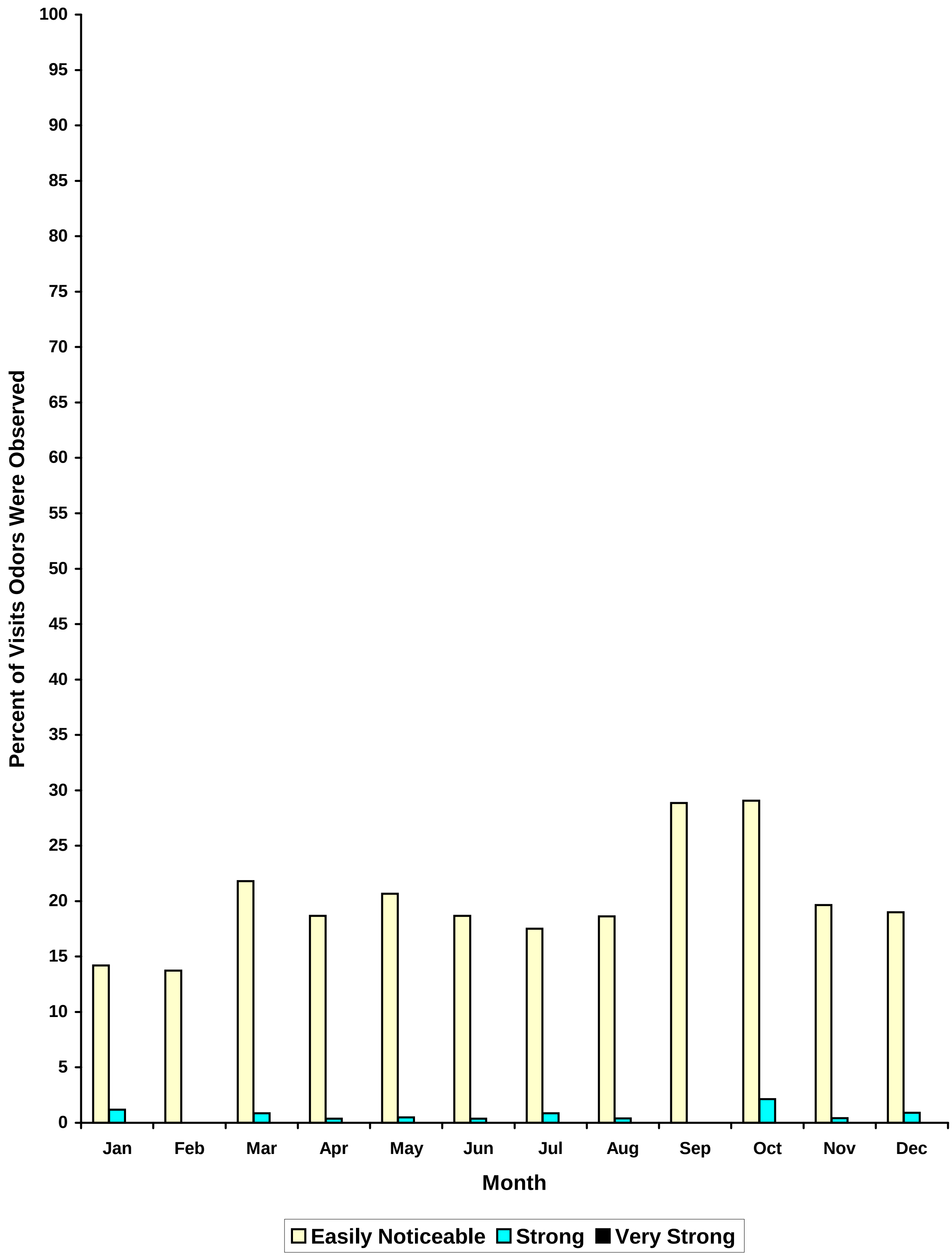


FIGURE II-3: ODOR OBSERVANCES AT CALUMET WRP
SOLIDS DRYING AREAS—2004

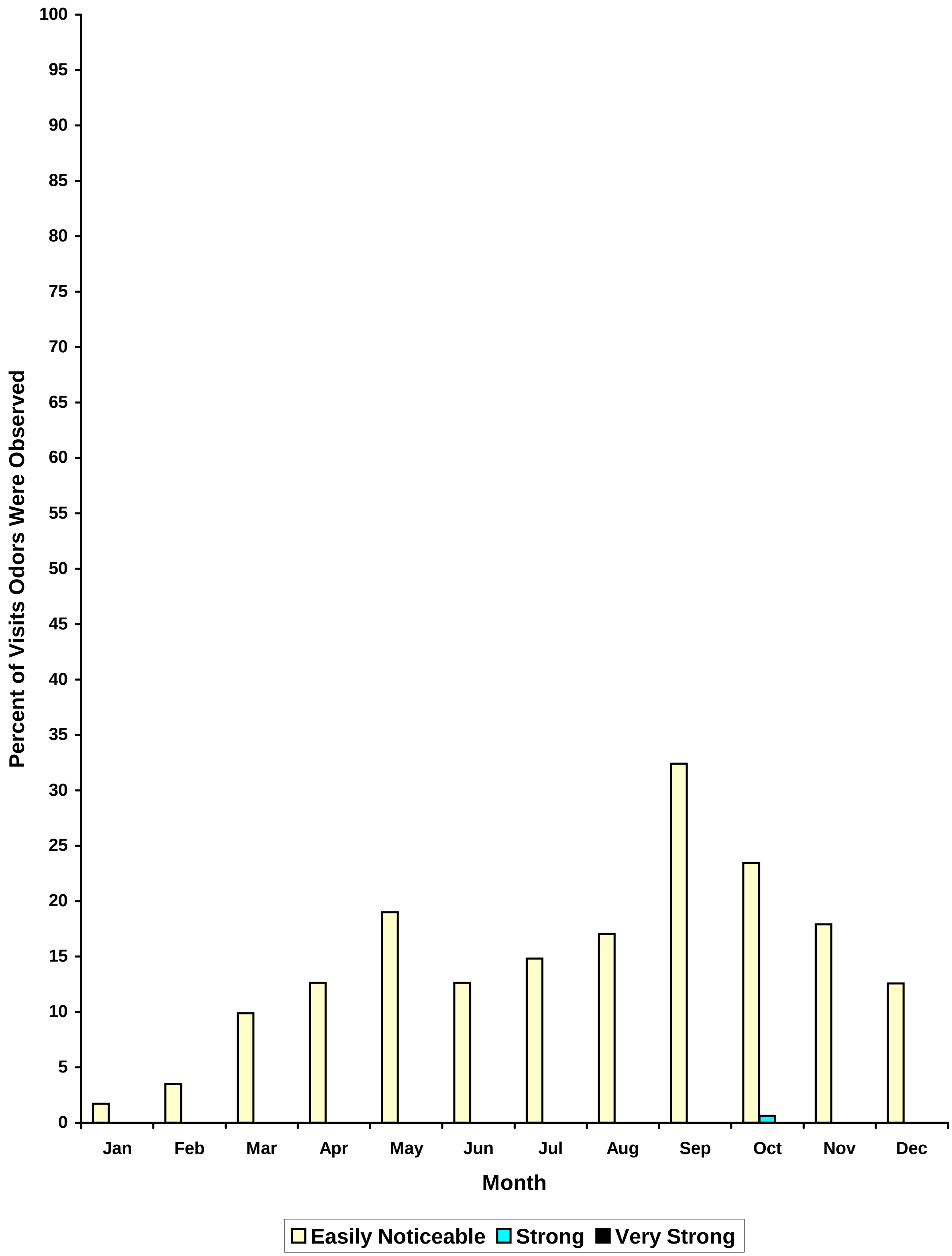


FIGURE II-4: ODOR OBSERVANCE AT RASMA SOLIDS DRYING AREA—2004

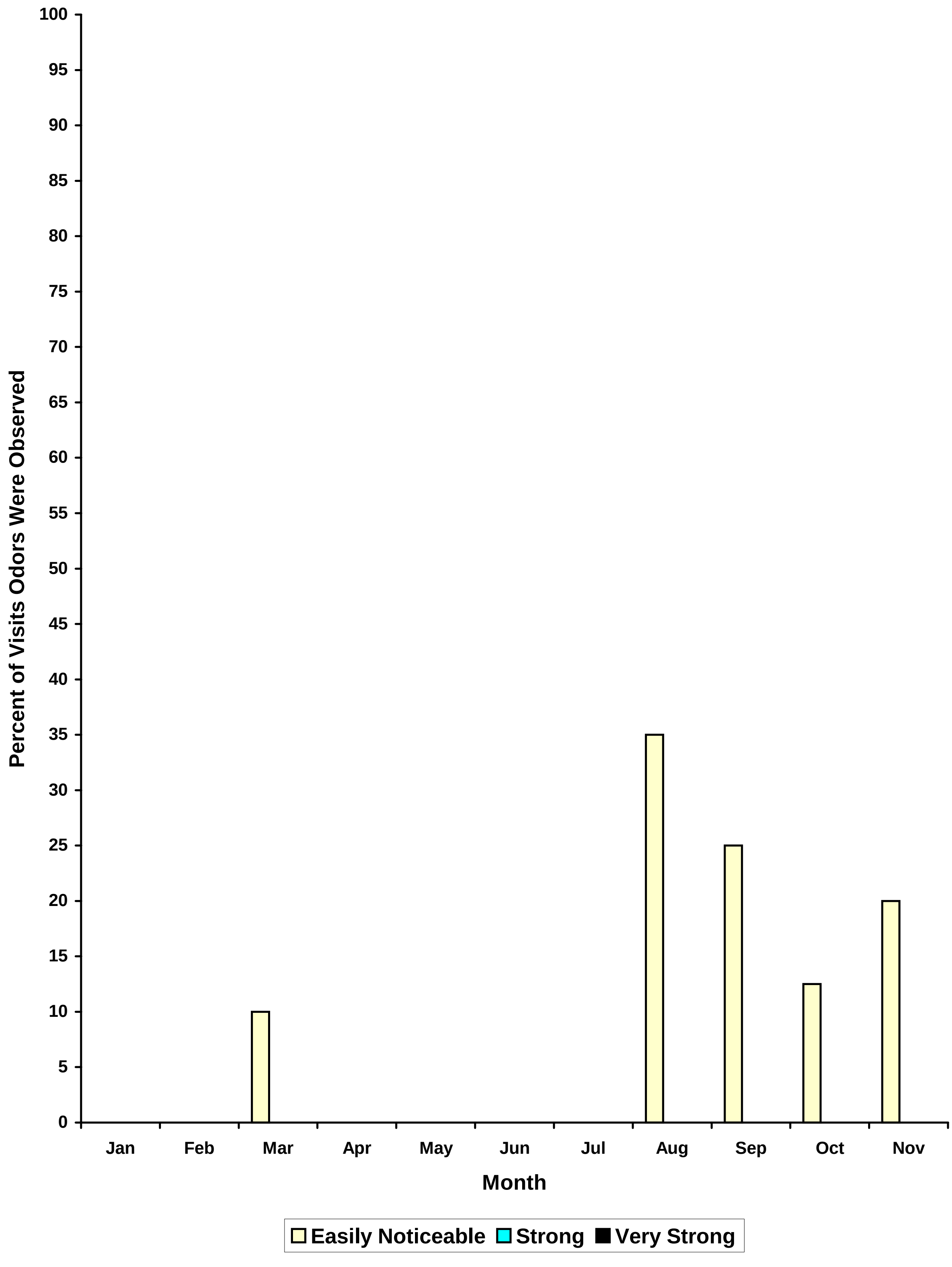


FIGURE II-5: ODOR OBSERVANCES AT STONY ISLAND
SOLIDS DRYING AREA—2004

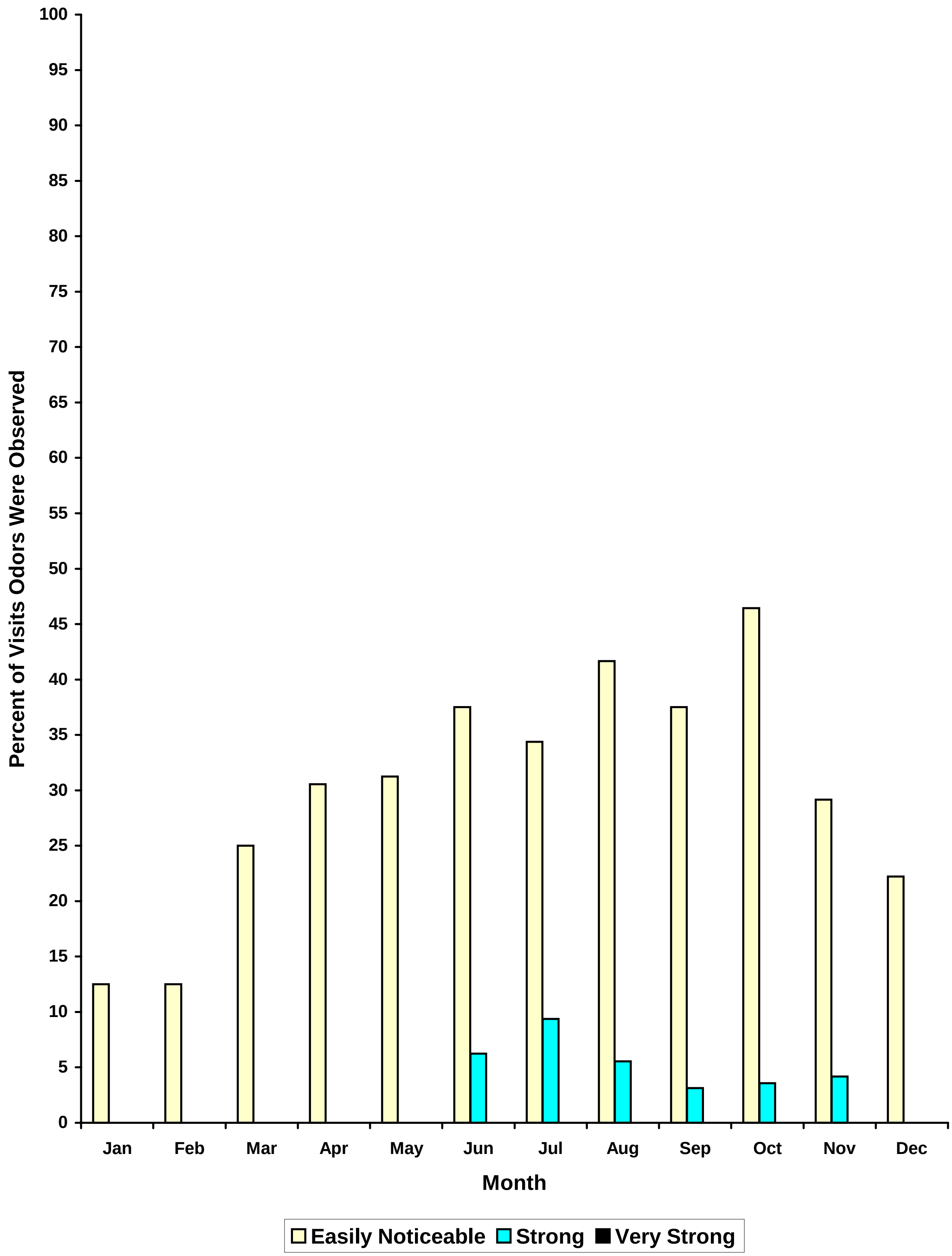


FIGURE II-6: ODOR OBSERVANCES AT JOHN E. EGAN WRP—2004

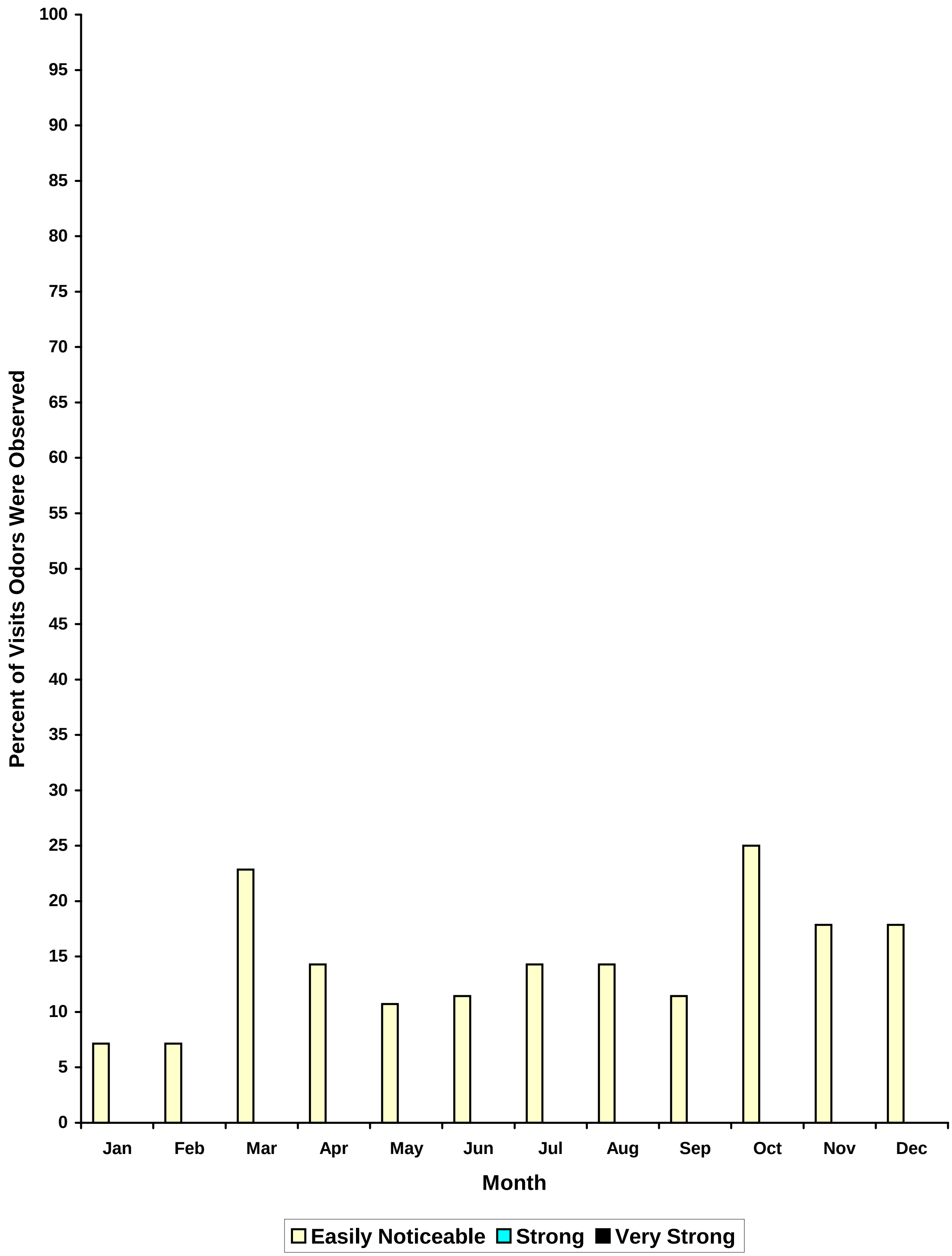


FIGURE II-7: ODOR OBSERVANCES AT STICKNEY WRP—2004

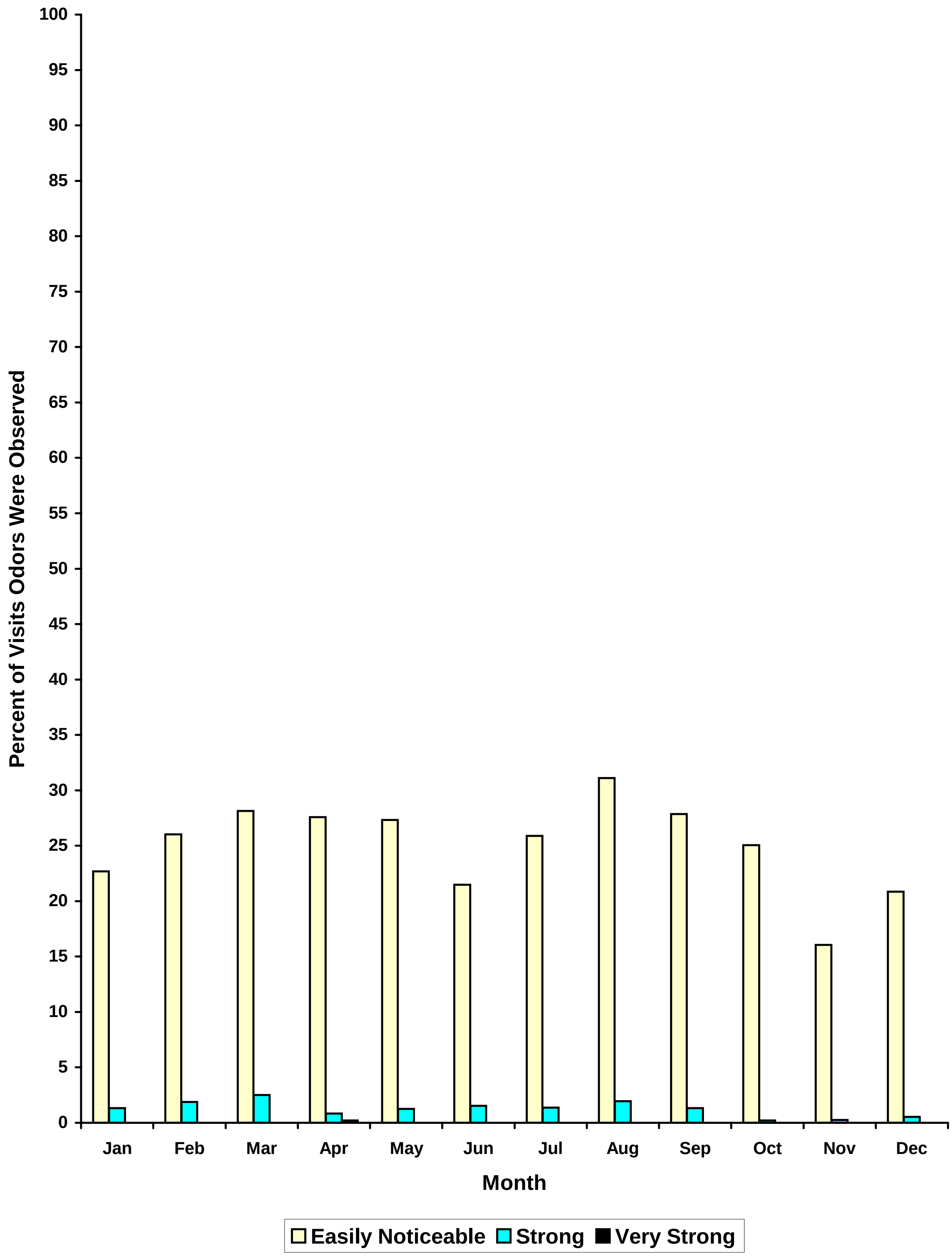


FIGURE II-8: ODOR OBSERVANCES AT JAMES C. KIRIE WRP—2004

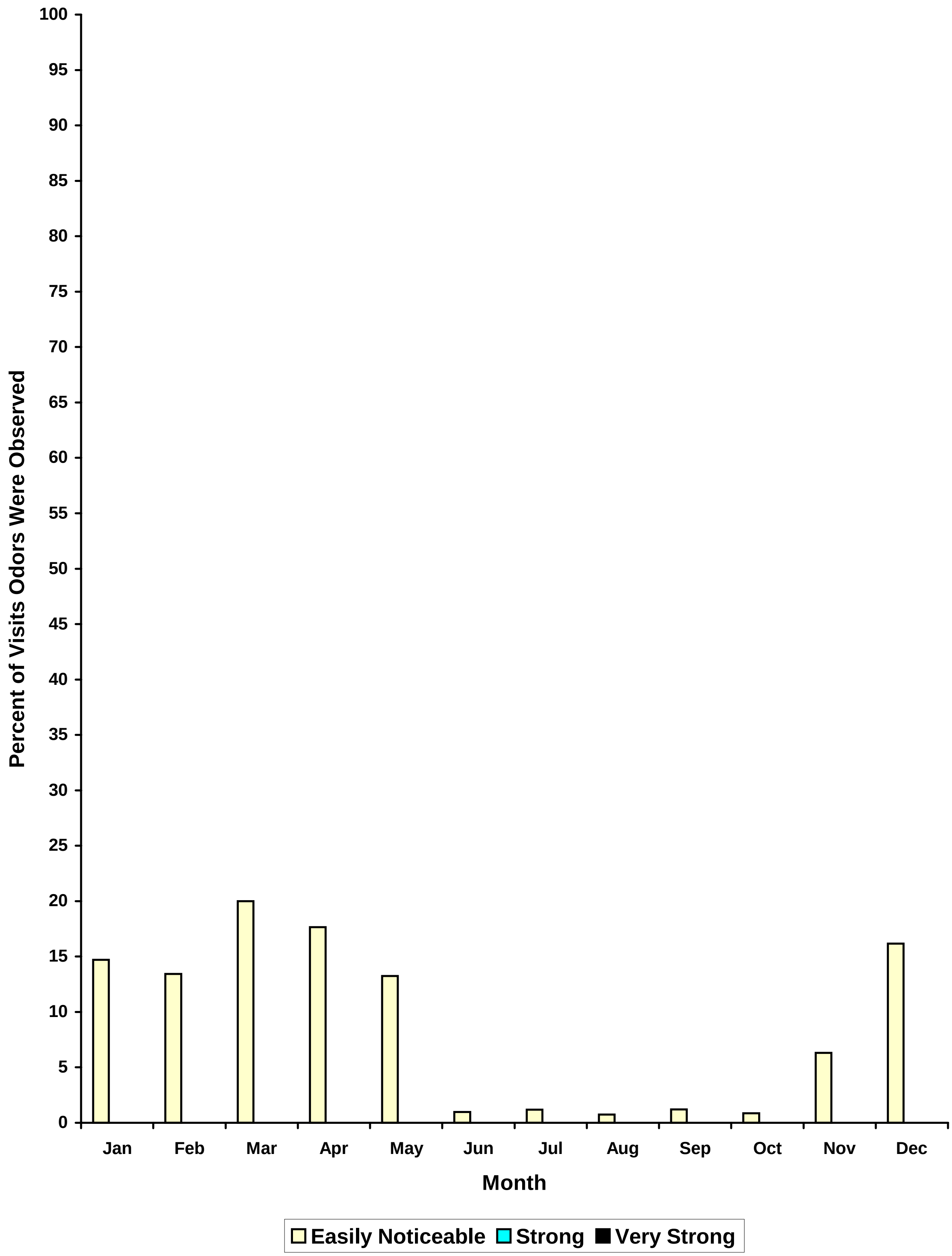


FIGURE II-9: ODOR OBSERVANCES AT NORTH SIDE WRP—2004

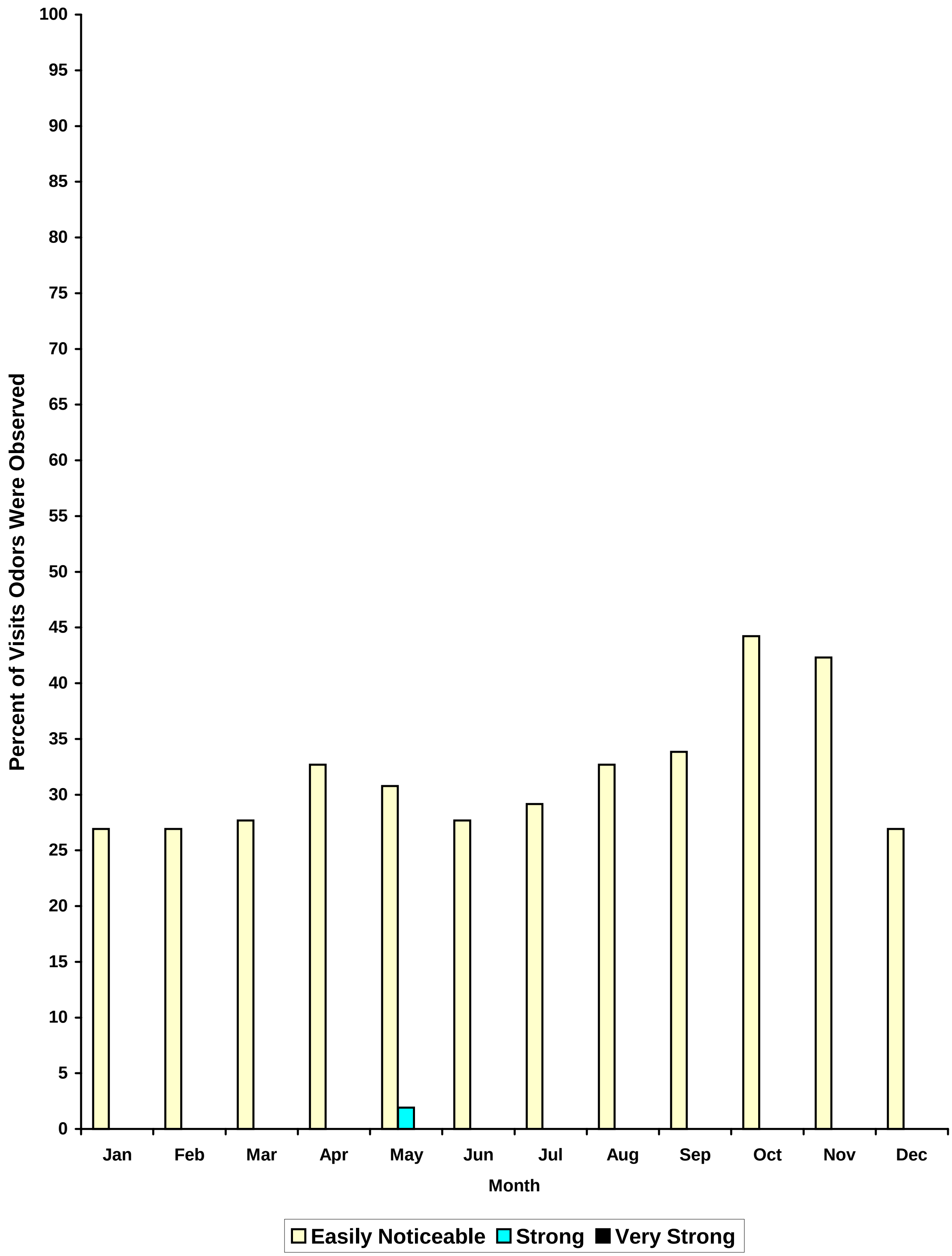


FIGURE II-10: LOCATION FOR CALCIUM NITRATE DOSING

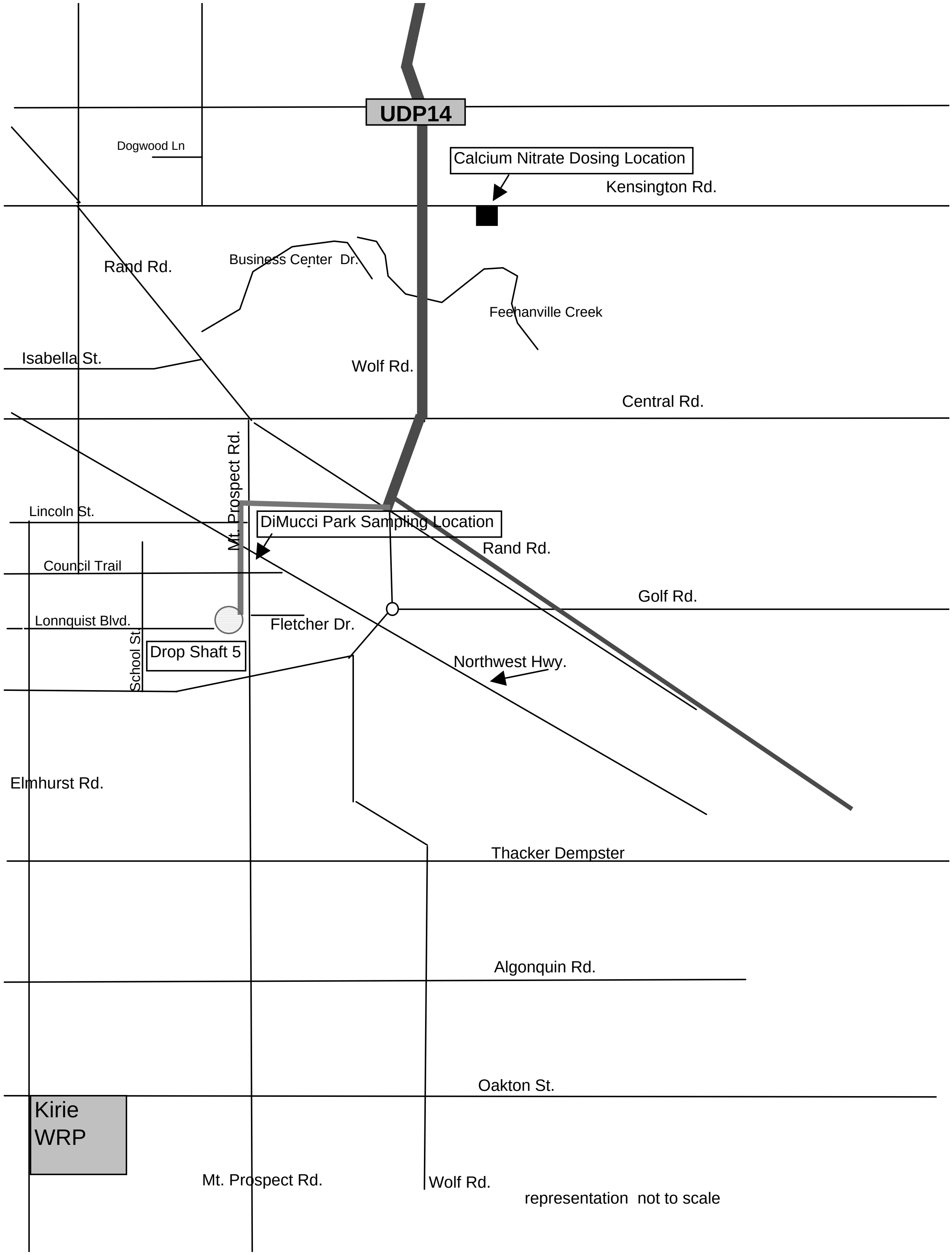


FIGURE II-11: CALCIUM NITRATE DOSE AND RESULTING NITRATE IN WASTEWATER DOWNSTREAM

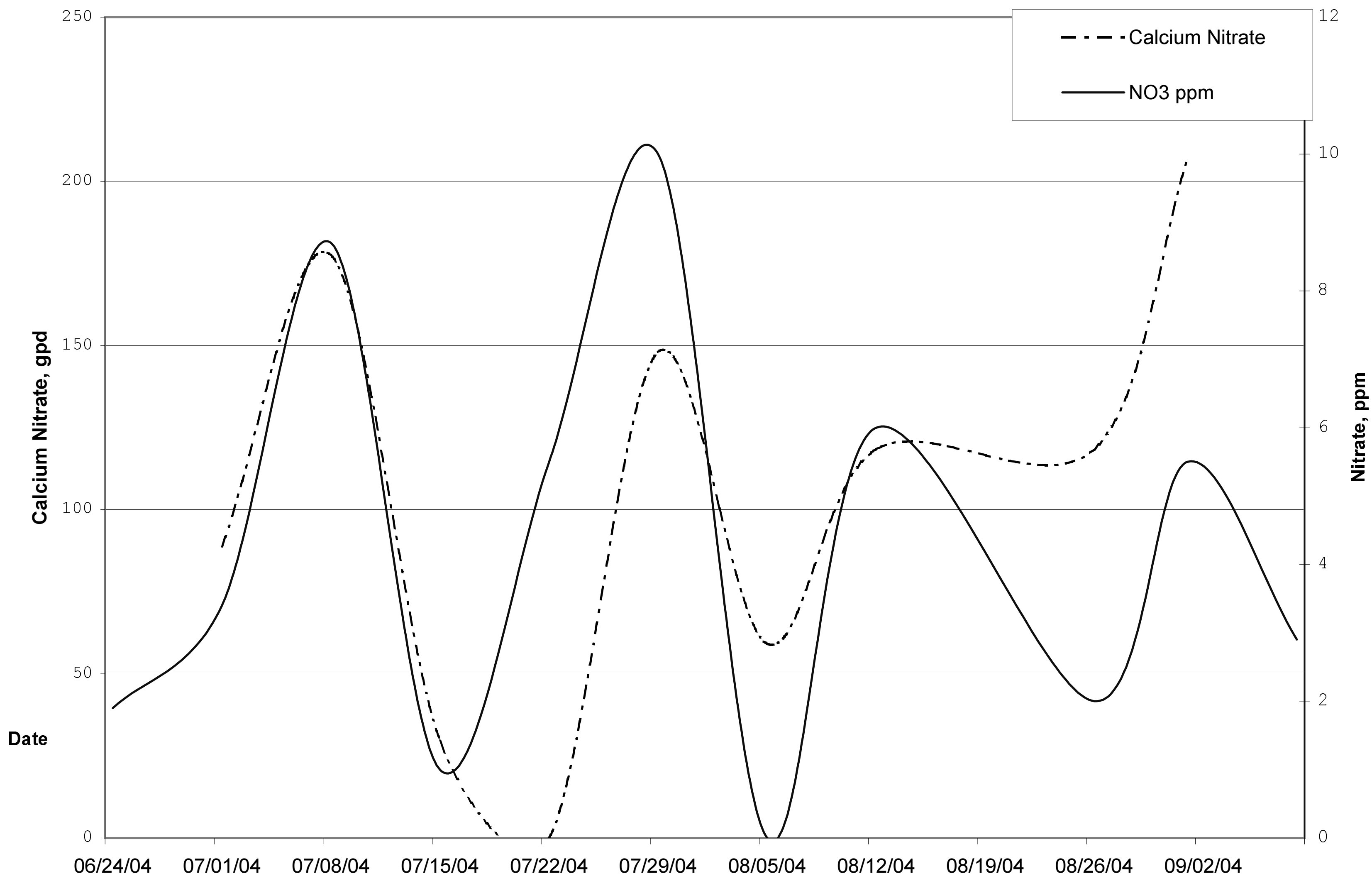


FIGURE II-12: RAIN, HEADSPACE TEMPERATURE AND CALCIUM NITRATE EFFECT ON H_2S CONCENTRATION

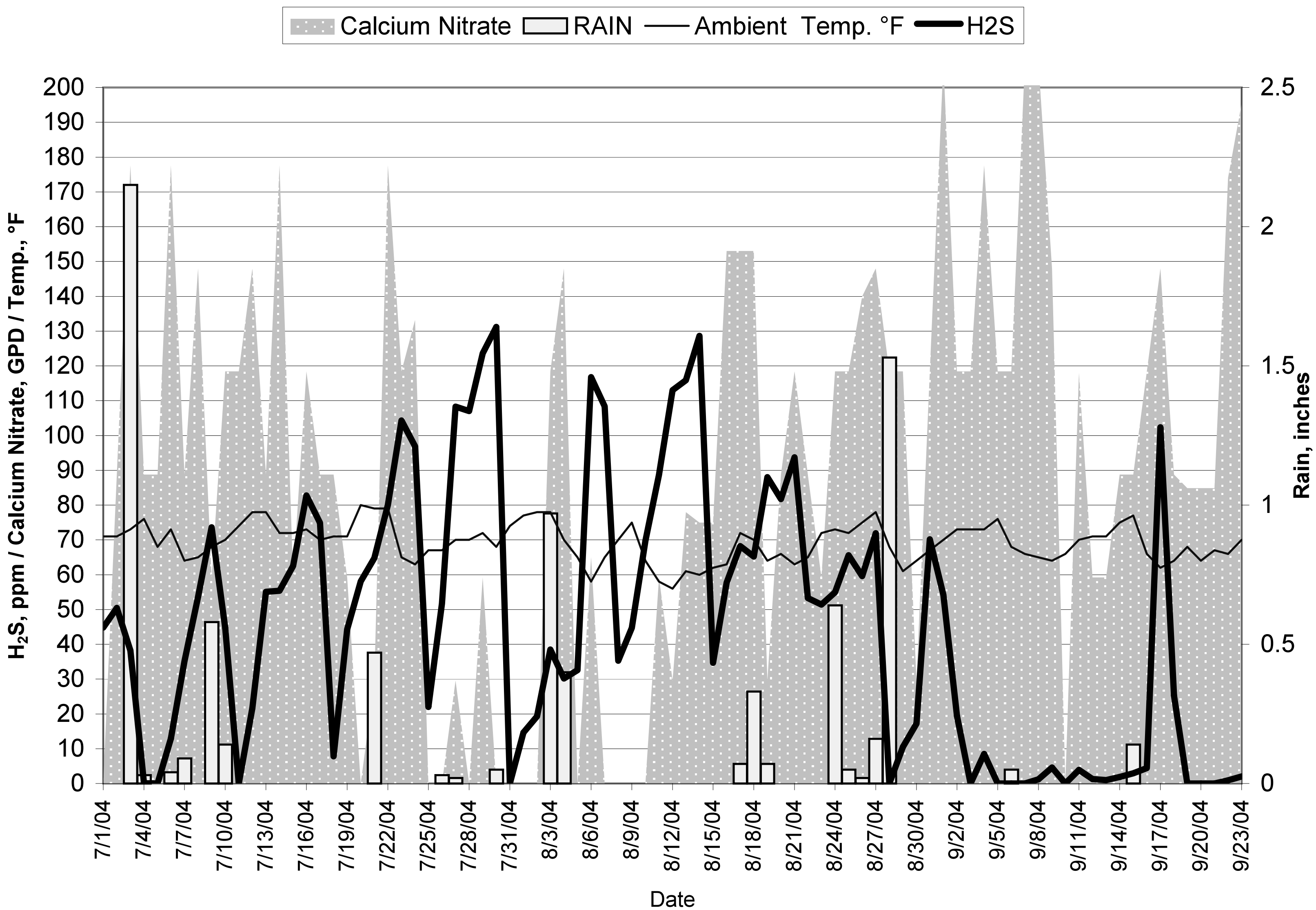


FIGURE II-13: CALUMET WRP HYDROGEN SULFIDE MONITORING LOCATIONS

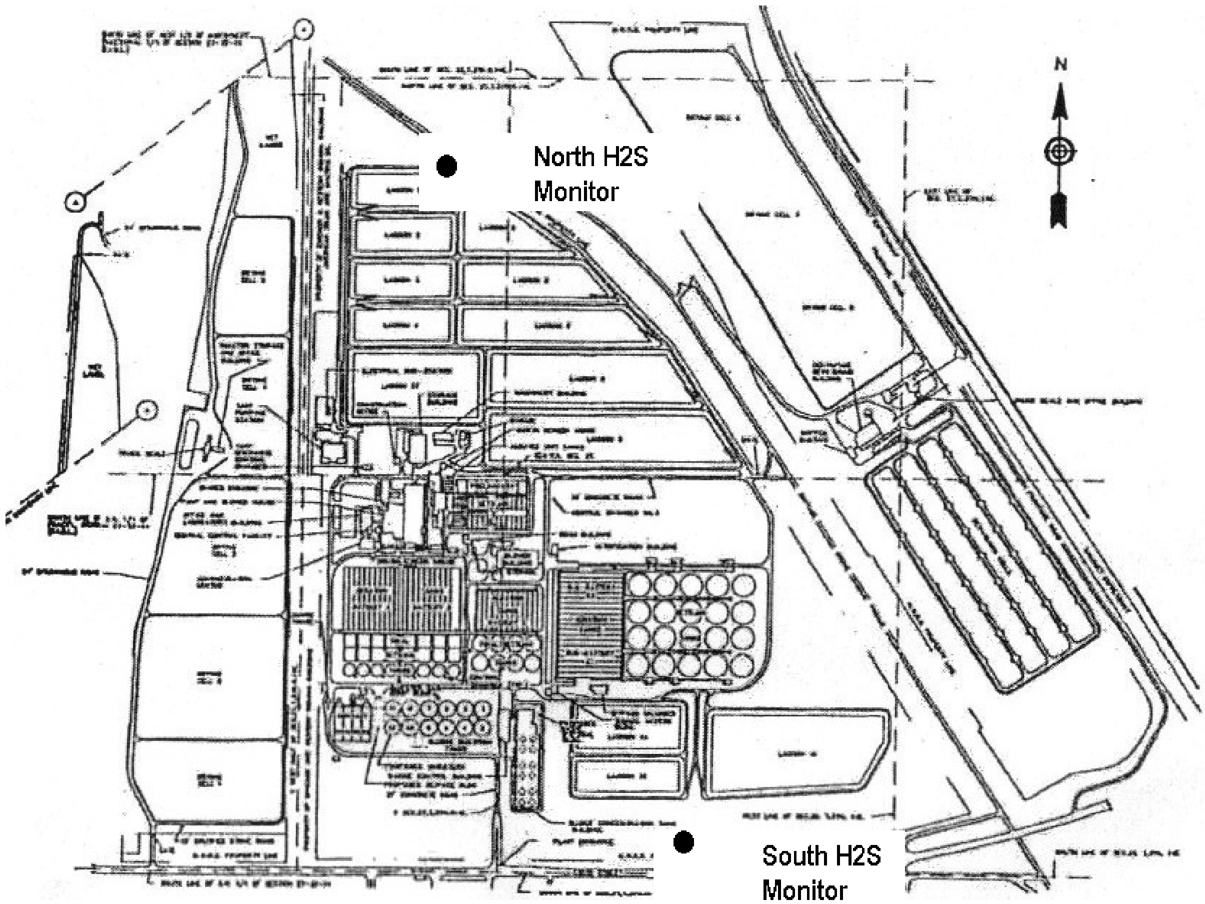
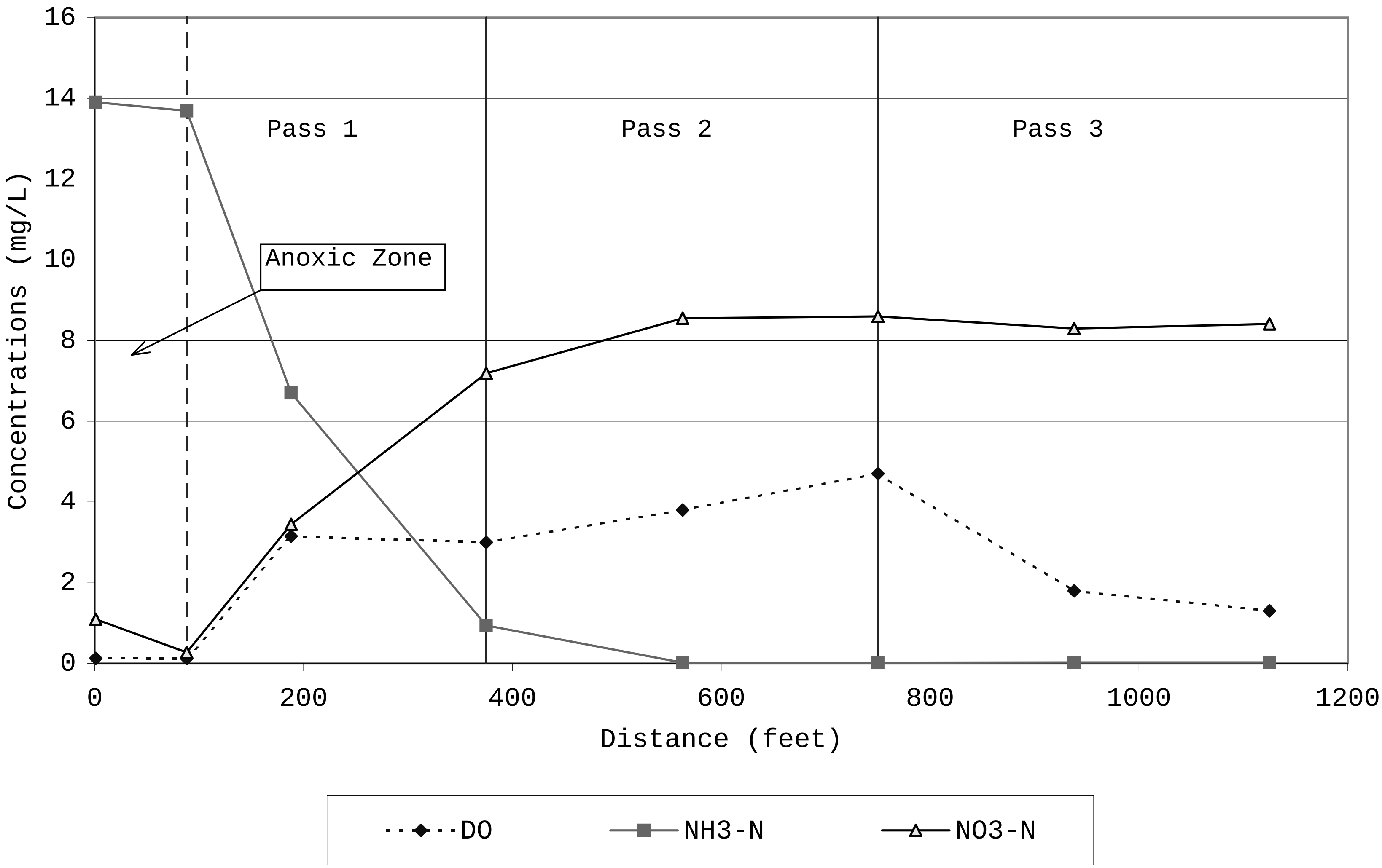


FIGURE II-14: DO, AMMONIA AND NITRATE NITROGEN PROFILES ALONG NORTH AERATION TANK 1 AT EGAN WRP
TAKEN WITH 20 MGD OF SEWAGE INFLOW AND 15.2 MGD OF RAS FLOW ON 7/28/04



BIOSOLIDS UTILIZATION AND SOIL SCIENCE SECTION

The Biosolids Utilization and Soil Science Section is responsible for determining, through monitoring and research activities, the environmental impact of the District's biosolids applications on agricultural fields, disturbed and urban lands, and landfill sites. The environmental monitoring component of the program includes the sampling and analysis of waters, soils, plant tissue, and biosolids at land application sites, landfills, and solids drying facilities receiving bio-solids. The results of this monitoring program are reported to the IEPA and the USEPA. The research component consists of demonstrations and applied research to support the local marketing of biosolids, address regulatory concerns, and provide technical support for biosolids marketing. The Section is also responsible for providing technical support for biosolids marketing, and oversight of technical aspects of biosolids land application contracts.

Fulton County Environmental Monitoring

The Fulton County Land Reclamation Site is a large tract of land, 6,122.5 hectares (15,264.5 acres), owned by the District in Fulton County, Illinois. The site is used to recycle biosolids for the purpose of reclaiming mine soil and fertilizing agricultural crops. To satisfy the permit requirements of the IEPA for operation of the site, the District established an environmental monitoring program to ensure that the land application of biosolids would not adversely effect surface waters, groundwaters, soils, and crops. The Land Reclamation Laboratory is responsible for collecting and analyzing environmental monitoring samples from the Fulton County Site. Monthly reports are generated that summarize the monitoring data required to demonstrate compliance with the IEPA, and USEPA regulations for land application of biosolids.

Summary. No supernatant or dewatered liquid fertilizer from Holding Basin 1 were applied to Fulton County fields during 2004. Air-dried, anaerobically digested biosolids from the District's Calumet WRP were trucked to the Fulton County site in 2004 and land-applied.

The water monitoring included:

- quarterly sampling of 20 groundwater monitoring wells;
- sampling of surface waters from 10 streams, 8 reservoirs, and 2 SP sites in the supernatant application area three times per year between April and November;
- sampling of 40 field runoff retention basins as needed;
- sampling of 19 lysimeters and three drainage tiles at the St. David Coal Refuse Pile quarterly;
- sampling of three lysimeters at the Morgan Mine Coal Refuse Pile quarterly; and
- sampling of 10 lysimeters at the United Electric Company (UEC) Coal Refuse Pile quarterly.

Water monitoring also included sampling of the discharges from the Acid-Mine Lake receiving drainage from the UEC Coal Refuse Pile for monthly and quarterly reports.

General Application Fields. Soil samples were collected from 46 fields in 2004 for chemical analysis. Plant tissue samples were collected from 21 hay fields, 25 soybean fields, 24 corn fields, and 1 oat field in 2004. Chemical analyses were performed on these samples during 2004. Climatological conditions were monitored at the project weather station.

Biosolids have been applied to fields at the Fulton County site since 1972. Table III-1 shows the concentrations of all measured parameters in field soils (0- to 15-cm depth), which received different cumulative rates of biosolids, and were sampled in 2004. The crops planted on these fields and yields for 2004 are shown in Table III-2.

Plant tissue samples (grain, leaf, and/or stover) are collected annually from fields leased to local farmers at the Fulton County site. Analyses for the total concentrations of metals found in the 2004 corn grain, corn leaf, hay, soybean grain, and oat grain are shown in Tables III-3 through 7, respectively.

Acid Mine Lake. As part of the purchasing agreements for the parcels of land comprising the Fulton County Land Reclamation Project, the District also took ownership of the old UEC Cuba Mine No. 9 site, which included an impoundment that collected surface water from exposed gob and coal fines areas. This Acid-Mine Lake originally had a pH that ranged from 1.8 to 2.0. After the UEC property was reclaimed with applications of lime, clay, and biosolids, the lake pH has been elevated to its current level, which ranges between 6.0 and 8.0 and requires no treatment when discharged. The only parameters currently required to be monitored are pH and settleable solids.

St. David, Morgan Mine, and United Electric Coal Refuse Reclamation Sites. In 1987, the District initiated an experiment on a coal refuse pile at St. David, Illinois, to determine the rates of anaerobically digested biosolids, agricultural lime, and clay necessary for long-term reclamation of coal refuse material (Table III-8). The experiment was initiated with the approval of the IEPA.

In 2000, Plot 1 was totally reclaimed by applying 1,000 dry tons biosolids/acre and 80 tons limestone/acre. This served as the control plot and was no longer used after the original experiment ended in 1996. The portions of Plot 2 next to Plot 1 that had eroded were also reclaimed in the same manner.

Data generated by this reclamation work were used to establish the reclamation protocols for the remainder of the St. David coal refuse pile. The reclamation of the Morgan Mine and UEC Cuba Mine No. 9 coal refuse pile properties also followed this protocol in 1991 and 1990, respectively, in Fulton County. The final reclamation of these coal refuse piles consisted of applying 1,000 dry tons biosolids/acre and 70 tons limestone/acre. This work also formed the basis for the demonstration and research plots recently established at the USX property on Chicago's southern lakefront.

Water was collected from the coal refuse pile lysimeters on a quarterly basis in 2004. Yearly means of four selected chemical parameters for 2000 through 2004 are presented in Tables III-9 through 11 for the lysimeters from these three reclaimed areas.

Hybrid Seed Database. The Land Reclamation and Soil Science Section is conducting a program to obtain hybrid seed information from each farmer for plantings in 2001 and beyond. These data will be correlated with biosolids application and yield data to produce recommendations leading to increased productivity for not only the Fulton County site, but farms in the Chicagoland area that are receiving biosolids from the District's water reclamation plants.

Miscellaneous Initiatives. During the year 2004, various alfalfa fields were monitored throughout the growing and harvesting seasons for signs of disease or insect infestations that would reduce crop yields, and thus, decrease the value of the product to the District's land renters.

The vast accumulation of data from the inception of the project in 1971 to the current time continued to be organized into various databases as a more convenient format for use by District personnel and other agencies.

Corn Fertility Experiment on Calcareous Mine Spoil. Since 1973, the District has had a corn fertility experiment on calcareous mine spoil at the Fulton County site. The purpose of this experiment is to evaluate the effect of long-term applications of anaerobically digested biosolids on crop yields, crop chemical composition, and mine spoil chemical composition. The experiment was designed to simulate biosolids application to fields at the site at agronomic and reclamation rates, and to provide information that can be used for management of biosolids and crops.

This is the longest running continuous biosolids research experiment in the country. Data on the metals uptake in corn tissues from these plots were used in the risk assessments conducted by the USEPA prior to the final promulgation of its 40 CFR Part 503 biosolids regulations in 1993. All 32 years of soil and plant tissue samples are available in the sample repository at the Fulton County R&D Laboratory.

The study consists of four treatments of biosolids or commercial fertilizer applied to the plots each year. The amounts of biosolids or commercial fertilizer added annually for each treatment are listed in Table III-12, along with the cumulative totals of biosolids applied per plot through 2004. Table III-13 shows a four-year comparison (2001-2004) of soil data from the experimental plots. Table III-14 shows the nutrient and metal concentrations in corn grain for the four treatments. Table III-15 shows the comparison of the grain and stover yields for 2002 through 2004.

Phosphorus Studies. As part of the studies that are conducted to address biosolids phosphorus in 2004, work was done on the Biosolids P Runoff study located in Field 63 at the Fulton County site. Details on this work were presented in the Biosolids P Studies section of this chapter of the report.

Hanover Park Fischer Farm

The Hanover Park Fischer Farm is a 48-hectare (120 acres) tract of land, which utilizes all of the biosolids produced by the Hanover Park WRP. The farm, located on the south side of the WRP grounds, has 12 gently sloping fields, each surrounded by a berm to control surface runoff. An underground tile drain system collects surface and subsurface drainage, which is returned to the Hanover Park WRP for treatment.

Anaerobically digested biosolids are applied by injection from tank trucks. The IEPA operating permit (Permit No. 2002-SC-0672) for the site limits the annual biosolids application rate to 56 dry Mg/ha (25 dry tons/acre). The crop plan for 2004 included the cultivation of corn in the 12 biosolids-treated fields. However, due to excessive rainfall during the planting season and resultant saturated field conditions, no corn could be planted. The wet field conditions also somewhat restricted the normal practice of biosolids application to fields during the spring. A total of 12.98 million gallons (MG) of biosolids was applied to the fields in 2004, as opposed to 14.28 MG in 2003. Of the total amounts, 3.81 MG was applied during the spring of 2004, as opposed to 6.13 MG in the spring of 2003.

Groundwater monitoring is required by the IEPA operating permit. Fields and monitoring locations at the Fischer Farm site are shown in Figure III-1. Four monitoring wells (W-5, W-6, W-7, and W-8) on the farm have been sampled twice monthly since biosolids applications began in 1979. The analytical data for groundwater sampled from these wells were submitted to the IEPA in the quarterly monitoring reports of 2004. The data show that, overall, the application of biosolids for twenty-five years has not significantly affected groundwater quality at the Hanover Park Fischer Farm site.

Two shallow wells (W-1 and W-3) located next to these experimental fields have been sampled twice per month since 1988 to monitor the chemical composition of the groundwater. The analytical data for these samples were submitted to the IEPA in quarterly monitoring reports during 2004.

In 2004, some of the fields were reconfigured by removing the berm between some adjacent fields to create new fields designations (Figure III-1). The five experimental fields were reconfigured to create three separate fields. Seven new farm fields designations were created as follows:

- Field No. 1 - Old Field Nos. 1, 4, and 7
- Field No. 2 - Old Field Nos. 2 and 5
- Field No. 3 - Old Field Nos. 3 and 6
- Field No. 4 - Old Field No. 8
- Field No. 5 - Old Field Nos. 13 and 14
- Field No. 6 - Old Field Nos. 15 and 16
- Field No. 7 - Old Field No. 12

Groundwater Monitoring at Solids Management Areas

Groundwater Quality Monitoring at the John E. Egan WRP Solids Drying Facility. In 1986, paved solids drying areas were constructed at the John E. Egan WRP facility. This area was designed to produce biosolids air-dried to a solids content of $\geq$60%. However, since the Egan WRP now has a thriving program of applying fresh centrifuge cake to farmland via a contractor, the Egan drying site is no longer being used. The IEPA operating permit (Permit No. 2000-AO-1383-1) for this drying facility requires groundwater monitoring. In October 1986, lysimeters were installed at the John E. Egan WRP for sampling groundwater immediately below the drying site. During 2003, groundwater samples were collected until the month of June. However, from June 12, 2003 sampling was discontinued following the IEPA's approval of a request from the District to discontinue monitoring. Hence, the submission of groundwater analytical data in quarterly monitoring reports to the IEPA is no longer required. During the final year of monitoring, there was no significant change in groundwater quality.

Groundwater Quality Monitoring at the Calumet WRP Solids Drying Facilities. In 1986, a paved solids drying area, the Calumet West Solids Management Area (SMA), was constructed at the Calumet WRP. In November 1990, a second paved solids drying area, the Calumet East SMA, was put into service at the Calumet WRP.

These areas were designed to produce biosolids air-dried to a solids content of ≥60%. The Calumet East and West SMAs have been continuously utilized for drying biosolids every year since their installation.

The IEPA operating permit (Permit No. 2000-AO-1382) for these facilities require groundwater monitoring. Lysimeters were installed at the Calumet West SMA in October 1986 for sampling groundwater immediately below the drying site. In November 1990, lysimeters were installed at the Calumet East SMA. The locations of lysimeters at the Calumet East and the Calumet West SMAs are presented in Figures III-2 and 3, respectively.

During 2004, samples were taken once per month at both Calumet drying sites. Analytical data for water samples taken in 2004 from the three lysimeters at the Calumet West and from the six lysimeters at the Calumet East SMAs were submitted to the IEPA in the respective quarterly reports. There are indications that the shallow groundwater at these two sites is highly mineralized, and the principal constituents are Ca, Mg, K, Na, SO4, and alkalinity.

Groundwater Quality Monitoring at LASMA. In 1983, the District began biosolids drying operations at LASMA. This involves spreading either dewatered lagoon biosolids or lagoon-aged, centrifuged, digested biosolids 45-60 cm (18-24 inches) deep on specially designed drying cells, and turning the biosolids over daily to enhance drying until the solids content is >60%. In 1983, the biosolids drying operations were performed on clay surfaces. These drying surfaces were paved with asphalt in 1984, and biosolids drying operations resumed in August 1984.

The IEPA operating permit for this site (2000-AO-1384-1) requires groundwater monitoring. Five wells were drilled into the limestone aquifer underlying the site, and were sampled every two weeks, beginning in spring 1983. After one year of biweekly sampling, a quarterly sampling schedule was instituted.

In July 1984, three functional lysimeters (L-1, L-3, and L-4) were installed for biweekly sampling of groundwater immediately above the limestone bedrock, which is located 6-12 m (20-40 ft) below the surface in this area. In early 1985, six additional lysimeters (L-2, L-5, L-6, L-7, L-8, and L-9) were installed at the site. By April 1985, a total of nine lysimeters were installed at LASMA as required by the IEPA operating permit. A site plan of lysimeters and monitoring wells at LASMA is attached (Figure III-4).

The operating permit for LASMA requires monthly monitoring of 28 parameters in lysimeter samples and 30 parameters in well samples. The analytical results for lysimeter and well samples collected in 2004 were submitted to the IEPA in quarterly monitoring reports. Lysimeter water is highly mineralized and is affected by the fill material in which the lysimeters are located and the groundwater quality is typical of limestone aquifers.

In 1991, increased Hg levels were discovered in lysimeter L-9. An investigation determined that the Hg increase was due to contamination through a particular air pump that was used to sample groundwater in 1991. Other lysimeters were also affected by use of this air pump in 1991, but Hg levels in all lysimeters, except in L-9, decreased after purging the lysimeters with deionized water. A new lysimeter (L-9N) was installed in June 2002, in proximity to the contaminated L-9. Both lysimeters, L-9N and L-9, were sampled simultaneously through 2003 in order to verify that the Hg originated from an external source. Within a few months, the source of contamination was indeed confirmed as external since L-9N samples contained only traces of Hg. Approval was obtained from the IEPA (2000-AO-1384-2) on March 24, 2004 to abandon L-9, and L-9N is its replacement for monthly monitoring.

Groundwater Quality Monitoring at RASMA. The solids drying area at RASMA was originally constructed with a clay base. Drying on a clay surface was in progress as early as 1987, until the area was paved with asphalt in 1992 and 1993. Drying operations on asphalt began in June 1993. Lysimeter locations at the RASMA site are shown in Figure III-5.

The IEPA operating permit for this site (2000-AO-1384) requires groundwater monitoring. Four lysimeters, approximately 20 feet deep, were installed for biweekly groundwater sampling, which began in September 1993. Three of the four lysimeters rarely yielded water samples. The installation contractor inspected and tested the lysimeters in June 1994 and found that the lysimeters were functioning with no problems. The contractor determined that, due to soil conditions, there was little free water available at the depths at which these three lysimeters were installed. The lysimeters were also inspected in 1999 and 2002. In December 2003, the contractor performed several soil borings in the vicinity of these three devices, and confirmed that they were inadvertently positioned in areas that were not conducive to moisture uptake and/or retention. A budget request was submitted to the Engineering Department in 2004 for the replacement of these lysimeters.

The current IEPA operating permit requires biweekly monitoring of 25 groundwater parameters. Analytical results for the lysimeter samples collected in 2004 at this site were submitted to IEPA in quarterly monitoring reports. Within the last year, there was no significant change in groundwater quality. The shallow groundwater at this site is highly mineralized, and the principal dissolved constituents are Ca, Mg, Na, SO_4, Cl, and HCO_3 (alkalinity).

Groundwater Quality Monitoring at HASMA. In 1990, the District began biosolids drying operations at HASMA. Dewatered lagoon biosolids or centrifuged, digested biosolids are agitated on this paved area to enhance drying to a solids content of $\geq$60%.

The IEPA operating permit for this site (2000-AO-5498) requires biweekly groundwater monitoring. Three lysimeters were initially installed for groundwater sampling immediately below the drying site. A site plan of lysimeter locations at HASMA is shown in Figure III-6.

In 1996, a new lysimeter, designated L-1N, was installed. The NH4-N concentrations in this lysimeter have been high from the time of lysimeter installation, and have been decreasing with time, but biosolids processing at this site is not considered a contributing factor. A budget request was submitted to the Engineering Department in 2004 for the replacement of lysimeter L-1N to determine if the high NH4-N concentrations are due to localized contamination at L-1N. Analytical data for water sampled from the four lysimeters in 2004 were submitted in quarterly reports to the IEPA.

Groundwater Quality Monitoring at the 122nd and Stony Island SMA. In 1991, the SMA at 122nd Street and Stony Island

Avenue was paved to facilitate the drying of biosolids for final distribution. From 1980 through 1991, drying was done on a clay surface. In 2004, the site was used to dewater centrifuged, digested biosolids from the Stickney and Egan WRPs. The dried biosolids were utilized in landfills as daily and final cover to enhance vegetative growth at these sites.

The IEPA operating permit for this drying facility (2000-AO-1384) requires groundwater monitoring. Four lysimeters were installed in September 1991 for sampling groundwater immediately below the drying site. Figure III-7 shows the location of lysimeters at the Stony Island drying site. Analytical results for water sampled monthly during 2004 from the four lysimeters at this drying facility were submitted to the IEPA in quarterly monitoring reports. In 2004, groundwater quality was quite similar to that of the previous years.

Biosolids as an Amendment for Improving Rootzone Microbial Population and Nutrient Supply in Golf Courses

Sand has been commonly used as the principal component of rootzone mix in golf course putting greens to improve drainage and reduce compaction. However, this type of rootzone does not provide sufficient nitrogen (N) for adequate turf performance. The United States Golf Association (USGA) recommends peat as an amendment for the sand layer in the rootzone on golf course putting greens. The peat helps to increase the supply of available water and N in the rootzone for turf growth. However, microbial transformation of organic N to plant available forms of N are relatively low in peat. More recently, composts are being tested as alternatives to peat. Because of their high organic matter and nutrient content, biosolids are a suitable alternative to peat as a rootzone amendment for putting greens.

In 1997, the District began a project at the North Shore Country Club located in the northern Chicago suburb of Glenview, to test the use of biosolids as an alternative to peat amendment to improve the nutrient supply in the rootzone of turfgrass grown on the golf course greens. In spring, summer, and fall 2004, soil samples were collected from the rootzone (0- to 12- inch depth) of each of four of the treatments that were established as amendments to the 0- to 12-inch layer on a volume percentage basis. The treatments sampled were sand (control), sand with Dakota reed sedge peat (10%), sand with yard-waste composts (10%), and sand with biosolids (10%). The samples were analyzed to compare the populations of nitrifying bacteria (nitrifiers) and concentrations of NO_3^- in these putting green root zones. Nitrifiers were analyzed using the most probable number method (MPN) and NO_3^- was extracted using the 1M KCl method. The nitrifiers consist of ammonium oxidizers and nitrite oxidizers that are involved in the transformation of NH_4^+ to NO_2^- and NO_2^- to NO_3^-, respectively.

As shown in Table III-16, rootzone amended with biosolids showed greater ammonium oxidizer population than peat (fall 2004). The nitrite oxidizer populations in the root zones were higher in the biosolids (fall) and compost (spring and fall) treatments than in the peat treatment. In nearly all seasons, the NO_3^- concentrations in rootzone amended with either biosolids or composts were higher than that amended with peat. There was no difference in nitrifier populations and NO_3^- concentrations between biosolids and composts-amended root zones. The study indicates that with respect to microbial transformation of organic N to plant available N, biosolids are a good alternative to peat as a rootzone amendment for golf course putting green.

Biosolids Effects on Microbial Population in UICF Plots

Some researchers have suggested that high concentrations of metals in biosolids reduce the benefits of land application of biosolids by suppressing populations of soil microorganisms, including those microorganisms that are beneficial to soil quality. Since of the United States Environmental Protection Agency promulgated their 40 CFR Part 503 Rule (Part 503) in 1993, the concentrations of metals in biosolids that are land applied are very low. Therefore, the hypothesis of this study is that land application of biosolids will not decrease the population of soil microorganisms.

In this study, soil samples were collected quarterly, beginning in the first quarter of 2003, from the long-term field experiment established on calcareous mine spoil in Fulton County, Illinois, known as the University of Illinois Corn Fertility plots (UICF). The field experiment was started in 1973 to evaluate long-term impacts of biosolids on corn production and soil constituents. This experiment included four replicates and four treatments: three biosolids application rates of 17, 34, and 67 Mg/ha and one NPK fertilizer control at agronomic rate, all applied annually under continuous corn cropping. The surface (0 –10 cm) soil was collected, and analyzed for microbial biomass using a fumigation and extraction method, and for nitrifiers and denitrifiers using the most probable number method (MPN). Populations of nitrifiers (ammonium oxidizers and nitrite oxidizers) and denitrifiers were determined because they are beneficial microorganisms involved in the nitrification and denitrification, respectively, which are important to N cycling.

The concentrations of trace metals in biosolids applied during the period 1994 to 2004 were considerably lower than those in biosolids applied before promulgation of Part 503. As shown in Table III-17, the application of biosolids increased the size of microbial biomass, although such effect was significant only for the highest biosolids application rate. The data also showed that the populations of ammonium and nitrite oxidizers and denitrifiers in the biosolids treatments were always higher than in the fertilizer control. More specifically, the populations of nitrite oxidizers were even significantly higher in the plots amended annually with 17 and 34 Mg/ha biosolids than in the fertilizer control. The study indicates that land application of biosolids in compliance with Part 503 does not suppress soil microorganism populations, even where soils received previous applications of biosolids having metal concentrations above the Part 503 Ceiling concentrations. Furthermore, these results indicate that biosolids application might increase the populations of some functional groups of microorganisms, probably due to the high organic carbon and labile N in the biosolids.

Nickel Phytotoxicity Study

The USEPA Part 503 regulations, which govern the land application of biosolids, set limits on trace element concentrations and loading rates based on a comprehensive risk assessment. The limits for zinc, nickel, and copper were based on the risk of phytotoxicity resulting from land application of biosolids. The Section has ongoing studies to evaluate the phytotoxicity threshold levels for these metals used in the risk assessment and the level of protection the Part 503 Rule provides to human health and the environment. During 2004, work continued on a study to evaluate phytoxicity thresholds for Ni.

Pots containing 15-kg Watseka loamy sand were spiked with a range from 0 to 50 mg Ni/kg soil and planted with "Contender" bean in the spring, followed by "California Blackeye" cowpeas. Other 15-kg pots were spiked with a range from 0 to 375 mg Ni/kg soil and seeded to "Titan" tall fescue in the spring, followed by Kentucky blue grass. Each crop was grown for 6 to 8 weeks. Leaf tissue samples were digested with concentrated nitric acid and analyzed for Ni employing ICP analysis. Prior to planting, soil from each pot was sampled, digested with concentrated nitric acid and analyzed for total Ni. Plant-available Ni in soil samples taken after tissue harvest was determined by the Mehlich 3-extraction method.

The results indicate that Ni has a profound effect on seed germination and root develop-ment. In the bean crops, which were more sensitive to soil Ni, concentrations exceeding 15 mg/kg extractable Ni delayed germination by up to two weeks. For the fescue and Kentucky blue grass, germination rates were reduced by extractable soil Ni concentrations exceeding 36 mg/kg.

Tissue Ni concentrations and dry matter yields of two groups of crops, bean and tall fescue, and Mehlich 3-extractable soil Ni concentrations are presented in Table III-18. Bean and fescue dry matter yields were highest at concentrations of 2-7 and 6-17 mg/kg extractable soil Ni respectively, which would suggest that both bean and fescue may benefit from trace applications of Ni to this soil. However, further increases in extractable Ni, above the stated ranges, resulted in decreases in dry matter yields, and eventually in the death of plants. Plant tissue Ni increased linearly with available soil Ni for both bean (r=0.96) and fescue (r = 0.98). At treatment rates exceeding 15 (with bean) and 30 (with fescue) mg/kg Ni, dry matter yields decreased linearly with increasing plant tissue Ni concentrations (r = –0.8887 for bean, and –0.8151 for fescue). Additional studies utilizing a wider range of test crops are in progress to further evaluate Ni phytotoxicity.

Biosolids Phosphorus Studies

Land application of biosolids and other soil amendments can cause phosphorus (P) in soils to increase to excessive levels that can potentially contaminate water bodies through surface runoff. Currently, a large portion (over 35 percent) of the District's biosolids is managed through the farmland application program in which Class B centrifuge cake biosolids are used as fertilizer on area farms. In an effort to minimize P contamination of surface waters, many states are beginning to implement phosphorus-based (P-based) agronomic biosolids application rates in place of the nitrogen-based (N-based) application rates that are currently used. Phosphorus-based application rates are developed based on P content of both the amendments and the soil, and on site characteristics that affect the potential for surface runoff to water bodies. The P-based agronomic biosolids application rates are much lower than the N-based rates and may substantially reduce the viability of land application programs in Illinois. In addition, the low application rates derived using a P-based approach can potentially make land application of biosolids operationally impractical and unattractive to farmers.

In 2003, the Biosolids Utilization and Soil Science Section began to collaborate with the IEPA to initiate studies to address the potential for environmental impacts associated with application of District biosolids to cropland. Studies were developed to address the following objectives:

1. To determine the bioavailability of P in District biosolids

2. To estimate the critical biosolids P application rate (environmental impact threshold) to farmland above which the potential for P losses in surface run-off water increases significantly.

3. To evaluate the effectiveness of two lengths of vegetated buffer strips established in the setback zones of land application fields in controlling P runoff. The information obtained from this objective will be used to determine if buffer strips can be used within the required setback zone to allow the land application of biosolids to be continued at N-based rates without the potential for significant P runoff losses from farmland, where soil test P exceeds environmental impact thresholds.

In 2004, work was started on the following studies:

- Bioavailability of P in District biosolids - Greenhouse study

- Potential of phosphorus runoff in biosolids amended soils

- Biosolids P runoff field study

Bioavailability of P in District Biosolids – Greenhouse Study. The greenhouse study was designed to evaluate the bioavailability of P in the District's air-dried Class A biosolids and centrifuge cake Class B biosolids, relative to triple superphosphate (TSP) fertilizer P. Seven-kilogram portions of a P-deficient sandy soil were blended with each of these three P sources to apply similar total P rates of 25, 50, 100, 150, 200, and 300 mg P/kg soil. An unamended control was also included. Four replicates of each treatment were prepared. The treated soils were placed in plastic bags and wetted to approximately 80 percent of field capacity moisture content, then incubated for 3 weeks in the laboratory. Following incubation, a sample of the amended soils was taken, then the soils were placed in pots in the greenhouse to form a 15-cm amended soil layer on top of a 20-cm deep layer of unamended soil. Wheat (Triticum aestivum cv. Patton) was planted in the pots in May 2004. The foliage of the wheat crop was clipped every 35 to 40 days and allowed to regrow. This sequence was continued for a total of four cycles. Following the fourth wheat clipping, a sample of the 0 to 12.5-cm soil layer was collected, then the pots were planted with ryegrass (Lolium perene cv. Pleasure) for another four cycles.

During 2004, a total of four wheat clippings and one ryegrass clipping were completed. This sequence of alternating wheat and ryegrass cropping will be continued during 2005 and 2006, to deplete all pots of the applied P, as indicated by consistent P deficiency levels in the harvested foliage.

The foliage at each clipping were weighed to determine dry matter yield, then analyzed for total P content. For each greenhouse pot, P uptake in the crop foliage was calculated as the product of foliage P concentration and dry matter yield. Soil samples collected from the pots at the beginning of each cropping cycle were analyzed for total P, water soluble P (WSP), and soil test P by the Bray P1 and Mehlich 3 methods.

The relationship between cumulative P uptake in the five plant foliage clippings completed in 2004 and the P added by the application of the Class A and Class B biosolids and the TSP treatments are presented in Figure III-8. The data show that during this period, cumulative P uptake from the three P sources was similar up to the 50 mg P/kg (350 mg P/pot) application rate, and at higher application rates, P uptake was much lower in the biosolids treatments than in TSP treatment. This indicates that P has much lower bioavailability in biosolids than in fertilizer.

Potential of Phosphorus Runoff in Biosolids Amended Soils. This study was con-ducted as a laboratory module to address Objective 2, to estimate the critical biosolids P application rate. Archived soil samples from fields at the District's Fulton County site that received multiple biosolids applications over periods of up to 20 years but that have not received biosolids in the past 10 years were selected to determine the biosolids loading rate associated with significant increase in the potential for P surface runoff losses. A total of 44 soil samples that were collected at various times during the period of biosolids application and samples collected in 2004 were selected from 13 fields such that the cumulative biosolids application rates varied widely, ranging from 0 to 1,000 Mg/ha (0 to 446 tons/ac). The soil samples were analyzed for WSP, Bray P1 soil test P, and 0.2 M ammonium oxalate extractable P, Al, and Fe. The WSP analysis was used as an indicator of the concentration of dissolved P that can contribute to the potential for P loss in surface runoff water. The P saturation index (PSI), which is an estimate of the degree to which P-binding sites in soils are saturated with bound P, was calculated from the molar concentrations of oxalate extractable P, Fe, and Al using the formula:

$$PSI = [P/ (Al + Fe)] \times 100$$

The relationship between WSP and cumulative P application rate and PSI are presented in Figure III-9. The data show that WSP increased with cumulative biosolids rate but gave no indication of a biosolids loading rate at which WSP increases significantly. The trend for the relationship between WSP and PSI shows that as PSI increased up to an inflection point at a value of approximately 18, there was no effect on WSP levels. Further increase in PSI above this inflection point coincided with a sharp increase in WSP. These relationships indicate that in estimating an environmental impact threshold or the potential for P runoff in biosolids amended soils, the degree of P saturation of the P-binding sites in the amended soils is a more important factor than the cumulative loading of biosolids or biosolids P.

Biosolids P Runoff Field Study. This study was designed to address Objective 3, to evaluate the effectiveness of the lengths of vegetated buffer strips. In 2004, five noncontiguous locations in Field 63 at the Fulton County site were selected as main plots. Each of the main plots was 0.72-ha (1 ac), 122 m (400 ft) long along the slope by 61 m (200 ft) wide, and was split into two subplots 30.5 m (100 ft) wide by 61 m (200 ft) long. The plots were graded lightly to improve surface uniformity such that the slope throughout most of the plots ranged from 3 to 5 percent. A vegetated buffer area was established by planting a mixture of alfalfa (*Medico sativa L.*) and bromegrass (*Bromus inermis*) on the entire 61-m length of the down-slope portion of the main plots. In each subplot, runoff collection devices were installed at the up-slope end, the middle (30.5 m), and the down-slope end (61 m) of the buffer strip. The typical layout of the main plots is shown in Figure III-10. This setup will allow us to evaluate the effectiveness of two lengths of vegetative buffer strips, 30.5 m and 61 m, in controlling P runoff from the amended portion of the subplots. The current surface water setback in the IEPA Part 391 design criteria for land application of biosolids is 30.5 m.

In spring 2005, biosolids will be applied to the up-slope half of eight of the subplots at two loading rates of 4.5 and 22.5 Mg/ha (2 and 10 dry tons/ac), such that there will be four replicates of each amended plot and two unamended control plots. The 4.5 and 22.5 Mg/ha biosolids loading represent the typical P-based and N-based application rates of District biosolids, respectively. Runoff water in the runoff collection devices resulting from storm events will be analyzed for P concentration.

Farmland Application of Class B Biosolids Project

A major portion of the District's biosolids is managed through farmland application of Class B centrifuge cake. Farmland application of Class B biosolids is cost-effective to the District and the nutrients in biosolids provide tremendous savings in fertilizer costs to the farmers. However, environmentalists continue to raise concerns about the safety of the practice of Class B biosolids application to farmland. Most of the concerns are regarding the potential for adverse impacts on human health and the environment from pathogens and trace metals in the farmlands treated with Class B biosolids. These concerns need to be addressed to protect the viability and sustainability of the District's Class B centrifuge cake biosolids farmland application program.
In fall 2004, the District began a research and demonstration project on two farmers' fields in Will and Kankakee Counties to demonstrate the safety of farmland application of Class B centrifuge cake biosolids, and to educate the communities in the vicinities of biosolids-amended farmlands. A large proportion of the District's Class B biosolids are applied to farmlands in these two counties.

Plot Layout and Treatments. The project was designed to evaluate and compare the impact of various rates of biosolids (0 to 200 percent of traditional agronomic application rate) and commercial N fertilizer (0 to 150 percent of agronomic N application rate) application on soil fertility, corn yield, and subsurface water quality. Plots were established on a 40-acre parcel of clayey soil in the township of Florence in Will County and on a 20-acre parcel of sandy soil in the township of Saint Anne in Kankakee County. Prior to biosolids application, lysimeters were installed at each site for monitoring the subsurface water quality. Details of plot layout, treatments, and location of lysimeters are given in Figures III-11 and 12. The anticipated duration of the research and demonstration project is three years.

The biosolids and fertilizer treatments were applied in fall 2004 at the Will County site, and will be applied in spring 2005 at the Kankakee County site, which are the conventional practices in these counties. The fall application in Will County is done to reduce the amount of field work required in the spring because the heavy textured soils tend to stay wet for a longer time, which may leave only a narrow window for completing the required field work before planting. The fall and spring treatment applications for the Will and Kankakee County sites, respectively, will be done each year for the duration of the project.

The biosolids and fertilizers (N, P, and K) were applied on November 17, 2004 to the Will County plots (clayey soil).

Sampling and Analyses. Details of sampling schedule and analysis of soil, plant tissues, and water samples are given in Table III-19. Soil sampling was done prior to application of biosolids at both sites to determine the background soil concentrations of plant nutrients and trace metals. At the Will County site, soil was sampled at four depths (15, 30, 60, and 90-cm depths). At the Kankakee County site, soil was sampled at four depths (15, 30, 60, and 120-cm depths). The soil samples were air-dried, ground, and sieved through a 2-mm sieve and stored in plastic bottles for chemical analysis.

Technical Support for Biosolids Management

The Biosolids Utilization and Soil Science Section provides technical support for biosolids management to both the M&O Department and biosolids users. This ensures full regulatory compliance of these projects and enhances the successful and safe use of the District's biosolids. The Section is also responsible for conducting and communicating the results of applied research on the beneficial use of the District's biosolids. The objectives of this research are to provide information on agronomic and environmental impacts of biosolids and to promote the beneficial use of biosolids. The support the section provides to the biosolids management program consists of the following:

1. Monitoring of air-dried biosolids products for compliance with USEPA and IEPA standards.

2. Collecting samples for internal studies and external requirements.

3. Reporting relevant data and information to contractors, biosolids users, IEPA, and USEPA.

4. Providing oversight support for District contracts for application of Class B centrifuge cake biosolids to farmland.

5. Educating biosolids users to ensure compliance with state and federal regulations governing biosolids use, and to provide technical information related to specific planned uses of biosolids.

6. Documenting biosolids use at major projects to produce case studies to promote future use of biosolids.

7. Initiating and documenting demonstration scale projects using biosolids to increase public acceptance and promote future projects.

8. Providing surveillance and documentation of management practices at local biosolids use projects.

9. Maintaining year-round demonstrations of biosolids as a topsoil substitute in the Lue-Hing R&D Complex greenhouse and hosting tours to educate potential biosolids users and promote local marketing.

10. Conducting applied research on agronomic and environmental aspects of biosolids use as a fertilizer, soil conditioner and topsoil substitute.

11. Presenting information at local and national scientific conferences and at meetings with potential biosolids users, promoting the beneficial use of the District's biosolids.

12. Interacting with state and federal regulators to defend the District's biosolids management activities, review and comment on development of new regulations, and obtain permitting or approval for new biosolids projects.

In 2004, the Section provided technical support, in the form of one or more of the activities listed above for several biosolids projects and potential users. Examples of biosolids projects conducted by, or supported by, the Section in 2004 include:

1. Rehabilitation of fairways using biosolids as a soil conditioner and topsoil substitute at the Water's Edge, Challet Hills, North Shore Country Club, and Cinder Ridge golf courses.

2. Development of athletic fields using biosolids as a soil conditioner by Oak Lawn Community High School and the Village of Riverside.

3. Use of biosolids as a topsoil substitute and soil conditioner to establish turfgrass at Eden Place Nature Center, an initiative of the Fuller Park Community Development Project.

4. Use of biosolids as a topsoil substitute in the final protective layer at various landfills.

5. Establishment of plots to demonstrate the beneficial use of Class B biosolids on farmland.

6. Collaborate with the University of Florida, Pennsylvania State University, and the IEPA to develop a comprehensive project work plan and begin field studies at Fulton County and in the greenhouse at Stickney to evaluate the environmental impacts of phosphorus in land applied biosolids.

7. Continuation of greenhouse studies to assess the risk of metal phytotoxicity.

8. Continue collaborative research with North Shore Country Club to assess the effectiveness of biosolids as a substitute for peat and other soil amendments typically utilized in construction of golf course greens and fairways.

9. Continue negotiations with the City of Chicago to promote the use of biosolids for development of parks and recreational areas in Chicago.

10. Establishment of plots at the Paxton 1 Landfill site to demonstrate the use of biosolids for blending with Illinois River sediment to produce topsoil.

11. Review field information packets for potential application fields under the Class B biosolids to farmland contract. This includes reviewing the field location, buffers established for surface water, roads and dwellings, contacts made with neighbors and public officials, and soil pH and liming. Approval or disqualification of the proposed fields is recommended to M&O.

TABLE III-1: MEAN pH, ELECTRICAL CONDUCTIVITY (EC), AND CONCENTRATIONS OF ORGANIC CARBON, NUTRIENTS AND METALS FOR BERMED BIOSOLIDS APPLICATION FIELDS AT THE FULTON COUNTY RECLAMATION SITE SAMPLED IN 2004[1]

Field Number	Cumulative Biosolids Applied[2]		pH	EC	Organic Carbon	TKN	Tot.-P	NH_3-N[3]	NO_2-N+ NO_3-N[3]	Zn	Cd	Cu	Cr	Ni	Pb
	--------Dry Solids--------			(dS/m)	(%)	----------mg/kg----------									
	Mg/ha	Tons/acre													
1	1,735	775	6.6	0.19	5.94	5,429	9,428	6.95	23.91	1076	66.0	542	830	122	260
2	1,816	810	6.6	0.31	6.08	5,762	11,227	3.50	49.77	977	53.5	462	672	104	228
3	1,814	810	6.6	0.26	6.37	6,267	8,399	4.40	29.99	827	42.0	392	557	85	189
4	1,522	680	6.6	0.38	5.76	5,622	8,879	3.75	33.50	890	43.7	404	582	92	193
5	1,562	698	6.7	0.47	5.81	6,185	9,342	12.70	66.46	874	43.0	417	561	89	189
6	614	274	7.2	0.14	2.70	2,714	3,205	0.85	3.71	315	18.9	142	235	48	73
7E	1,494	667	6.6	0.36	5.25	5,184	7,988	4.60	25.95	895	54.6	448	688	102	218
7W	1,494	667	7.0	0.21	3.15	3,308	3,977	2.85	10.38	425	23.4	199	292	55	94
8	1,320	589	6.6	0.20	4.57	4,509	7,628	6.35	15.72	774	46.2	389	577	89	182
9	1,602	716	6.6	0.49	5.53	5,444	8,433	13.90	85.75	799	42.4	392	562	88	178

TABLE III-1 (Continued): MEAN pH, ELECTRICAL CONDUCTIVITY (EC), AND CONCENTRATIONS OF ORGANIC CARBON, NUTRIENTS AND METALS FOR BERMED BIOSOLIDS APPLICATION FIELDS AT THE FULTON COUNTY RECLAMATION SITE SAMPLED IN 2004[1]

Field Number	Cumulative Biosolids Applied[2]		pH	EC	Organic Carbon	TKN	Tot.-P	NH_3-N[3]	NO_2-N+ NO_3-N[3]	Zn	Cd	Cu	Cr	Ni	Pb
	--------Dry Solids-------			(dS/m)	(%)	----------mg/kg----------									
	Mg/ha	Tons/acre													
10	1,073	479	6.3	0.17	5.84	5,340	10,147	1.90	15.83	1,150	77.7	624	980	122	300
11	1,485	663	6.5	0.37	4.92	4,524	7,696	3.00	106.5	914	57.5	451	720	107	233
12	1,398	624	6.8	0.27	4.40	3,983	7,096	3.15	90.53	751	46.0	370	571	86	182
13	1,367	610	6.8	0.18	4.81	4,109	8,091	1.65	20.91	916	57.7	460	721	98	229
14	1,473	657	6.8	0.16	4.68	4,598	8,502	1.30	16.05	827	48.0	401	615	91	203
15	1,482	662	6.8	0.20	4.82	4,465	8,056	1.00	21.70	838	45.8	392	581	85	194
16E	1,510	674	6.7	0.41	4.14	3,923	6,222	3.90	86.18	692	42.7	337	540	79	171
16W	1,510	674	6.6	0.32	4.81	4,405	7,593	4.10	97.04	784	48.8	384	607	86	192
17	1,722	770	6.7	0.57	6.50	6,506	10,765	16.55	75.62	961	52.5	471	659	101	223
19	644	287	6.6	0.13	3.13	2,974	4,285	5.50	10.31	507	33.5	243	437	53	140

TABLE III-1 (Continued): MEAN pH, ELECTRICAL CONDUCTIVITY (EC), AND CONCENTRATIONS OF ORGANIC CARBON, NUTRIENTS AND METALS FOR BERMED BIOSOLIDS APPLICATION FIELDS AT THE FULTON COUNTY RECLAMATION SITE SAMPLED IN 2004[1]

Field Number	Cumulative Biosolids Applied[2]		pH	EC	Organic Carbon	TKN	Tot.-P	NH_3-N[3]	NO_2-N+ NO_3-N[3]	Zn	Cd	Cu	Cr	Ni	Pb
	--------Dry Solids--------			(dS/m)	(%)	----------mg/kg----------									
	Mg/ha	Tons/acre													
20	531	237	6.7	0.13	3.92	3,797	5,657	4.35	10.18	630	41.9	314	530	69	166
21	618	276	6.6	0.14	3.27	3,604	5,091	8.65	12.40	595	39.8	282	494	64	159
22	455	203	6.6	0.15	3.79	3,619	6,308	5.60	14.76	690	46.8	341	583	73	186
23	473	211	6.5	0.16	3.60	3,619	5,554	8.30	10.46	688	46.0	332	569	73	181
25	869	388	6.7	0.13	4.46	4,183	6,222	3.85	12.14	722	40.2	328	503	75	171
26	1,086	485	7.1	0.26	4.58	4,428	6,959	7.70	18.01	737	42.7	349	537	82	176
27	847	378	6.8	0.57	4.58	4,635	7,833	6.00	48.70	762	43.8	356	562	79	188
28	903	403	6.9	0.39	5.32	5,229	8,605	7.90	30.78	932	57.6	478	726	110	229
30	1,169	522	7.0	0.49	4.86	4,947	7,782	4.60	13.26	820	44.6	386	572	92	187
31	557	249	6.6	0.14	3.02	3,271	5.365	7.60	10.81	633	43.7	320	531	77	167

TABLE III-1 (Continued): MEAN pH, ELECTRICAL CONDUCTIVITY (EC), AND CONCENTRATIONS OF ORGANIC CARBON, NUTRIENTS AND METALS FOR BERMED BIOSOLIDS APPLICATION FIELDS AT THE FULTON COUNTY RECLAMATION SITE SAMPLED IN 2004[1]

Field Number	Cumulative Biosolids Applied[2]		pH	EC	Organic Carbon	TKN	Tot.-P	NH_3-N[3]	NO_2-N+ NO_3-N[3]	Zn	Cd	Cu	Cr	Ni	Pb
	--------Dry Solids--------			(dS/m)	(%)	--------mg/kg--------									
	Mg/ha	Tons/acre													
32	601	269	7.0	0.20	4.18	4,205	6,788	8.95	9.80	735	43.3	345	545	88	175
33	1,109	495	6.9	0.42	5.49	5,614	9,976	7.70	47.70	1,003	60.1	516	764	112	232
34	566	253	6.8	0.15	3.19	3,204	6,068	5.05	14.97	706	47.4	341	583	77	184
35	1,048	468	6.8	0.24	4.40	4,435	7,319	6.25	28.01	759	43.2	360	567	74	183
36	1,083	483	6.8	0.24	4.08	4,353	7,165	9.55	22.15	744	43.5	356	551	78	173
37	801	358	6.8	0.18	3.78	3,968	6,685	2.70	18.97	733	44.5	352	560	79	174
39	646	288	7.1	0.19	3.60	3,908	5,262	4.15	13.55	570	30.3	265	391	66	124
40	497	222	6.8	0.13	3.81	3,701	5,828	4.60	9.14	712	46.9	361	582	83	178
41	979	437	7.1	0.25	5.39	5,622	8,382	6.35	20.44	702	32.0	318	414	67	147
42	858	384	7.0	0.47	4.58	4,776	7,593	6.80	48.88	801	48.4	381	598	84	191

TABLE III-1 (Continued): MEAN pH, ELECTRICAL CONDUCTIVITY (EC), AND CONCENTRATIONS OF ORGANIC CARBON, NUTRIENTS AND METALS FOR BERMED BIOSOLIDS APPLICATION FIELDS AT THE FULTON COUNTY RECLAMATION SITE SAMPLED IN 2004[1]

Field Number	Cumulative Biosolids Applied[2]		pH	EC	Organic Carbon	TKN	Tot.-P	NH_3-N[3]	NO_2-N+ NO_3-N[3]	Zn	Cd	Cu	Cr	Ni	Pb
	--------Dry Solids--------			(dS/m)	(%)	---mg/kg---									
	Mg/ha	Tons/acre													
43	984	439	7.2	0.24	4.85	4,976	7,799	5.00	20.61	674	34.6	318	448	68	150
44	806	360	7.1	0.22	4.31	4,353	6,994	5.45	24.47	719	43.0	354	544	82	170
45	1,659	741	7.0	0.75	4.98	4,769	7,439	8.55	67.54	707	38.0	345	484	71	160
47	1,122	500	7.0	0.32	6.87	6,445	10,987	8.35	24.65	1,643	78.5	535	921	130	304
63-8[4]	21.5	9.6	7.4	0.18	1.85	2,121	636	6.15	7.18	71	1.5	19	28	30	11
83[4,5]	0	0	6.9	0.21	2.08	1,506	542	4.15	4.77	96	1.4	8	15	14	24

[1]Sampling depth 0-15 cm.
[2]Through 2004.
[3]1-M KCl-extractable.
[4]Fields included because of P-study.
[5]Only commercial fertilizer was applied to this field.

TABLE III-2: 2004 FULTON COUNTY CROP YIELD DATA

Field Number	Soil Type[1]	Cumulative Biosolids Applied[2]		Corn	Soybeans	Oats
		---------------Dry Solids---------------		bu/acre	bu/acre	bu/acre
		Mg/ha	tons/acre			
2	MS	1,816	810	138		
4	MS	1,522	680	138		
5	MS	1,562	698	165		
7E	MS	1,494	667		37	
7W	MS	1,494	667		38	
8	MS	1,320	589		41	
9	MS	1,602	716	165		
11	MS	1,485	663	175		
12	MS	1,398	624	175		
16E	1/4 MS	1,510	674	175		
16W	1/4 MS	1,510	674	175		

TABLE III-2 (Continued): 2004 FULTON COUNTY CROP YIELD DATA

Field Number	Soil Type[1]	Cumulative Biosolids Applied[2]		Corn	Soybeans	Oats
		--------------Dry Solids--------------		bu/acre	bu/acre	bu/acre
		Mg/ha	tons/acre			
17	MS	1,722	770	165		
18	1/2 MS	1	0.5	200	36	
19	PL	644	287		47	
20	PL	531	237	195		
21	PL	618	276		47	
22	PL	455	203		47	
23	PL	473	211		47	
24	MS	1	0.5	175		
25	MS	869	388		40	
26	MS	1,086	485		40	
27	2/3 MS	847	378		39	

TABLE III-2 (Continued): 2004 FULTON COUNTY CROP YIELD DATA

Field Number	Soil Type[1]	Cumulative Biosolids Applied[2]		Corn	Soybeans	Oats
		---------------Dry Solids---------------		bu/acre	bu/acre	bu/acre
		Mg/ha	tons/acre			
28	MS	903	403		41	
29	MS	1	0.5			85
30	MS	1,169	522		45	
31	PL	557	249		45	
34	PL	566	253		46	
35	PL	1,048	468		47	
36	PL	1,083	483		41	
37	PL	801	358	155		
38A	MS	9	4		35	
38C	MS	9	4		38	
40	1/2 MS	497	222	180		

TABLE III-2 (Continued): 2004 FULTON COUNTY CROP YIELD DATA

Field Number	Soil Type[1]	Cumulative Biosolids Applied[2]		Corn	Soybeans	Oats
		---------------Dry Solids---------------		bu/acre	bu/acre	bu/acre
		Mg/ha	tons/acre			
42	MS	858	384	137.4		
45	3/4 MS	1,659	741	149.6		
50	5/6 MS	7	3	120	45	
51	1/4 MS	46	20	150		
52	MS	9	4	120		
54	MS	14	6	179		
55	MS	7	3	179		
56	MS	13	6	179		
59	PL	2	1	149		
63-8	MS	22	10		48	
75	MS	336	150		30	

TABLE III-2 (Continued): 2004 FULTON COUNTY CROP YIELD DATA

Field Number	Soil Type[1]	Cumulative Biosolids Applied[2]		Corn	Soybeans	Oats
		---------------Dry Solids---------------		bu/acre	bu/acre	bu/acre
		Mg/ha	tons/acre			
80	PL	0	0		49	
82	PL	0	0		36	
83	PL	0	0	115		
84	MS	0	0		32	

[1]MS = mine-spoil; fractions appearing before MS indicate the proportion of the field that consists of mine-spoil with the remainder of the surface being placed land. PL = placed land indicating that the field has not been strip mined.
[2]Through 2004.

TABLE III-3: MEAN CONCENTRATIONS OF METALS IN CORN GRAIN SAMPLED AT THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	----	----	----	----	mg/kg	----	----	----	----
2	41	0.26	2.4	1.1	1.1	0.48	3,949	55	1,276
4	34	0.07	2.2	0.18	0.38	<0.10	3,870	44	1,249
5	35	0.17	1.8	0.19	1.1	<0.10	3,395	42	1,191
9	36	0.04	1.8	0.11	0.58	<0.10	3,708	29	1,128
11	36	<0.01	1.8	0.18	0.59	<0.10	4,123	42	1,295
12	34	<0.01	1.3	0.23	0.80	<0.10	3,510	38	1,162
16E	34	<0.01	1.1	0.12	0.70	<0.10	3,736	36	1,217
16W	33	<0.01	1.1	0.11	0.47	<0.10	3,867	33	1,269
17	38	0.18	1.7	0.13	1.0	<0.10	3,578	42	1,272
18-2[1]	24	<0.01	1.1	0.12	0.44	<0.10	3,669	35	1,083
20	21	<0.01	0.99	0.15	0.25	<0.10	3,667	26	1,153

TABLE III-3 (Continued): MEAN CONCENTRATIONS OF METALS IN CORN GRAIN SAMPLED AT THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	-----	-----	-----	-----	-mg/kg-	-----	-----	-----	-----
24	20	<0.01	0.94	0.12	0.26	<0.10	3,561	26	1,102
37	24	0.06	1.7	0.31	0.92	<0.10	3,445	40	1,115
40	25	<0.01	1.4	0.16	1.0	<0.10	2,938	40	1,042
42	25	<0.01	1.7	0.14	0.59	<0.10	4,043	35	1,225
45	25	<0.01	1.5	0.17	0.62	<0.10	3,994	36	1,338
50-1[1]	21	<0.01	2.2	0.16	0.40	<0.10	3,078	38	953
51	23	<0.01	1.4	0.16	0.26	<0.10	3,433	41	1,157
52	21	<0.01	2.0	1.0	1.7	<0.10	4,429	29	1,211
54	30	<0.01	1.5	0.16	0.48	<0.10	4,450	35	1,369
55	23	<0.01	1.1	0.12	0.24	<0.10	3,904	32	1,191
56	26	<0.01	1.4	0.12	0.69	<0.10	4,029	37	1,135

TABLE III-3 (Continued): MEAN CONCENTRATIONS OF METALS IN CORN GRAIN SAMPLED AT THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	mg/kg								
59	22	<0.01	1.4	0.13	0.22	<0.10	4,118	39	1,322
83	19	<0.01	1.6	0.13	0.78	<0.10	3,238	36	1,009

[1]Only this section of this field was planted in corn.

TABLE III-4: MEAN CONCENTRATIONS OF METALS IN CORN LEAF SAMPLES COLLECTED AT THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	mg/kg								
2	183	8.5	17	0.32	0.20	<0.20	19,566	8,041	5,689
4	105	4.9	14	0.36	0.11	<0.20	18,681	7,639	4,660
5	216	4.6	19	0.48	0.21	<0.20	21,622	8,216	5,485
9	124	3.2	15	0.30	0.16	<0.20	25,667	6,159	3,888
11	198	5.7	18	0.36	0.31	<0.20	25,930	6,318	3,314
12	156	3.7	18	0.42	0.20	<0.20	19,446	8,092	5,003
16E	98	2.5	11	0.44	0.24	<0.20	23,060	5,100	2,894
16W	141	3.4	14	0.36	0.40	<0.20	21,817	6,345	3,342
17	180	10	18	0.34	0.28	<0.20	23,884	6,223	2,974
18-2[1]	25	<0.02	10	0.26	0.34	<0.20	20,988	6,381	4,327
20-1[2]	138	3.7	12	0.35	0.42	<0.20	21,263	7,595	4,429
20-2[2]	108	3.2	13	0.41	0.30	<0.20	11,476	10,873	7,173

TABLE III-4 (Continued): MEAN CONCENTRATIONS OF METALS IN CORN LEAF SAMPLES COLLECTED AT THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	mg/kg								
24	ND[3]	ND	ND	ND	ND	ND	ND	ND	ND
37	77	4.7	12	0.34	0.18	<0.20	21,663	6,555	4,020
40-1[2]	97	5.8	11	0.38	0.40	<0.20	14,708	6,755	4,848
40-2[2]	64	2.1	11	0.58	0.14	<0.20	12,582	6,688	6,649
42	132	9.2	16	0.32	0.10	<0.20	22,698	6,464	3,523
45	90	6.0	13	0.27	<0.07	<0.20	19,943	6,296	4,342
50-1[1]	29	<0.02	12	0.28	0.18	<0.20	15,042	6,855	4,349
51	42	0.45	11	0.28	0.10	<0.20	19,426	6,763	3,533
52	21	<0.02	13	0.30	0.12	<0.20	19,781	6,610	4,105
54	48	<0.02	12	0.28	<0.07	<0.20	24,241	7,033	3,184
55	49	<0.02	14	0.32	0.18	<0.20	23,745	6,702	3,590
56	50	<0.02	12	0.28	0.12	<0.20	23,144	7,048	3,578

TABLE III-4 (Continued): MEAN CONCENTRATIONS OF METALS IN CORN LEAF SAMPLES COLLECTED AT THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	mg/kg								
59	ND	ND	ND	ND	ND	ND	ND	ND	ND
83	40	0.10	9.2	0.25	0.26	<0.20	23,855	5,045	2,000

[1]Only this half of the fields were planted in corn.
[2]These fields were broken down into two sections each for special leaf sampling.
[3]ND=No data. These fields were inadvertently missed during leaf sampling.

TABLE III-5: MEAN CONCENTRATIONS OF METALS IN HAY SAMPLES COLLECTED AT THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Cutting	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
		mg/kg								
10-1	1	87	3.8	8.7	1.6	9.3	<0.10	25,671	10,776	2,651
10-2	1	91	3.5	7.7	1.1	2.6	<0.10	21,457	5,252	1,771
62-1	1	16	<0.01	8.5	0.22	0.66	<0.10	19,085	11,376	2,787
62-2	1	19	<0.01	8.4	0.26	0.74	<0.10	16,509	9,588	2,924
63-1-2	1	24	<0.01	8.3	0.32	0.82	<0.10	20,703	8,703	2,615
63-2-1	1	20	<0.01	9.3	0.16	0.74	<0.10	22,139	10,914	3,021
63-2-2	1	21	<0.01	11	0.20	0.52	<0.10	20,294	12,411	2,974
63-3-1	1	12	<0.01	6.8	0.15	0.52	<0.10	16,588	8,930	2,578
63-3-2	1	18	0.05	4.5	0.41	0.24	<0.10	17,636	4,347	1,890
63-4-1	1	18	<0.01	5.4	0.57	0.45	<0.10	21,085	4,976	2,083
63-4-2	1	17	<0.01	6.2	0.33	0.58	<0.10	21,788	6,211	1,913
63-5-1	1	18	<0.01	5.1	0.19	0.30	<0.10	20,588	6,114	2,421

TABLE III-5 (Continued): MEAN CONCENTRATIONS OF METALS IN HAY SAMPLES COLLECTED AT THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Cutting	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
		----------	----------	----------	----------	mg/kg	----------	----------	----------	----------
63-5-2	1	18	<0.01	7.3	0.28	0.73	<0.10	18,190	9,976	2,241
63-6-1	1	15	<0.01	7.8	0.25	0.57	<0.10	18,566	10,382	2,947
63-6-2	1	20	<0.01	7.8	0.26	0.70	<0.10	16,406	13,354	3,465
63-7-1	1	24	<0.01	7.6	0.47	0.90	<0.10	16,822	13,824	3,448
63-7-2	1	22	<0.01	8.7	0.15	1.9	<0.10	17,869	14,025	2,749
73-1	1	27	0.02	5.6	0.26	0.68	<0.10	20,768	6,399	1,793
73-2	1	21	<0.01	7.2	0.21	0.51	<0.10	21,317	10,391	2,047
76-1	1	19	<0.01	8.8	0.18	0.76	<0.10	18,747	10,129	2,560
76-2	1	20	<0.01	7.6	0.17	0.55	<0.10	17,805	10,496	2,821
10-1	2	95	4.1	9.4	1.3	12	<0.10	22,072	11,585	3,604
10-2	2	86	4.3	9.7	2.3	7.6	<0.10	27,943	10,619	2,558
62-1	2	16	<0.01	8.5	0.16	0.84	<0.10	18,153	11,428	2,256

TABLE III-5 (Continued): MEAN CONCENTRATIONS OF METALS IN HAY SAMPLES COLLECTED AT THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Cutting	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	mg/kg									
62-2	2	12	<0.01	9.4	0.28	0.69	<0.10	11,685	13,626	3,914
63-1-2	2	24	<0.01	11	0.20	0.46	<0.10	14,173	11,242	2,761
63-2-1	2	20	<0.01	10	0.24	0.62	<0.10	21,719	10,470	2,387
63-2-2	2	21	<0.01	10	0.18	0.60	<0.10	21,122	9,683	2,577
63-3-1	2	14	<0.01	7.8	0.18	0.71	<0.10	22,450	11,046	2,772
63-3-2	2	18	<0.01	9.5	0.24	0.62	<0.10	22,282	9,489	2,296
63-4-1	2	20	<0.01	10	0.15	0.70	<0.10	25,500	8,395	2,764
63-4-2	2	17	<0.01	9.6	0.19	0.76	<0.10	20,006	8,522	2,344
63-5-1	2	15	<0.01	8.4	0.16	0.55	<0.10	22,748	9,588	2,714
63-5-2	2	17	<0.01	7.7	0.16	0.64	<0.10	24,831	7,573	1,706
63-6-1	2	13	<0.01	7.7	0.20	0.68	<0.10	17,888	10,916	2,236
63-6-2	2	13	<0.01	8.5	0.17	0.90	<0.10	12,515	13,867	3,381

TABLE III-5 (Continued): MEAN CONCENTRATIONS OF METALS IN HAY SAMPLES COLLECTED AT THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Cutting	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
		mg/kg								
63-7-1	2	14	<0.01	7.0	0.17	0.54	<0.10	9,136	8,624	2,350
63-7-2	2	16	<0.01	8.5	0.18	0.51	<0.10	10,726	9,437	2,589
73-1	2	19	<0.01	6.8	0.16	0.76	<0.10	22,140	9,350	2,076
73-2	2	20	<0.01	8.2	0.18	0.52	<0.10	20,524	10,060	3,060
76-1	2	17	<0.01	8.7	0.13	0.62	<0.10	15,936	8,343	2,618
76-2	2	16	<0.01	8.9	0.15	0.70	<0.10	17,880	8,718	2,744

TABLE III-6. MEAN CONCENTRATIONS OF METALS IN SOYBEAN GRAIN SAMPLED AT THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	mg/kg								
7E	58	0.88	13	0.32	11	<0.10	20,515	2,654	2,840
7W	64	1.0	14	0.28	12	<0.10	22,937	2,838	3,130
8	64	0.96	14	0.27	12	<0.10	22,301	2,800	3,094
18-1[1]	40	<0.01	14	0.26	4.1	<0.10	20,343	3,106	2,484
19	63	0.98	10	0.31	11	<0.10	19,986	2,714	2,648
21	67	1.2	9.8	0.32	15	<0.10	21,463	2,572	2,886
22	68	1.4	10	0.58	13	<0.10	21,567	2,713	2,885
23	67	1.2	10	0.29	16	<0.10	20,260	2,688	2,780
25	56	0.84	9.8	0.22	7.6	<0.10	22,948	2,416	2,632
26	61	1.4	11	0.24	11	<0.10	23,170	2,696	2,890
27	62	0.34	12	0.24	12	<0.10	22,797	2,666	3,069
28	58	0.33	10	0.22	7.7	<0.10	22,548	2,720	3,016

TABLE III-6 (Continued). MEAN CONCENTRATIONS OF METALS IN SOYBEAN GRAIN SAMPLED AT THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	mg/kg								
30	58	0.77	11	0.23	5.8	<0.10	22,872	2,437	2,849
31	59	1.1	10	0.30	13	<0.10	22,312	2,643	2,853
34	68	1.9	10	0.32	15	<0.10	23,992	2,649	3,074
35	64	0.69	10	0.35	13	<0.10	22,606	2,395	3,069
36	65	1.2	10	0.65	13	<0.10	21,490	2,665	2,811
38A	55	<0.01	18	0.22	4.7	<0.10	22,572	3,139	2,551
38C	52	<0.01	18	1.9	5.5	<0.10	19,296	3,170	2,299
50-2[1]	44	<0.01	15	0.33	5.3	<0.10	22,407	2,708	2,701
63-8[1]	50	<0.01	17	0.23	3.1	<0.10	20,763	3,261	2,654
75	46	<0.01	14	0.26	19	<0.10	22,725	2,811	2,671
80	47	<0.01	15	0.27	19	<0.10	23,503	2,863	2,753
82	46	<0.01	14	0.28	20	<0.10	23,082	2,811	2,657

TABLE III-6 (Continued). MEAN CONCENTRATIONS OF METALS IN SOYBEAN GRAIN SAMPLED AT THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	----------	----------	----------	----------	mg/kg	----------	----------	----------	----------
84	46	<0.01	14	0.61	19	<0.10	22,443	2,740	2,633

[1]Only this section of these fields was planted in soybeans.

TABLE III-7. MEAN CONCENTRATIONS OF METALS IN OAT GRAIN SAMPLES COLLECTED FROM THE FULTON COUNTY RECLAMATION SITE IN 2004

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	---mg/kg---								
29	31	<0.01	3.2	2.5	3.7	0.25	5,614	718	1,309

TABLE III-8. AMENDMENTS USED IN RECLAMATION OF COAL REFUSE AT ST. DAVID, ILLINOIS

Plot Number	Treatment Composition[1]					
	Biosolids		Lime[2]		Clay[2]	
	Mg/ha	tons/acre	Mg/ha	tons/acre	cm	Inches
1	0	0	0	0	0	0
2	784	350	0	0	0	0
3	784	350	179	80	0	0
4	784	350	179	80	10.2	4
5	1,568	700	0	0	0	0
6	1,568	700	179	80	0	0
7	1,568	700	179	80	10.2	4
8	2,240	1,000	0	0	0	0
9	2,800	1,250	0	0	0	0
10	3,360	1,500	0	0	0	0

[1]Application rates for biosolids and lime are on a dry weight basis.
[2]Applied only when required in the plan.

TABLE III-9. YEARLY MEAN CONCENTRATIONS OF CHEMICAL PARAMETERS IN WATER FROM LYSIMETERS AT THE ST. DAVID, ILLINOIS, COAL REFUSE PILE RECLAMATION SITE 2000 - 2004

Chemical Parameters	Year	Plot Number 1	2	3	4	5	6	7	8	9	10
pH	2000	NA[1]	7.2	7.3	7.1	7.4	7.5	NA	6.8	7.1	NA
	2001	4.8	7.0	6.9	7.2	7.3	7.2	7.1	6.7	6.7	6.6
	2002	7.1	7.0	7.0	7.2	7.2	7.1	6.8	6.8	7.0	6.9
	2003[2]	7.1	7.6	7.2	7.3	7.4	7.8	NA	7.6	7.6	NA
	2004	7.5	7.8	7.0	7.7	7.2	8.0	NA	NA	8.0	NA
		mg/L									
$SO_4^=$	2000	NA	2,082	1,622	1,621	1,579	2,119	NA	865	2,071	NA
	2001	13,323	1,823	1,155	1,511	1,414	1,841	1,421	1,120	1,864	1,758
	2002	5,040	1,628	1,598	1,828	1,351	1,988	1,430	1,024	1,745	1,932
	2003	2,105	2,098	1,140	1,540	1,407	1,794	NA	578	1,909	NA
	2004	2,840	2,168	1,650	1,745	1,444	2,205	NA	NA	1,960	NA
NH_4-N	2000	NA	0.22	0.15	0.21	0.16	0.14	NA	0.49	0.27	NA
	2001	1.88	0.24	0.23	0.19	0.24	0.19	0.34	0.31	0.30	0.40
	2002	0.45	0.15	0.14	0.11	0.07	0.13	0.51	0.15	0.21	0.17
	2003	0.12	0.04	0.03	0.06	0.11	0.04	NA	<0.01	0.03	NA
	2004	0.22	0.11	0.08	0.11	0.10	0.17	NA	NA	0.20	NA
NO_2+NO_3-N	2000	NA	2.55	2.18	3.31	6.44	0.33	NA	9.54	56.1	NA
	2001	355	1.68	1.09	2.44	6.39	1.41	30.8	2.44	64.3	50.2
	2002	270	1.72	0.73	2.69	4.09	1.02	18.8	3.80	64.9	41.9
	2003	94.3	1.56	1.20	3.00	4.30	1.44	NA	3.13	85.3	NA
	2004	79.5	1.46	0.64	3.20	3.36	0.72	NA	NA	115	NA

[1]NA = Samples are not available due to insufficient precipitation.

[2]From 2003 onward, lysimeters were sampled quarterly, rather than monthly.

TABLE III-10. YEARLY MEAN CONCENTRATIONS OF CHEMICAL PARAMETERS IN WATER FROM LYSIMETERS AT THE MORGAN MINE COAL REFUSE RECLAMATION SITE 2000 - 2004

Chemical Parameters	Year	Lysimeter Number 1	Lysimeter Number 2	Lysimeter Number 3
pH	2000	6.9	6.9	6.5
	2001	6.8	6.8	6.4
	2002	6.9	6.9	6.6
	2003[1]	6.8	6.9	6.7
	2004	6.7	6.9	7.1
		----------------------------	mg/L	----------------------------
$SO_4^{=}$	2000	1,754	1,807	3,502
	2001	1,569	1,924	3,018
	2002	1,621	2,019	2,520
	2003	1,727	1,866	2,623
	2004	1,621	2,068	2,090
NH_4-N	2000	1.33	0.78	3.02
	2001	0.98	0.96	2.29
	2002	0.96	1.68	0.98
	2003	1.36	4.79	1.14
	2004	0.73	0.67	0.70
NO_2+NO_3-N	2000	7.65	3.34	302
	2001	6.96	3.72	138
	2002	3.35	3.97	38.2
	2003	2.34	3.63	43.1
	2004	4.48	8.74	12.5

[1]From 2003 onward, lysimeters were sampled quarterly, rather than monthly.

TABLE III-11. YEARLY MEAN CONCENTRATIONS OF CHEMICAL PARAMETERS IN WATER FROM LYSIMETERS AT THE UNITED ELECTRIC COAL REFUSE PILE RECLAMATION SITE 2000 - 2004

Chemical Parameters	Year	Lysimeter Number									
		1	2	3	4	5	6	7	8	9	10
pH	2000	NA[1]	6.9	7.4	7.0	7.2	7.3	7.3	7.0	7.3	NA
	2001	NA	7.0	7.3	7.1	7.2	4.8	7.3	7.2	7.2	NA
	2002	NA	7.2	7.4	7.2	7.4	4.8	7.4	7.0	7.3	NA
	2003[2]	NA	7.2	7.4	7.1	7.3	6.6	7.4	7.1	7.3	NA
	2004	NA	6.8	7.3	6.9	7.1	NA	7.3	7.0	7.2	NA
		mg/L									
$SO_4^{=}$	2000	NA	1582	1930	2139	2283	2229	1956	2951	3059	NA
	2001	NA	987	1684	2189	2077	1677	1606	3424	2873	NA
	2002	NA	978	1675	2323	2057	1541	1929	4076	3140	NA
	2003	NA	1439	1751	2089	2063	1415	1736	3772	2722	NA
	2004	NA	1446	1428	2244	1918	NA	1698	3780	2585	NA
NH_4-N	2000	NA	0.61	0.48	0.43	0.30	0.83	0.73	25.0	0.36	NA
	2001	NA	0.39	0.50	0.44	0.33	0.66	0.29	22.2	0.37	NA
	2002	NA	0.31	0.43	0.47	0.34	0.64	0.27	11.9	0.38	NA
	2003	NA	0.25	0.40	0.45	0.37	0.36	0.20	9.10	0.36	NA
	2004	NA	0.37	0.50	0.50	0.47	NA	0.32	14.3	0.59	NA
NO_2+NO_3-N	2000	NA	133	111	38.2	5.60	81.8	35.5	0.40	7.70	NA
	2001	NA	47.4	84.0	47.6	11.8	36.5	76.2	5.00	1.20	NA
	2002	NA	31.6	32.7	17.5	3.47	14.2	32.7	2.83	1.46	NA
	2003	NA	47.6	26.9	25.9	3.46	22.5	15.4	3.54	1.53	NA
	2004	NA	82.0	15.8	63.5	1.18	NA	24.2	2.73	1.23	NA

[1]NA = Samples are not available due to low precipitation.

[2]From 2003 onward, lysimeters were sampled quarterly, rather than monthly.

TABLE III-12. FULTON COUNTY RESEARCH AND DEVELOPMENT LABORATORY
2004 UICF BIOSOLIDS APPLICATION RATES

Treatment[1]	Biosolids Application Rate			
	Annual		Cumulative	
	--------------------------------Dry Solids Applied----------------------------------			
	Mg/ha	tons/acre	Mg/ha	tons/acre
Control	0.0	0.0	0.0	0.0
1/4 Max	16.8	7.5	522	234
1/2 Max	33.6	15.0	1044	466
Max	67.2	30.0	2085	931

[1]Control Plots receive 336-224-112 kg/ha of N-P-K annually and biosolids amended plots receive 112 kg K /ha annually.

TABLE III-13. MEAN pH, ELECTRICAL CONDUCTIVITY (EC), AND CONCENTRATIONS OF ORGANIC CARBON, NUTRIENTS AND METALS IN SURFACE SOIL[1] FROM THE CORN FERTILITY EXPERIMENTAL PLOTS AT THE FULTON COUNTY RECLAMATION SITE FOR 2001 - 2004

Plot[2]	Year	pH	EC	Organic Carbon	0.1N HCl Extracted						Concentrated HNO_3 Extracted						TKN	Tot-P
					Zn	Cd	Cu	Cr	Ni	Pb	Zn	Cd	Cu	Cr	Ni	Pb		
			dS/m	%	mg/kg													
Check	2001	7.4	0.398	1.28	142	10.7	58.9	19.9	13.5	28.8	188	10.2	82.5	146	45.1	46.3	1,249	2,535
	2002	7.2	0.433	1.18	132	10.4	56.6	18.0	11.9	25.8	162	9.51	75.2	124	36.4	38.6	1,374	2,690
	2003	7.2	0.500	1.01	123	9.68	51.6	15.9	12.2	23.4	174	10.4	84.3	137	40.7	41.4	1,170	2,665
	2004	6.7	0.675	0.92	113	8.61	45.9	14.4	10.4	21.5	144	8.60	73.8	116	36.5	35.1	1,485	2,611
1/4	2001	7.6	0.223	1.75	235	17.4	103	31.6	17.1	44.7	315	16.9	141	232	55.5	72.2	1,494	2,749
	2002	7.6	0.213	1.92	249	18.5	108	33.3	16.2	44.2	287	15.9	129	208	45.1	63.9	1,817	3,019
	2003	7.6	0.185	1.62	219	15.9	96.1	28.7	15.9	39.3	298	16.7	151	220	49.2	66.4	1,701	2,781
	2004	7.4	0.225	1.76	251	17.8	106	32.3	15.8	43.1	299	16.4	144	218	47.7	66.1	2,384	4,330
1/2	2001	7.6	0.238	2.80	430	30.2	179	55.5	26.7	64.2	530	30.1	241	388	77.3	120	2,349	4,355
	2002	7.4	0.203	3.05	446	30.6	185	56.9	25.1	57.9	461	25.5	210	324	59.6	99.0	2,786	4,921
	2003	7.4	0.300	2.74	410	27.4	166	49.0	23.8	49.8	495	27.8	241	350	64.3	106	2,823	5,121
	2004	7.0	0.333	2.59	408	26.9	164	48.7	22.5	52.3	451	24.8	221	321	59.8	98.5	2,327	4,868
Max	2001	7.4	0.293	3.97	693	45.9	279	83.9	41.2	75.8	808	46.3	384	610	101	185	3,548	6,645
	2002	7.1	0.280	5.08	766	49.8	308	90.5	40.7	66.1	761	42.7	360	639	84.5	162	3,618	8,242
	2003	7.1	0.313	4.46	698	43.7	275	76.8	37.7	54.5	807	44.5	389	653	88.3	169	3,735	9,669
	2004	7.0	0.493	3.73	613	38.1	240	68.7	31.9	56.6	622	34.0	314	430	73.1	133	3,046	5,847

[1]Sampling depth = 0-15 cm.

[2]Check = No biosolids application - inorganic fertilizer. 1/4, 1/2, and Max = 16.8, 33.6, and 67.2 Mg/ha/yr biosolids loading rates, respectively.

TABLE III-14. MEAN CONCENTRATIONS OF TKN, PHOSPHORUS, AND METALS IN 33P69 HYBRID CORN GRAIN FROM THE CORN FERTILITY EXPERIMENTAL PLOTS AT THE FULTON COUNTY RECLAMATION SITE

Analyte[2]	Treatment[1]			
	Control	1/4-Max	1/2-Max	Max
	mg/kg			
TKN	19,480	18,616	23,836	23,831
Tot.-P	3,013	3,070	2,971	2,875
Zn	24.4	27.4	31.9	30.6
Cd	<0.010	<0.010	<0.010	<0.010
Cu	0.81	1.08	1.03	1.10
Cr	0.121	0.118	0.119	0.116
Ni	1.00	1.13	0.79	0.68
Pb	<0.100	<0.100	<0.100	<0.100
K	4,030	4,049	4,115	3,952
Ca	31.4	34.7	29.7	31.7
Mg	1,442	1,479	1,503	1,383

[1]Control = No biosolids application - inorganic fertilizer. 1/4-Max, 1/2-Max, and Max represent biosolids application rates of 16.8, 33.6, and 67.2 Mg/ha/yr, respectively.

[2]Tissue digested with HNO_3 for metals, TKN = Total Kjeldahl-N, and Tot.-P = Total Phosphorus.

TABLE III-15. AVERAGE CORN GRAIN AND CORN STOVER YIELDS FOR HYBRID 33P69 GROWN AT THE CORN FERTILITY EXPERIMENTAL PLOTS FROM 2002 THROUGH 2004

		Treatment[1]											
		Control			1/4-Max			1/2-Max			Max		
Harvested Tissue	Units	2002	2003	2004	2002	2003	2004	2002	2003	2004	2002	2003	2004
Grain	Bu/acre	48	22	38	25	21	61	40	40	72	52	51	83
	Mg/ha	3.0	1.4	2.4	1.6	1.3	3.8	2.5	2.5	4.5	3.2	3.2	5.2
Stover	Tons/acre	1.3	1.2	1.7	0.9	0.9	1.7	1.0	1.5	0.8	1.2	1.6	0.9
	Mg/ha	3.0	2.7	3.9	2.1	2.0	3.9	2.2	3.4	1.7	2.8	3.6	2.0

[1]Control = No biosolids application - inorganic fertilizer. 1/4-Max, 1/2-Max, and Max represent biosolids application rates of 16.8, 33.6, and 67.2 Mg/ha/yr, respectively.

TABLE III-16. CONCENTRATION OF NITRATE-N AND DENSITY OF NITRIFIERS (AMMONIUM AND NITRITE OXIDIZER) IN FOUR PUTTING GREEN ROOTZONES AT NORTH SHORE COUNTRY CLUB RESEARCH PLOTS IN 2004

Treatments	Nitrate-N	Ammonium Oxidizer	Nitrite Oxidizer
	mg N/kg	---------------- [Log (X +1)][1]	----------------
Spring			
Control	15.2 ab[2]	4.37 a	3.71 bc
Dakota peat	14.4 a	4.64 a	3.49 ab
Yard compost	17.7 b	4.59 a	3.91 c
Biosolids	19.3 b	4.59 a	3.72 bc
Summer			
Control	0.8 a	2.62 a	3.33 a
Dakota peat	1.8 b	3.51 b	3.64 a
Yard compost	2.8 c	3.71 b	3.66 a
Biosolids	3.2 c	3.53 b	3.51 a
Fall			
Control	8.3 ac	3.55 a	3.73 a
Dakota peat	6.3 a	3.84 ac	3.86 a
Yard compost	9.4 ac	4.10 bc	4.81 b
Biosolids	12.1 bc	4.12 b	4.70 b

[1]X = number of individuals in 1 gram soil.

[2]Values in a column of a season followed by the same letter are not significantly different at P = 0.05.

TABLE III-17. MEAN MICROBIAL BIOMASS CARBON (MBC) AND DENSITY OF NITRIFIERS (AMMONIUM AND NITRITE OXIDIZER) AND DENITRIFIERS OVER 3 SEASONS (FALL 2003, AND SPRING AND SUMMER 2004) IN THE UICF PLOTS AT THE FULTON COUNTY SITE

Biosolids Rate	Ammonium Oxidizer	Nitrite Oxidizer	Denitrifier	MBc
Mg/ha/yr	[Log (X+1)][1]			(mg/kg)
0	3.62 a[2]	4.16 a	4.13 a	200 a
17	3.76 a	4.59 bc	4.44 a	256 ac
34	4.08 a	4.54 bc	4.15 a	261 ac
68	4.00 a	4.39 ac	4.13 a	327 bc

[1]X = number of individuals in 1 gram soil.
[2]Values in a column followed by the same letter are not significantly different at $P = 0.05$.

TABLE III-18. AVAILABLE SOIL NI, TISSUE NI CONCENTRATIONS, AND DRY MATTER YIELDS AS AFFECTED BY VARIOUS LEVELS OF NI APPLIED TO A WATSEKA LOAMY SAND IN 2004

Ni Treatment Applied[1] (mg/kg soil)	Mehlich 3-Extractable Ni[2] (mg/kg soil)	Tissue Ni[3] Concentrations (mg/kg tissue)	Dry Matter Yield (g/pot)	Relative Dry Matter Yield (%)
Bean				
0	0.130	5.56	5.56	100
5	2.63	38.6	6.40	115
10	4.62	55.8	6.22	112
15	7.55	60.2	5.87	105
20	8.76	65.9	4.11	74
25	11.8	77.0	4.10	74
30	15.2	141	2.04	37
40	21.3	230	1.95	35
50	26.8	314	1.09	20
Tall Fescue				
0	0.451	5.50	10.9	100
10	6.12	38.2	14.1	129
30	16.8	109	13.6	125
50	35.7	180	4.84	44
75	41.4	267	4.31	40
100	73.4	ND[4]	0.043	0.40

[1]Ni applied as soluble $NiSO_4$ salt.
[2]Mehlich 3-extractable Ni from soil.
[3]Plant tissue digested with concentrated HNO_3.
[4] ND = No data due to insufficient tissue for analysis.

TABLE III-19. SAMPLING SCHEDULE AND ANALYSES OF SOIL, PLANT TISSUES, AND SUBSURFACE WATER SAMPLES FOR THE FARMLAND APPLICATION OF CLASS B CENTRIFUGE CAKE BIOSOLIDS PROJECT

Sampling Event*	Sample Type	Parameters Analyzed
1	Deep soil cores	TKN, TP; KCl-ext. (NO_3-N, NH_3-N); Avail. P; Exch. bases; HNO_3 acid-metals; 2:1 H_2O-ext. (pH, EC, SO_4-S, NH_3-N, NO_3-N); Hg; OC
2	Shallow soil cores	KCl-ext. (NO_3-N, NH_3-N); Avail. P; 2:1 H_2O-ext. (pH, EC, NH_3-N, NO_3-N)
3	Leaf tissues	TKN, TP
4	Stover, stalk, and grain tissues	TKN; TP; S; HNO_3 acid-metals
5	Subsurface water	pH; EC; TKN; TP; NO_3-N, NO_2-N, NH_3-N; Ca; Na; K; Mg; Fe; Cd; As; Cr; Cu; Ni; Pb; Zn; Mo; Mn; Co

*Sampling Event 1 will first occur before biosolids application and then every year after crop harvesting; Sampling Event 2 will occur approximately two weeks after biosolids application or planting the corn; Sampling Event 3 will occur in the mid-season at the silking stage; Sampling Event 4 will occur at the time of harvesting; Sampling Event 5 will occur every month or after rainfall events of more than one inch.

FIGURE III-1. LOCATION OF THE FISCHER FARM FIELDS AND WELLS AT THE HANOVER PARK WRP

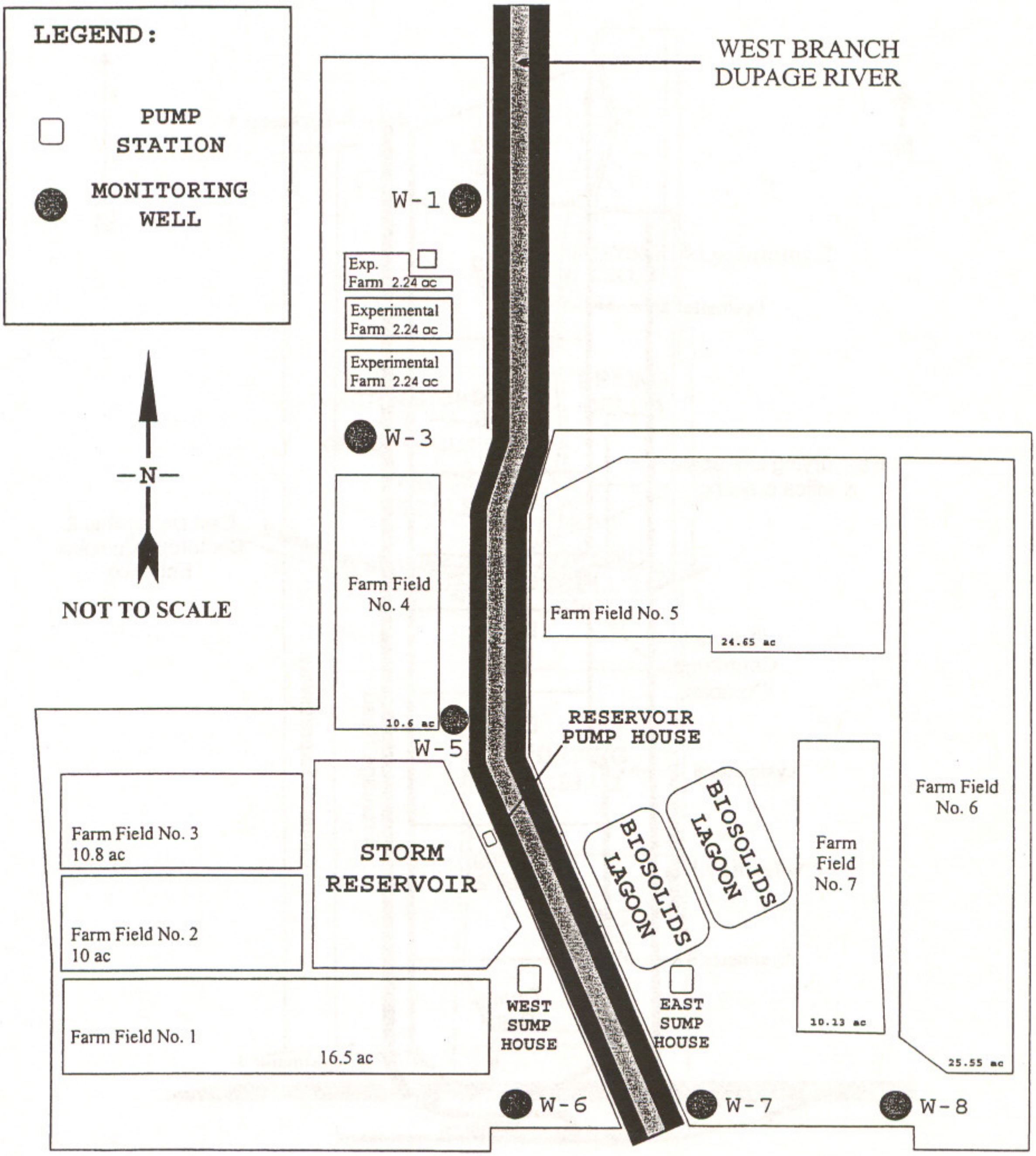


FIGURE III-2. LOCATION OF THE LYSIMETERS AT THE CALUMET EAST SOLIDS MANAGEMENT AREA

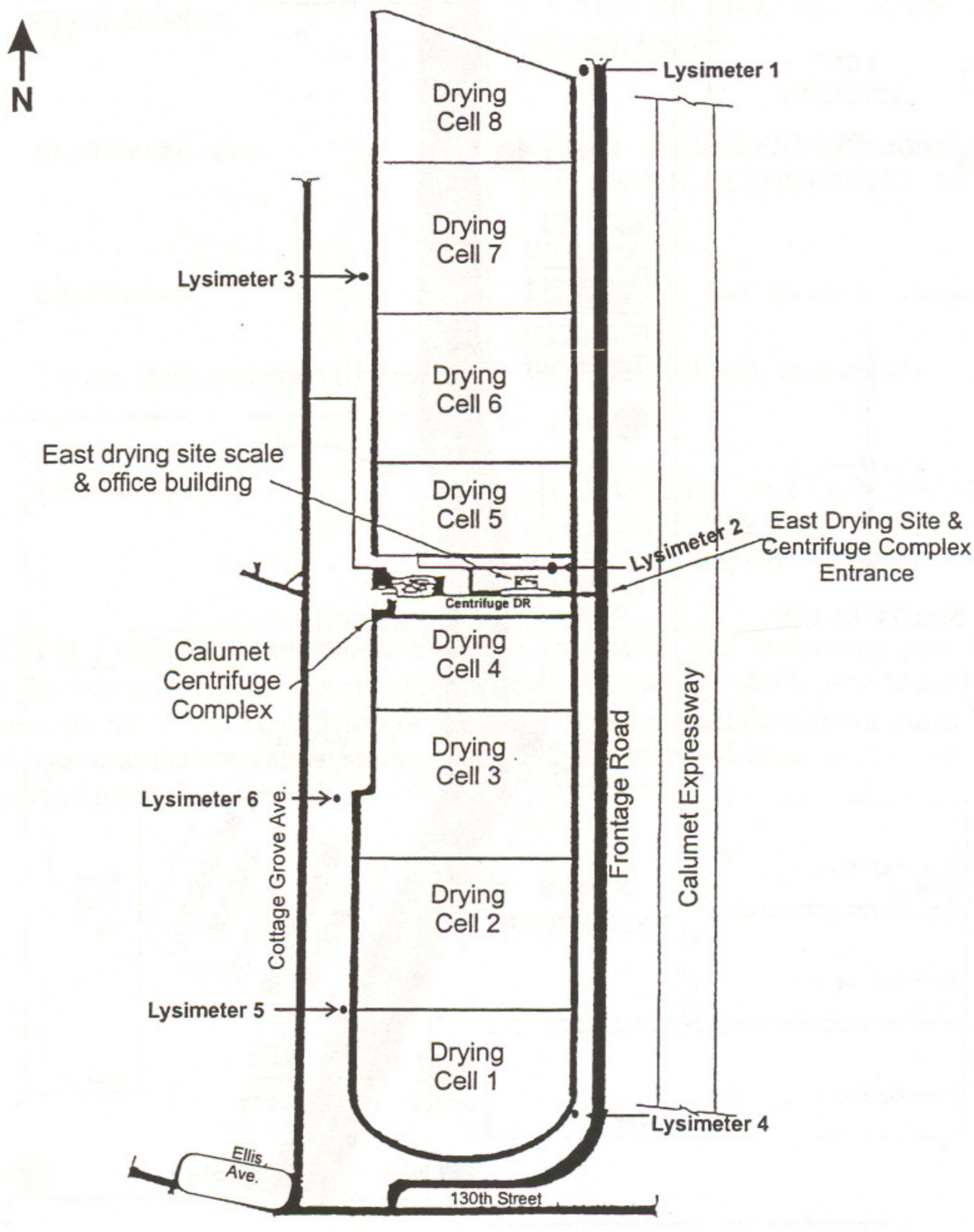


FIGURE III-3. LOCATION OF THE LYSIMETERS AT THE CALUMET WEST SOLIDS MANAGEMENT AREA

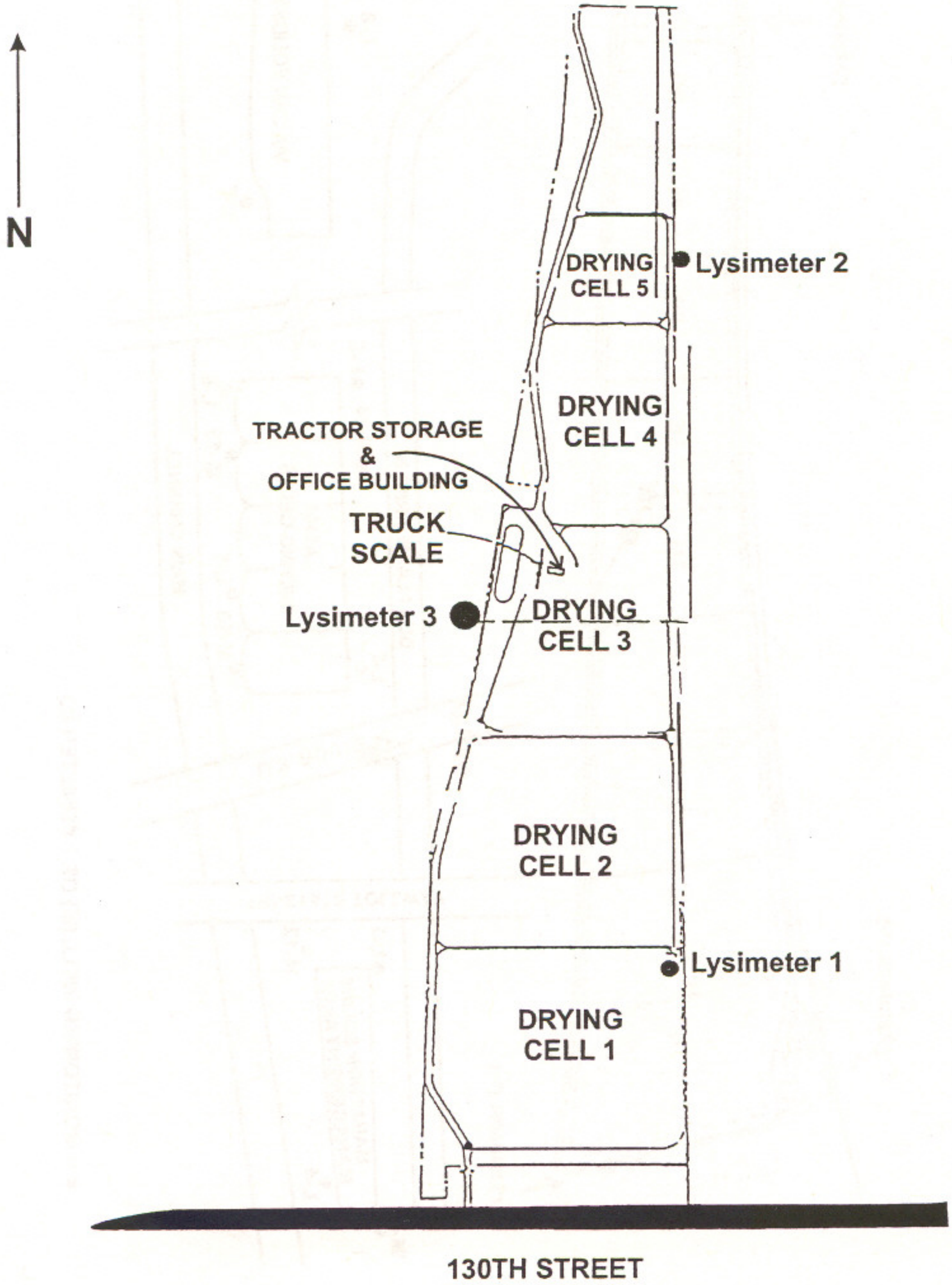
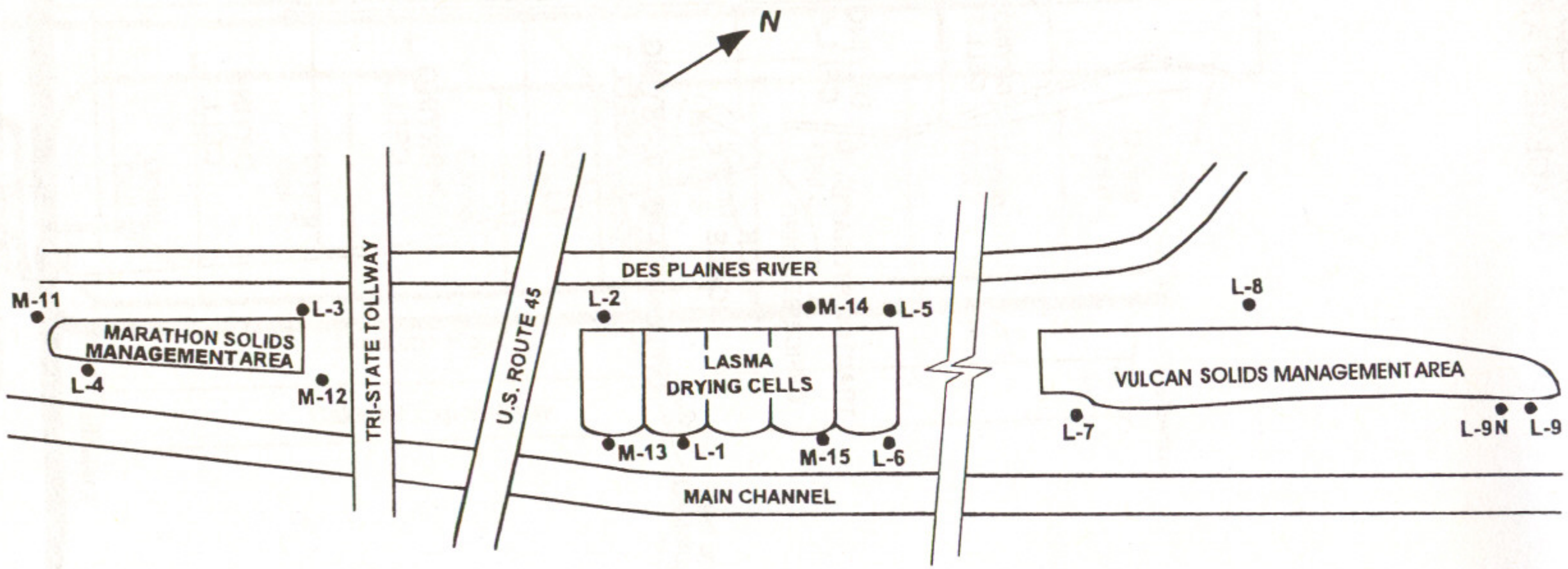


FIGURE III-4. LOCATION OF THE MONITORING WELLS AND LYSIMETERS AT LASMA



● = MONITORING WELL (M) OR LYSIMETER (L)

FIGURE III-5. LOCATION OF THE LYSIMETERS AT RASMA

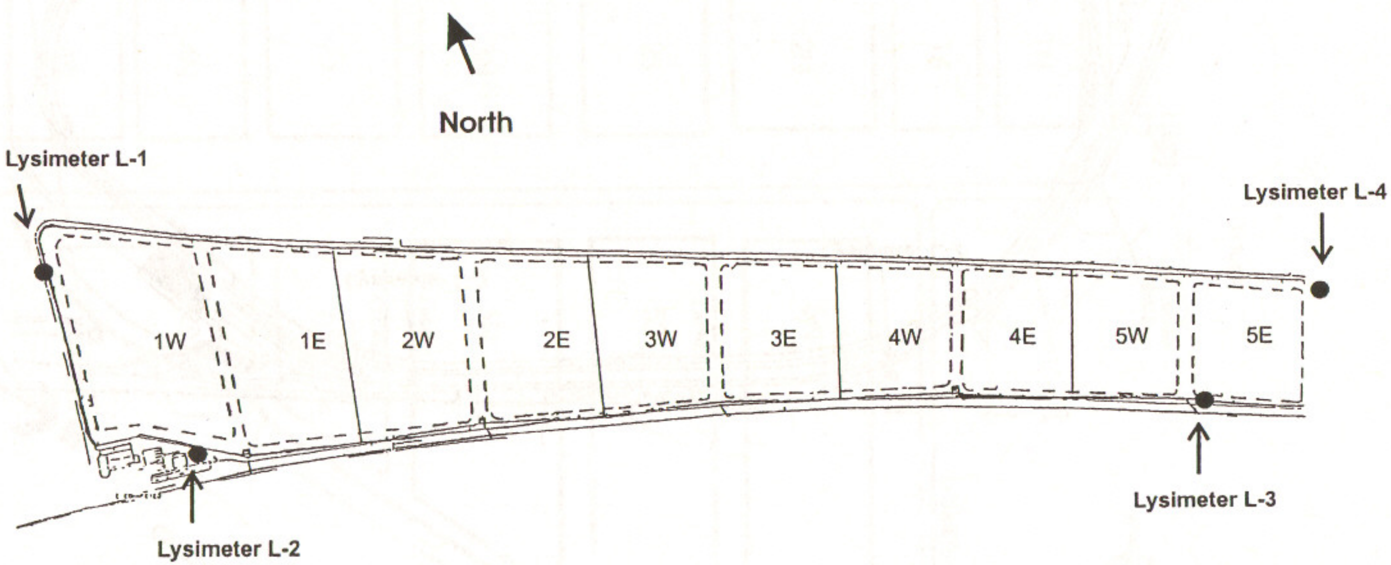


FIGURE III-6. LOCATION OF THE LYSIMETERS AT HASMA

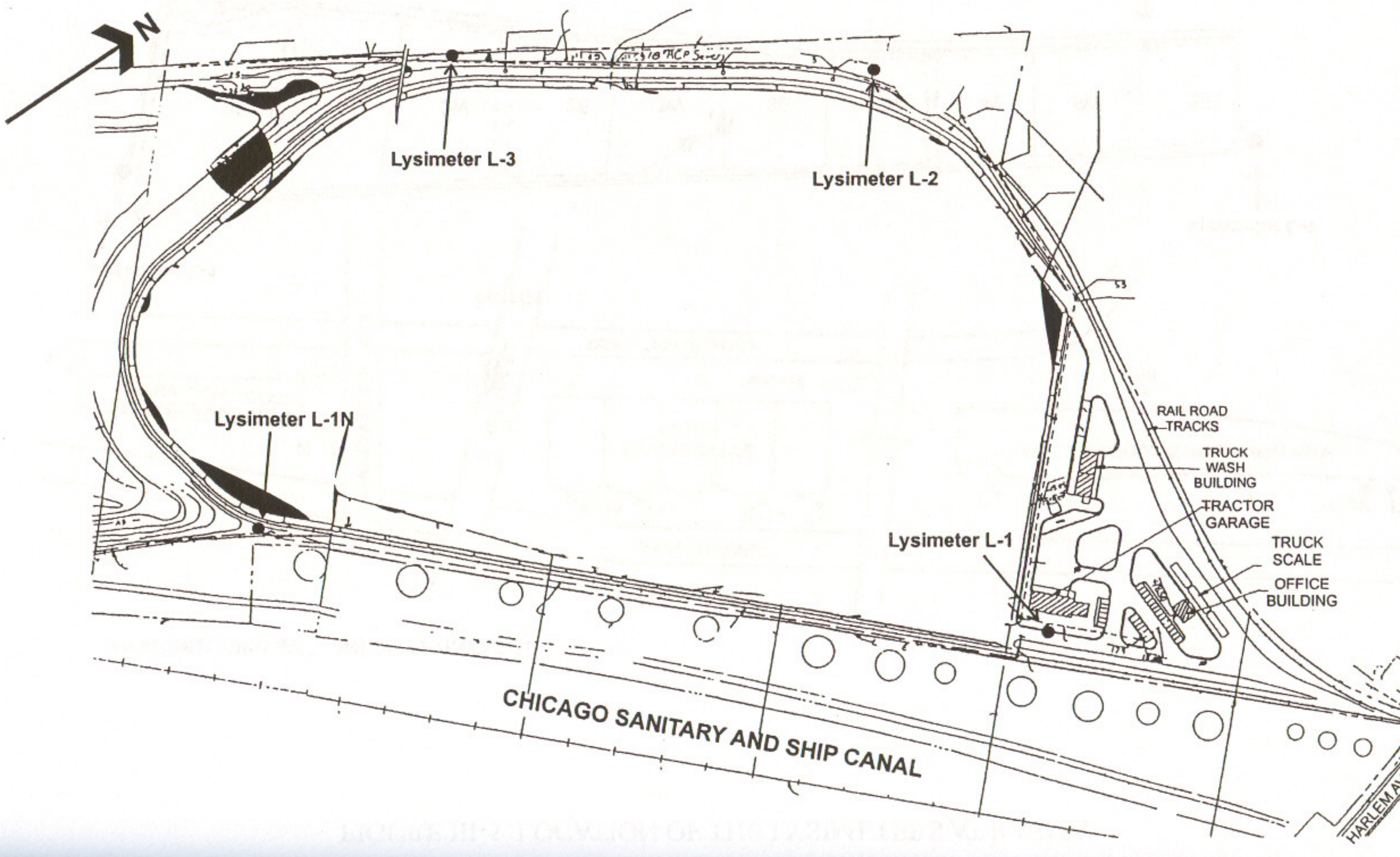


FIGURE III-7. LOCATION OF THE LYSIMETERS AT THE STONY ISLAND AVENUE SOLIDS MANAGEMENT AREA

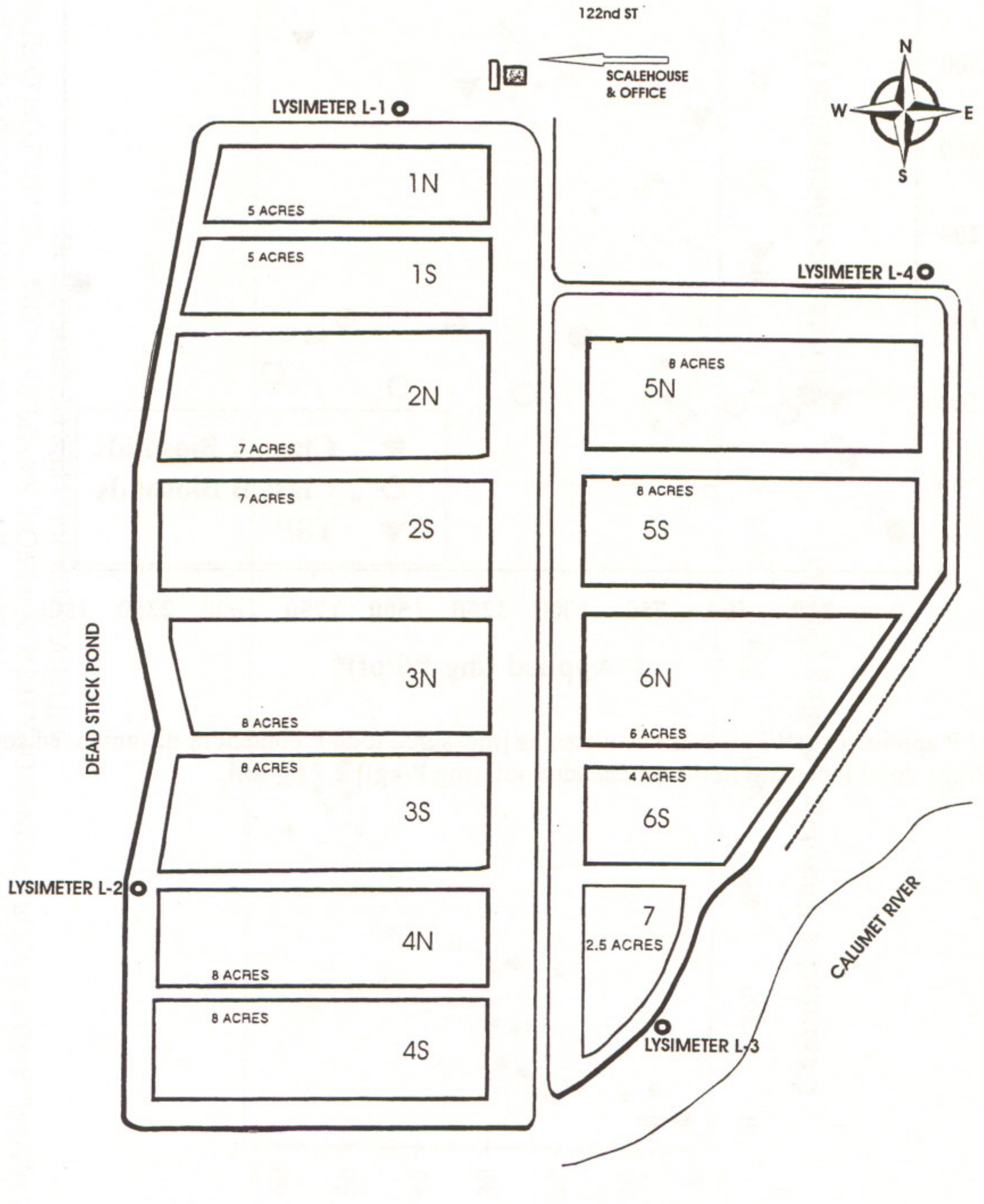
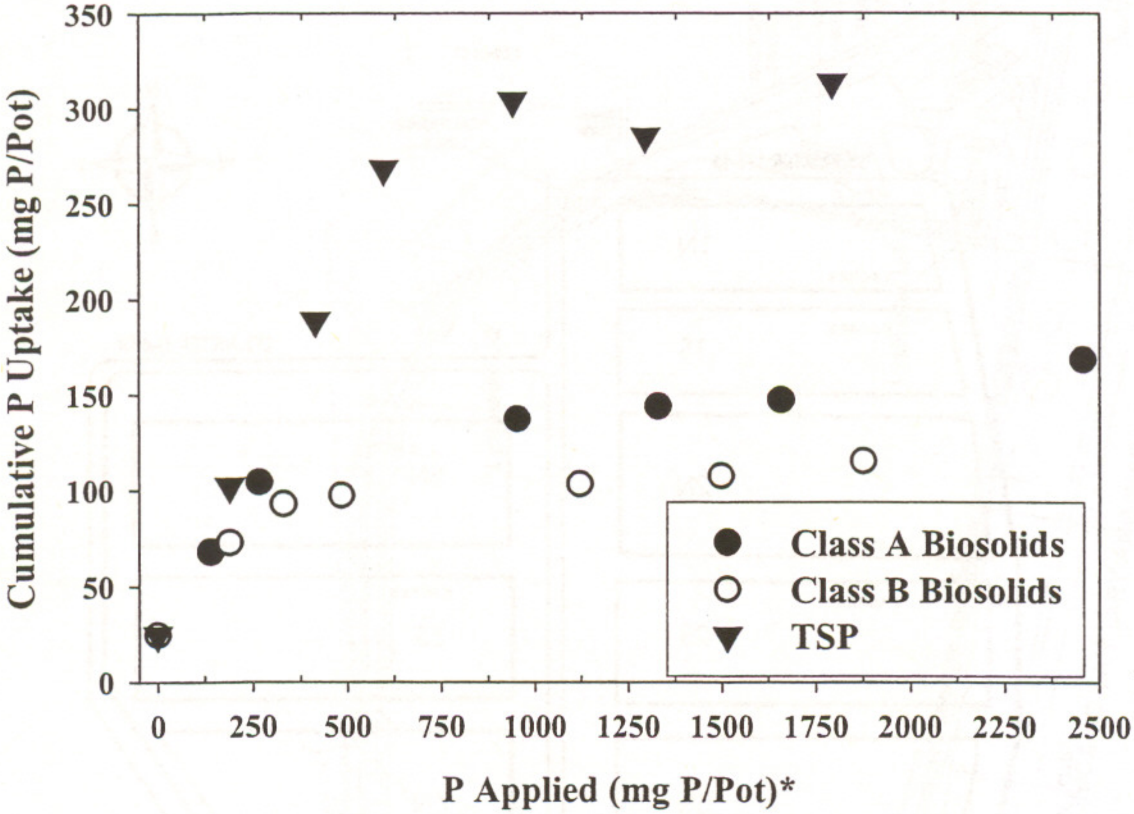


FIGURE III-8. CUMULATIVE P UPTAKE IN FOLIAGE CLIPPINGS OF FOUR WHEAT AND ONE PERENNIAL RYEGRASS CROPS GROWN CONSECUTIVELY IN THE GREENHOUSE IN SOIL AMENDED WITH SIX TOTAL P RATES APPLIED THROUGH TRIPLE SUPERPHOSPHATE (TSP) AND CLASS A AND CLASS B BIOSOLIDS



*Total P applied (mg P/Pot) was calculated as [measured total P content in the amended soils (mg P/kg) -total P content in the unamended soil (mg P/kg)] x 7 kg soil.

FIGURE III-9. RELATIONSHIP BETWEEN WATER SOLUBLE P CONCENTRATION AND CUMULATIVE BIOSOLIDS P LOADING AND P SATURATION INDEX (PSI) IN 44 SOIL SAMPLES FROM THE FULTON COUNTY SITE AMENDED WITH VARIOUS RATES OF BIOSOLIDS

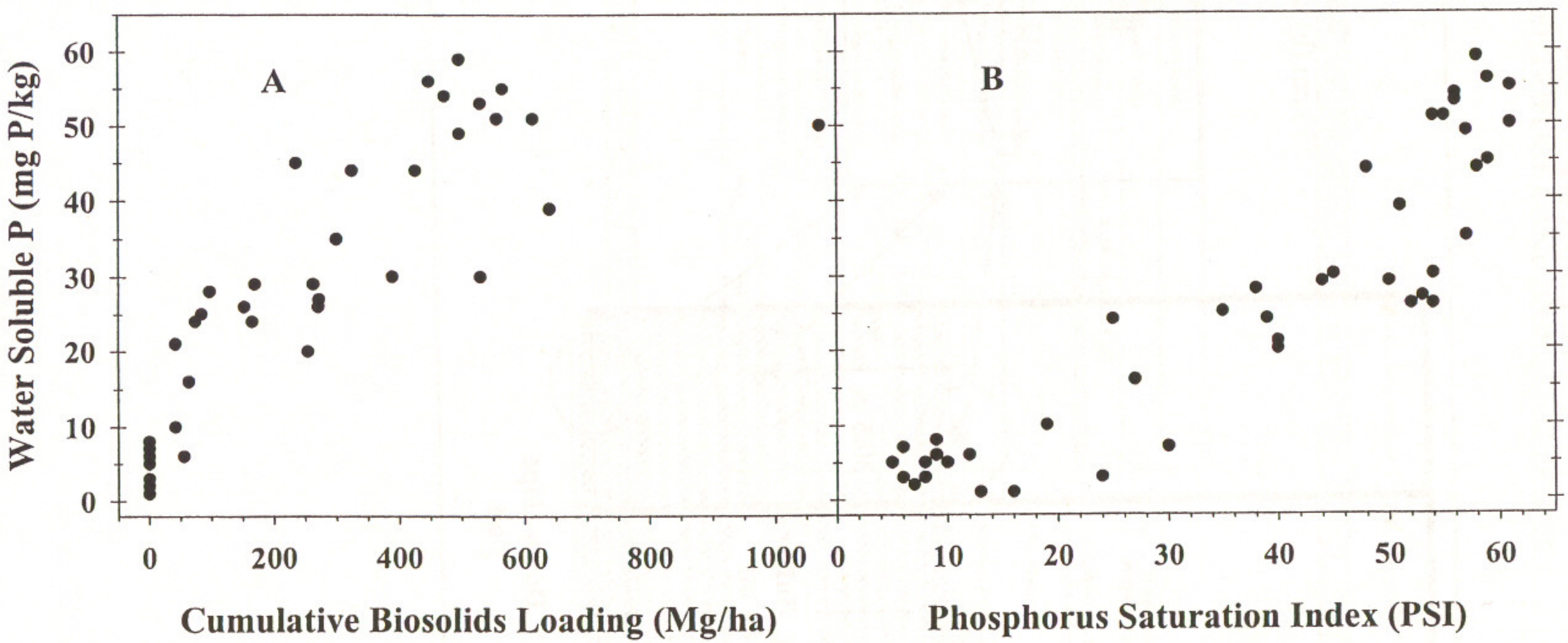


FIGURE III-10. SKETCH OF TYPICAL DESIGN OF MAIN PLOT, SUBPLOT, AND LOCATION OF RUNOFF COLLECTION DEVICES IN THE BIOSOLIDS P RUNOFF FIELD STUDY

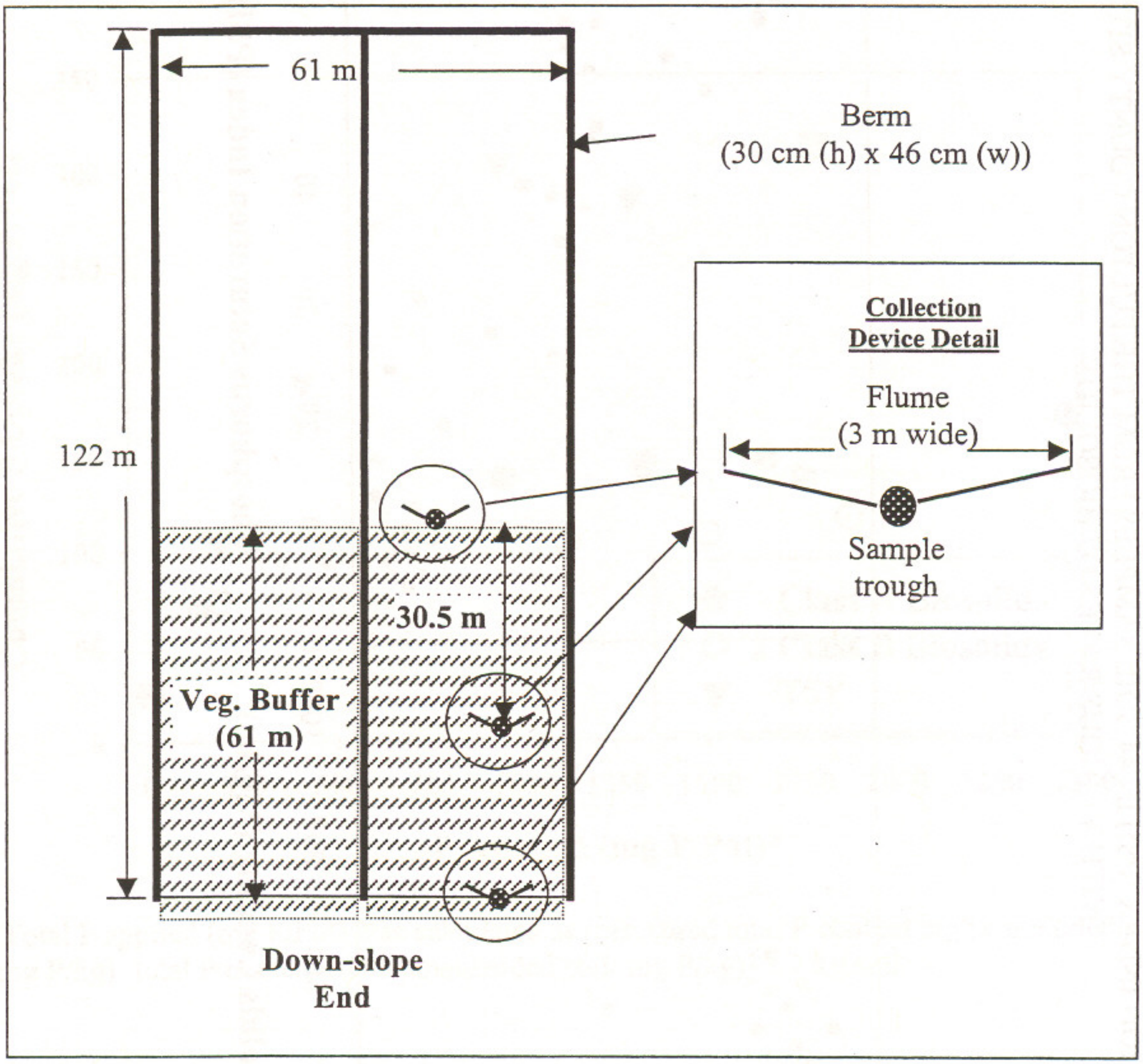


FIGURE III-11. SCHEMATIC OF THE KANKAKEE COUNTY RESEARCH PLOTS SHOWING THE TREATMENTS AND LOCATIONS OF SUBSURFACE WATER SAMPLING DEVICES FOR THE FARMLAND APPLICATION OF CLASS B CENTRIFUGE CAKE BIOSOLIDS PROJECT

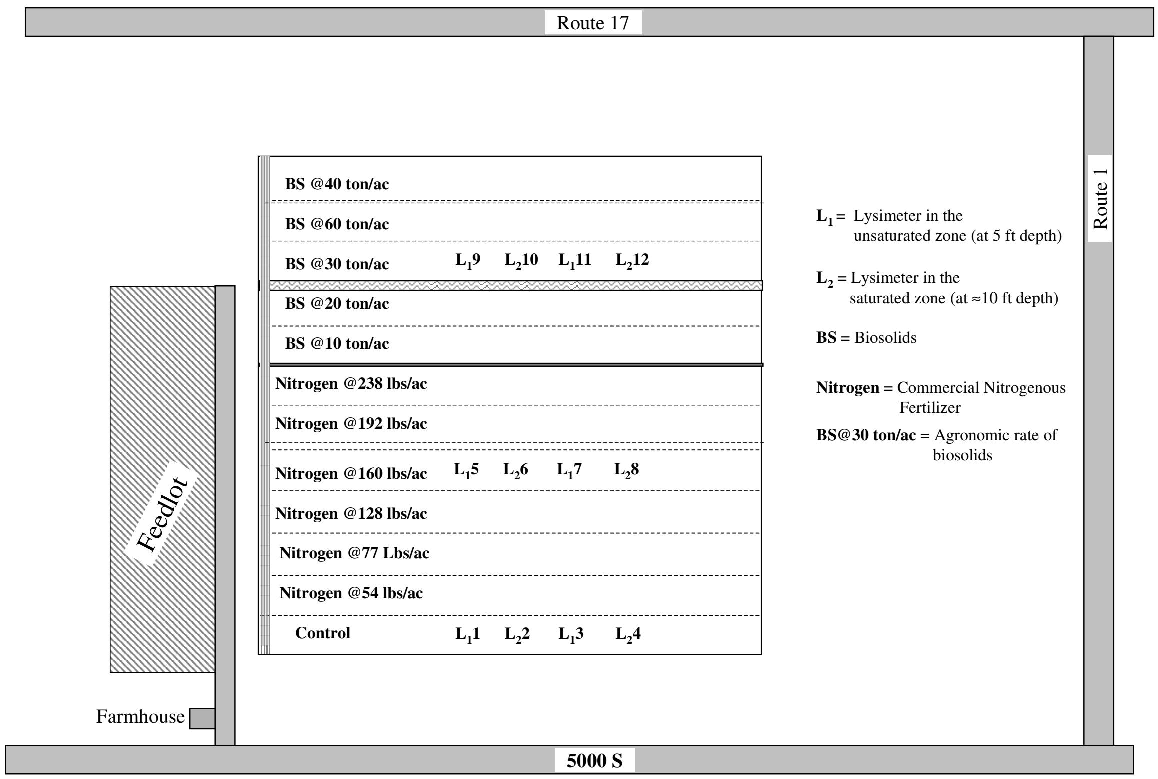
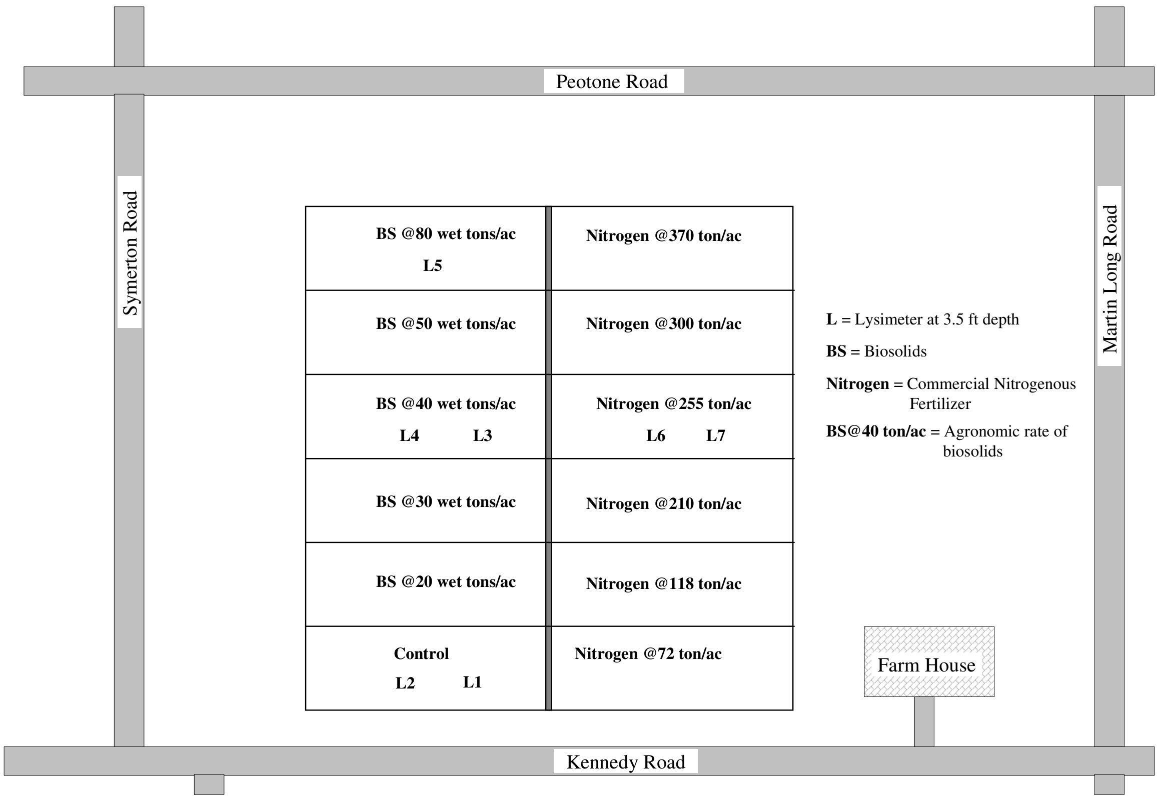


FIGURE III-12. SCHEMATIC OF THE WILL COUNTY RESEARCH PLOTS SHOWING THE TREATMENTS AND LOCATIONS OF SUBSURFACE WATER SAMPLING DEVICES FOR THE FARMLAND APPLICATION OF CLASS B CENTRIFUGE CAKE BIOSOLIDS PROJECT



ANALYTICAL MICROBIOLOGY AND BIOMONITORING SECTION

The Analytical Microbiology and Biomonitoring Section is composed of four professional and 12 technical personnel. The Section is organized into four groups, which perform specific monitoring or research activities. The four groups are:

I. Analytical Microbiology
II. Virology
III. Parasitology
IV. Biomonitoring

Section personnel are often involved in studies of wastewater treatment, biosolids assessment, and environmental monitoring which require the application of specific microbiological disciplines and expertise. The areas of study in which the Section personnel can be involved during the course of a given year include, but are not limited to:

- public health risk assessment;
- ecological risk assessment;
- water quality monitoring;
- ecotoxicology and biomonitoring;
- bioassay methodology;
- microbial processes;
- enumeration of viral, microbial, and parasitic indicators;
- enumeration of specific pathogens;
- the microbiology of specific wastewater or biosolids treatment options; and
- emerging organic contaminants including endocrine disrupters, pharmaceuticals, and personal care products.

Overview of Section Activities

In 2004, personnel in the Section participated in a variety of monitoring and research activities. Listed below are the most important of these activities under the heading of the group which lead the effort.

Analytical Microbiology Group.

a. Water Reclamation Plant (WRP) Quality Control. Monitoring WRP effluents for the presence and density of fecal coliforms (FC) for disinfection control.

b. Chicago Area Waterways. Monitoring District waterways in Cook County upstream and downstream of the Calumet, North Side, Stickney, and Lemont WRPs.

c. Groundwater Monitoring Wells - TARP. Monitoring FC presence and density in groundwater monitoring wells near TARP tunnels, as required by Illinois Environmental Protection Agency (IEPA) operational permits.

d. Groundwater Monitoring Wells - Land Reclamation. Monitoring the presence and density of FC in groundwater monitoring wells around biosolids processing and application sites in Cook County.

e. Part 503 Compliance Monitoring. Analysis of biosolids for FC.

f. Biosolids Beneficial Use. Monitoring bacterial densities in farm soil after application of biosolids.

g. Surface Water Analyses. Monitoring *Escherichia coli* (EC) levels at the 63rd Street and Foster Avenue Beaches.

h. Potable Water Analysis. Monitoring drinking water at District WRPs, and other locations.

i. Effects of Pharmaceuticals and Personal Care Products. Study of antibiotic resistant bacteria in wastewater influent and effluent at each District WRP.

j. Reviews. Review research reports and proposed regulations to determine their impact on District operations.

Virology Group.

a. Part 503 Compliance Monitoring. Analysis of biosolids for enteric viruses.

b. Process Certification for Class A Biosolids. Analysis of biosolids for enteric viruses to demonstrate that the District's codified treatment processes consistently produce Class A biosolids as defined in the Part 503 Regulations.

c. Monitoring of Biosolids for Coliphages [Somatic and F specific RNA (FRNA)]. Research on the use of FRNA phages as indicators for enteric viruses in biosolids.

d. Biosolids Beneficial Use Support. Monitoring virus densities in farm soil after application of biosolids.

e. Reviews. Review research reports and proposed regulations to determine their impact on District operations.

Parasitology Group.

a. Part 503 Compliance Monitoring. Analysis of biosolids for viable *Ascaris* ova.

b. Process Certification for Class A Biosolids. Analysis of biosolids for viable *Ascaris* ova to demonstrate that the District's codified treatment processes consistently produce Class A biosolids as defined in the Part 503 Regulations.

c. Biosolids Beneficial Use Support. Monitoring viable *Ascaris* ova densities in farm soil after application of biosolids.

d. Reviews. Review research reports and proposed regulations to determine their impact on District operations.

Biomonitoring Group.

a. Whole Effluent Toxicity (WET) Testing for National Pollutant Discharge Elimination System (NPDES) Permits. Use of fathead minnows (*Pimephales promelas*) and daphnids (*Ceriodaphnia dubia*) to assess acute and chronic toxicity of effluents from District WRPs.

b. Chronic Whole Effluent Toxicity (WET) Testing of Effluents from the Stickney, Calumet, and North Side WRPs. Joint study involving the District, USEPA, and IEPA.

c. Reviews. Review research reports and proposed regulations to determine their impact on District operations.

Analytical Microbiology Group Responsibilities

The Illinois Department of Public Health (IDPH) certifies the Analytical Microbiology Laboratory for the Bacterial Analysis of Water. The Laboratory has held this certification since 1979. The Analytical Microbiology Group is responsible for all bacterial population density analyses used for the WRP effluent monitoring required by NPDES permits. Monitoring the densities of FC bacteria in effluents of the District's WRPs was begun in 1972, when first required by NPDES permits, and continues to the present. Monitoring of the Chicago beaches is conducted when river reversals to Lake Michigan occur after large amounts of rainfall. In 2004, there were no reversals to Lake Michigan. The Analytical Microbiology Group also conducts microbiological analyses in support of other Sections.

Table IV-1 summarizes the number and type of analyses performed by the Analytical Microbiology Group in 2004. Bacterial analyses for total coliforms (TC), FC, and EC are used by the District as indicators of the sanitary quality of water. The heterotrophic plate count (HPC) is a procedure for estimating the number of viable heterotrophic bacteria in water. Bacteria were identified to species (ID-CONF) using specific biochemical metabolic characteristics.

Certification by the IDPH. The Analytical Microbiology Group is certified by the IDPH, Registry #17508, for the following laboratory examinations:

- HPC for water;
- TC with EC broth verification examination of water from public water supplies and their sources [membrane filtration (MF), and multiple tube fermentation (MTF)];
- FC examination of water from public water sources (MF and MTF);
- TC and EC examination of samples of water from public water supplies and their sources (minimal medium orthonitro-phenyl-β-D-galactopyranoside-4-methylumbelliferyl-β-D-glucuronide).

The Analytical Microbiology Group's facilities, equipment, and procedures were the subject of the biennial on-site evaluation for certification by the IDPH on November 9, 2004, and were found to be in general compliance with the provisions of the 18th Edition of *Standard Methods for the Examination of Water and Wastewater* (SM 18th ed.), and the Illinois Rules for Certification and Operation of Environmental Laboratories, Title 77, Part 465. The Group collects and analyzes potable water samples from District facilities as required.

NPDES Compliance Monitoring. Fecal coliform data from disinfected effluents are made available to the Hanover Park, James C. Kirie, and John E. Egan WRPs within 24 hours of sample collections. These data are used as a guide in maintaining proper chlorination at these District WRPs, and for reporting compliance with NPDES permit regulations. All District WRPs with NPDES disinfection requirements have a seasonal exemption from November 1 through April 30 of each year and are not subject to any effluent disinfection requirements during this period.

NPDES permits also require additional monitoring when increased flows caused by storms exceed the design (treatment) capacities of the WRPs. These storms can cause the WRPs to divert a portion of the influent, which is then given minimal treatment, before being delivered to the receiving stream. Storm related excess flow discharges (WRP bypasses) must be monitored for the FC bacteria levels. During 2004 the Analytical Microbiology Group performed only one analysis for FC bacteria on a storm related excess flow discharge. This was for the Egan WRP on March 5.

Part 503 Compliance Monitoring. In 2004, the Analytical Microbiology Group performed MPN analyses for FC bacteria on 64 samples of biosolids to determine if they met the Class A pathogen requirement of less than 1000 FC MPN/g (dry weight) specified in the Part 503 Regulations. The results were reported to M&O personnel responsible for the District's Controlled Solids Distribution Program at the solids management areas. The District has more distribution options for biosolids demonstrated to be Class A than for non-Class A biosolids.

Monitoring Bacterial Densities in Biosolids-Amended Farm Soil. In 2004, the Analytical Microbiology Laboratory began monitoring FC and *Salmonella* densities in farm soil after application of biosolids. These analyses were conducted as part of full scale studies being conducted in Will and Kankakee Counties to demonstrate the benefits and safety of applying Class B centrifuge cake biosolids to farmland. See the Biosolids Utilization and Soil Science Section chapter of this report for more details on this project.

Monitoring of Spatially Related Densities of *Eschericia coli* (EC) at the Foster Avenue and 63rd Street Beaches. As directed by the General Superintendent, spatially related densities of EC at the Foster Avenue and 63rd Street Beaches were studied in 2004. Water samples were collected weekly, beginning in the third week of August, from the 63rd Street and Foster Avenue beaches, for a period of four weeks, and these samples were analyzed for EC bacteria. Samples were collected at each beach at two locations (A and B) which are 100 feet apart (Figures IV-1 and IV-2) along two perpendicular transects. Along each transect, five samples were collected at different distances from shore. At each sampling location near-shore water samples were collected at the following depths:

1. Sand-swash depth (10-inch deep water), where the sample bottle could be submerged without sand contamination;

2. 18-inch deep water (knee-depth) where the sample bottle was just below the water surface directly out into the water perpendicular to the shoreline;

3. 36-inch deep water (waist-depth) where the sample bottle was just below the water surface directly out into the water, perpendicular to the shoreline.

In addition, samples were collected three feet below the water surface at two off-shore locations:

4. 500 yards off shore directly in line with the locations of the near-shore beach samples;

5. 1000 yards off shore directly in line with the locations of the near-shore beach samples.

These sampling locations were chosen for the following reasons. United States

Environmental Protection Agency Guidance (Guidance) recommends that beach monitoring water samples be collected at knee depth. The Guidance also recommends that other samples be collected as is felt to be necessary for a particular beach (e.g., surface of water, waist depth, and sediment). The off shore locations were selected to rule out the possibility that pollution is carried to these beaches from other parts of the Lake by the current.

Personnel from the Industrial Waste Division collected all of the water samples. All samples were analyzed for EC by the District's Analytical Microbiology Laboratory within eight hours of collection. The density of EC in the samples was measured with the Quanti-Tray™ 2000 (IDEXX Laboratories, Westbrook, Maine). This is the same method used by the Illinois Department of Public Health (IDPH) and the Chicago Park District for Lake Michigan beach monitoring.

The geometric means of the measured EC densities in the samples collected at each of the sampling locations at the 63rd Street and Foster Avenue beaches are shown in Tables IV-2 and IV-3, respectively. At the 63rd Street Beach, the EC density in 16 of the 24 near shore samples exceeded USEPA recreational water quality guidelines (single sample maximum allowable density = 235 EC per 100 mL). The value of 235 EC per 100 mL (single sample) is the limit established in the Swimming Pool and Bathing Beach Code (77 Illinois Administrative Code 820) (Bathing Beach Code). The geometric means of the EC densities at the near shore locations (A-1, A-2, A-3, B-1, B-2, and B-3) were all greater than the USEPA recommended steady-state geometric mean value of 126 EC per 100 mL. At both Locations A and B the geometric means of the EC densities for samples collected at the sand-swash depth (10 in) were greater than those collected at knee-depth (18 in) which were greater than those collected at waist-depth (36 in).

At the Foster Avenue Beach, the EC density in all of the samples was less than 235 EC per 100 mL. The general trend of the EC densities observed at the 63rd Street Beach, i.e., EC density greater at the sand-swash depth than at knee-depth than at waist-depth, was also observed at the Foster Avenue Beach, although at consistently lower values.

Results of the off shore monitoring may be summarized as follows. The measured EC density was below detectable levels (<1 per 100 mL) in seven of 16 samples collected off the 63rd Street Beach and in six of 16 samples collected off the Foster Avenue Beach. The geometric means of the EC densities for the off shore samples ranged from 1 per 100 mL to 4 per 100 mL at the 63rd Street Beach and from 1 per 100 mL to 2 per 100 mL at the Foster Avenue Beach.

These data suggest the following general findings:

1. The microbiological water quality at the 63rd Street Beach is poor. This finding is consistent with other reports (Whitman and Nevers, *Applied and Environmental Microbiology* 69: 5555-5562; District Report No. 03-12A). The abundance of gulls at the 63rd Street Beach has been mentioned as a significant source of EC given the high density of indicator bacteria present in bird feces. The enclosed location of the 63rd Street Beach (a 700 m breakwater to the south; and a 450 m shoreline revetment followed by a 150 m breakwater to the north) is viewed as

limiting the self purification process of the Lake which occurs at other beaches.

2. The microbiological water quality at the Foster Avenue Beach is acceptable as judged by the USEPA recreational water quality criteria and the Bathing Beach Code.

3. The measured EC densities at these beaches appear to be inversely correlated with the water depths at which the samples were collected. These data suggest that measured EC and therefore the number of beach closings can be influenced by the location and depth at which the samples are taken.

4. Results of the offshore sampling suggest that the current is not transporting pathogens to the 63rd Street or Foster Avenue Beaches from other parts of the Lake.

Study of Antibiotic Resistant Bacteria in Wastewater. In 2004, the District began a study of the total numbers, percentages, and antibiotic resistant patterns of antibiotic resistant FC in raw sewage entering the District's seven WRPs and the effect of secondary sewage treatment on these organisms. The first phase of this study is complete and a final report is being written.

Support of Other Sections. The Analytical Microbiology Group supported a variety of Environmental Monitoring and Research and Industrial Waste Division programs in 2004. These include effluent analysis, biosolids processing and land reclamation, biosolids indicator organism densities, Lake Michigan monitoring, major treatment facility monitoring, TARP monitoring, research support, industrial waste surveys, the Chicago Area and Illinois waterways surveys, emergency response, combined sewer overflow analysis, and other miscellaneous samples. Table IV-4 is a summary of the major programs receiving support from 2003 through 2004, and the number of analyses performed for each program.

Virology Group Responsibilities

In 2004, the Virology Group analyzed 24 biosolids samples for site-specific Processes to Further Reduce Pathogens (PFRP) equivalency monitoring and for compliance with the Part 503 sludge regulations. Enteric virus densities in all samples of biosolids produced by the District's codified process were determined to be below the detectable limit, which is less than one plaque forming unit (PFU) per four grams total solids (dry weight basis). Positive recovery studies were performed on these samples for quality assurance purposes. The mean recovery of spiked viruses was 73.6 percent. Recoveries ranged from 38.1 to 122 percent and were dependent upon the sample spiked. Results of these analyses are shown in Table IV-5.

The District uses the USEPA approved method (Appendix H, EPA/625/R-92/013) for determining the density of enteric viruses in biosolids. The analytical method for enteric viruses involves the elution of viruses from solids, concentration of the eluates, and an assay for plaque-forming viruses using BGM-K cells.

Monitoring of Biosolids for Coliphages and Enteric Viruses. The USEPA coliphage method was modified and adapted by the District to determine FRNA and somatic coliphage concentrations in raw wastewater, digester feed, digester draw, centrifuge cake, and air-dried biosolids. Research is currently being conducted to evaluate the usefulness of coliphages as an alternative indicator for the presence of enteric viruses in biosolids. Data collected to date suggest that FRNA coliphages are a good alternate indicator for predicting the presence or absence of enteric viruses in air-dried biosolids, specifically, and for assessing the efficiency of wastewater solids treatment, in general. Mean concentrations of coliphages (FRNA and somatic) and enteric viruses in Stickney and Calumet WRP biosolids processing operation sites are shown in Figures IV-3 and IV-4, respectively.

Monitoring Virus Densities in Farm Soil. In 2004, the Virology Laboratory began monitoring virus in farm soil after application of biosolids. These analyses were conducted as part of full scale studies set up in Will and Kankakee Counties to demonstrate the benefits and safety of applying Class B centrifuge cake biosolids to farmland. See the Biosolids Utilization and Soil Science Section chapter of this report for more details on this project.

Parasitology Group Responsibilities

In 2004, the Parasitology Group analyzed 23 biosolids samples for site-specific equivalency monitoring and for compliance with the Part 503 regulations. *Ascaris* ovum densities in all samples of biosolids produced by the District's codified process were determined to be below the detectable limit which is less than one viable *Ascaris* ovum per four grams total solids (dry weight basis). Results of these analyses are shown in Table IV-6. Since 1996 when the District began monitoring the levels of FC bacteria (see Analytical Microbiology Group Activities above), enteric viruses (see Virology Group Activities above), and viable *Ascaris* in its dried biosolids product for compliance with the Class A biosolids criteria in the Part 503 regulations, all biosolids produced by the District's codified process have been in compliance with the Class A criteria for shipment and use under the District's Controlled Solids Distribution Program.

The District uses the USEPA approved method (Appendix I, EPA/625/R-92/013) for enumerating viable *Ascaris* ova in biosolids. The *Ascaris* method employs a combination of sieving, flotation, centrifugation, incubation, and microscopic analysis to extract and enumerate viable *Ascaris* ova.

Monitoring Viable *Ascaris* Densities in Farm Soil. In 2004, the Virology Laboratory began monitoring viable *Ascaris* in farm soil after application of biosolids. These analyses were conducted as part of full scale studies set up in Will and Kankakee Counties to demonstrate the benefits and safety of applying Class B centrifuge cake biosolids to farmland. See the Biosolids Utilization and Soil Science Section chapter of this report for more details on this project.

Microscopic Image Analysis. The District uses microscopic image analysis (MIA) as an aid to monitoring viable *Ascaris* ova in biosolids. The MIA system, mounted on a Nikon Eclipse E600 phase contrast microscope, includes a digital camera with a video image acquisition mode to transmit microscopic images from slides to a computer workstation (Figure IV-5). Digital images are stored and analyzed using the MetaMorph™ imaging system (Figure IV-6). The MIA system has proven itself to be a useful tool for the verification and monitoring of biosolids for Part 503 compliance. For each digital image the following information is automatically stored in a computer file by the imaging software: 1) length of the ovum; 2) width of the ovum; 3) date and time the image was recorded; 4) sample identification number. A series of video digital images is recorded for each ovum examined when larval movement is observed in order to document viable Ascaris ova.

In 2003, a study was initiated to determine the feasibility of automating the MIA system for routine monitoring of biosolids for viable Ascaris ova. The objectives of this study include optimization of the following MetaMorphTM image parameters: radial dispersion, pixel area, shape factor, optical density, and area. Viability staining is also being studied. Data collected to date are promising and indicate that automating the MIA system for routine monitoring may be possible.

Biomonitoring Group Responsibilities

NPDES Compliance Biomonitoring. In 2004, acute whole effluent toxicity (WET) tests with fish (Pimephales promelas) and daphnids (Ceriodaphnia dubia) were conducted on effluent samples from the James C. Kirie WRP for NPDES Permit compliance. No acute toxicity was observed. Chronic WET tests were also conducted on effluent samples from the Hanover Park WRP for NPDES Permit compliance. No chronic toxicity was observed. These data are shown in Table IV-7. Biomonitoring reports for the Hanover Park and James C. Kirie WRPs were submitted to the IEPA in compliance with the respective NPDES permits.

Chronic Wet Assessment. In July 2002, the District entered into a cooperative agreement with the IEPA and the USEPA-Region 5 to investigate chronic whole effluent toxicity at the Calumet, North Side, and Stickney WRPs. The objective of the WET assessment was to determine whether the effluents from the Calumet, North Side, and Stickney WRPs exhibit any chronic toxicity. Chronic toxicity tests were conducted in the District's Biomonitoring Laboratory and the USEPA Central Regional Laboratory from 2002 through 2004. No chronic toxicity was found to be associated with the final effluent from any of these WRPs. A final report is being prepared by representatives of the District, the USEPA, and the IEPA.

TABLE IV-1: ANALYTICAL MICROBIOLOGY GROUP SAMPLES AND ANALYSES 2003 THROUGH 2004

		Analysis or Test Performed[1]										
Year	Samples	TC	FC	FS	PA	SAL	HPC	EC	ENT	IQC	ID-CONF	Total
2003	2,612	37	2,525	0	0	2	43	316	0	7,667	358	10,948
2004	2,737	120	2,611	0	0	16	43	356	0	7,875	274	11,295

[1]TC = Total Coliform; FC = Fecal Coliform; FS = Fecal Streptococcus; PA = Pseudomonas aeruginosa; SAL = Salmonella sp.; SPC – Heterotrophic Plate Count; EC = Escherichia coli; ENT = Enterococcus sp.; IQC = Internal Quality Control testing (reported as the number of procedures performed); ID-CONF = Organism Identification using specific biochemical metabolic characteristics.

TABLE IV-2: DENSITIES OF *ESCHERICIA COLI* (EC) AT THE 63RD STREET BEACH IN AUGUST AND SEPTEMBER, 2004[1]

Location[2]	Sampling Point (Water Depth)	EC per 100 mL Geometric Mean
A-1	Sand-swash depth (10 in)	747
A-2	Knee-depth (18 in)	237
A-3	Waist-depth (36 in)	152
A-4	500 yards (17 ft)	2
A-5	1000 yards (18 ft)	2
B-1	Sand-swash depth (10 in)	409
B-2	Knee-depth (18 in)	295
B-3	Waist-depth (36 in)	142
B-4	500 yards (17 ft)	4
B-5	1000 yards (18 ft)	1

[1]Samples were collected on the following dates: August 18 and 25 and September 1 and 9.
[2]See Figure 1.

TABLE IV-3: DENSITIES OF *ESCHERICIA COLI* (EC) AT THE FOSTER AVENUE BEACH IN AUGUST AND SEPTEMBER, 2004[1]

Location[2]	Sampling Point (Water Depth)	EC per 100 mL Geometric Mean
A-1	Sand-swash depth (10 in)	47
A-2	Knee-depth (18 in)	43
A-3	Waist-depth (36 in)	34
A-4	500 yards (17 ft)	2
A-5	1000 yards (18 ft)	1
B-1	Sand-swash depth (10 in)	61
B-2	Knee-depth (18 in)	42
B-3	Waist-depth (36 in)	26
B-4	500 yards (17 ft)	2
B-5	1000 yards (18 ft)	1

[1]Samples were collected on August 19 and 26 and September 2 and 9.
[2]See Figure 2.

TABLE IV-4: INDICATOR BACTERIA ANALYSES PERFORMED BY THE ANALYTICAL MICROBIOLOGY GROUP FOR VARIOUS DISTRICT PROGRAMS 2002 THROUGH 2004

	Total Coliform			Fecal Coliform			Escherichia *coli*		
Program	2002	2003	2004	2002	2003	2004	2002	2003	2004
Effluent Analysis	11	12	12	765	716	717	315	64	20
Land Reclamation	-[a]	-	-	461	309	145	-	-	-
Sludge Indicator Organism Density	-	-	-	122	100	70	-	-	-
District Waterway Surveys	-	-	-	711	637	904	241	237	228
Industrial Waste Surveys	-	-	-	8	7	3	-	-	-
Research -Support	-	-	-	91	-	199	98	-	-
Lake Michigan Monitoring[1]	-	-	77	85	75	10	40	15	90
Major Treatment Facility Monitoring	-	-	-	27	-	13	-	-	-
Illinois Waterway	-	-	-	-	-	-	-	-	-
TARP	-	-	-	759	681	750	-	-	-
Emergency Response	-	-	-	-	-	-	-	-	-
Combined Sewer Overflow	-	-	-	-	-	-	-	-	-
Other[2]	52	25	66	-	-	-	-	-	18
Total	63	37	155	3,029	2,525	2,811	694	316	356

[a]No samples analyzed.
[1]Includes festivals and District bypasses to Lake Michigan.
[2]Includes drinking water.

TABLE IV-5: VIROLOGICAL ANALYSIS OF CLASS A BIOSOLIDS IN 2004[1]

Drying Area	Number Samples Positive/Number Samples Collected	PFU/4 g dry wt Range[2,3]	Percent Recovery of Seeded Viruses[4] Range
Calumet	0/10	<0.7996 - <0.8007	54.9 – 89.9
LASMA[5]	0/5	<0.7998 - <0.8005	52.2 – 84.8
HASMA[6]	0/2	<0.7951 - <0.8005	56.8 – 64.2
Marathon	0/3	<0.8000 - <0.8003	40.3 – 85.3
Stony Island[7]	0/2	<0.7999 - <0.8002	122 - 122
Vulcan	0/2	<0.7992 - <0.8002	38.1 – 90.1

[1]Results of analyses performed in the District's Virology Laboratory for site-specific PFRP equivalency monitoring and other monitoring.
[2]Confirmed plaque forming units/4 g.
[3]Failure to detect viruses in solids eluates is recorded as less than (<) the limit of test sensitivity.
[4]Positive recovery controls: percent recovery of 400 plaque forming units of poliovirus 1 Sabin seeded into a 4 g aliquot of sample. A positive recovery control was performed for each sample analyzed.
[5]Lawndale Avenue Solids Management Area.
[6]Harlem Avenue Solids Management Area.
[7]Stony Island Solids Management Area.

TABLE IV-6: *ASCARIS* ANALYSIS OF CLASS A BIOSOLIDS IN 2004[1]

Sample Source	Range of TS[2]	Total Number of Samples Collected	Total Number of Samples that Meet Class A Pathogen Requirement[3]	Range of Total Viable *Ascaris* per 4 gram dry wt
Calumet	63-83	10	10	< 0.0133 - 0.0800
Stony Island[4]	67	1	1	< 0.0800
LASMA[5]	63-86	5	5	< 0.0800 – 0.3200
Vulcan	68-91	2	2	< 0.0800 - < 0.0800
HASMA[6]	74-76	2	2	< 0.0133 - 0.0800
Marathon	59-84	3	3	< 0.0133 – 0.1600

[1]Test Method for Detecting, Enumerating, and Determining the Viability of *Ascaris* Ova in Sludge, Appendix I, Environmental Regulations and Technology, EPA/625/R-92/013, Revised 2003.
[2]TS=Percent Total Solids.
[3]Viable Helminth ova must be less than 1 viable *Ascaris* ovum per 4 g total solids (dry weight) in order to meet the Class A pathogen requirement (EPA/625/R-2/013,2003).
[4]Stony Island Solids Management Area.
[5]Lawndale Avenue Solids Management Area.
[6]Harlem Avenue Solids Management Area.

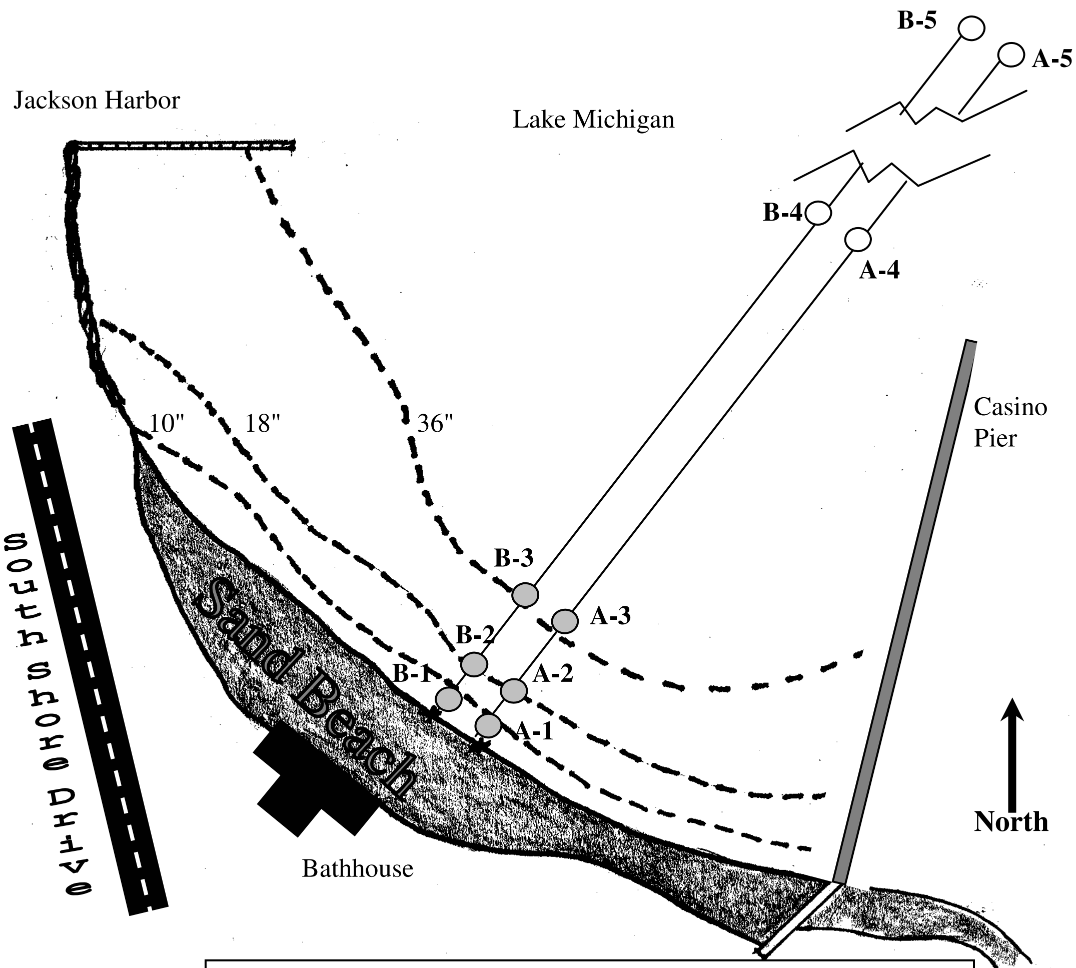
TABLE IV-7: RESULTS OF WHOLE EFFLUENT TOXICITY (WET) TESTS CONDUCTED ON WATER RECLAMATION PLANT EFFLUENTS FOR NPDES PERMIT COMPLIANCE DURING 2004

Effluent Tested	Date (s) Collected	WET Test[1]		Results[2]
James C. Kirie WRP	01/12/04	Acute *P. promelas*	(Survival)	NTE
		Acute *C. dubia*	(Survival)	
Hanover Park WRP	05/17-22/04	Chronic *P. promelas*	(Survival)	NTE
			(Growth)	NTE
		Chronic *C. dubia*	(Survival)	NTE
			(Reproduction)	NTE

[1]WET Tests: Acute *Pimephales promelas* (Survival) and Acute *Ceriodaphnia dubia* (Survival), EPA 821-R-02-012, (Fifth Edition), 2002; Chronic *Pimephales promelas* (Survival, Growth) and Chronic *Ceriodaphnia dubia* (Survival, Reproduction), EPA 821/R-02/013, (Fourth Edition), 2002.

[2]Results: NTE = no toxic effect.

FIGURE IV-1: MAP OF 63RD STREET BEACH SHOWING SAMPLING LOCATIONS



Wading Sample Point	Boat Sample Point
Details of Figure 1 are approximations only.	

FIGURE IV-2: MAP OF FOSTER AVENUE BEACH SHOWING SAMPLING LOCATIONS

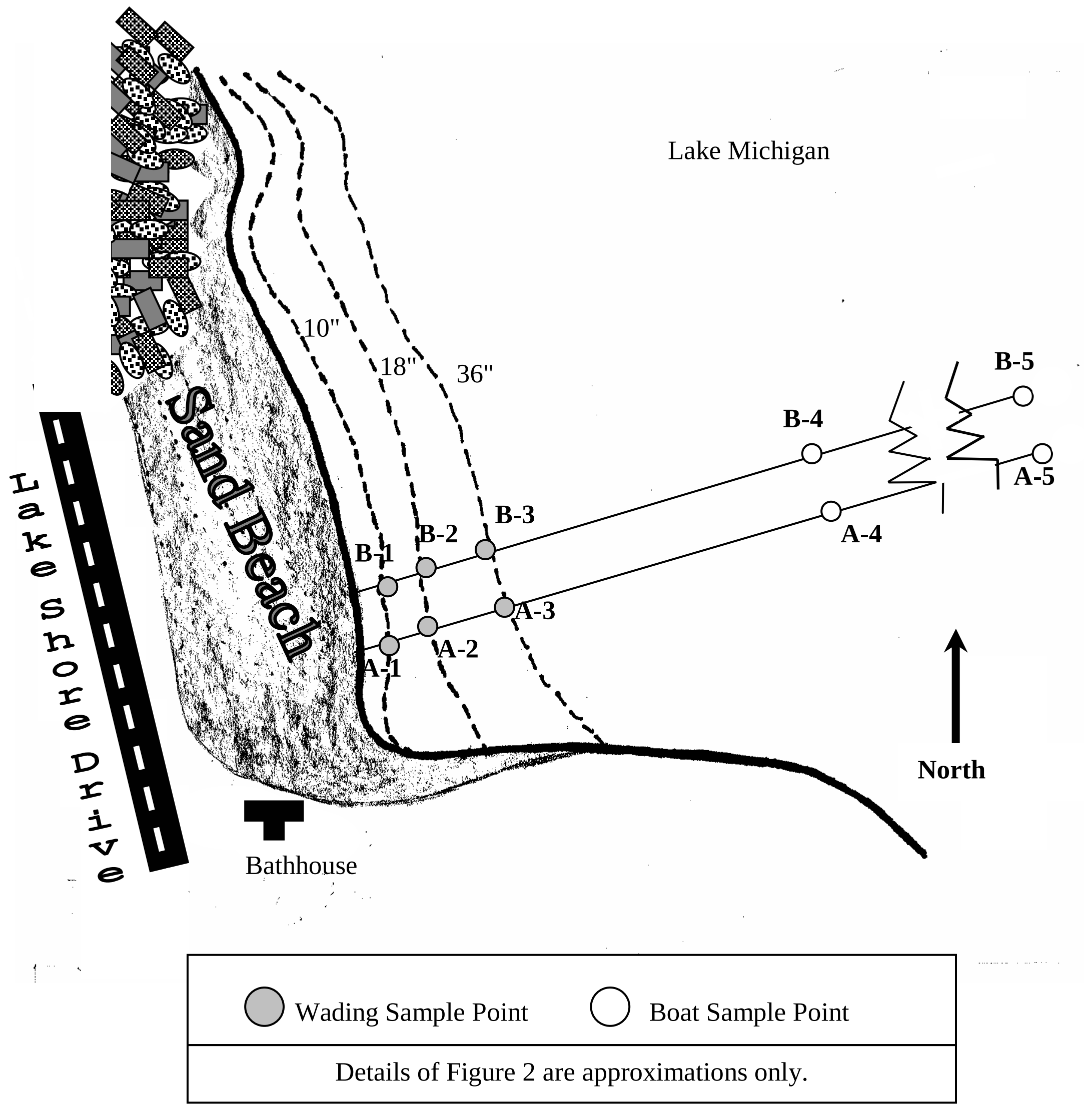
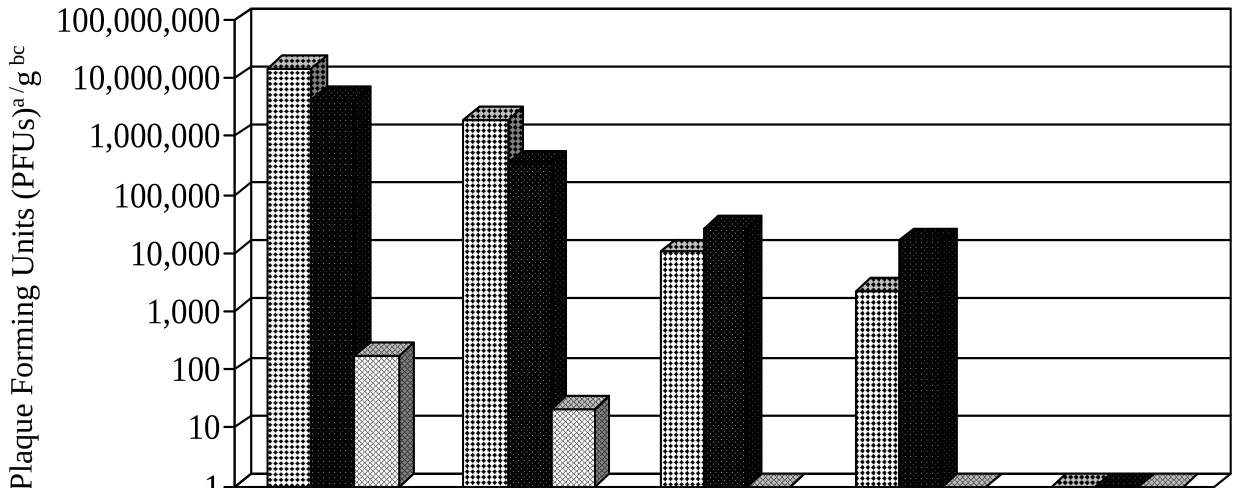


FIGURE 3: MEAN CONCENTRATIONS OF COLIPHAGES (SOMATIC [SP] & F SPECIFIC [FRNA]) AND ENTERIC VIRUS [EV] IN STICKNEY WRP SLUDGE PROCESSING OPERATION SITES



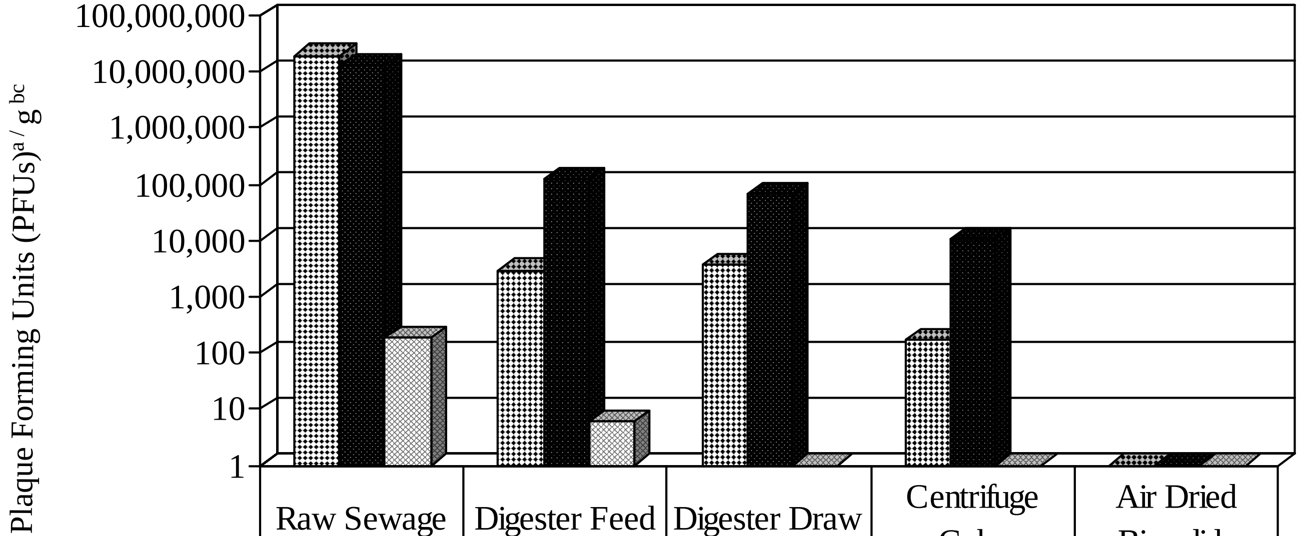
	Raw Sewage	Digester Feed	Digester Draw	Centrifuge Cake	Air Dried Biosolids
FRNA PFU/g	14,965,467	1,930,933	10,600	2,233	< 0.1441
SP PFU/g	4,257,900	350,300	26,233	16,100	< 0.1441
EV PFU/4g	< 172.6	< 21.5	< 0.9566	< 0.7366	< 0.7998

[a] Plaque Forming Units

[b] FRNA & SP Results Based on Dry Weight of 1 g of as-received Biosolids

[c] EV Results Based on Dry Weight of 4 g of as-received Biosolids

FIGURE 4: MEAN CONCENTRATIONS OF COLIPHAGES (SOMATIC [SP] & F SPECIFIC [FRNA]) AND ENTERIC VIRUS [EV] IN CALUMET WRP SLUDGE PROCESSING OPERATION SITES



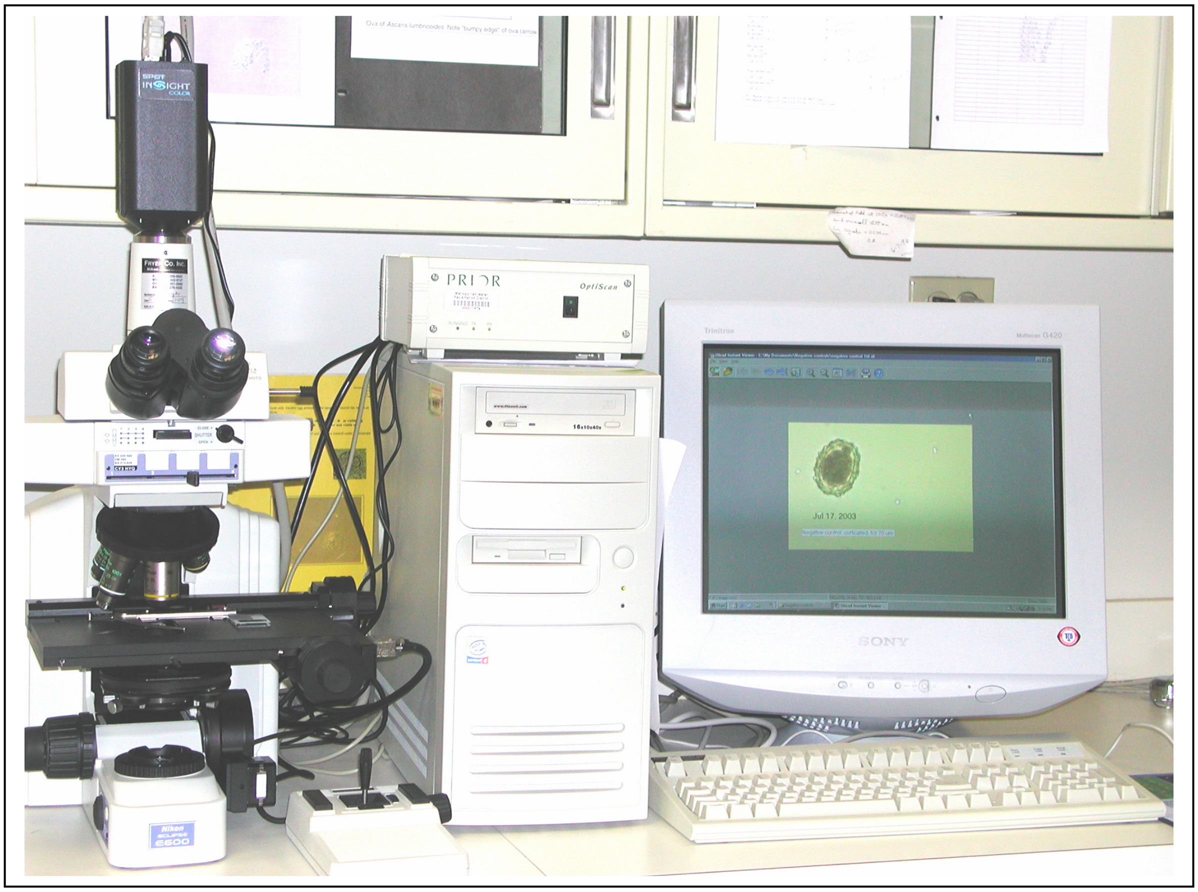
	Raw Sewage	Digester Feed	Digester Draw	Centrifuge Cake	Air Dried Biosolids
FRNA PFU/g	19,386,100	2,967	3,600	164	< 0.1296
SP PFU/g	13,036,100	121,900	66,500	10,600	< 0.1296
EV PFU/4g	<186.7	< 5.9	<0.5334	< 0.7931	< 0.8000

[a] Plaque Forming Units

[b] FRNA & SP Results Based on Dry Weight of 1 g of as-received Biosolids

[c] EV Results Based on Dry Weight of 4 g of as-received Biosolids

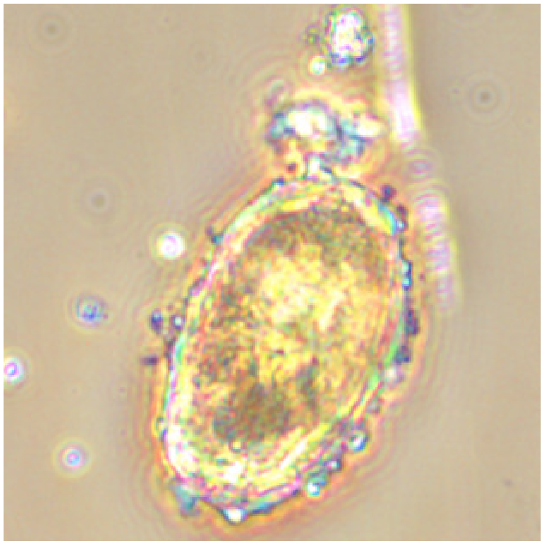
FIGURE IV-5: MICROSCOPIC IMAGE ANALYSIS SYSTEM (MIA)



Nikon E600 Research Phase Contrast Microscope with a Digital Snap Video Camera Transmitting Microscopic Images from Slide to a Computer Workstation with a Metamorph™ Software Program.

FIGURE IV-6: DIGITAL IMAGES OF *ASCARIS LUMBRICOIDES* (OR VARIETY *SUUM*)

A

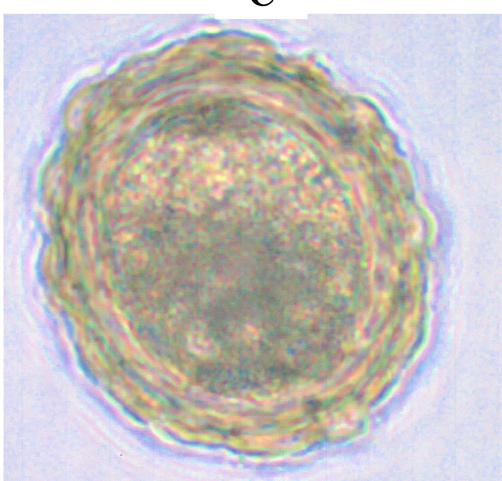


July 8, 2004

B

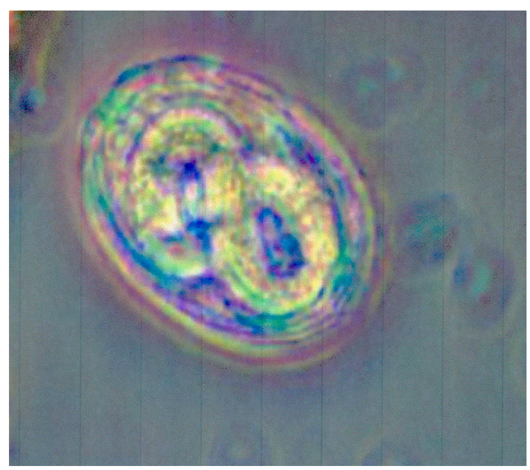
July 28, 2004

C



Negative Control

D



Positive Control

A. Non Viable ovum; 74.04 µm long.
B. Viable fertile ovum; 66.28 µm long.
C. Non-viable ovum; 66 µm long.
D. Viable, decorticated ovum; 68 µm long.

AQUATIC ECOLOGY AND WATER QUALITY SECTION

The Aquatic Ecology and Water Quality Section is primarily responsible for assessing the water and sediment quality in both shallow water and deep-draft waterways in the District's service area. The biological monitoring program, which runs in conjunction with the Ambient Water Quality Monitoring (AWQM) Program, includes chlorophyll monitoring, the study of the benthic invertebrate and fish communities, characterization of the physical habitat, and assessment of sediment toxicity and sediment chemistry. The primary objective of the monitoring program is to provide scientific data to the District and the Illinois Environmental Protection Agency (IEPA) regarding the biological condition of the Chicagoland waterways. The IEPA uses the data to assess the biological integrity, physical habitat, and sediment quality in waterways in the District's service area. These assessments are summarized in the IEPA's 305(b) use assessment report. Results from the 305(b) report are used by IEPA to prepare a list of impaired waters through the 303(d) listing process.

The biological portion of the AWQM Program began in 2001 and is conducted from June through September at 59 stations on the Chicago Waterway System (Figure V-1). Fifteen of the 59 sampling stations are assessed annually, with the remaining 44 stations assessed once every four years.

Additional water and sediment quality monitoring is conducted outside of the District's service area in the lower Des Plaines River and the Illinois River. Special water quality surveys are also conducted to provide technical assistance for the M&O and Engineering Departments.

Fish Monitoring in 2004

During July through October of 2004, fish were collected by electrofishing and seining at 34 biological monitoring stations on Chicago area waterways. Two thousand six hundred and sixty-seven fish composed of 45 species were identified, weighed, and measured for length. The fish were also examined for parasites and disease.

Data from these collections are shown in Table V-1 for the deep-draft waterways and in Table V-2 for the shallow waterways. The most abundant species (those comprising a three percent or greater portion of the total catch) in the deep-draft waterways included gizzard shad, carp, and bluntnose minnow. In the shallow waterways, spotfin shiner, blackstripe topminnow, green sunfish, and bluegill were the most abundant.

Chlorophyll Monitoring 2001–2004

As a photosynthetic component of all algae cells, the determination of chlorophyll *a* is an accepted way of quantifying algal biomass in lakes and streams. Chlorophyll *a* values are of interest to regulatory agencies since it is also widely accepted that high algae concentrations may indicate nutrient impairment. The IEPA is cooperating with other state and local agencies to promulgate regional water quality criteria for nutrients and possibly chlorophyll. In light of this consideration, the District began monitoring chlorophyll on a monthly basis in August 2001 as part of the AWQM Program. Results are shown in Table V-3. The highest mean values of chlorophyll *a* occurred at Station 86, Burnham Avenue (40 µg/L) on the Grand Calumet River, and at Station 29, Stephen Street (41 µg/L) and Station 91, Material Service Road (46 µg/L) on the Des Plaines River.

Illinois Waterway Monitoring

Water Quality. In 1984, the Research and Development (R&D) Department established a long-term water and sediment monitoring program along the Illinois Waterway from the Lockport Lock to the Peoria Lock, a distance of approximately 133 miles. The purpose of the monitoring program was to assess the chemical and microbiological quality of the water and to characterize the chemical quality of the sediments.

Historically, water samples were collected annually during May, August, and October from each of the 49 sampling stations (Figure V-2 and V-3). During October, sediment samples were collected at 14 selected stations. Similar monitoring studies were conducted during 2004.

The mean dissolved oxygen (DO) concentrations along the six navigational pools (Lockport, Brandon Road, Dresden Island, Marseilles, Starved Rock, and Peoria) during May, August, and October of 2004 are presented in Figure V-4. During 2004, the mean DO concentration increased substantially along the Illinois Waterway from the Lockport Pool (4.4 mg/L) to the upper Peoria Pool (10.2 mg/L), and then fell slightly in the lower Peoria Pool (9.0 mg/L). The increase in DO along the waterway may be attributable to re-aeration at the Brandon Road, Dresden Island, and Marseilles navigational dams and due to photosynthesis.

Figure V-5 displays the mean concentrations of ammonia nitrogen measured along the Illinois Waterway in 2004. Ammonia nitrogen levels fall off rapidly throughout the Brandon Road Pool. Mean ammonia nitrogen concentration decreased from 0.71 mg/L in the Lockport Pool to 0.16 mg/L in the lower Peoria Pool. Nutrient uptake by algae and aquatic vegetation resulting in primary production, instream nitrification, and dilution from the Kankakee River and other tributaries may account for the decrease in ammonia nitrogen.

The mean total nitrogen (TN) concentration along the Illinois Waterway remained fairly uniform after a significant drop between the Dresden Island and Marseilles Pools as evidenced by Figure V-6. The mean concentration of TN decreased overall between the Lockport Pool (7.15 mg/L) and the lower Peoria Pool (4.18 mg/L). The decrease in TN may be a result of nutrient uptake by aquatic plants, in-stream nitrification/ denitrification, and dilution from tributaries.

Figure V-7 shows the mean concentration of total phosphorus (TP) measured in 2004 during the three monitoring periods. There was a decline in the mean concentration of TP from the Lockport Pool (1.72 mg/L) to the lower Peoria Pool (0.52 mg/L). The decrease in TP may be explained by nutrient uptake from biological production and sedimentation of particulate phosphorus.

Fecal coliform (FC) levels fell substantially along the Illinois Waterway, especially throughout the Dresden Island Pool. Geometric mean FC values decreased from 176 cfu/100 mL in the Lockport Pool to 37 cfu/100 mL in the lower Peoria Pool as shown in Figure V-8.

Sediment Quality. Sediment quality can considerably impact water quality, benthic community structure, food chain dynamics, and other aspects of freshwater ecosystems. Since sediment acts as a reservoir for persistent or bioaccumulative contaminants, sediment data reflects a long-term record of quality. Sediment chemistry results are presented in Table V-4. Trace metal data from the sediments along the Illinois Waterway are shown in Table V-5.

The mean total solids (TS) in the sediment increased between Lockport (41.9 percent) and the Marseilles Pool (75.1 percent), and then decreased along the Illinois Waterway until the lower Peoria Pool (58.3 percent). There was generally a decrease in the mean total volatile solids (TVS) from the Lockport Pool (10 percent) to the Starved Rock Pool (1 percent), and then a slight increase until the lower Peoria Pool (5 percent).

Mean ammonia nitrogen concentrations in sediment decreased markedly from 127 mg/kg in the Lockport Pool to a mean of 23 mg/kg in the lower Peoria Pool.

While the concentrations of the 13 trace metals measured in the sediment were quite variable among the 14 sampling stations, significantly higher levels of cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc were detected in the Lockport and Brandon Road Pools compared to the Dresden Island, Marseilles, and Starved Rock Pools. There were also elevated levels of iron, manganese, mercury, and zinc in some of the sediment from the Peoria Pools. Station 35 in the upper Peoria Pool showed a very high mercury concentration of 1.2743 mg/kg in the sediment.

Council For Food and Agricultural Research Nutrient Study

A cooperative study regarding nutrients in waterways throughout Illinois was undertaken with the University of Illinois and the Illinois Council on Food and Agricultural Research (CFAR). The results of this study will be considered by IEPA when promulgating nutrient standards. Five monitoring stations were chosen on the Des Plaines River, Salt Creek, and the North Branch of the Chicago River for this three-year project. Starting in April of 2004, water samples were collected two times per month through November, once in December (winter sampling only once per month), and on four consecutive days during three rain events. Water samples were analyzed for nutrients and other relevant constituents, the results of which are shown in Table V-6. The Aquatic Ecology Section collected and sent one sediment sample from each station to collaborators at the University of Illinois, and one benthic invertebrate sample from each station for analysis by the District contractor.

Continuous Monitoring of Dissolved Oxygen

In order to gain a better understanding of the oxygen dynamics in Chicago area deep-draft waterways, the R&D Department developed a comprehensive continuous DO monitoring program beginning in August 1998 in the Chicago River System, and in July 2001 in the Calumet River System.

Dissolved oxygen was measured hourly using remote (in-situ) water quality monitors deployed in protective stainless steel housing enclosures. In the Chicago River System, the monitors were located at 21 stations on the North Shore Channel, North Branch of the Chicago River, Chicago River, South Branch of the Chicago River, Bubbly Creek, and the Chicago Sanitary and Ship Canal. In the Calumet River System, the monitors were located at 13 stations on the Calumet River, Grand Calumet River, Little Calumet River, and the Calumet-Sag Channel. One station was located in the Des Plaines River System.

A summary of the DO results, including the number and percent of DO values measured with the monitors during the period from January through December of 2004 that were above the Illinois Pollution Control Board (IPCB) DO standards, are presented in Table V-7.

During 2004, the stations that recorded the lowest percentage of DO values meeting the IPCB DO standards were Linden (71 percent), Simpson (48 percent), and Main (81 percent) Streets on the North Shore Channel; 36th Street (71 percent) and I-55 (60 percent) on Bubbly Creek; Cicero Avenue (77 percent), Route 83 (73 percent), and Lockport Powerhouse (73 percent) on the Chicago Sanitary and Ship Canal; Torrence Avenue on the Grand Calumet River (78 percent), and Ashland Avenue (57 percent) on the Little Calumet River. Overall, 173,138 of 196,942 DO measurements (88 percent) met the IPCB DO water quality standards in the Chicago and Calumet River Systems.

Fecal Coliform Densities in District Waterways During Dry and Wet Weather

This study was initiated in 2004 to determine the distribution and die-off of FC bacteria in District waterways relative to issues raised by the Chicago Area Waterways Use Attainability Analysis. The FC density was measured at each of 12 locations in two segments of the Chicago Waterway System, including the North Area waterways (North Shore Channel and North Branch Chicago River) and South Area waterways (Little Calumet River and Calumet-Sag Channel). Sample stations are shown in Figure V-9.

Water samples were collected twice a month between April 1 and December 31, 2004. The Industrial Waste Division (IWD) collected water samples for FC at the North Area stations on the first Tuesday and second Monday of each month and at the South Area stations on the third Tuesday and fourth Monday of each month. IWD also collected water samples for FC each day, for a maximum of three days, following any rain event sufficient to cause an overflow at the North Side Pumping Station (for North Area stations) or at the 122nd Street, 125th Street, or 95th Street Pumping Stations (for South Area stations). No samples were collected on weekends or holidays. FC data from routine bridge run samples collected during January through March 2004 at the North and South Area stations were also included as dry weather data in this study. Water samples were analyzed for FC by the Analytical Microbiology Section of the EM&R Division using the FC membrane filter procedure.

Results of dry and wet weather FC are summarized in Table V-8. Fecal coliform data are expressed as colony forming units (cfu) per 100 mL. For the 12 sampling stations, dry weather FC ranged from 9 to 220,000 cfu/100 mL. During wet weather, FC ranged from 80 to 470,000 cfu/100 mL. Geometric mean dry weather FC ranged from 70 to 7,400 cfu/100 mL. Geometric mean wet weather FC ranged from 240 to 26,000 cfu/100 mL.

Downstream from the North Side WRP effluent outfall, dry weather geometric mean FC decreased from 7,400 cfu/100 mL at Foster Avenue on the North Shore Channel to 1,600 cfu/100 mL at Grand Avenue on the North Branch of the Chicago River. Wet weather geometric mean FC decreased from 21,000 cfu/100 mL at Foster Avenue on the North Shore Channel to 5,700 cfu/100 mL at Grand Avenue on the North Branch of the Chicago River.

Downstream from the Calumet WRP effluent outfall, dry weather geometric mean FC decreased from 2,700 cfu/100 mL at Halsted Street on the Little Calumet River to 100 cfu/100 mL at Route 83 on the Calumet-Sag Channel. Wet weather geometric mean FC decreased from 4,600 cfu/100 mL at Halsted Street on the Little Calumet River to 1,200 cfu/100 mL at Route 83 on the Calumet-Sag Channel.

Comparisons of geometric means of FC bacteria, with calculated die-off density estimates for wet and dry weather, are shown in Figure V-10 (North Area) and Figure V-11 (South Area). The estimated die-off curves, which were produced using nonlinear regression, fit the sample geometric means well, with R^2 values all greater than 0.94. The data for stations located upstream of the WRPs (Oakton Street on the North Shore Channel and Indiana Avenue on the Little Calumet River) and for stations located in tributaries (i.e., Albany Avenue on the North Branch of the Chicago River and Ashland Avenue on the Little Calumet River) were plotted in Figures V-10 and V-11 but were not included in the die-off regression analysis. It should be noted that the highest wet weather FC (470,000 cfu/100 mL) during this study occurred upstream of the North Side WRP at Oakton Street on the North Shore Channel and the highest dry weather FC (220,000 cfu/100 mL) occurred at Ashland Avenue on the Little Calumet River. This highest dry weather FC result appears to be an anomaly, but it has not been excluded in the analysis of the data set.

In order to estimate waterway FC that might occur during wet weather conditions if there was complete disinfection of WRP effluent outfalls, dry weather FC were subtracted from wet weather FC and are shown in Figure V-12 (North Area) and Figure V-13 (South Area) with the calculated wet and dry weather FC. The calculated wet weather and calculated dry weather FC data displayed in Figures V-12 and V-13 were derived from the die-off equations determined from Figures V-10 and V-11. During wet weather, elimination of the FC contributions from the WRPs (dry weather FC) made little difference to the waterway FC in either area. Estimated wet weather FC, with or without disinfection of WRP effluent, would not meet present General Use Water Quality Standards for at least a distance of 26 miles downstream of the WRPs. Densities of FC bacteria, with or without disinfection, would be equivalent at this distance downstream of the WRPs. WRP effluent disinfection will not be effective for improving water quality during wet weather.

Table V-9 shows estimated FC calculated from die-off equations at distances of 5 miles and at points downstream of WRP effluent outfalls at which General Use Water Quality Standards are first predicted to be met. FC less than the 200 cfu/100 mL IPCB General Use stream standard at North Area stations were predicted to occur 21 miles downstream of the North Side WRP during dry weather, 29 miles downstream during wet weather, and 27 miles downstream if disinfection eliminated FC from the North Side WRP effluent outfall during wet weather. FC less than the 200 cfu/100 mL IPCB General Use stream standard at South Area stations were predicted to occur 14 miles downstream of the Calumet WRP during dry weather and 37 miles downstream during wet weather, with or without disinfection having eliminated all FC from the Calumet WRP effluent outfall during wet weather.

Disinfection of WRP effluent during wet weather would not improve water quality below either the North Side or Calumet WRPs such that present General Use Water Quality Standards would be met.

It is expected that the IEPA may eventually replace FC limits in District National Pollution Discharge Elimination System permits and water quality standards with limits for *Escherichia coli* (EC) densities. In anticipation of this, Zmuda, Gore, and Abedin (R&D Report 04-10, July 2004) formulated ratios from which EC could be converted from FC for both the Chicago River and Calumet River Systems. Their best estimates for EC/FC ratios were 0.93 for the Calumet River System and 0.83 for the Chicago River System.

Given this relationship between FC and EC and the FC die-off equations developed for dry weather in this study, it is estimated that within 4.95 miles of the Calumet WRP and within 11.8 miles of the North Side WRP, the EC water quality standard of 1030 cfu/100 mL currently being considered for the new limited contact recreation use category would be met under dry weather conditions in their receiving streams.

TABLE V-1 : FISH COLLECTED FROM DEEP-DRAFT WATERWAYS DURING 2004

Fish Species or Hybrid (x)	North Shore Channel Touhy Avenue	North Branch Chicago River Albany Avenue	Bubbly Creek[1]	Chicago Sanitary & Ship Canal[2]	Calumet River 130th Street	Little Calumet River Halsted Street	Calumet-Sag Channel[3]
Gizzard shad	109	61	70	180	176	36	148
Goldfish	1	0	1	2	0	9	0
Carp	40	10	22	101	18	24	62
Carp x Goldfish Hybrid	1	0	4	2	1	0	0
Golden shiner	35	3	12	13	0	9	0
Emerald shiner	0	1	0	8	2	20	1
Spottail shiner	0	0	0	0	0	0	1
Spotfin shiner	1	4	7	7	0	0	0
Bluntnose minnow	0	0	2	68	76	1	8
Fathead minnow	0	0	0	1	6	0	0
White sucker	0	0	0	0	5	18	0
Black bullhead	0	0	0	0	0	1	0
Yellow bullhead	0	0	0	5	0	0	1
Channel catfish	0	0	2	4	0	0	0
Mosquitofish	0	0	0	2	0	0	0
White bass	0	0	0	1	0	0	0
White perch	0	0	0	0	0	8	1
Yellow bass	0	0	0	0	0	2	1
Rock bass	2	0	0	0	6	0	0

TABLE V-1 (Continued): FISH COLLECTED FROM DEEP-DRAFT WATERWAYS DURING 2004

Fish Species or Hybrid (x)	North Shore Channel Touhy Avenue	North Branch Chicago River Albany Avenue	Bubbly Creek[1]	Chicago Sanitary & Ship Canal[2]	Calumet River 130th Street	Little Calumet River Halsted Street	Calumet-Sag Channel[3]
Green sunfish	5	2	1	8	3	1	12
Pumpkinseed	29	3	30	48	4	11	0
Bluegill	16	1	18	5	5	25	2
Smallmouth bass	0	0	0	0	43	0	2
Largemouth bass	10	3	14	14	17	37	14
White crappie	0	0	1	0	0	1	0
Black crappie	0	0	0	0	0	2	1
Freshwater drum	0	0	0	0	1	2	1
Round goby	0	0	0	1	0	0	2
Nile tilapia	0	0	1	0	0	0	0
Total Number	249	88	185	470	363	207	257
Total Species	11	9	14	18	14	17	15

[1]Interstate Highway 55, 35th Street, and Racine Avenue Pumping Station.
[2]Cicero Avenue, Harlem Avenue, 16th Street Lockport, SEPA 5.
[3]Cicero Avenue, SEPA 4, SEPA 5.

TABLE V-2 : FISH COLLECTED FROM SHALLOW WATER STREAMS DURING 2004

Fish Species or Hybrid (x)	Buffalo Creek Lake Cook Road	Des Plaines River[1]	Higgins Creek[2]	Salt Creek[3]	West Branch Du Page River[4]	Poplar Creek Route 19	North Branch Chicago River Albany Avenue
Bowfin	0	1	0	0	0	0	0
Gizzard shad	0	10	0	0	0	0	0
Northern pike	0	5	0	0	0	0	0
Goldfish	0	1	0	10	0	0	0
Carp	1	24	0	17	4	0	0
Hornyhead chub	0	0	0	0	0	7	0
Spottail shiner	0	1	0	0	0	0	0
Spotfin shiner	0	32	0	28	0	0	0
Sand shiner	0	1	0	4	0	0	0
Bluntnose minnow	0	9	0	2	0	3	0
Fathead minnow	0	0	1	0	2	0	0
Creek chub	0	0	0	10	1	2	0
White sucker	0	7	2	6	1	2	3
Spotted sucker	0	11	0	0	0	0	0
Golden redhorse	0	0	0	0	0	1	0
Black bullhead	0	0	0	1	1	1	0
Yellow bullhead	7	16	0	9	3	3	0
Channel catfish	0	5	0	0	0	0	0
Tadpole madtom	0	2	0	0	0	0	0
Blackstripe topminnow	9	26	0	0	0	0	0
Rock bass	0	3	0	0	0	0	0
Green sunfish	11	166	0	22	61	19	3

TABLE V-2 (Continued): FISH COLLECTED FROM SHALLOW WATER STREAMS DURING 2004

Fish Species or Hybrid (x)	Buffalo Creek Lake Cook Road	Des Plaines River[1]	Higgins Creek[2]	Salt Creek[3]	West Branch Du Page River[4]	Poplar Creek Route 19	North Branch Chicago River Albany Avenue
Pumpkinseed	0	0	0	10	2	0	0
Warmouth	1	2	0	0	0	0	0
Orangespotted sunfish	1	16	0	3	0	0	0
Bluegill	16	34	0	103	18	0	0
Largemouth bass	0	9	0	16	2	0	0
Black crappie	0	7	0	3	2	0	0
Green sunfish x Pumpkinseed Hybrid	2	0	0	1	1	0	0
Yellow perch	0	1	0	0	0	0	0
Blackside darter	0	1	0	0	0	0	0
Sauger	0	7	0	0	0	0	0
Walleye	0	0	0	9	0	0	0
Freshwater drum	0	1	0	0	0	0	0
Round goby	0	3	0	0	0	0	0
Total Fish	48	401	3	254	98	38	6
Total Fish Species	8	27	2	17	12	8	2

[1]Lake Cook Road, Oakton Street, Belmont Avenue, Roosevelt Road, Ogden Avenue, Willow Springs Road, Stephen Street, Material Service Road.
[2]Elmhurst Road, Wille Road.
[3]Higgins Road, Arlington Heights Road, Devon Avenue, Wolf Road, Brookfield Avenue.
[4]Springinsguth Road, Walnut Lane, Lake Street.

TABLE V-3 : MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM CHICAGO AREA WATERWAYS FROM AUGUST 2001 THROUGH DECEMBER 2004

Station No.	Station Name	Number of Samples	Mean (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Standard Deviation (µg/L))
	West Fork North Branch Chicago River					
106	Dundee Rd.	18	25	4	118	31
103	Golf Rd.	34	18	2	96	18
	Middle Fork North Branch Chicago River					
31	Lake-Cook Rd.	33	9	<1	35	8
	Skokie River					
32	Lake-Cook Rd.	33	14	1	91	17
105	Frontage Rd.	41	22	2	80	17
	North Branch Chicago River (Wadeable Portion)					
104	Glenview Rd.	29	18	1	47	12
34	Dempster St.	40	16	1	39	10
96	Albany Ave.	37	17	2	61	15
	North Shore Channel					
35	Central St.	32	7	<1	91	18
102	Oakton St.	38	11	<1	65	18
36	Touhy Ave.	40	1	<1	5	1
101	Foster Ave.	40	3	<1	31	5
	North Branch Chicago River (Deep-Draft Portion)					
37	Wilson Ave.	41	4	<1	18	4
73	Diversey Ave.	41	4	<1	12	3
46	Grand Ave.	41	5	1	20	5
	Chicago River					
74	Outer Drive	36	3	1	18	4
100	Wells St.	37	3	1	16	3

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM CHICAGO AREA WATERWAYS FROM AUGUST 2001 THROUGH DECEMBER 2004

Station No.	Station Name	Number of Samples	Mean (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Standard Deviation (µg/L))
	<u>South Branch Chicago River</u>					
39	Madison St.	39	4	1	16	4
108	Loomis St.	41	5	<1	26	6
	<u>Bubbly Creek (South Fork South Branch Chicago River)</u>					
99	Archer Ave.	41	15	<1	90	20
	<u>Chicago Sanitary and Ship Canal</u>					
40	Damen Ave.	24	7	1	25	7
-	Western Ave.[a]	17	3	1	7	2
75	Cicero Ave.	41	7	1	25	7
41	Harlem Ave.	41	3	1	8	2
42	Route 83	41	4	<1	24	4
48	Stephen St.	41	5	1	20	4
92	Lockport	171	5	<1	37	5
	<u>Calumet River</u>					
49	Ewing Ave.	38	2	1	5	1
55	130th St.	37	7	1	22	5
	<u>Wolf Lake</u>					
50	Burnham Ave.	40	6	<1	18	5
	<u>Grand Calumet River</u>					
86	Burnham Ave.	33	40	3	313	69
	<u>Little Calumet River (Deep-Draft Portion)</u>					
56	Indiana Ave.	37	20	3	64	14
76	Halsted St.	39	7	<1	29	7
	<u>Thorn Creek</u>					
54	Joe Orr Rd.	21	7	1	33	8
97	170th St.	38	10	2	32	7

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM CHICAGO AREA WATERWAYS FROM AUGUST 2001 THROUGH DECEMBER 2004

Station No.	Station Name	Number of Samples	Mean (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Standard Deviation (µg/L))
		Little Calumet River (Wadeable Portion)				
52	Wentworth Ave.	35	7	1	40	7
57	Ashland Ave.	35	10	2	43	9
		Calumet-Sag Channel				
58	Ashland Ave.	41	10	1	35	10
59	Cicero Ave.	40	11	1	56	12
43	Route 83	38	14	<1	93	18
		Buffalo Creek				
12	Lake-Cook Rd.	27	28	7	65	13
		Higgins Creek				
77	Elmhurst Rd.	22	12	4	23	5
78	Wille Rd.	40	3	<1	15	3
		Des Plaines River				
13	Lake-Cook Rd.	39	27	7	105	20
17	Oakton St.	35	27	2	108	24
19	Belmont Ave.	39	19	<1	91	23
20	Roosevelt Rd.	34	15	<1	81	19
22	Ogden Ave.	32	18	1	94	23
23	Willow Springs Rd.	35	25	1	161	34
29	Stephen St.	38	41	1	299	62
91	Material Service Rd.	39	46	3	214	51
		Salt Creek				
79	Higgins Rd.	32	36	10	114	23
80	Arlington Hts. Rd.	38	15	2	41	11
18	Devon Ave.	38	17	4	45	9
24	Wolf Rd.	39	10	1	49	11
21	First Ave.[b]	9	11	2	46	14
109	Brookfield Ave.	25	13	<1	50	14

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM CHICAGO AREA WATERWAYS FROM AUGUST 2001 THROUGH DECEMBER 2004

Station No.	Station Name	Number of Samples	Mean (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Standard Deviation (µg/L))
		West Branch DuPage River				
63	Longmeadow Lane [c]	2	17	8	25	13
110	Springinsguth Rd.	10	11	1	23	7
89	Walnut Lane	38	6	1	31	7
64	Lake St.	40	23	5	103	19
		Poplar Creek				
90	Route 19	34	12	1	32	8

[a]Samples were taken at Western Ave. instead of Damen Ave. during 2001-2002 due to bridge construction.
[b]First Ave. station on Salt Creek was replaced by Brookfield Ave. in July 2002 due to low flow.
[c]Longmeadow Ln. station on West Branch DuPage River was replaced by Springinsguth Rd. in January 2004 due to low flow.

TABLE V-4: CHEMICAL CHARACTERISTICS OF SEDIMENT COLLECTED FROM MONITORING STATIONS IN THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES, STARVED ROCK, AND PEORIA POOLS OF THE ILLINOIS WATERWAY, OCTOBER 2004

		Constituents (Expressed on a dry weight basis)							
Station No.	Navigational Pool	Total Solids (%)	Total Volatile Solids (% of Total)	Ammonia Nitrogen (mg/kg)	Total Kjeldahl Nitrogen (mg/kg)	Nitrite + Nitrate Nitrogen (mg/kg)	Total Phos-phorus (mg/kg)	Total Cyanide (mg/kg)	Phenols (mg/kg)
1	Lockport	41.9	10	127	3,169	6.57	6,315	1.534	0.119
2	Brandon Road	40.7	11	79	3,323	10.69	3,257	1.958	0.167
5	Dresden Island	65.2	4	23	693	4.98	1,255	1.245	0.035
8	Dresden Island	25.4	15	77	8,673	9.68	1,142	0.122	0.020
12	Marseilles	75.9	1	6	163	1.67	628	0.041	0.211
18	Marseilles	74.3	4	19	886	2.68	722	0.028	0.042
23	Starved Rock	84.9	1	4	115	2.00	302	0.005	0.034
28	Upper Peoria	76.6	<1	4	38	1.07	89	<0.002	0.112
32	Upper Peoria	67.8	5	5	958	1.86	799	0.012	0.177
35	Upper Peoria	56.7	9	56	2,703	3.15	1,532	0.190	0.240
38	Upper Peoria	51.4	5	35	1,676	2.77	1,699	1.760	0.101
41	Upper Peoria	52.4	7	73	2,251	3.05	1,442	0.042	0.120
44	Lower Peoria	52.4	7	28	2,365	4.71	863	No Data	No Data
48	Lower Peoria	64.1	3	18	924	3.21	523	No Data	No Data

TABLE V-5: TRACE METALS IN SEDIMENT COLLECTED FROM MONITORING STATIONS IN THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES, STARVED ROCK, AND PEORIA POOLS OF THE ILLINOIS WATERWAY, OCTOBER, 2004

Station No.	Navigational Pool	(mg/kg dry weight)										
		Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Silver	Zinc
1	Lockport	4	8.5	170	148	27,782	173	438	0.6352	79	0.9	738
2	Brandon Road	6	16.7	189	313	28,321	221	439	0.9349	88	1.7	961
5	Dresden Island	<1	4.2	133	58	21,045	65	284	0.3513	72	<0.3	278
8	Dresden Island	3	0.8	28	37	16,521	22	226	0.1324	24	<0.3	110
12	Marseilles	<1	0.2	21	7	5,665	14	183	0.0162	13	<0.3	42
18	Marseilles	<1	0.6	25	16	12,389	23	387	0.1365	13	<0.3	76
23	Starved Rock	<1	0.2	42	7	13,655	16	489	0.0295	27	<0.3	68
28	Upper Peoria	<1	<0.1	36	2	3,579	9	86	0.0707	19	<0.3	18
32	Upper Peoria	6	1.1	41	19	26,474	18	1,527	0.0596	35	<0.3	108
35	Upper Peoria	20	1.6	84	67	28,632	73	377	1.2743	36	<0.3	298
38	Upper Peoria	1	1.4	52	33	19,776	29	459	0.1435	50	<0.3	152
41	Upper Peoria	1	2.0	38	32	19,248	33	585	0.2464	25	<0.3	183
44	Lower Peoria	<1	0.8	39	48	24,167	19	566	0.0925	56	<0.3	114
48	Lower Peoria	1	1.0	32	21	17,203	26	437	0.1897	22	<0.3	130

TABLE V-6: SUMMARY OF WATER QUALITY FROM FULLERTON AVENUE ON THE NORTH BRANCH CHICAGO RIVER, IRVING PARK ROAD AND OGDEN AVENUE ON THE DES PLAINES RIVER, AND JFK BOULEVARD AND WOLF ROAD ON SALT CREEK DURING 2004 FOR CFAR PROJECT

Station Name	Sampling Date	Chl. *a* (μg/L)	DO (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Ortho-Phosphate (mg/L)	TKN (mg/L)	TP (mg/L)	TSS (mg/L)	Turbidity (NTU)
Fullerton Ave.	4/21/04	4.5	5.5	ND	ND	ND	1.27	9.23	2.00	11	7.1
	5/5/04	ND	5.8	2.47	5.058	0.708	1.65	3.16	2.16	20	8.1
	5/18/04*	12.6	4.3	2.87	5.006	0.630	1.18	4.26	1.46	25	16.1
	5/19/04*	7.6	5.6	0.47	3.276	0.219	0.42	1.51	0.52	28	26.2
	5/20/04*	8.5	6.0	0.44	4.995	0.231	0.50	0.80	0.63	22	17.2
	5/21/04*	7.6	4.5	2.16	3.401	0.433	0.87	2.63	1.02	26	29.3
	6/2/04	4.8	6.3	0.80	2.951	0.340	0.34	2.13	0.65	30	27.9
	6/16/04	4.8	4.2	0.47	4.509	0.260	0.48	1.31	0.50	29	12.5
	6/30/04	2.2	5.6	0.42	3.523	0.189	0.39	1.10	0.57	15	10.5
	7/14/04	4.6	5.5	1.88	4.360	0.541	1.05	2.79	1.12	33	18.4
	7/28/04	1.7	5.1	0.49	3.687	0.274	0.34	1.34	0.47	28	21.6
	8/11/04	90.9	6.2	0.60	3.700	0.360	0.61	1.44	0.74	26	21.5
	8/25/04	2.3	4.4	1.19	2.703	0.193	0.44	1.84	0.59	42	30.7
	9/8/04	4.4	4.7	0.70	4.755	0.172	0.51	1.59	0.80	23	16.9
	9/22/04	3.2	5.0	1.20	5.729	0.282	1.07	1.74	1.05	17	11.2
	10/6/04	ND	4.9	1.78	6.113	0.299	1.49	3.37	1.73	23	11.3
	10/20/04	0.3	6.5	1.89	8.234	0.468	1.84	3.71	2.46	16	13.0
	11/3/04	1.9	8.5	0.18	3.861	0.059	0.51	1.01	0.55	18	14.6
	11/16/04*	1.9	4.7	1.16	7.375	0.519	1.41	2.46	1.74	13	7.9
	11/17/04*	4.0	6.5	0.92	6.913	0.446	1.71	1.87	1.78	8	7.7
	11/18/04*	4.4	5.5	1.08	7.461	0.578	1.43	2.18	1.51	10	7.2
	11/19/04*	3.9	5.0	1.11	7.478	0.489	1.25	2.53	1.17	12	7.1
	11/29/04*	4.1	5.8	0.23	4.944	0.267	0.69	1.25	0.52	12	10.9
	11/30/04*	3.5	6.7	0.93	5.094	0.737	1.04	2.17	0.88	14	10.0
	12/1/04*	3.1	6.5	2.91	2.217	0.733	0.89	4.23	0.90	6	11.8
	12/2/04*	3.7	8.1	1.26	ND	ND	0.56	1.88	0.43	10	14.4

TABLE V-6 (Continued): SUMMARY OF WATER QUALITY FROM FULLERTON AVENUE ON THE NORTH BRANCH CHICAGO RIVER, IRVING PARK ROAD AND OGDEN AVENUE ON THE DES PLAINES RIVER, AND JFK BOULEVARD AND WOLF ROAD ON SALT CREEK DURING 2004 FOR CFAR PROJECT

Station Name	Sampling Date	Chl. *a* (µg/L)	DO (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Ortho-Phosphate (mg/L)	TKN (mg/L)	TP (mg/L)	TSS (mg/L)	Turbidity (NTU)
Irving Park Rd.	4/21/04	28.0	6.5	0.21	2.995	0.086	0.26	2.07	0.53	42	43.5
	5/5/04	ND	9.9	0.10	4.798	0.028	0.51	1.13	0.69	32	20.5
	5/18/04*	13.7	5.8	0.17	2.763	0.039	0.26	1.76	0.32	69	50.1
	5/19/04*	15.0	6.0	0.26	2.306	0.054	0.21	1.97	0.51	86	96.7
	5/20/04*	12.4	6.3	0.10	2.795	0.040	0.25	0.42	0.26	31	29.1
	5/21/04*	12.0	5.6	0.37	2.367	0.043	0.46	0.52	0.23	46	35.7
	6/2/04	5.1	6.9	0.14	1.247	0.052	0.18	0.84	0.21	15	16.9
	6/16/04	5.3	4.8	0.13	2.202	0.035	0.30	0.96	0.27	17	21.0
	6/30/04	5.8	6.0	0.14	2.897	0.030	0.43	1.37	0.50	50	23.0
	7/14/04	8.7	5.2	0.12	2.163	0.021	0.52	0.85	0.46	47	26.9
	7/28/04	2.9	4.2	0.17	4.956	0.028	0.84	0.92	0.71	17	16.0
	8/11/04	3.1	4.7	0.14	3.831	0.034	0.66	2.50	0.86	35	18.7
	8/25/04	22.7	3.1	0.48	3.593	0.064	0.79	1.40	0.87	25	18.0
	9/8/04	1.7	3.9	0.34	6.712	0.060	1.02	1.40	1.31	23	18.1
	9/22/04	49.4	4.2	0.20	6.982	0.041	1.46	0.71	1.58	23	16.8
	10/6/04	2.8	5.3	0.22	10.399	0.030	1.58	1.61	1.82	40	21.0
	10/20/04	0.9	7.6	0.23	10.427	0.051	1.81	1.61	2.18	16	18.4
	11/3/04	1.7	7.4	0.42	5.625	0.062	1.04	1.28	1.18	14	15.3
	11/16/04*	1.2	8.5	0.27	7.718	0.037	1.33	1.44	1.49	27	11.6
	11/17/04*	1.4	8.2	0.24	8.217	0.041	1.61	1.22	1.58	20	20.4
	11/18/04*	1.5	7.5	0.20	8.188	0.052	1.68	1.14	1.61	24	18.5
	11/19/04*	4.9	6.7	0.26	5.745	0.081	1.21	2.37	1.34	62	51.1
	11/29/04*	7.7	6.7	0.20	3.518	0.037	0.70	1.40	0.62	24	19.9
	11/30/04*	6.7	9.6	0.14	3.928	0.026	0.75	1.06	0.58	20	15.6
	12/1/04*	7.7	8.4	0.17	3.092	0.028	0.57	1.10	0.55	29	35.0
	12/2/04*	9.7	10.6	0.32	3.711	0.030	0.65	2.55	0.58	18	20.6

TABLE V-6 (Continued): SUMMARY OF WATER QUALITY FROM FULLERTON AVENUE ON THE NORTH BRANCH CHICAGO RIVER, IRVING PARK ROAD AND OGDEN AVENUE ON THE DES PLAINES RIVER, AND JFK BOULEVARD AND WOLF ROAD ON SALT CREEK DURING 2004 FOR CFAR PROJECT

Station Name	Sampling Date	Chl. *a* (µg/L)	DO (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Ortho-Phosphate (mg/L)	TKN (mg/L)	TP (mg/L)	TSS (mg/L)	Turbidity (NTU)
JFK Blvd.	4/21/04	35.5	8.0	0.28	4.108	0.068	1.06	1.76	1.46	17	12.4
	5/5/04	ND	8.9	0.11	8.010	0.006	1.66	0.88	1.99	24	6.8
	5/18/04*	19.1	6.5	0.17	1.953	0.035	0.32	1.25	0.80	11	12.3
	5/19/04*	13.2	5.0	0.19	1.096	0.011	0.25	1.24	0.28	15	11.1
	5/20/04*	9.4	7.1	0.14	2.019	0.014	0.28	0.41	0.41	13	12.0
	5/21/04*	39.1	7.7	0.13	1.186	0.019	0.17	0.84	0.39	11	12.9
	6/2/04	11.4	8.2	0.39	0.951	0.022	0.07	1.07	0.19	24	22.8
	6/16/04	12.5	5.7	0.19	2.108	0.014	0.36	0.93	0.38	11	10.1
	6/30/04	4.7	7.4	0.10	9.711	0.009	1.47	0.99	2.64	5	3.1
	7/14/04	7.7	7.6	0.06	8.380	0.007	1.35	0.76	2.20	11	5.0
	7/28/04	7.9	7.8	0.08	11.996	0.000	2.90	1.09	3.89	6	4.0
	8/11/04	2.3	5.8	0.15	ND	0.013	2.49	1.57	2.95	53	15.2
	8/25/04	15.2	6.4	0.42	9.633	0.044	2.68	1.19	3.17	12	4.3
	9/8/04	11.9	6.0	0.31	11.490	0.021	2.45	1.41	2.76	10	4.3
	9/22/04	46.2	6.5	0.07	13.455	0.023	3.86	0.73	4.40	28	10.7
	10/6/04	5.3	5.8	0.14	12.717	0.000	3.73	1.58	4.72	13	5.0
	10/20/04	0.3	7.3	0.13	13.172	0.018	3.68	1.73	4.23	8	4.0
.	11/3/04	37.0	10.0	0.07	3.878	0.022	0.81	1.28	1.06	20	14.0
	11/16/04*	8.6	7.0	0.19	11.416	0.038	2.86	1.75	3.70	7	4.4
	11/17/04*	9.6	7.8	0.25	13.579	0.061	3.51	1.47	3.61	7	4.1
	11/18/04*	23.3	7.2	0.10	14.715	0.028	3.84	2.00	4.35	43	14.9
	11/19/04*	24.4	6.9	0.13	10.032	0.048	2.83	1.82	3.32	10	6.9
	11/29/04*	19.7	9.9	0.25	2.174	0.110	0.43	1.29	0.41	6	9.9
	11/30/04*	20.1	11.1	0.12	4.025	0.021	0.67	1.01	0.67	8	6.4
	12/1/04*	19.7	10.1	0.55	2.930	0.106	0.68	1.58	0.72	5	10.9
	12/2/04*	17.0	11.7	0.28	4.084	0.023	0.70	1.07	0.66	4	10.6

TABLE V-6 (Continued): SUMMARY OF WATER QUALITY FROM FULLERTON AVENUE ON THE NORTH BRANCH CHICAGO RIVER, IRVING PARK ROAD AND OGDEN AVENUE ON THE DES PLAINES RIVER, AND JFK BOULEVARD AND WOLF ROAD ON SALT CREEK DURING 2004 FOR CFAR PROJECT

Station Name	Sampling Date	Chl. *a* (µg/L)	DO (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Ortho-Phosphate (mg/L)	TKN (mg/L)	TP (mg/L)	TSS (mg/L)	Turbidity (NTU)
Ogden Ave.	4/21/04	24.0	8.0	0.18	3.662	0.067	0.39	1.65	0.74	30	26.0
	5/5/04	ND	10.3	0.22	4.454	0.030	0.54	1.10	0.71	36	15.2
	5/18/04*	14.9	6.0	0.15	2.973	0.044	0.29	1.69	0.43	65	38.6
	5/19/04*	13.0	6.8	0.17	2.937	0.050	0.42	1.99	0.59	68	44.3
	5/20/04*	10.5	7.3	0.13	2.422	0.047	0.23	0.71	0.39	65	54.9
	5/21/04*	12.5	6.8	0.20	2.533	0.053	0.29	1.04	0.39	73	54.0
	6/2/04	3.6	6.9	0.11	1.179	0.055	0.29	0.68	0.25	25	22.8
	6/16/04	6.1	5.5	0.18	2.055	0.035	0.43	1.23	0.38	39	26.8
	6/30/04	4.9	7.4	0.16	3.012	0.021	0.58	1.27	0.59	49	32.1
	7/14/04	5.5	7.1	0.11	2.232	0.024	0.53	0.91	0.54	48	29.6
	7/28/04	2.5	6.8	0.10	4.987	0.019	0.86	0.86	0.99	17	16.2
	8/11/04	1.3	7.2	0.11	3.962	0.026	0.91	0.97	0.98	20	18.4
	8/25/04	9.6	7.1	0.33	2.820	0.055	0.52	1.53	0.96	110	90.4
	9/8/04	1.6	4.3	0.33	6.234	0.057	1.21	1.03	1.50	20	14.2
	9/22/04	113.7	7.5	0.02	7.159	0.030	1.72	0.46	1.77	31	22.0
	10/6/04	1.2	9.5	0.15	8.580	0.038	1.46	1.46	1.65	21	13.6
	10/20/04	0.7	9.3	0.13	9.735	0.043	1.78	1.41	2.01	10	12.5
	11/3/04	5.0	9.3	0.20	3.397	0.064	0.80	1.14	0.91	26	26.0
	11/16/04*	0.9	10.0	0.26	8.274	0.060	1.55	1.17	1.60	8	10.6
	11/17/04*	1.7	10.3	0.22	8.603	0.043	1.84	1.12	1.68	9	9.0
	11/18/04*	2.1	10.0	0.21	8.881	0.045	1.77	0.90	1.81	19	14.2
	11/19/04*	1.5	7.9	0.18	8.160	0.050	1.83	1.07	1.70	15	14.9
	11/29/04*	9.0	9.5	0.27	3.375	0.066	0.68	1.35	0.62	27	24.8
	11/30/04*	10.2	11.1	0.16	3.212	0.031	0.64	0.96	0.51	23	17.1
	12/1/04*	7.9	10.4	0.15	3.260	0.033	0.59	1.13	0.55	37	31.7
	12/2/04*	8.3	11.7	0.34	3.277	0.042	0.60	1.16	0.55	23	25.8

TABLE V-6 (Continued): SUMMARY OF WATER QUALITY FROM FULLERTON AVENUE ON THE NORTH BRANCH CHICAGO RIVER, IRVING PARK ROAD AND OGDEN AVENUE ON THE DES PLAINES RIVER, AND JFK BOULEVARD AND WOLF ROAD ON SALT CREEK DURING 2004 FOR CFAR PROJECT

Station Name	Sampling Date	Chl. *a* (µg/L)	DO (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Ortho-Phosphate (mg/L)	TKN (mg/L)	TP (mg/L)	TSS (mg/L)	Turbidity (NTU)
Wolf Rd.	4/21/04	12.1	7.3	0.39	3.799	0.119	0.79	1.80	1.38	33	27.2
	5/5/04	ND	8.7	0.26	5.854	0.073	1.24	0.75	1.38	38	12.2
	5/18/04*	7.2	5.8	0.40	3.331	0.083	0.57	1.45	0.99	46	25.7
	5/19/04*	12.3	5.6	0.24	2.642	0.051	0.38	1.63	0.88	57	33.1
	5/20/04*	6.9	7.1	0.19	2.388	0.048	0.32	0.50	0.57	43	29.3
	5/21/04*	9.3	6.1	0.36	3.169	0.074	0.40	1.06	0.71	60	41.0
	6/2/04	3.2	6.5	0.15	1.095	0.039	0.18	1.01	0.35	41	30.0
	6/16/04	6.7	5.5	0.15	2.054	0.031	0.34	1.01	0.46	41	26.2
	6/30/04	2.3	6.4	0.20	5.654	0.052	0.62	0.82	1.31	29	7.0
	7/14/04	8.0	5.8	0.24	3.751	0.079	0.76	0.71	1.17	22	12.3
	7/28/04	1.7	6.2	0.25	8.623	0.088	1.66	1.02	2.28	19	16.0
	8/11/04	379.1	5.1	0.33	6.375	0.090	1.46	0.98	2.01	30	20.8
	8/25/04	9.5	6.6	0.52	3.197	0.072	0.87	1.43	1.14	53	54.6
	9/8/04	2.3	4.2	0.31	7.468	0.078	1.84	1.15	2.28	26	14.8
	9/22/04	2.1	6.6	0.11	10.363	0.093	2.99	0.54	3.40	24	16.4
	10/6/04	1.2	5.5	0.28	10.871	0.041	2.24	1.68	2.99	32	20.4
	10/20/04	2.4	8.1	0.20	11.284	0.056	2.71	1.83	3.19	32	29.3
	11/3/04	16.5	9.7	0.19	2.601	0.042	0.60	1.59	0.75	34	29.7
	11/16/04*	3.8	9.5	0.24	12.540	0.031	2.48	1.26	2.76	18	12.9
	11/17/04*	5.9	9.0	0.20	12.234	0.049	2.76	1.46	3.02	23	20.4
	11/18/04*	5.8	9.2	0.15	11.441	0.052	2.11	1.48	2.74	34	22.4
	11/19/04*	8.4	8.4	0.19	11.590	0.056	ND	1.56	2.93	48	39.3
	11/29/04*	16.7	8.4	0.14	2.328	0.058	0.49	1.17	0.48	25	21.7
	11/30/04*	14.7	10.5	0.31	3.153	0.106	0.62	1.16	0.59	24	20.9
	12/1/04*	11.9	9.2	0.26	3.607	0.055	0.62	1.31	0.64	42	42.0
	12/2/04*	12.8	11.5	0.44	3.998	0.104	0.75	1.35	0.81	19	22.8

*Denotes rain event sampling.
ND = No Data.

TABLE V-7: NUMBER AND PERCENT OF DISSOLVED OXYGEN VALUES MEASURED ABOVE THE ILLINOIS POLLUTION CONTROL BOARD WATER QUALITY STANDARD[1]

Monitoring Station	Waterway	IPCB DO Standard	Number of DO Values	Number of DO Values Above Standard	Percent of DO Values Above Standard
	Chicago River System				
Linden Street	North Shore Channel	5	335	237	71
Simpson Street	North Shore Channel	5	1,981	961	48
Main Street	North Shore Channel	5	7,827	6,314	81
Foster Avenue	North Shore Channel	4	3,362	3,362	100
Addison Street	North Branch Chicago River	4	8,276	8,195	99
Fullerton Avenue	North Branch Chicago River	4	8,610	8,261	96
Division Street	North Branch Chicago River	4	1,676	1,665	99
Kinzie Street	North Branch Chicago River	4	8,530	8,268	97
Chicago River Controlling Works	Chicago River	5	1,508	1,508	100
Michigan Avenue	Chicago River	5	1,641	1,641	100
Clark Street	Chicago River	5	8,590	8,403	98
Jackson Boulevard	South Branch Chicago River	4	1,834	1,834	100
Loomis Street	South Branch Chicago River	4	8,279	8,214	99
36th Street	Bubbly Creek	4	7,605	5,396	71
Interstate Highway 55	Bubbly Creek	4	8,109	4,891	60
Cicero Avenue	Chicago Sanitary and Ship Canal	4	8,588	6,591	77
B&O Railroad	Chicago Sanitary and Ship Canal	4	8,416	8,146	97
Route 83	Chicago Sanitary and Ship Canal	4	8,114	5,913	73
River Mile 302.6	Chicago Sanitary and Ship Canal	4	2,026	2,026	100
Romeoville Road	Chicago Sanitary and Ship Canal	4	2,003	2,003	100
Lockport Powerhouse	Chicago Sanitary and Ship Canal	4	8,611	6,311	73
	Des Plaines River System				
Jefferson Street	Des Plaines River	4	8,176	8,021	98
	Calumet River System				
130th Street	Calumet River	5	1,749	1,749	100
Torrence Avenue	Grand Calumet River	4	8,781	6,818	78
Conrail Railroad	Little Calumet River	4	2,005	2,005	100
C&W Indiana Railroad	Little Calumet River	4	7,604	7,554	99
Halsted Street	Little Calumet River	4	8,610	8,570	>99
Ashland Avenue	Little Calumet River	5	8,327	4,713	57
Division Street	Calumet-Sag Channel	3	3,516	3,516	100
Kedzie Avenue	Calumet-Sag Channel	3	1,798	1,798	100
Cicero Avenue	Calumet-Sag Channel	3	8,731	8,674	99
River Mile 311.7	Calumet-Sag Channel	3	3,342	3,342	100
Southwest Highway	Calumet-Sag Channel	3	1,883	1,883	100
104th Avenue	Calumet-Sag Channel	3	7,710	7,205	93
Route 83	Calumet-Sag Channel	3	8,783	8,719	99

[1]Dissolved oxygen was measured hourly using a YSI Model 6920 or Model 6600 continuous water quality monitor.

TABLE V-8: FECAL COLIFORM DENSITY IN CHICAGO AREA WATERWAYS DURING DRY AND WET WEATHER
JANUARY THROUGH DECEMBER 2004

Sample Station (Miles from WRP)	Dry Weather Fecal Coliform (cfu/100 mL)				Wet Weather Fecal Coliform (cfu/100 mL)			
	Number of Samples	Minimum	Maximum	Geometric Mean	Number of Samples	Minimum	Maximum	Geometric Mean
			North Shore Channel					
Oakton Street(0.6)[a]	18	40	19,000	670	12	700	470,000	7,800
Foster Avenue(3.1)[b]	18	1,800	25,000	7,400	12	4,600	130,000	21,000
			North Branch Chicago River					
Albany Avenue(3.3)[c]	17	200	2,000	710	12	990	130,000	10,000
Wilson Avenue(4.0)[b]	18	2,200	22,000	6,100	12	5,400	380,000	26,000
Diversey Parkway(6.6)[b]	18	1,200	8,800	3,400	12	4,500	67,000	12,000
Grand Avenue(10.7)[b]	18	550	24,000	1,600	12	1,100	110,000	5,700
			Little Calumet River					
Indiana Avenue(1.4)[a]	16	9	7,200	70	12	80	560	240
Halsted Street(1.0)[b]	19	270	15,000	2,700	12	2,200	54,000	4,600
Ashland Avenue(1.3)[c]	17	120	220,000	4,000	12	990	80,000	5,000
			Calumet-Sag Channel					
Ashland Avenue(2.1)[b]	19	250	12,000	2,100	12	2,000	36,000	4,800
Cicero Avenue(6.2)[b]	19	20	9,300	710	12	770	39,000	2,700
Route 83(16.9)[b]	17	20	510	100	12	210	31,000	1,200

[a]Upstream WRP effluent outfall.
[b]Downstream WRP effluent outfall.
[c]Tributary Downstream WRP effluent outfall.

TABLE V-9: FECAL COLIFORM DENSITIES[1] CALCULATED FROM DIE-OFF EQUATIONS AT 5 MILES AND AT FIRST POINT OF COMPLIANCE WITH GENERAL USE WATER QUALITY STANDARD DOWNSTREAM OF WATER RECLAMATION PLANT EFFLUENT OUTFALLS

Weather Type	River Miles Below WRP Effluent Outfall					
	5	14	21	27	29	37
	cfu/100 mL					
North Area						
Wet	17,193	3,021	781	245	**167**	36
Dry	4,944	804	**196**	58	39	8
Wet minus Dry	12,249	2,217	585	**187**	128	28
South Area						
Wet	3,334	1,509	814	480	402	**199**
Dry	1,096	**171**	41	12	8	1
Wet minus Dry	2,238	1,338	773	468	394	**198**

[1]Values in bold type indicate first occurrence of a calculated fecal coliform density less than the 200 cfu/100 mL IPCB General Use stream standard.

FIGURE V-1: AMBIENT WATER QUALITY MONITORING PROGRAM
SAMPLE STATIONS

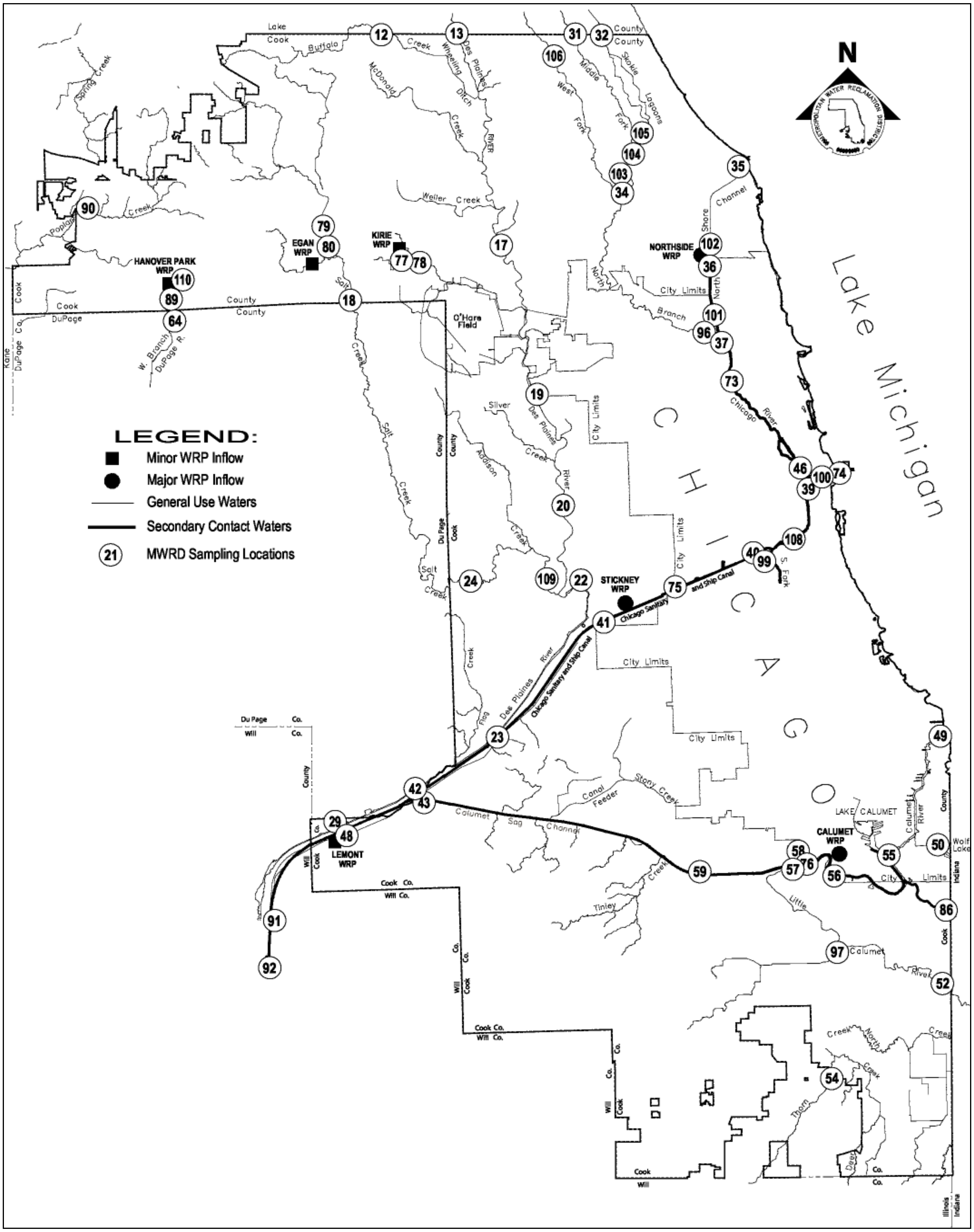


FIGURE V-2: MAP OF THE ILLINOIS WATERWAY FROM LOCKPORT TO MARSEILLES SHOWING SAMPLING STATIONS 1 TO 21

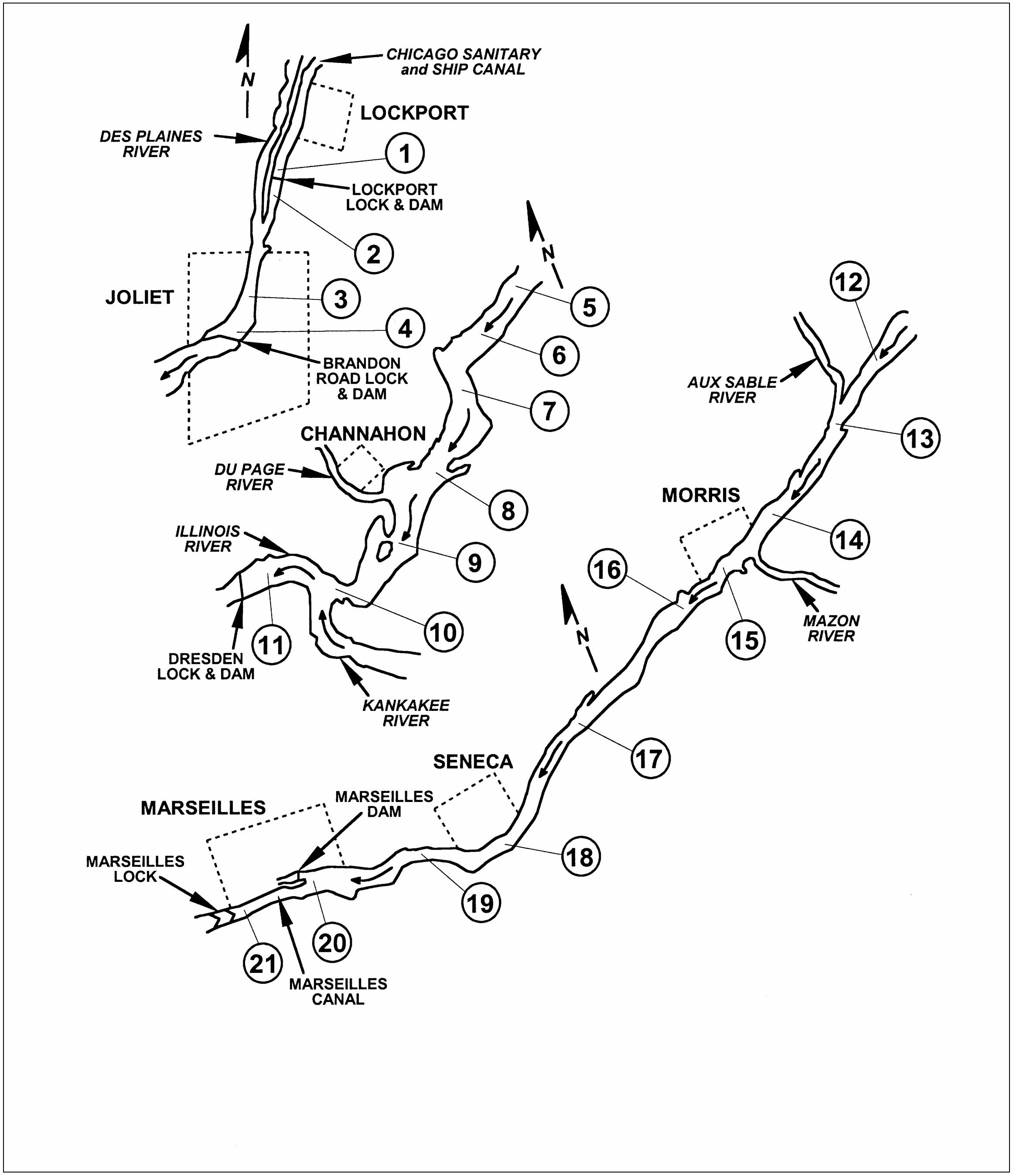


FIGURE V-3: MAP OF THE ILLINOIS WATERWAY FROM OTTAWA TO PEORIA SHOWING SAMPLING STATIONS 22 TO 49

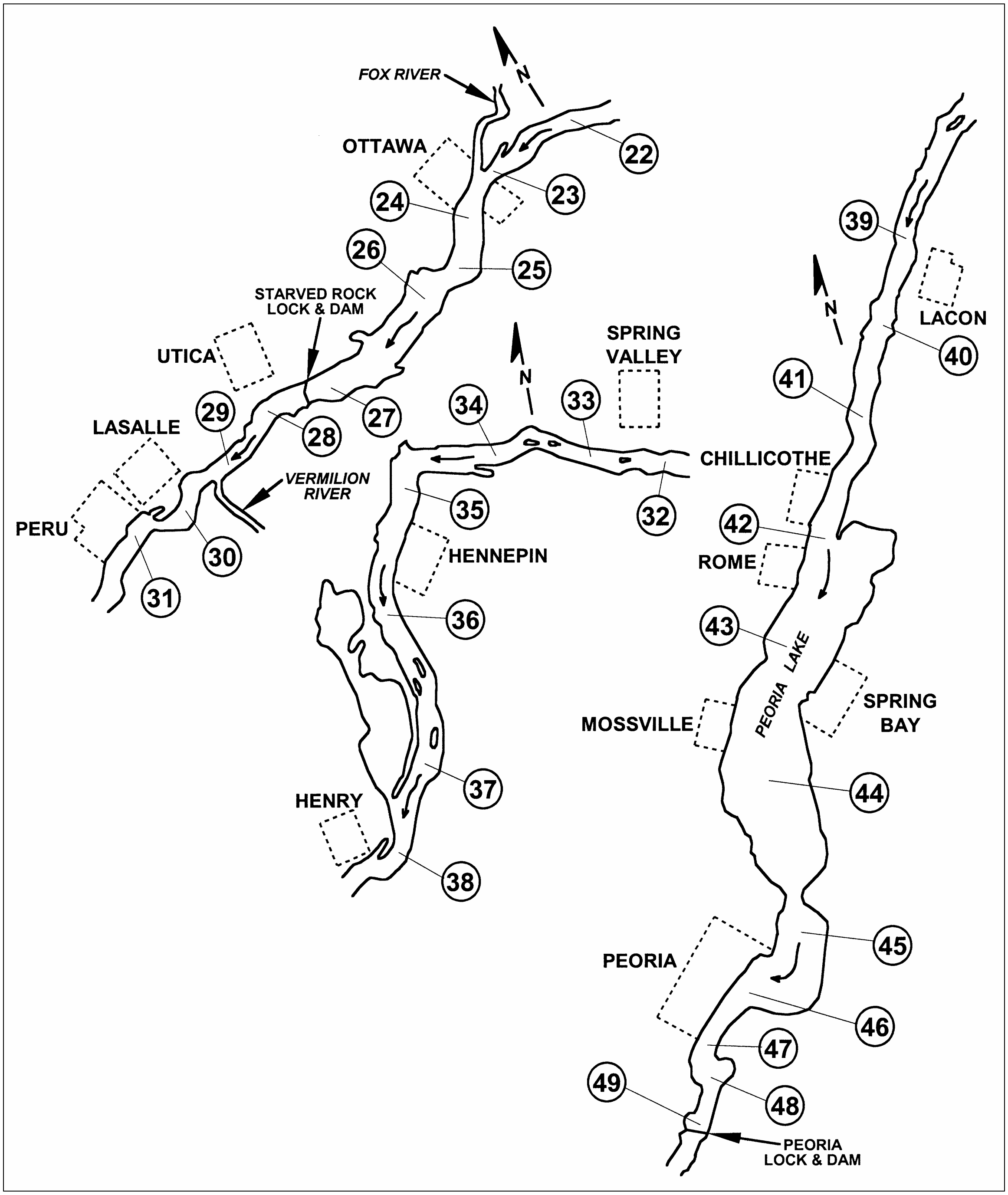


FIGURE V-4: MEAN DISSOLVED OXYGEN CONCENTRATION AT 49 STATIONS ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT LOCK TO THE PEORIA LOCK DURING MAY, AUGUST, AND OCTOBER 2004

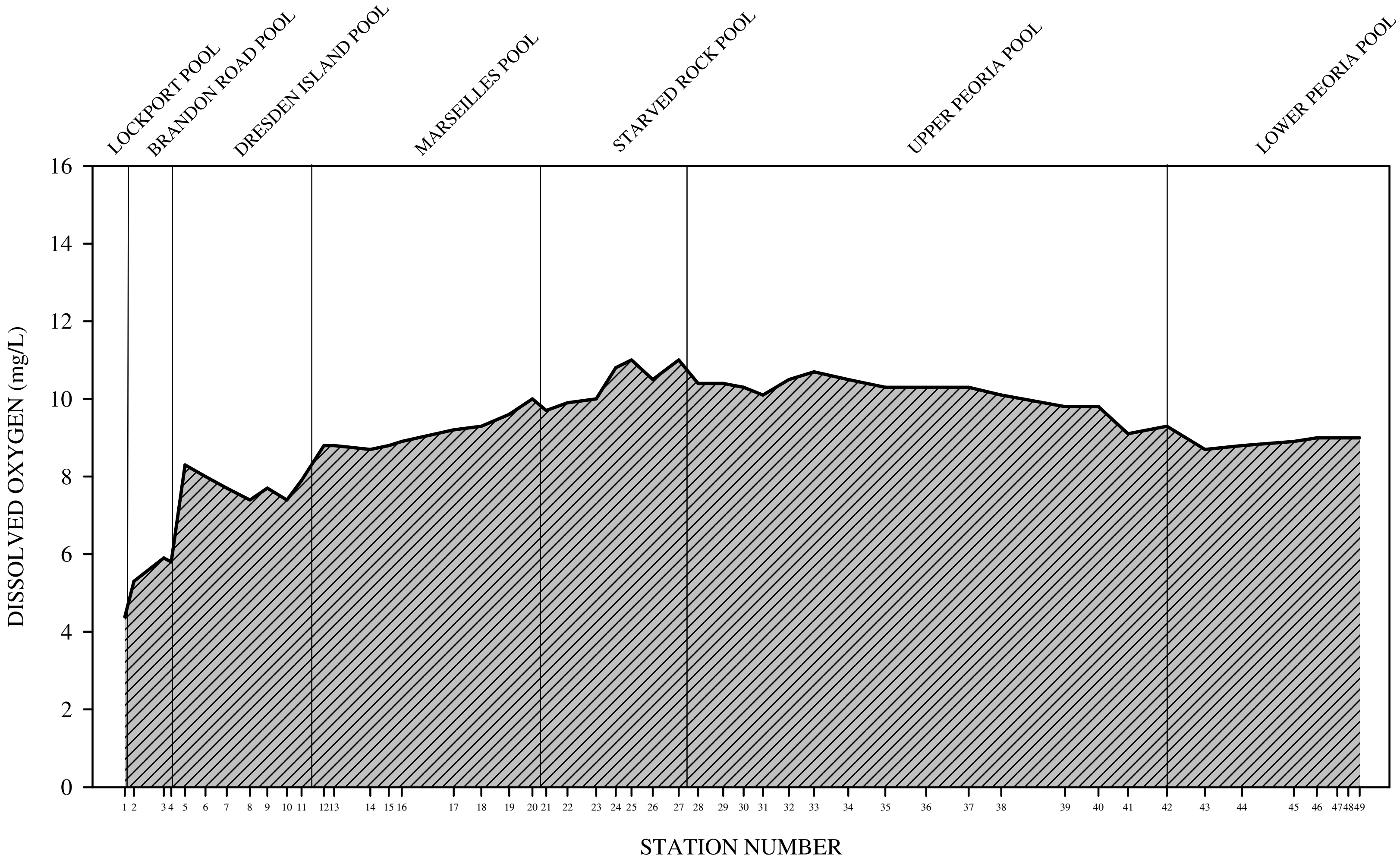


FIGURE V-5: MEAN AMMONIA NITROGEN CONCENTRATION AT 49 STATIONS ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT LOCK TO THE PEORIA LOCK DURING MAY, AUGUST, AND OCTOBER 2004

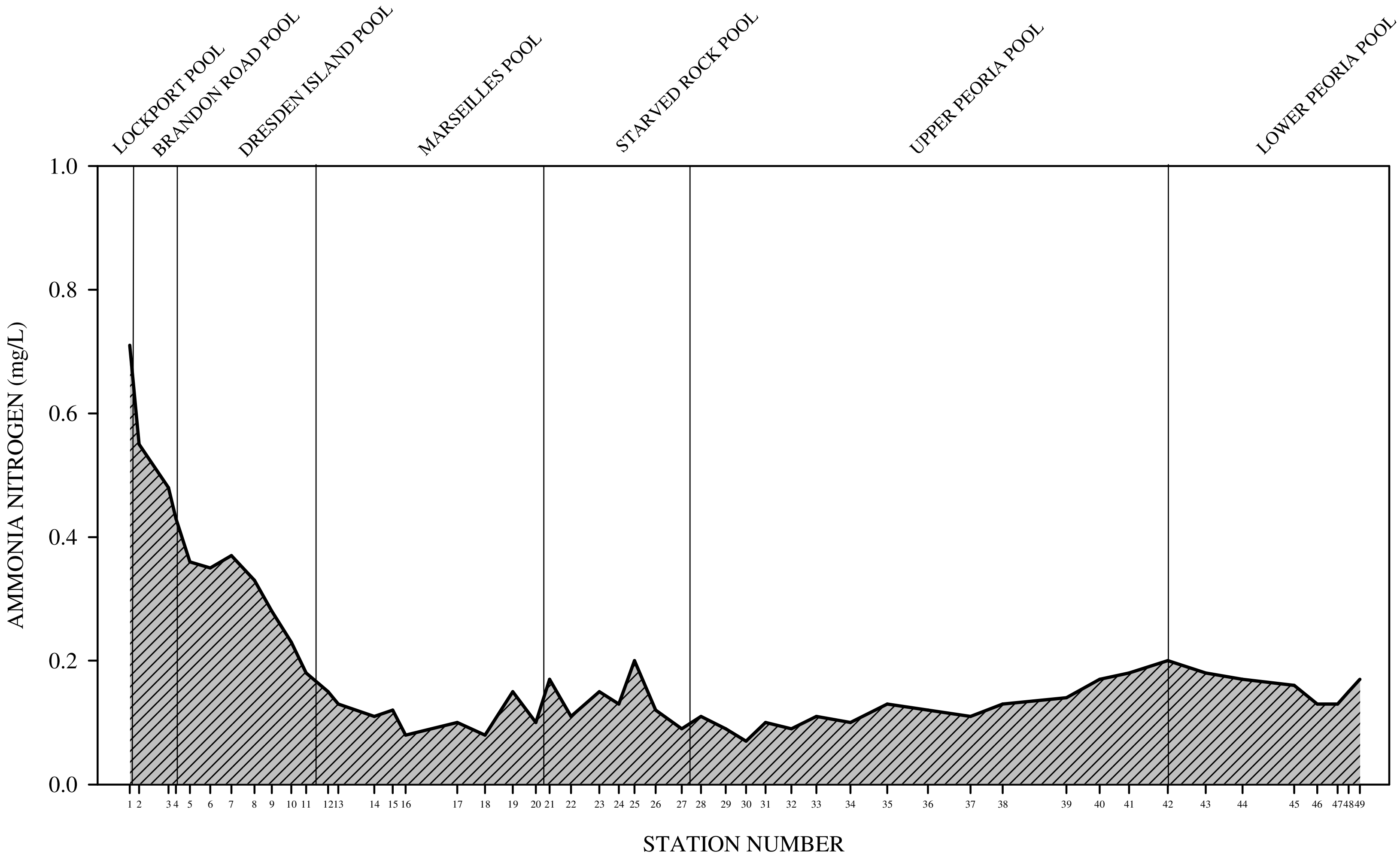


FIGURE V-6: MEAN TOTAL NITROGEN CONCENTRATION AT 49 STATIONS ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT LOCK TO THE PEORIA LOCK DURING MAY, AUGUST, AND OCTOBER 2004

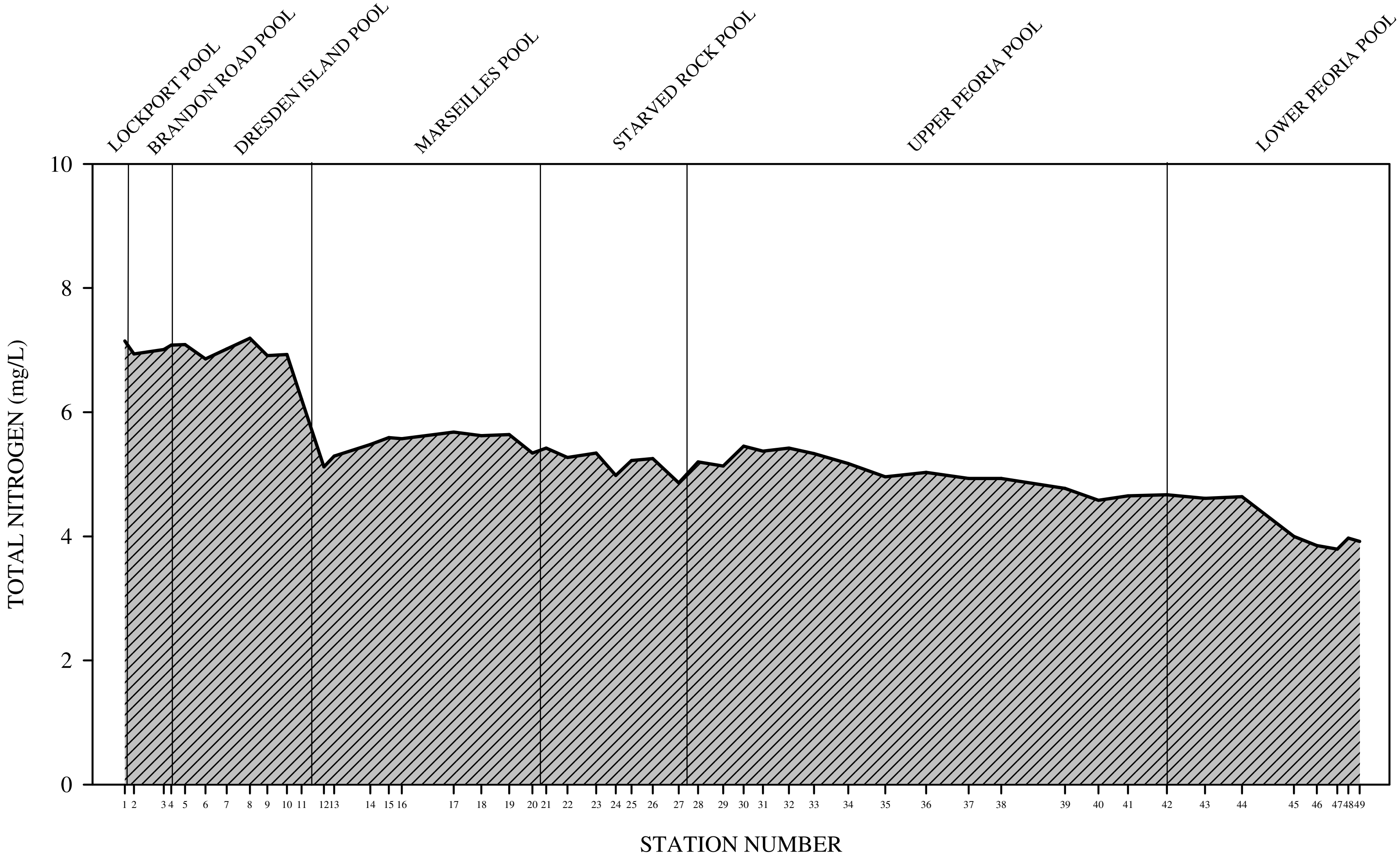


FIGURE V-7: MEAN TOTAL PHOSPHORUS CONCENTRATION AT 49 STATIONS ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT LOCK TO THE PEORIA LOCK DURING MAY, AUGUST, AND OCTOBER 2004

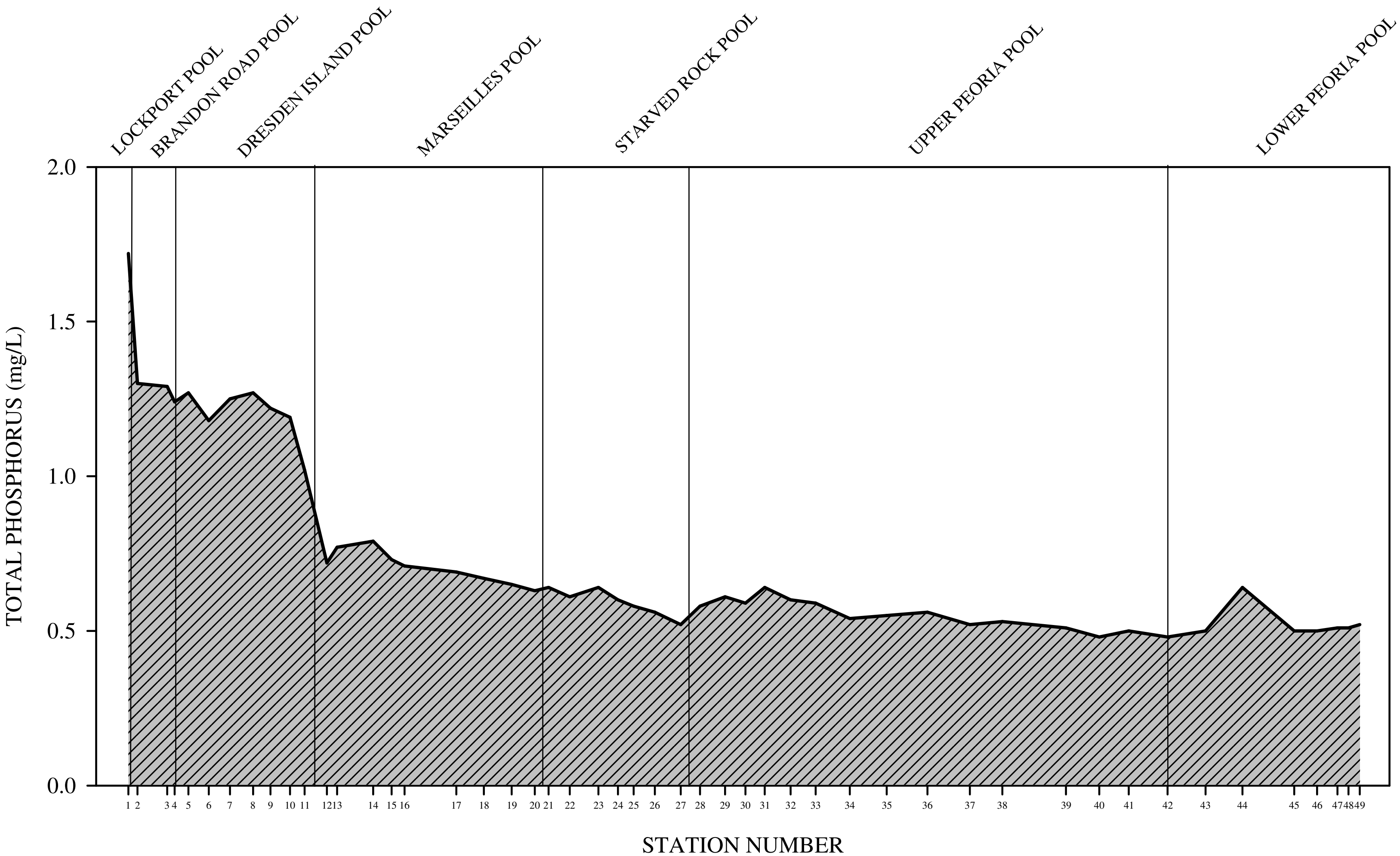


FIGURE V-8: GEOMETRIC MEAN FECAL COLIFORM AT 49 STATIONS ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT LOCK TO THE PEORIA LOCK DURING MAY, AUGUST, AND OCTOBER 2004

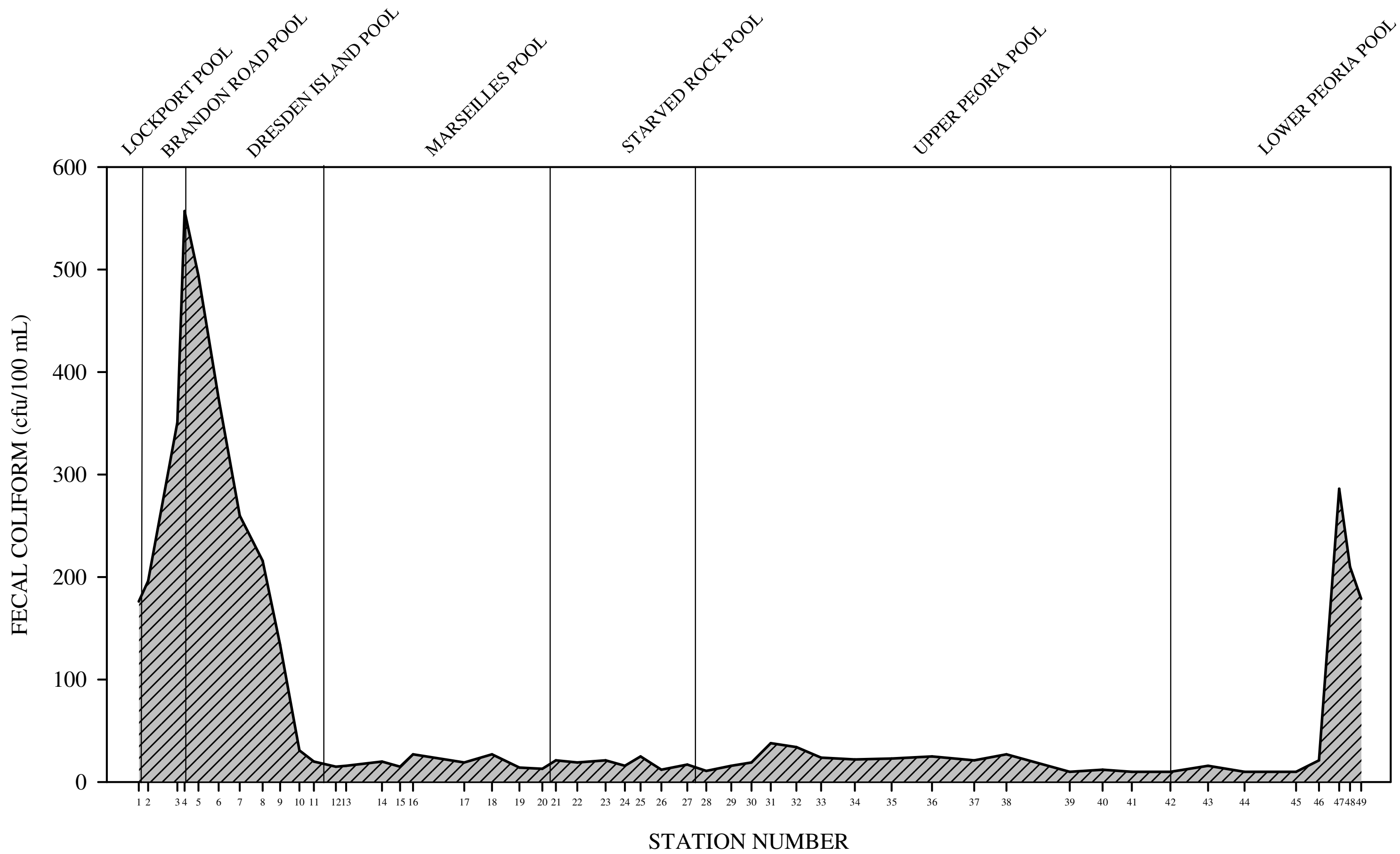


FIGURE V-9: CHICAGO WATERWAY SYSTEM SAMPLE STATIONS FOR FECAL COLIFORM DENSITY STUDY

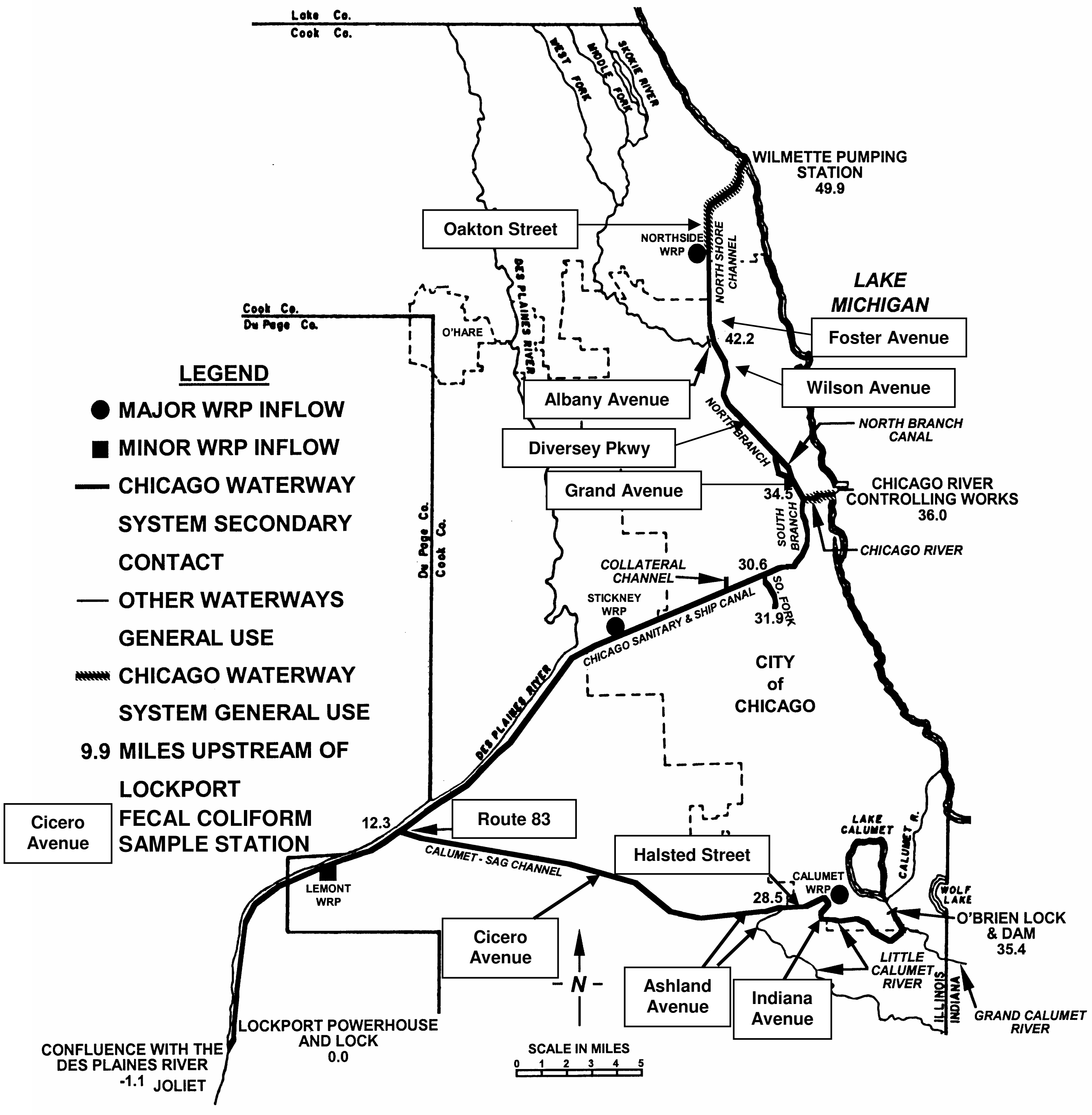


FIGURE V-10: GEOMETRIC MEANS OF FECAL COLIFORM BACTERIA AT NORTH AREA STATIONS WITH ESTIMATED DIE-OFF DENSITIES (UPSTREAM AND TRIBUTARY DENSITIES NOT INCLUDED IN DIE-OFF ESTIMATES)

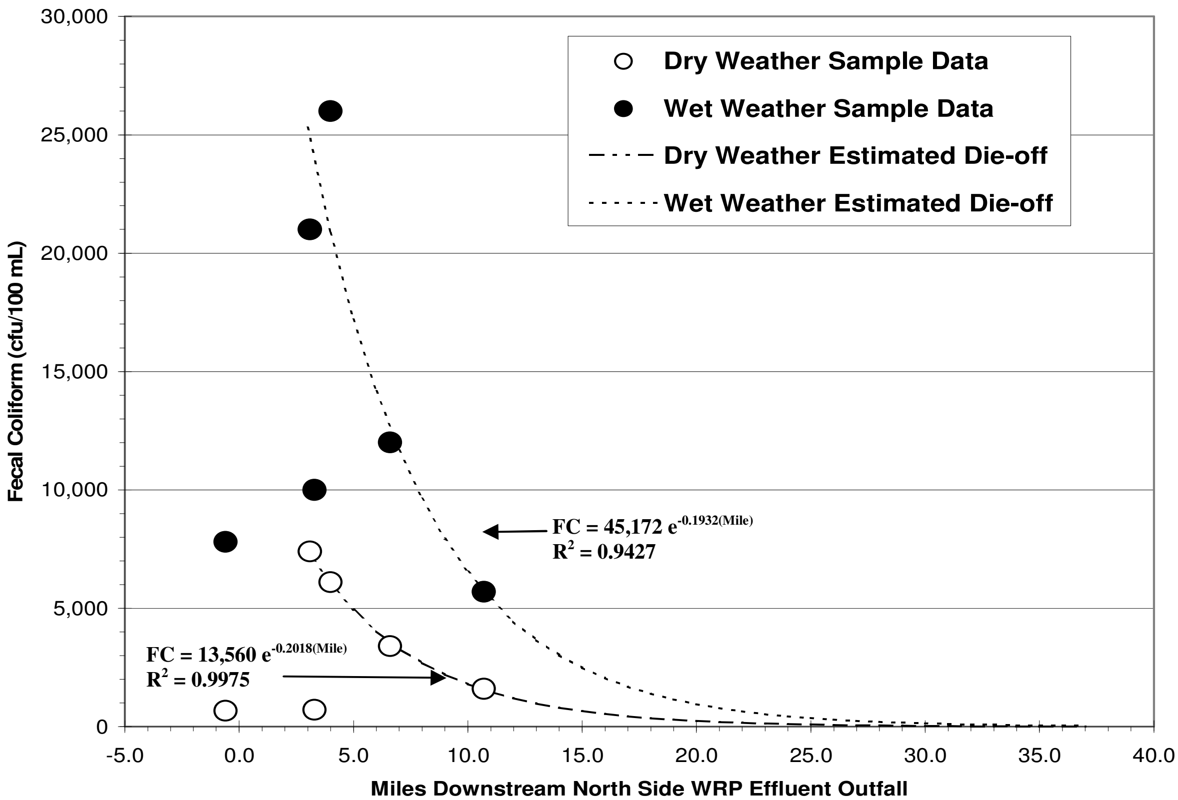


FIGURE V-11: GEOMETRIC MEANS OF FECAL COLIFORM BACTERIA AT SOUTH AREA STATIONS WITH ESTIMATED DIE-OFF DENSITIES (UPSTREAM AND TRIBUTARY DENSITIES NOT INCLUDED IN DIE-OFF ESTIMATES)

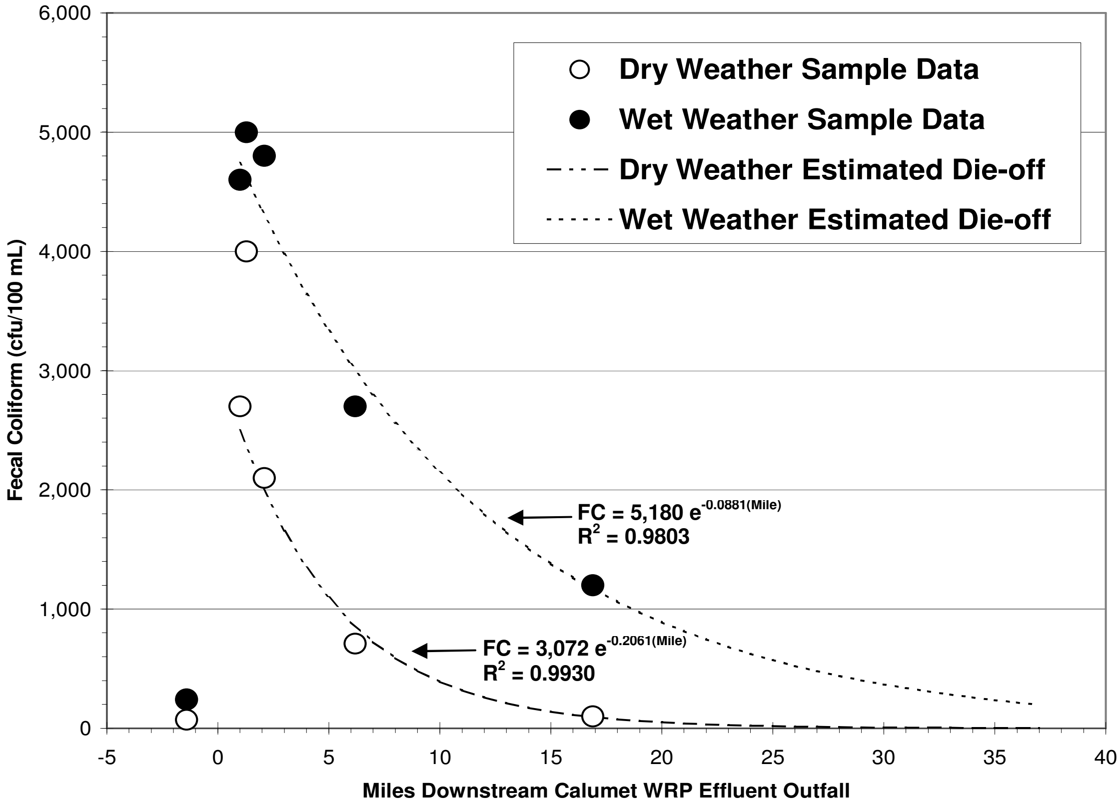


FIGURE V-12: ESTIMATED FECAL COLIFORM BACTERIA DENSITIES DOWNSTREAM OF THE NORTH SIDE WATER RECLAMATION PLANT DURING WET AND DRY WEATHER, AND WHEN DRY WEATHER DENSITIES ARE SUBTRACTED FROM WET WEATHER DENSITIES

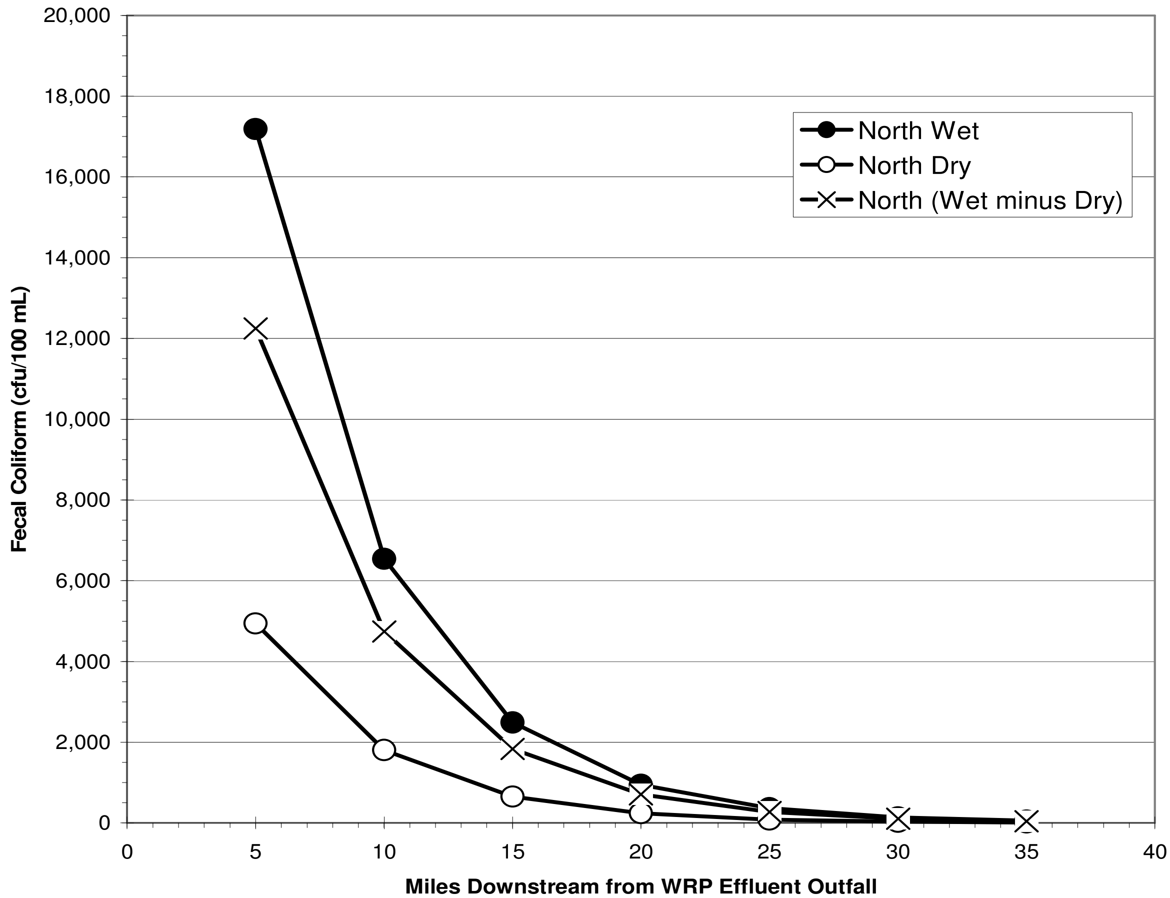
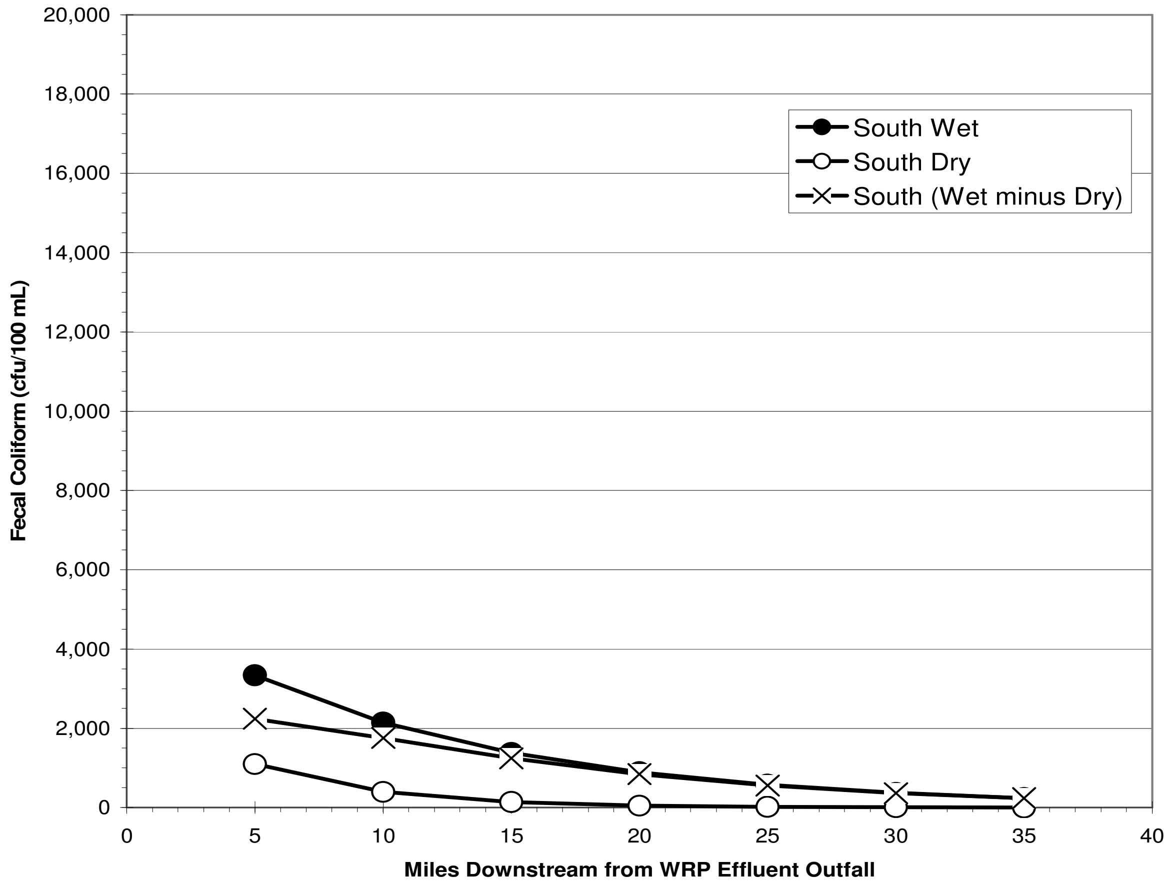


FIGURE V-13: ESTIMATED FECAL COLIFORM BACTERIA DENSITIES DOWNSTREAM OF THE CALUMET WATER RECLAMATION PLANT DURING WET AND DRY WEATHER, AND WHEN DRY WEATHER DENSITIES ARE SUBTRACTED FROM WET WEATHER DENSITIES



RADIOCHEMISTRY SECTION

The Radiochemistry Section is responsible for the radiological monitoring of waters, wastewaters, sludges, and biosolids, and the maintenance of radiation safety at the District. It also performs special tasks involving the use of ionizing radiation and radioisotopes.

The Radiochemistry Laboratory was certified by the Illinois Department of Nuclear Safety, now the Illinois Emergency Management Agency, Division of Nuclear Safety (IEMA-DNS) on October 2, 2001 and has maintained its certification status. The laboratory is approved for the examination of gross alpha/beta, tritium, and photon emitting radionuclides in public water supplies.

The Radiochemistry Section participates in the ambient water quality monitoring program of the Chicago Area waterways system. The radiological monitoring of area waterways under the jurisdiction of the District includes the Calumet, Chicago, and Des Plaines River systems.

The radiological monitoring of raw and treated wastewaters from the District's seven WRPs was initiated in 1967 as the State of Illinois Sanitary Water Board developed effluent criteria (Technical Release 20-22, April 1, 1967). Although the present NPDES permits from the IEPA do not include limits for radioactivity in the District's effluents, monitoring continued into 2004 since there are radioactivity water quality standards for the General Use waters.

Since 1978, the Section has conducted radiological monitoring of biosolids from both the LASMA and HASMA drying sites. Beginning in 1993, the solids survey was greatly increased to include raw sludge or digested biosolids from District WRPs and air-dried biosolids ready for final use at all of the Stickney and Calumet solids management areas.

The Section also maintains the radioactive material license issued to the District by the IEMA-DNS, assuring that the program involving radioactive material is conducted according to the license conditions and regulations.

The Section participates in the Environmental Resource Associates (ERA) Rad-Chem Proficiency Testing (PT) program as required by the IEMA-DNS for maintaining laboratory certification. Water samples were analyzed for gross alpha, gross beta, barium-133, cesium-134, cesium-137, cobalt-60, zinc-65, and tritium radioactivity.

Radiation Safety

The Radiochemistry Section continues to maintain a radiation safety program for the District. The program includes:

- keeping up-to-date the IEMA-DNS radioactive material license;
- low-level radioactive waste management;
- personnel monitoring for radiation exposure;
- operational checks of radiation survey meters;
- radiation survey of the Radiochemistry Laboratory working areas;

- leak testing of the radioactive sealed sources; and

- physical inventory of licensed radioactive materials.

The District possesses a radioactive material license from the IEMA-DNS. The radiation protection program is conducted in accordance with the license conditions. An application for renewal of the radioactive material license was submitted in 2004 to the IEMA-DNS. The license has been renewed up to February 28, 2010.

The Illinois Low-Level Radioactive Waste Management Act requires all generators and brokers of low-level radioactive waste (LLRW) in Illinois to file an annual survey form with the IEMA-DNS. In 2004, the relevant forms were received from the IEMA-DNS, completed, and returned to the IEMA-DNS.

The monitoring of District employees for radiation exposure was carried out using dosimeter badges and finger ring dosimeters. The dosimeters are worn by laboratory personnel, and users of moisture/density gauges. A total of 252 dosimeters were analyzed in 2004. No employee of the District was exposed to an overdose of radiation.

The operational checks of radiation survey meters were carried out on the day radioactive materials were used or at least once a month. A record was maintained for the operational checks of radiation survey instruments.

The Radiochemistry Laboratory is regularly surveyed for radiation contamination. A total of 120 wipe tests were performed in 2004. No contamination was found in any work area.

As per IEMA-DNS regulations, radioactive sealed sources are tested for leakage or contamination at intervals not to exceed six months. All of the radioactive sealed sources used by the District personnel were tested for leakage twice in 2004.

Nickel-63 sources constitute a part of the electron capture detectors of gas chromatographs used by the R&D Department. Leak tests were performed on the following detectors in March and September 2004:

Varian A-12876
Varian A-12877
Hewlett-Packard U-1440
Hewlett-Packard U-1451
Finnigan 5678
Finnigan 5680

No leaks were detected in any detectors used by the District.

Two leak tests each were performed in 2004 on the APD2000 CW Detector, and an XRF Paint Analyzer, owned by the Safety Section of General Administration. The APD2000 CW detector is equipped with a nickel-63 sealed source and the XRF Paint Analyzer is equipped with a Cobalt-57 sealed source. No leaks were detected in the detectors.

Leak tests were also performed on four Troxler surface moisture/density gauges used by the Construction Division of the Engineering Department. A total of 16 leak tests were performed in 2004. No leaks were detected in any of these gauges.

A physical inventory of the radioactive sealed sources possessed by the District was carried out twice in the year 2004. A record of this inventory was maintained as per license conditions.

Certification by the IEMA-DNS

The Radiochemistry Laboratory was certified by the Illinois Department of Nuclear Safety, now the IEMA-DNS, on October 2, 2001. The laboratory was audited by IEMA-DNS in 2004 to evaluate the facilities, personnel, equipment, record keeping and quality control procedures. The laboratory maintained its certification status and was approved for the examination of gross alpha, gross beta, tritium, and photon emitters.

Participation in the ERA Proficiency Testing Program

The Radiochemistry Section participated in the ERA RadChem PT program, along with other certified laboratories. The participation in the PT study is an IEMA-DNS requirement to maintain laboratory certification.

The participating laboratories receive, for analysis, water samples from ERA. The known radioactivity concentrations and the participant's experimental results are published in the ERA's report.

During 2004, the Radiochemistry Section analyzed four PT water samples for gross alpha, gross beta, barium-133, cobalt-60, cesium-134, cesium-137, zinc-65 and tritium radioactivity. The analytical results were reported to the ERA. Acceptable results were obtained on all the samples.

Levels of Radioactivity in Raw and Treated Wastewaters

Radiological monitoring of raw wastewaters and final effluents from the District's seven WRPs continued in 2004. Data from the monitoring serves as a measure of present-day radioactivity levels in comparison to levels in past years. The IPCB has established General Use water quality standards for radioactivity in the waters of the State. According to IPCB regulations (Title 35, Chapter 1, Section 302.207) gross beta concentration shall not exceed 100 pCi/L, and the concentration of radium-226 and strontium-90 shall not exceed 1 and 2 pCi/L of water, respectively, in General Use waters. There are no IPCB or USEPA radioactivity standards for raw sewage or final effluents. However, the District uses the IPCB General Use waters limits for gross beta concentration as the standard for monitoring effluents.

The radioactivity analysis was conducted on 24-hour composite samples of raw sewage and final effluent. The samples were processed using USEPA, Environmental Monitoring and Support Laboratory procedures, March 1979, and counted for gross alpha and gross beta radioactivity on a Tennelec LB5100 alpha/beta gas proportional counter. The gas proportional counter was calibrated for alpha efficiency using thorium-230, and for beta efficiency using cesium-137 standards obtained from North American Scientific, California.

For calculation purposes, less than lower limit of detection (LLD) values were considered as real numbers, i.e., <1 pCi/L was considered as 1. Average radioactivity was calculated by adding the monthly activity and dividing the sum by the number of observations. In a set of data points with a combination of real numbers and LLD values, if any value in the individual data set with the less than symbol was higher than the average value, then the average value was reported with the less than symbol (<). If all the values in the individual data set with the less than symbol were lower than the average values, then the average value was reported without the less than symbol.

In a set of data points with a combination of real numbers and LLD values, the highest real number was considered as the maximum value. The lowest real number was considered as the minimum value if the number was lower than the lowest LLD value of the data set, otherwise LLD value was reported as the minimum value.

Table VI-1 presents the 2004 yearly averages of gross alpha radioactivity for the raw sewage and final effluent from the District's seven WRPs. With the exception of the Lemont WRP, average raw sewage gross alpha radioactivity at all the WRPs was less than the LLD (4.1 to 7.3 pCi/L). The gross alpha radioactivity in raw sewage at the Lemont WRP was 18.6 pCi/L. This level of radioactivity in Lemont raw sewage has been observed since the Village of Lemont began utilizing a water-treatment process for removal of radium from their water supply in 1989 as the backwash water from the system is discharged into the Lemont WRP. However, this backwash from the Lemont drinking water system does not pose a threat to the District's compliance status. The gross alpha radioactivity in the final effluent at all the WRPs was less than the LLD (3.6 to 8.6 pCi/L).

Table VI-2 presents the 2004 yearly averages for gross beta radioactivity in raw sewage and final effluent from the District's seven WRPs. The Lemont WRP has the highest average raw sewage and final effluent gross beta radioactivity levels, 28.3 and 19.3 pCi/L, respectively. At the remaining six WRPs, the average raw sewage gross beta radioactivity ranged from 10.9 to 21.8 pCi/L, and the average final effluent gross beta radioactivity ranged from 9.2 to 12.9 pCi/L.

Levels of Radioactivity in Sludge and Biosolids

In 1993, the Radiochemistry Section revised and expanded its monitoring program of District sludges in response to the increased emphasis on monitoring biosolids quality brought about by adoption of the USEPA's Part 503 Sewage Sludge Regulations. Although there are no standards for radioactivity in these regulations, it was felt that the District should expand its database on the radiological characteristics of its sludge and biosolids.

During 2004, sludge or biosolids samples were collected monthly at all WRPs. Biosolids samples were also collected monthly from the eight solids drying sites of the District from May through September.

Sludge and biosolids samples were processed according to the *Standard Methods* (20^{th} Edition, 1998) procedures, and counted for gross alpha and gross beta radioactivity using a Tennelec LB5100 alpha/beta counting system. The instrument was calibrated with a thorium-230 standard for gross alpha, and a cesium-137 standard for gross beta radioactivity determinations. The results, in pCi/g of dry weight (DW), were averaged and are tabulated in Tables VI-3 and VI-4.

In Table VI-3, the average gross alpha radioactivity of digester draw biosolids from the Calumet, John E. Egan, Hanover Park, and Stickney WRPs and waste-activated sludge from the Lemont, North Side, and James C. Kirie WRPs ranged from a low of 7.1 pCi/g DW at the James C. Kirie WRP to a high of 100.2 pCi/g DW at the Lemont WRP. The average gross beta radioactivity of these sludges and biosolids ranged from a low of 12.1 pCi/g DW at the Hanover Park WRP to a high of 63.4 pCi/g DW at the Lemont WRP.

Table VI-4 presents the gross alpha and gross beta radioactivity data for air-dried biosolids from the District's solids management areas. The average gross alpha radioactivity ranged from a low of 14.9 pCi/g DW for the LASMA drying site to a high of 22.6 pCi/g DW for the RASMA drying site. The average gross beta radioactivity ranged from a low of 21.8 pCi/g DW for the Calumet East drying site to a high of 25.2 pCi/g DW for the RASMA drying site.

Sludge and biosolids samples were also processed for the determination of gamma-emitting radionuclides. The samples were dried on hot plates. The dried samples were ground and passed through a 30-mesh sieve. The samples were packed in three-ounce canisters and sealed with a vinyl electrical tape to avoid loss of the gaseous progeny of uranium and thorium. The samples were stored for at least 30-days for radium-radon to reach equilibrium before counting. The samples were analyzed by a gamma spectroscopy system equipped with a high-purity germanium detector and Genie-2000 spectroscopy software analysis package from Canberra Industries.

Eleven specific radionuclides, with a potential for reconcentration in sludge, were analyzed. Only three of them were detected at measurable levels. The radium-226 activity concentration was calculated from the 186 keV photopeak, cesium-137 radioactivity concentration was calculated from 661.6 keV photopeak, and potassium-40 radioactivity from 1461 keV photopeak. Two of these three radionuclides, radium-226 and potassium-40 are of natural origin. The third radionuclide, cesium-137, is man-made and may have arisen from fallout of nuclear weapons testing in the middle of the 20th century.

Table VI-5 presents the potassium-40, radium-226, and cesium-137 concentrations in the District's sewage sludge and biosolids. The average potassium-40 radioactivity ranged from 4.6 pCi/g DW at Hanover Park WRP to 9.8 pCi/g DW at Stickney WRP. The average radium-226 radioactivity ranged from 3.6 pCi/g DW at Hanover Park WRP to 65.6 pCi/g DW at Lemont WRP. The average cesium-137 radioactivity ranged from non-detectable levels at Egan, Hanover Park, and Lemont WRPs to 0.07 pCi/g DW at Stickney WRP.

Table VI-6 presents the potassium-40, radium-226, and cesium-137 concentrations in the District's biosolids from the solids management areas. The average potassium-40 radioactivity ranges from 7.0 pCi/g DW at Calumet East to 10.5 pCi/g DW at Marathon drying site. The average radium-226 radioactivity in the biosolids ranged from 3.7 pCi/g DW at RASMA to 4.8 pCi/g DW at Calumet East and Calumet West drying sites. The average cesium-137 radioactivity ranged from 0.06 pCi/g DW at Calumet East, Calumet West, RASMA, and Marathon drying sites to 0.08 pCi/g DW at LASMA drying site.

Radiological Monitoring of the Chicago Area Waterways

Radiological monitoring is a part of the overall monitoring program of the water quality within the District's waterways. Radiological monitoring involves the determination of gross alpha and gross beta radioactivity of samples collected from the waterways. The program includes the Calumet, Chicago, and Des Plaines River systems comprising 170 miles (273.6 km) of waterways. There were sixteen sampling locations on the Chicago River system, nine on the Calumet River system, and twenty on the Des Plaines River system. Each location was sampled once per month.

The waterways samples were processed using USEPA, Environmental Monitoring and Support Laboratory procedures, March 1979, and the gross alpha and gross beta radioactivity was counted using a Tennelec LB5100 gas proportional counter.

Table VI-7 presents the 2004 average values for gross alpha and gross beta radioactivity for the Chicago Area waterways at each of the 45 sampling locations. The average gross alpha radioactivity in the water samples from all 45 stations was less than the detection limits (2.9 to 6.7 pCi/L). The average gross beta radioactivity ranged from 4.5 to 16.8 pCi/L.

The concentrations of radioactivity in all samples analyzed were well within the USEPA Drinking Water Standards of 15 pCi/L for gross alpha (excluding radon and uranium), and 50 pCi/L (screening level) for gross beta particle activity minus the naturally occurring potassium-40 beta particle activity.

TABLE VI–1: AVERAGE GROSS ALPHA RADIOACTIVITY IN RAW AND TREATED WASTEWATER FROM DISTRICT WRPs – 2004

WRP Type of Sample	Gross Alpha Radioactivity (pCi/L)
<u>Stickney</u>	
Raw (West Side)	<4.7
Raw (Southwest)	<7.3
Secondary – Final Effluent	<4.1
<u>Calumet</u>	
Raw	<4.8
Secondary – Final Effluent	<4.4
<u>North Side</u>	
Raw	<4.1
Secondary – Final Effluent	<3.6
<u>Hanover Park</u>	
Raw	<4.4
Tertiary – Final Effluent	<3.7
<u>John E. Egan</u>	
Raw	<4.4
Tertiary – Final Effluent	<3.8
<u>Lemont</u>	
Raw	18.6
Secondary – Final Effluent	<8.6
<u>James C. Kirie</u>	
Raw	<4.9
Tertiary – Final Effluent	<4.2

< = Less than LLD.

TABLE VI–2: AVERAGE GROSS BETA RADIOACTIVITY IN RAW AND TREATED WASTEWATER FROM DISTRICT WRPs - 2004

WRP Type of Sample	Gross Beta Radioactivity (pCi/L)
Stickney	
Raw (West Side)	13.6
Raw (Southwest)	21.8
Secondary – Final Effluent	9.8
Calumet	
Raw	12.3
Secondary – Final Effluent	9.2
North Side	
Raw	10.9
Secondary – Final Effluent	9.3
Hanover Park	
Raw	13.6
Tertiary – Final Effluent	11.0
John E. Egan	
Raw	13.9
Tertiary – Final Effluent	11.3
Lemont	
Raw	28.3
Secondary – Final Effluent	19.3
James C. Kirie	
Raw	15.7
Tertiary – Final Effluent	12.9

TABLE VI–3: GROSS ALPHA AND GROSS BETA RADIOACTIVITY OF WRP SLUDGES AND BIOSOLIDS - 2004

WRP Type of Sample	No. of Samples	Gross Alpha (pCi/g DW)			Gross Beta (pCi/g DW)		
		Average	Minimum	Maximum	Average	Minimum	Maximum
Calumet Digester Draw	12	14.1	10.5	22.7	24.8	19.2	28.8
John E. Egan Digester Draw	12	9.9	7.4	12.6	19.3	14.5	23.2
Lemont[1] Activated Sludge	12	100.2	53.0	152.9	63.4	42.3	78.9
Hanover Park Digester Draw	12	8.2	5.0	10.5	12.1	10.4	14.8
James C. Kirie[1] Activated Sludge	12	7.1	5.3	9.7	13.3	8.8	17.5
North Side[1] Activated Sludge	12	7.8	4.8	12.3	12.8	8.5	17.3
Stickney Digester Draw	12	12.1	6.8	19.9	24.8	19.7	28.5

[1]No digesters at this WRP.

TABLE VI–4: GROSS ALPHA AND GROSS BETA RADIOACTIVITY IN DISTRICT BIOSOLIDS - 2004

Drying Site Location	No. of Samples	Gross Alpha (pCi/g DW)			Gross Beta (pCi/g DW)		
		Average	Minimum	Maximum	Average	Minimum	Maximum
LASMA	5	14.9	11.8	19.8	24.3	20.4	25.7
Calumet East	5	15.4	9.7	23.3	21.8	19.8	23.4
Calumet West	5	20.5	10.9	28.6	22.5	19.1	27.8
HASMA	5	15.8	12.7	19.9	23.8	21.3	27.6
Marathon	5	15.0	9.1	21.1	24.1	19.6	28.7
Stony Island	5	17.2	12.3	21.1	25.0	23.2	26.9
Vulcan	5	16.2	9.8	21.4	24.2	23.4	24.8
RASMA	2	22.6	20.8	24.3	25.2	24.7	25.7

TABLE VI–5: CONCENTRATION OF GAMMA-EMITTING RADIONUCLIDES IN WRP SLUDGE AND BIOSOLIDS - 2004

Sample Location WRP	No. of Samples	Potassium-40 (pCi/g DW)			Radium-226 (pCi/g DW)			Cesium-137 (pCi/g DW)		
		Average	Min.	Max.	Average	Min.	Max.	Average	Min.	Max.
Calumet	4	8.6	8.2	9.3	5.5	4.6	7.5	0.06	0.04	0.08
John E. Egan	4	8.2	6.3	10.2	3.8	3.6	3.9	ND	ND	ND
Hanover Park	4	4.6	4.2	5.1	3.6	3.2	4.2	ND	ND	ND
Stickney	4	9.8	9.4	10.4	4.0	3.7	4.3	0.07	0.06	0.09
Lemont	4	6.3	5.6	6.7	65.6	37.7	88.6	ND	ND	ND

ND – Not Detected

TABLE VI–6: CONCENTRATION OF GAMMA-EMITTING RADIONUCLIDES IN DISTRICT BIOSOLIDS - 2004

Sample Location	No. of Samples	Potassium-40 (pCi/g DW)			Radium-226 (pCi/g DW)			Cesium-137 (pCi/g DW)		
		Average	Min.	Max.	Average	Min.	Max.	Average	Min.	Max.
Calumet East	5	7.0	6.4	8.0	4.8	4.3	5.3	0.06	ND	0.08
Calumet West	5	7.5	4.8	11.7	4.8	3.9	5.4	0.06	0.04	0.07
RASMA	2	9.4	8.9	9.9	3.7	3.6	3.8	0.06	0.06	0.07
Stony Island	5	8.8	8.2	9.4	4.0	3.7	4.3	0.07	0.06	0.09
HASMA	5	8.8	8.4	9.3	3.8	3.4	4.3	0.07	0.06	0.09
LASMA	5	9.7	9.5	10.4	4.1	3.8	4.4	0.08	0.07	0.08
Marathon	5	10.5	9.6	12.0	3.8	3.2	4.3	0.06	0.06	0.08
Vulcan	5	9.2	8.7	9.7	3.9	3.6	4.1	0.07	0.07	0.08

ND – Not Detected

TABLE VI–7: AVERAGE GROSS ALPHA AND GROSS BETA RADIOACTIVITY FOR THE CHICAGO AREA WATERWAYS - 2004

Location	Gross Alpha (pCi/L)	Gross Beta (pCi/L)
Lake-Cook Rd., Des Plaines	<4.2	9.9
Oakton Street, Des Plaines	<4.4	9.2
Belmont Ave., Des Plaines	<4.1	9.8
Roosevelt Road, Des Plaines	<4.4	9.0
Ogden Avenue, Des Plaines	<4.0	9.5
Willow Springs Rd., Des Plaines	<4.2	9.4
Stephen Street, Des Plaines	<4.2	9.2
Material Service Rd., Des Plaines	<4.7	9.5
Lake-Cook Rd., Buffalo Creek	<4.4	7.7
Elmhurst Rd., Higgins Creek	<5.9	8.3
Wille Rd., Higgins Creek	<4.2	13.3
Higgins Rd., Salt Creek	<5.2	8.2
Arlington Heights Rd., Salt Creek	<4.6	9.7
Devon Ave., Salt Creek	<4.6	9.9
Wolf Rd., Salt Creek	<4.5	9.4
Brookfield Ave., Salt Creek	<4.6	9.0
Route 19, Popular Creek	<4.8	5.6
Springinsguth Rd., W. Br. Dupage River	<5.1	8.2
Walnut Lane, W. Br. Dupage River	<4.3	9.2

TABLE VI-7: (Continued) AVERAGE GROSS ALPHA AND GROSS BETA RADIOACTIVITY FOR THE CHICAGO AREA WATERWAYS - 2004

Location	Gross Alpha (pCi/L)	Gross Beta (pCi/L)
Lake St., W. Br. Dupage River	<4.5	10.8
Central St., N. Shore Channel	<3.0	4.5
Oakton St., N. Shore Channel	<3.2	5.8
Touhy Avenue, N. Shore Channel	<3.6	8.6
Dundee Rd., W. Fork N. Branch	<6.4	16.8
Golf Rd., W. Fork N. Branch	<4.4	11.0
Lake-Cook Rd., Middle Fork, N. Branch	<4.7	7.4
Glenview Rd., Middle Fork, N. Branch	<4.2	9.2
Lake-Cook Rd., Skokie River	<4.5	7.1
Frontage Rd., Skokie River	<4.3	9.6
Dempster St., N. Br. Chicago River	<4.8	8.9
Albany Ave., N. Br. Chicago River	<4.0	9.1
Lake Shore Dr., Chicago River	<3.4	5.5
Wells St., Chicago River	<3.4	6.6
Cicero Ave., Chicago Sanitary & Ship Canal	<3.9	8.9
Harlem Ave., Chicago Sanitary & Ship Canal	<4.0	8.8
Lockport, Chicago Sanitary and Ship Canal	<4.0	9.0
Ewing Ave., Calumet River	<2.9	4.8
130^{th} St., Calumet River	<3.2	6.9
Burnham Ave., Wolf Lake	<2.9	7.0

TABLE VI-7: (Continued) AVERAGE GROSS ALPHA AND GROSS BETA RADIOACTIVITY FOR THE CHICAGO AREA WATERWAYS - 2004

Station No.	Location	Gross Alpha (pCi/L)	Gross Beta (pCi/L)
	Indiana Ave., Little Calumet River	<3.4	7.1
	Halsted St., Little Calumet River	<3.7	8.4
	Wentworth Ave., Little Calumet River	<3.8	11.2
	Ashland Ave., Little Calumet River	<4.4	10.9
	Joe Orr Road, Thorn Creek	<6.7	12.2
	170th St., Thorn Creek	<6.4	11.7

< = Less than LLD.

APPENDIX I

APPENDIX I

MEETINGS AND SEMINARS 2004
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

1. Aquatic Nuisance Species Dispersal Barrier Meeting, Chicago, Illinois, January 2004.

2. Asian Carp Rapid Response Planning Team Meeting, Chicago, Illinois, January 2004.

3. Calumet Government Working Group, 2004 First Quarter Meeting, Chicago, Illinois, January 2004.

4. Illinois Water Environment Association, Government Affairs in Water Pollution Control Seminar, Lisle, Illinois, January 2004.

5. Midwest Water Analysts Association, Winter Expo 2004, Kenosha, Wisconsin, January 2004.

6. United States Department of Agriculture, CSRS Regional Research Committee W-170 Annual Meeting, Lake Buena Vista, Florida, January 2004.

7. Illinois Nutrient Standards Science Committee Meeting, Springfield, Illinois, February 2004.

8. Illinois Soil Classifiers, Annual Education Seminar, Wheaton, Illinois, February 2004.

9. Illinois Water Environment Association, Industrial Pretreatment and Hazardous Waste Winter Meeting, Lombard, Illinois, February 2004.

10. Lake Michigan Air and Waste Management Association, Technical Tools for Air Emission Management Seminar, Willowbrook, Illinois, February 2004.

11. Midwest Section of Air and Waste Management Association, Luncheon Meeting, Chicago, Illinois, February 2004.

12. United States Environmental Protection Agency, Region V, 2004 Midwest Surface Water Monitoring and Standards Meeting, Chicago, Illinois, February 2004.

13. United States Geological Survey, United States Environmental Protection Agency, Region V, and St. Cloud State University, Workshop on Environmental Fate and Effects of Alkylphenols in the Aquatic Environment, Mounds View, Minnesota, February 2004.

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MEETINGS AND SEMINARS 2004
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

14. Water Environment Federation, 18th Annual Residuals and Biosolids Management Conference, Salt Lake City, Utah, February 2004.

15. Asian Carp Rapid Response Planning Team Meeting, Chicago, Illinois, March 2004.

16. Illinois Water Environment Association, 25th Annual Conference, Rockford, Illinois, March 2004.

17. Industrial Water, Waste, and Sewage Group Dinner Meeting, Chicago, Illinois, March 2004.

18. Northwestern Indiana Regional Planning Commission, Interagency Task Force on E. coli, Portage, Indiana, March 2004.

19. Pittsburgh Conference, Chicago, Illinois, March 2004.

20. Third World Conference, 30th Annual Conference, Global Change: Development, Peace, and Security, Chicago, Illinois, March 2004.

21. Universal Imaging Institute, Quantitative Imaging Microscopy Training, Downington, Pennsylvania, March 2004.

22. Water Environment Research Foundation, Joint Research Council and Subscriber Meeting, Phoenix, Arizona, March 2004.

23. Water Environment Research Foundation, PSC Meeting, Lewisburg, Pennsylvania, March 2004.

24. Calumet Government Working Group, 2004 Second Quarter Meeting, Chicago, Illinois, April 2004.

25. Central States Water Environment Association, Annual Education Seminar, Madison, Wisconsin, April 2004.

26. Hydromantis GPS-X Software Training, Hamilton, Ontario, April 2004.

APPENDIX I

MEETINGS AND SEMINARS 2004
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

27. Water Environment Federation, Odors and Air Emissions Conference, Bellevue, Washington, April 2004.

28. American Society for Microbiology, 104th General Meeting on Infectious Diseases, New Orleans, Louisiana, May 2004.

29. Aquatic Nuisance Species Dispersal Barrier Meeting, Chicago, Illinois, May 2004.

30. DuPage River, Salt Creek Watershed Workgroup Meeting, Elmhurst, Illinois, May 2004.

31. Illinois Environmental Protection Agency, Nutrient Criteria Workgroup Meeting, Springfield, Illinois, May 2004.

32. Illinois Environmental Protection Agency, Public Hearing, Impaired Waters of Illinois, Draft Section 303(d) List, Springfield, Illinois, May 2004.

33. Midwest Water Analysts Association, 2004 Spring Meeting, Kenosha, Wisconsin, May 2004.

34. Garden Clubs of Illinois, Annual Meeting, Barrington, Illinois, June 2004

35. North American Benthological Society, Annual Meeting, Vancouver, British Columbia, June 2004.

36. United States Army Corps of Engineers, Hearing on Integrated River Management for Upper and Illinois Waterway System, Peoria, Illinois, June 2004.

37. Association of Metropolitan Sewerage Agencies and United States Environmental Protection Agency, Water9 Model Evaluation Meeting, Research Triangle Park, North Carolina, July 2004.

38. DuPage River, Salt Creek Watershed Workgroup Meeting, Elmhurst, Illinois, July 2004.

39. United States Environmental Protection Agency, Region V, Water Environment Federation, Innovative Uses of Biosolids and Animal Manure Symposium, Chicago, Illinois, July 2004.

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MEETINGS AND SEMINARS 2004
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

40. American Fisheries Society, 134th Annual Meeting, Madison, Wisconsin, August 2004.

41. Illinois Pollution Control Board, Hearing on Dissolved Oxygen Standards RO4-25, Springfield, Illinois, August 2004.

42. Illinois Water Environment Association, State Fair Watershed Park Booth, Springfield, Illinois, August 2004.

43. Northwestern Indiana Regional Planning Commission, Interagency Task Force on E.coli, Portage, Indiana, August 2004.

44. United States Geological Survey, Streamgage Cooperators Meeting, Alton, Illinois, August 2004.

45. Water Environment Federation, Central States Water Environment Association, Collection Systems 2004 Conference, Milwaukee, Wisconsin, August 2004.

46. Water Environment Research Foundation, Web Seminar on Land Application of Biosolids, Online, August 2004.

47. DuPage River, Salt Creek Watershed Workgroup Meeting, Elmhurst, Illinois, September 2004.

48. Midwest Water Analysts Association, 2004 Fall Meeting, Milwaukee, Wisconsin, September 2004.

49. Calumet Government Working Group, 2004 Third Quarter Meeting, Chicago, Illinois, October 2004.

50. Chicago River Summit, Chicago, Illinois, October 2004.

51. DUFLOW Model Training, Cicero, Illinois, October 2004.

52. DuPage River, Salt Creek Watershed Workgroup Meeting, Elmhurst, Illinois, October 2004.

53. Great Lakes Withdrawal Meeting, Gurnee, Illinois, October 2004.

APPENDIX I

MEETINGS AND SEMINARS 2004
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

54. Illinois Pollution Control Board, Phosphorus Hearing, Springfield, Illinois, October 2004.

55. Illinois Water 2004 Conference, Urbana, Illinois, October 2004.

56. Marquette University Environmental Engineering Seminar, Microbial Source Tracking by Fatty Acid Methyl Ester Profiles of Indicator Organisms, Milwaukee, Wisconsin, October 2004.

57. Soil Science Society of America, Annual Meeting, Seattle, Washington, October 2004.

58. Soil, Sediments, and Water Conference, Boston, Massachusetts, October 2004.

59. United States Environmental Protection Agency, Region V, Product Expo Seminar, Chicago, Illinois, October 2004.

60. Unsteady Flow Water Quality Model Duflow Training, Cicero, Illinois, October 2004.

61. Water Environmental Federation, 77th Annual Technical Exhibition and Conference, New Orleans, Louisiana, October 2004.

62. Aquatic Nuisance Species Dispersal Barrier Meeting, Chicago, Illinois, November 2004.

63. DuPage River, Salt Creek Watershed Workgroup Meeting, Elmhurst, Illinois, November 2004.

64. Great Lakes Beach Association, 2004 Annual Conference on Recreational Water Quality, Parma, Ohio, November 2004.

65. Industrial Water, Waste, and Sewage Group Dinner Meeting, Chicago, Illinois, November 2004.

66. Water Environment Research Foundation, Web Seminar on Nutrients, Online, November 2004.

67. Calumet Government Working Group, 2004 Fourth Quarter Meeting, Chicago, Illinois, December 2004.

APPENDIX I

MEETINGS AND SEMINARS 2004
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

68. DePaul University, Landscaping for Native Plants Symposium, Chicago, Illinois, December 2004.

69. DuPage River, Salt Creek Watershed Workgroup Meeting, Elmhurst, Illinois, December 2004.

70. Great Lakes By-products Management Association, 5th Annual Conference, Chicago, Illinois, December 2004.

71. Water Environment Research Foundation, Web Seminar on Wet Weather Management, Online, December 2004.

APPENDIX II

APPENDIX II

PRESENTATIONS 2004
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

1. "Could Dioxins Accumulate in Biosolids-Amended Soil?" Presented at the Sustainable Land Application Conference, Lake Buena Vista, Florida, by Lakhwinder S. Hundal, Thomas C. Granato, and Richard I. Pietz, January 2004. PS

2. "Phosphorus Release in Chicago Biosolids and Biosolids Amended Soil." Presented at the Sustainable Land Application Conference, Lake Buena Vista, Florida, by Albert E. Cox and Thomas C. Granato, January 2004. PS

3. "Using Chlorophyll Monitoring to Estimate Nutrient Enrichment in Chicago Area Waterways." Presented at the Midwest Water Analysts Association Winter Expo, Kenosha, Wisconsin, by Jennifer L. Wasik, January 2004. PP

4. "Characteristics of Chicago Biosolids and Their Use as a Conditioner to Enhance Soil Restoration." Presented at the Illinois Soil Classifiers Association, Wheaton, Illinois, by Thomas C. Granato, Albert E. Cox, and Lakhwinder S. Hundal, February 2004. PP

5. "Surface Water Quality During Thirty-One Years of Biosolids Application to Mine Spoil Soils for Land Reclamation." Presented at the Water Environment Federation 18th Annual Residuals and Biosolids Management Conference, Salt Lake City, Utah, by Guanglong Tian, Thomas C. Granato, Richard I. Pietz, and Carl Carlson, Jr., February 2004. B

6. "Anaerobic Digestion of Biosolids to Meet the Requirement for Vector Attraction Reduction at the Calumet Water Reclamation Plant." Presented at the Illinois Water Environment Association Annual Meeting, Rockford, Illinois, by Heng Zhang, Jain S. Jain, Antonio Quintanilla, and Yiping Zhou. March 2004. B

7. "Emerging Pathogens Issues in 21st Century." Presented at the 30th Third World Conference (An Interdisciplinary and Intercultural Conference), Global Change: Development, Peace, and Security, Chicago, Illinois, by Geeta Rijal, March 2004. PP

8. "Using Chlorophyll Monitoring to Estimate Nutrient Enrichment in Chicago Area Waterways." Presented at the Illinois Water Environment Association Annual Meeting, Rockford, Illinois, by Jennifer L. Wasik, March 2004. PP

9. "Beneficial Use of Biosolids in Metropolitan Chicago." Presented at the University of Illinois, Department of Environmental Science and Natural Resources, Urbana, Illinois, by Thomas C. Granato, April 2004. PP

APPENDIX II

PRESENTATIONS 2004
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

10. "Beneficial Use of Class A Biosolids from Low Tech PFRP Equivalent Processing." Presented at the Central States Water Environment Association Annual Education Seminar, Madison, Wisconsin, by Thomas C. Granato, April 2004. PP

11. "Evaluation of Six Estimators to Determine the *Escherichia coli* to Fecal Coliform Ratio in Wastewater Effluents and Ambient Waters." Presented at the American Society of Microbiology 104th General Meeting, New Orleans, Louisiana, by James Zmuda, Richard Gore, and Zainul Abedin, May 2004. PS

12. "Usefulness of Monitoring Class A. Biosolids for FRNA Coliphages." Presented at the American Society of Microbiology 104th General Meeting, New Orleans, Louisiana, by Geeta Rijal and James Zmuda, May 2004. PS

13. "Chlorophyll Monitoring in Chicago's Urban Waterways." Presented at the North American Benthological Society Annual Meeting, Vancouver, British Columbia, by Jennifer L. Wasik, June 2004. PP

14. "Endocrine Disruptors and Other Emerging Pollutants in the Water Environment." Presented at the Garden Clubs of Illinois Annual Meeting, Barrington, Illinois, by Bernard Sawyer, June 2004. PP

15. "Occurrence and Levels of Organic Priority Pollutants in Combined Sewer Overflows in the Chicago Metropolitan Area." Presented at the Water Environment Federation and Central States Water Environment Association Collection Systems 2004 Conference, Milwaukee, Wisconsin, by Heng Zhang, Jain S. Jain, Bernard Sawyer, and Mary Khalil. August 2004. B

16. "Long-Term Effect of Biosolids Application on Soil Microbial Biomass and Potentially Mineralizable N." Presented at the American Society of Agronomy/Soil Science Society of America/Crop Science Society of America Annual Meeting, Seattle, Washington, by Guanglong Tian, Thomas C. Granato, Richard I. Pietz, and Carl Carlson, Jr., October 2004. PP

17. "Monitoring Improvement in Water Quality Following Reclamation of Acidic Coal Refuse with Biosolids." Presented at the Proceedings of Soil Sediments and Water Conference, Boston, Massachusetts, by Pauline V. Lindo, Thomas C. Granato, and Richard I. Pietz, and Carl Carlson, Jr., October 2004. PS

APPENDIX II

PRESENTATIONS 2004
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

18. "Successful Uses of Biosolids in Urban Reclamation in Metropolitan Chicago." Presented at the American Society of Agronomy/Soil Science Society of America/Crop Science Society of America Annual Meeting, Seattle, Washington, by Thomas C. Granato, Albert E. Cox, and Lakhwinder S. Hundal, October 2004. PP

19. "Use of Biosolids as a Topsoil Substitute for Greening-up a Steel Mill Slag Brownfield in Metro Chicago." Presented at the American Society of Agronomy/Soil Science Society of America/Crop Science Society of America Annual Meeting, Seattle, Washington, by Lakhwinder S. Hundal, Thomas C. Granato, and Richard I. Pietz, October 2004. PP

20. "VOCs in CSOs and CSO Storage Facilities in the Chicago Metropolitan Area." Presented at the Water Environment Federation 77th Annual Technical Exhibition and Conference, New Orleans, Louisiana, by Jain S. Jain, Heng Zhang, Bernard Sawyer, and Mary Khalil. October 2004. B

21. "Estimation of the *Escherichia coli* to Fecal Coliform Ratio in Wastewater Effluents and Ambient Waters of the Metropolitan Water Reclamation District of Greater Chicago." Presented at the Fourth Annual Great Lakes Beach Association Conference, Parma, Ohio, by James Zmuda, Richard Gore, and Zainul Abedin, November 2004. PS

22. "Fish Populations in Chicago Area Waterways." Presented at the Metropolitan Water Reclamation District of Greater Chicago, Research and Development Department, 2004 Seminar Series, by Samuel G. Dennison, November 2004. PP

23. "Environmental Risk Assessment and Benefits of Using Biosolids for Greening-up a Steel Mill Slag Brownfield in Metro Chicago." Presented at the Great Lakes By-products Management Association 5th Annual Conference, Chicago, Illinois, by Lakhwinder S. Hundal, Thomas C. Granato, Bernard Sawyer, and Richard Lanyon, December 2004. PP

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*P = Available as a paper
B = Available as both a paper and PowerPoint Presentation
PP = Available as PowerPoint Presentation
PS = Poster Presentation

APPENDIX III

APPENDIX III

PAPERS PUBLISHED 2004
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

1. Granato, T. C., "Beneficial Use of Class A Biosolids from Low Tech PFRP Equivalent Processing." Proceedings of Central States Water Environment Association Annual Education Seminar, Madison, Wisconsin, 2004.

2. Granato, T. C., R. I. Pietz, G. J. Knafl, C. R. Carlson, P. Tata, and C. Lue-Hing, "Trace Element Concentrations in Soil, Corn Leaves, and Grain After Cessation of Biosolids Applications." Journal of Environmental Quality, 33: 2078-2089, 2004.

3. Tian, G., T. C. Granato, R. I. Pietz, and C. Carlson, "Surface Water Quality During 31 Years of Biosolids Application to Mine Spoil Soils for Land Reclamation." Proceedings of the Water Environment Federation 18th Annual Residuals and Biosolids Management Conference, Salt Lake City, Utah, 2004.

4. Zhang, H., J. S. Jain, B. Sawyer, and M. Khalil. "Occurrence and Levels of Organic Priority Pollutants in Combined Sewer Overflows in the Chicago Metropolitan Area." Proceedings of the Water Environment Federation and Central States Water Environment Association Collection Systems 2004 Conference, Milwaukee, Wisconsin, 2004.

5. Zhang, H., J. S. Jain, B. Sawyer, and M. Khalil. "VOCs in CSOs and CSO Storage Facilities in the Chicago Metropolitan Area." Proceedings of the Water Environment Federation 77th Annual Technical Exhibition and Conference, New Orleans, Louisiana, 2004.

APPENDIX IV

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
RESEARCH AND DEVELOPMENT DEPARTMENT
2004 SEMINAR SERIES

Date	Subject
Friday **February 27, 2004**	***Overview of New Microbiological Methods for Environmental Decision Making*** Professor Joan Rose Michigan State University, East Lansing, Michigan
Friday **March 26, 2004**	***Impact of Alkylphenol Ethoxylates and Other Endocrine Disruptors on the Aquatic Environment*** Mr. Peter Howe, Life Scientist, Water Division Mr. Dan Hopkins, Regional Team Manager Toxics Reduction Team United States Environmental Protection Agency Region V, Chicago, Illinois
Friday **April 30, 2004**	***Preparing an Environmental Management System (EMS) for Biosolids*** Mr. Michael Moore, Manager Environmental Compliance Monitoring Orange County Sanitation District Fountain Valley, California
Friday **May 21, 2004**	***Using Source Tracking as a Tool for Studying Lake Michigan Beach Closings*** Mr. Mark Pfister, Aquatic Biologist Lake County Health Department Waukegan, Illinois
Friday **June 25, 2004**	***Development of a Dynamic Model for Predicting Dissolved Oxygen Concentrations in the Chicago River*** Professor Charles Melching Marquette University, Milwaukee, Wisconsin

RESERVATIONS REQUIRED (at least 24 hours in advance)
CONTACT:
Mr. Bernard Sawyer, Assistant Director of Research & Development
Environmental Monitoring and Research Division
(708) 588-4264 or (708) 588-4059

(Note: Some seminars may be eligible for Professional Development Credits/CEUs)

LOCATION:
Stickney Water Reclamation Plant
Lue-Hing Research and Development Complex
6001 West Pershing Road, Cicero, Illinois 60804-4112
(Picture ID required for plant entry)

TIME: 10:00 A.M.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
RESEARCH AND DEVELOPMENT DEPARTMENT
2004 SEMINAR SERIES

Date	Subject
Friday **July 30, 2004**	***Update on the Chicago Waterways System Use Attainability Analysis (UAA)*** Mr. Ronald French, Senior Scientist CDM, Inc., Chicago, Illinois
Friday **August 27, 2004**	***Large Scale Nutrient Removal Pilot Plant Studies for New York City Wastewater*** Mr. Louis Carrio, Chief, Process Planning Section New York City Dept. of Environmental Protection Flushing, New York
Friday **September 24, 2004**	***Land Application of Biosolids: A Benefit or Risk to Soil Ecosystem Health?*** Professor Nicholas Basta Ohio State University, Columbus, Ohio
Friday **October 29, 2004**	***Update on Stickney Water Reclamation Plant Master Plan Study*** Mr. Christopher Haite, Principal Civil Engineer Engineering Department Metropolitan Water Reclamation District of Greater Chicago (District), Chicago, Illinois Mr. Gary Shimp, Project Manager Black and Veatch, Chicago, Illinois
Friday **November 19, 2004**	***Fish Populations in the Chicago Area Waterways*** Mr. Samuel Dennison, Biologist IV Research and Development Department District, Cicero, Illinois

RESERVATIONS REQUIRED (at least 24 hours in advance)
CONTACT:
Mr. Bernard Sawyer, Assistant Director of Research & Development
Environmental Monitoring and Research Division
(708) 588-4264 or (708) 588-4059

(Note: Some seminars may be eligible for Professional Development Credits/CEUs)

LOCATION:
Stickney Water Reclamation Plant
Lue-Hing Research and Development Complex
6001 West Pershing Road, Cicero, Illinois 60804-4112
(Picture ID required for plant entry)

TIME: 10:00 A.M.

APPENDIX V

Environmental Monitoring and Research Division

Section 121 – Administrative Section

Sawyer, Bernard, Assistant Director of R&D (84059)
Messina, Deborah, Secretary (84264)
Granato, Thomas, Acting Research Scientist 4 (84116/84063)
Urlacher, Nancy, Administrative Assistant (84176)
Abedin, Zainul, Biostatistician (83672)
Emery, David, Associate Statistician (83780)

Section 122 – Wastewater Treatment Process Research Section

Jain, Jain, Research Scientist 3 (84068)
Lordi, David, Research Scientist 3 (84072)
Franklin, Laura, Prin. Office Support (83625)
Patel, Kamlesh, Research Scientist 2 (83735)
Zhang, Heng, Research Scientist 2 (84069)
Bernstein, Doris, Research Scientist 1 (84108)
Kaschak, John, Research Scientist 1 (83651)
MacDonald, Dale, Research Scientist 1 (83472)
Oskouie, Ali, Research Scientist 1 (84070)
Haizel, Anthony, Laboratory Tech 2 (83577)
Reddy, Thota, Laboratory Tech 2 (83736)
Bodnar, Robert, Laboratory Tech 1 (83750)
Byrnes, Marc, Laboratory Tech 1 (83750)
Pierson, Rodney, Laboratory Tech 1 (83751)
Saric, Ron, Laboratory Tech 1 (83750)
Swies, Christopher, Laboratory Tech 1 (83750)

Section 123 – Biosolids Utilization and Soil Science Section

Cox, Albert, Acting Soil Scientist 3 (84054)
Yarn, Sabina, Prin. Office Support (83615)
Vacant, Soil Scientist 2
Hundal, Lakhwinder, Soil Scientist 2 (84201)
Lindo, Pauline, Soil Scientist 1 (84109)
Tian, Guanglong, Soil Scientist 1 (83579)
Dennison, Odona, Sanitary Chemist 1 (84246)
Patel, Minaxi, Sanitary Chemist 1 (84066)
Mackoff, Ilyse, Laboratory Tech 2 (83770)
Tate, Tiffany, Laboratory Tech 2 (83655)
Patel, Upendra, Laboratory Tech 1 (83769)
Shingles, Craig, Laboratory Tech 1 (83796)
Vacant, Laboratory Assistant (83766)
Vacant, Laboratory Assistant (83765)

Section 124 – Analytical Microbiology and Biomonitoring Section

Zmuda, James, Microbiologist 4 (84224)
Griffith, Rhonda, Prin. Office Support (84251)
Rijal, Geeta, Microbiologist 3 (83767)
Gore, Richard, Microbiologist 2 (84112)
Yamanaka, Jon, Biologist 1 (84225)
Billett, George, Laboratory Tech 2 (83721)
Jackowski, Kathleen, Laboratory Tech 2 (83637)
Maka, Andrea, Laboratory Tech 2 (83629)
Rahman, Shafiq, Laboratory Tech 2 (83775)
Shukla, Hemangini, Laboratory Tech 2 (84220)
Hussaini, Syed, Laboratory Tech 1 (84220)
Kaehn, James, Laboratory Tech 1 (83775)
Mangkorn, Damrong, Laboratory Tech 1 (83721)
Roberts, David, Laboratory Tech 1 (83637)
Burke, Michael, Laboratory Assistant (83637)
Latimore, Thomas, Laboratory Assistant (83713)

Section 125 – Land Reclamation and Soil Science (Fulton County)

(309) 647-8200

Carlson, Jr., Carl, Sanitary Chemist 2
Boucek, Jr., Emil, Field and Lab Tech
DeWees, Josh, Field and Lab Tech
Swango, Rosalie, Field and Lab Tech

Section 126 – Aquatic Ecology and Water Quality Section

Dennison, Sam, Biologist 4 (84060)
Scrima, Joan, Prin. Office Support (84168)
Sopcak, Michael, Biologist 3 (83748)
Wasik, Jennifer, Biologist 2 (84074)
Minarik, Thomas, Biologist 1 (84223)
Gallagher, Dustin, Laboratory Tech 2 (83798)
Rohe, Donald, Laboratory Tech 2 (83739)
Schackart, Richard, Laboratory Tech 2 (83744)
Vick, Justin, Laboratory Tech 2 (83764)
Vacant, Laboratory Tech 1 (83749)
Whitington, Angel, Laboratory Tech 1 (83794)

Section 128 – Radiochemistry Section

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