Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

RESEARCH AND DEVELOPMENT DEPARTMENT

REPORT NO. 07-05

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

2005

ANNUAL REPORT

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

2005

ANNUAL REPORT

Research and Development Department
Louis Kollias, Director

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ACKNOWLEDGMENTS

This 2005 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

The mention of trade names of specific products does not constitute endorsement of them by the Metropolitan Water Reclamation District of Greater Chicago.

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:

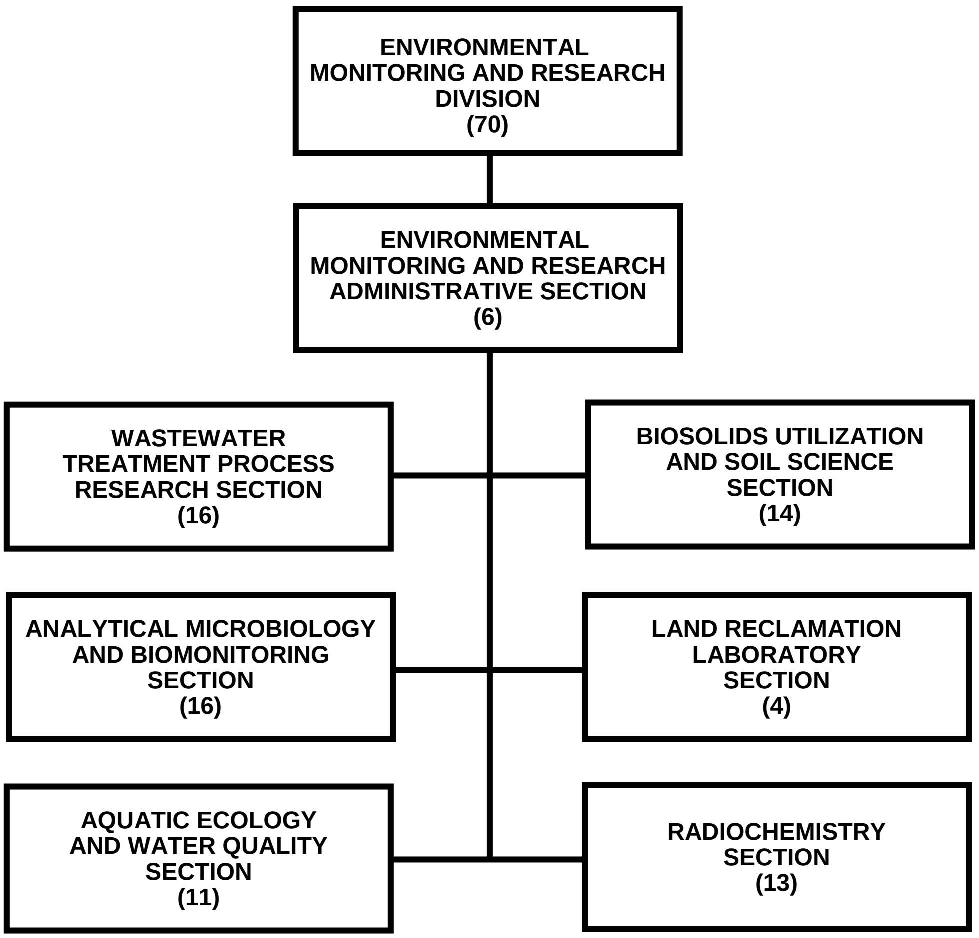
1. Administrative
2. Wastewater Treatment Process Research
3. Biosolids Utilization and Soil Science – Stickney
4. Land Reclamation Laboratory - Fulton County
5. Analytical Microbiology and Biomonitoring
6. Aquatic Ecology and Water Quality
7. Radiochemistry

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

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 2005, 1,521 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 Group 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 $\LaTeX$ and Visual Basic Programs with SAS, Access, Excel, Outlook, and Power Point software programs. This computer automation has enabled the section to produce reports, tables, and texts in suitable designs, and to respond to many requests in a shorter period of time.

Statistical and Computing Support. During 2005, 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 Wastewater Treatment Process Research Section on reduction of TARP groundwater monitoring wells. The analysis was completed in November 2005.

2. Statistical support was provided to the Analytical Microbiology and Biomonitoring Section on a project entitled, “Effect of Secondary Sewage Treatment on the Total Numbers and Percentages of Antibiotic Resistant Fecal Coliforms in Municipal Raw Sewage.” The statistical analyses for the project were completed in November 2005.

3. Statistical support was provided to Analytical Microbiology and Biomonitoring Section on a project entitled, “Protecting Lake Michigan Water Quality: Addressing Beach Issues.”

4. Statistical support was provided to the Biosolids Utilization and Soil Science Section to study the effect of long-term application of biosolids to land at the

District's Fulton County Project sites on surface water chemistry. Data collected from the reservoirs and creeks from 1972 through 2002 were analyzed.

5. Continuous supports are being provided to the Biosolids Utilization and Soil Science Section to produce quarterly reports on biosolids management at the District's Biosolids Management Areas to meet IEPA permit requirements.

6. Statistical support was provided to the Biosolids Utilization and Soil Science Section to support requests to IEPA for termination of monitoring requirements at the Fulton County Project site.

7. Statistical support and consulting was provided to the Biosolids Utilization and Soil Science Section on projects including the USX Demonstration Project and the St. David Coal Refuse Reclamation Project.

8. Statistical support and consulting was provided on data management, automation of reports, etc. to various sections in the Division.

Water Quality Data. Each year, the Experimental Design and Statistical Evaluation Group summarizes results of the District's Ambient Water Quality Monitoring program for the Chicago Waterway System. Surface water quality data for 2005 were evaluated regarding compliance with water quality standards set by the Illinois Pollution Control Board (IPCB). In 2005, 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 2005, 31 water quality parameters had IPCB General Use standards. Benzene and total mercury had IPCB Human Health standards.

Twenty-one 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 selenium, total 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. Eight of the remaining 10 parameters, viz., dissolved oxygen, temperature, pH, chloride, sulfate, fluoride, total hexavalent chromium, and total manganese had compliance rate greater than 86.5 percent in all river systems. Total dissolved solids had a compliance rate greater than 76.5 percent in all river systems. Fecal coliform had the lowest compliance rate, and it was in the range of 38.6 to 45.8 percent in the Chicago, Calumet, and the Des Plaines River Systems. The compliance rates of total mercury with respect to IPCB Human Health Standard were 70.6, 73.6, and 85.0 percent, respectively, in the Chicago, Calumet, and Des Plaines River Systems.

Secondary Contact Water. Twenty-three water quality parameters measured in the secondary contact waters during 2005 had applicable IPCB standards. Sixteen parameters were in complete compliance with the IPCB standards for the Chicago and the Calumet River Systems in 2005. They were temperature; phenols; fats, oils, and greases; total cyanide; fluoride; total silver; total arsenic; total barium; soluble cadmium; total copper; total hexavalent chromium; total nickel; total manganese; total zinc; total selenium; and total iron. The percent compliance of the remaining 7 parameters (dissolved oxygen, pH, un-ionized ammonia, total dissolved solids, total iron, total lead, and total mercury), which were not in total compliance in both the river systems varied from 94.2 percent to total compliance.

WASTEWATER TREATMENT PROCESS RESEARCH SECTION

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 2005, the Section was primarily concerned with studies relating to polymer testing, odor monitoring and control, sludge treatment technologies, oxygen transfer efficiency, ammonia loads to the Stickney WRP, and settling and chemical characteristics of combined sewer overflows. The Section also participated in the Stickney, North Side, and Calumet WRP Master Plans and the operation of the Tunnel and Reservoir Plan (TARP) System. Studies initiated in 2005 included grit testing of primary sludges at the District's WRPs, preliminary evaluation of ultraviolet disinfection, a study to quantify and compare volatile organic compound concentrations in discharges to TARP dropshafts that receive flow from predominantly residential sources versus flows from sources with substantial industrial sources, application of GPS-X model to evaluate Stickney and Kirie WRPs performance, and Unsteady Flow Water Quality Modeling to support the Use Attainability Analysis for the Chicago Waterways. The main projects performed by the Section are summarized below.

Polymer Testing Programs

During 2005, polymers were tested for use in dewatering and thickening of various sludges at District WRPs.

Polymer Testing Program for the District Centrifuge Complexes. During February and August 2005, winter and summer polymer testing, respectively, was carried out at the Stickney WRP for the selection and purchase of polymers used in the centrifugal dewatering of anaerobically digested sludge. The testing procedure is performed seasonally at Stickney because the change in sludge characteristics during these seasons requires different polymers at this WRP.

Polymer testing was also carried out for post-digestion centrifugal dewatering at the Calumet WRP during April 2005. A total of ten polymers were tested with ferric chloride as a preconditioner.

Contract documents were prepared and issued by the District for the solicitation and submittal of polymers for testing at the Stickney WRP and the Calumet WRP, with the objective of selecting suitable polymers meeting the centrifuge performance criteria described therein at the lowest cost. This includes polymer cost, sludge transportation cost, and air-drying cost.

The polymer selection procedure consisted of testing a maximum of two polymers from any given vendor on a full-scale centrifuge. The polymer that passes the test performance criteria as described in the bid documents, and has the lowest cost for conditioning per unit mass of sludge is the polymer of choice for purchase. A summary of the relevant information about the winter and summer tests conducted at the Stickney WRP is presented in Tables II-1 and II-2, respectively. The Calumet WRP test summary is presented in Table II-3.

Polymer Testing Program for Gravity Concentration Tanks at the Calumet WRP. In September 2005, bench-scale polymer testing was carried out at the Lue-Hing Research and Development Complex for the selection and purchase of polymers used in the gravity concentration tanks to thicken the primary and waste-activated sludge at the Calumet WRP. Documents were issued by the District for the solicitation and submittal of polymers for testing at the Lue-Hing Research and Development Complex at the Stickney WRP with the objective of selecting suitable polymers meeting the gravity concentration tanks performance criteria described therein at the lowest cost.

The polymer selection procedure consisted of testing a maximum of three polymers from any given vendor on a bench-scale test to obtain a capillary suction time (CST) of ten seconds. The polymers that passed the test performance criteria (the CST requirement of 10 seconds as described in the bid documents) were subjected to bench-scale settling tests at "optimum dose." The polymers were then ranked based on their performance. Thus, the polymers that met the criteria and had the lowest cost for concentrating per unit mass of sludge became the polymer of choice for purchase. A summary of the relevant information about the tests conducted during September 2005 for the Calumet WRP gravity concentration tanks is presented in Table II-4.

Polymer Testing Program for Gravity Belt Thickeners at the Hanover Park WRP. In June 2005, polymer testing was carried out at the Hanover Park WRP for the selection and purchase of polymers used in the gravity belt thickening of waste-activated sludge. Documents were issued by the District for the solicitation and submittal of polymers for testing at the Hanover Park WRP, with the objective of selecting suitable polymers meeting the gravity belt thickener (GBT) performance criteria described therein at the lowest cost.

The polymer selection procedure consisted of testing a maximum of two polymers from any given vendor on a full-scale GBT to obtain a cake solids of 6.0 percent. This criterion was upgraded from 5.5 to 6.0 percent from the previous contract. The polymer that passed the test performance criteria as described in the bid documents and had the lowest cost for conditioning per unit mass of sludge became the polymer of choice for purchase. A summary of the relevant information about the tests conducted at the Hanover Park WRP is presented in Table II-5.

Summer/Winter Polymer Testing Program for the Stickney Centrifuge Complex. In November 2005, full-scale polymer testing was carried out at the Stickney WRP to verify that changing of polymers used in the centrifugal dewatering of anaerobically digested sludge from summer to winter formulation was appropriate. This full-scale polymer testing procedure is performed twice at Stickney, once in summer and once in winter, as the change in sludge characteristics during these seasons require different polymers at this WRP. Summer tests were not requested by the M&O Department.

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 visit the monitoring 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.

For each month, average odor intensity data from the 16 stations were calculated. Table II-6 summarizes the observations of odor monitoring personnel during 2005, 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 11 and 51 percent of the monthly visits during the year, there were no very strong odor observations. The strong odor observations, which occurred over the period of March through October, 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.

Tables II-7 and II-8 summarize the observations of easily noticeable, strong, and very strong odors made during 2005 in terms of frequency of occurrence for the Calumet WRP and the Calumet Drying Areas, respectively. The odors were at generally low levels in 2005, with very strong odors observed only at the Calumet Solids Drying Area, 0.05 percent of all observations. 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 11 and 30 percent of the monthly observations at the Calumet WRP and between 2 and 24 percent at the drying areas.

Odor Monitoring at the RASMA Solids Drying Area. The odor monitoring program at RASMA 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 2005 is presented in Table II-9 expressed as frequency of occurrence. No very strong odors were observed. Strong odors were observed in May and September 2005. Easily noticeable odors were detected between 0 and 35 percent of the time and were observed mainly during the drying period of May through November 2005.

Odor Monitoring at the Stony Island Solids Drying Area. The odor monitoring program at the Stony Island Solids Drying 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.

Table II-10 summarizes the observations of easily noticeable, strong, and very strong odors made during 2005 in terms of frequency of observation. There were no very strong odor observations. Strong odors were only observed from June through October, and varied between 2 and 16 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 2005 is presented in Table II-11. Odor of an easily noticeable intensity was observed from 4 to 25 percent of the monthly observations made at the John E. Egan WRP. No very strong odors or strong odors were observed in 2005.

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.

The percentage of visits at which easily noticeable, strong, and very strong odors were observed in 2005 are presented in Table II-12. Easily noticeable odors were observed less than 33 percent of the time during every month of the year. A single very strong odor was observed in the months of May through August. Strong odor observations varied from 0 to 3.9 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.

Table II-13 summarizes the observations of odor monitoring personnel during 2005. There were no strong or very strong odors observed in 2005. Easily noticeable odors were detected in less than 2.2 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. Table II-14 summarizes the monthly observations of odor monitoring personnel in 2005. No very strong odors were observed during the year, and some strong odors were observed in May through August 2005. The easily noticeable odors ranged between 20 and 46 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 2005, influent samples were collected in February and August. The average influent concentrations found are presented in Table II-15 for the three major District WRPs. The estimated emissions of individual HAPs for the three major District WRPs are summarized in Table II-16.

According to the BASTE model, all of the individual HAP emissions were less than the 10 tons/year criterion. Dichloromethane, toluene, and 2,2,4-trimethylpentane were the predominant compounds emitted from the wastewater treatment processes at the Stickney WRP. The HAP emissions from the Calumet WRP were very low, all less than 1 ton/yr, with toluene being the predominant compound. 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.

Grit Testing of Primary Sludge at the Major WRPs Using Eutek Cup Pilot Unit

Objective. The objective of the pilot-scale study was to evaluate whether any grit is found in the primary sludge at the North Side, Calumet, and Stickney WRPs, and, if so, to quantify and characterize the grit.

This study was a cooperative effort of the R&D, Engineering, and M&O Departments and representatives of Eutek Corporation, a grit-removal equipment manufacturer, and Grit Solutions, a consulting firm hired by Eutek Corporation.

Grit Sampling Technique. Eutek's SCS™ Sludge Degritting System mobile unit was used to sample grit in the primary sludge at North Side, Calumet and Stickney WRPs, and in the combined sludge from the North Side WRP. The degritting system was rented by the Engineering Department. The mobile unit was set up at each of the WRPs by M&O Department personnel with the assistance of a Eutek representative. Operation of the mobile unit was then handled by personnel from Grit Solutions, who collected the required samples. The mobile unit was set up next to the primary settling tanks; primary sludge was sampled from the conduit that conveys the primary sludge to the sludge concentration tanks. The feed sludge was pumped and mixed with supernatant from the unit to maintain a total flow of 400 GPM to the vortex separator (Slurry Cup™). The diluted feed sludge passed through the slurry vortex cup in which inertia due to centrifugal forces separated the relatively heavier material which passed down into a settling clarifier. The heavier material settled to the bottom and was picked up by a conveyor ("Grit Snail™") and was discharged into the collection container. The overflow from the vortex unit was collected in a recycle tank for dilution of the sludge, and the excess flow was discharged back to the primary settling tanks along with the supernatant from the clarifier.

The dates, hours of operation, the sludge flow rate, and the volume of material collected from the SCS™ unit were recorded for each sampling run. A grab sample of the primary sludge feed was collected at the beginning of each run, as it was not possible to collect a sample while the unit was in operation. The separated grit material samples were split into two portions for analysis by both Grit Solutions and by the District's R&D Laboratories. The District samples were analyzed for total solids and volatile solids by the Analytical Laboratory Division, and 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 total and volatile solids. The inert material that remains after heating to 550°C is operationally defined as grit, and was subjected to sieve analysis.

The sieve analysis method used is a modified ASTM D 422-63 (Re-Approved 1990) method for quantitative determination of the distribution of particle sizes. 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).

North Side WRP Results and Discussion. Samples of the separated grit material from the primary sludge were collected on May 9, 10, and 11, 2005. The operational information and details of the sludge flows and material collected are summarized in Table II-17. The average volume of the grit material collected (28.9 gallons) was approximately 0.06 percent of the average sludge volume processed (47,320 gallons). A substantial rainfall occurred during the nighttime hours of May 10-11, 2005, resulting in higher flows to the North Side WRP. The daily average plant flow on May 11, 2005, was approximately twice that of the previous days. The volume of material collected was substantially increased, 52.4 gallons in 39,960 gallons, or 0.13 percent of the volume of sludge processed on that day.

Total Solids and Volatile Solids in the Collected Grit Material. The total and volatile solids results from the material collected by the Eutek unit are presented in Table II-18. On average, the collected material had 29.8 percent total solids, of which 49.4 percent was organic and 50.6 was inert, or grit.

An estimate of the volume of grit in the North Side WRP's primary sludge was calculated using the average values of 28.9 gallons of material collected per run, total solids of 29.8 percent, inorganic solids 50.6 percent, and assuming that all of the collected material solids had a specific gravity of 2.65. Based upon the percentage of water and solids, the specific gravity of the collected material was estimated to be:

$$\frac{70.2(1) + 29.8(2.65)}{100} = 1.49$$

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

$$\frac{0.298 \times 0.506}{1.49} \times 28.9 \text{ gallons} = 2.92 \text{ gallons of grit}$$

The volume of grit in a million gallons of preliminary sludge would be:

$$\frac{2.92 \times 10^6}{47{,}320} = 61.7 \text{ gallons of grit / MG sludge}$$

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

Sieve Analysis of Grit. After incineration at 550°C, the material was subjected to sieve analysis. The results of the sieve analysis for each of the sample periods are presented in Table II-19 as percent of material retained on each sieve, and in Table II-20 as a cumulative percentage.

The material collected on May 9, 2005, was split into two portions and analyzed separately in order to assess the variation between analyses. The results in Table II-19 show excellent agreement between the two portions.

The fraction with the largest percentage of material retained was 150 µm for May 9, 2005, to May 11, 2005, at 24.1 to 27.0 percent of the total grit. The May 11, 2005, sample also showed a greater percentage of larger particle sizes of 13.4 percent at 300 µm and 25.5 percent at 212 µm. At a grit particle size of 150 µm, approximately 50 percent was smaller for the May 9 and 10, 2005, samples. The May 11, 2005, samples had only 22 percent smaller than 150 µm. The percentage of larger particles (425 µm or greater) was higher on May 11, 2005 (12 percent) as compared to the dry weather days (6 percent).

The primary sludge grit samples collected at each WRP were also analyzed by Grit Solutions, and in general Grit Solutions' ash-sieve analyses and the District's results were within approximately five percent, which is considered very reasonable.

Summary and Conclusions. The following conclusions are drawn based on the pilot-scale tests conducted on the primary sludge at the North Side WRP:

1. The grit material collected (average of 28.9 gallons) was approximately 0.06 percent by volume of the average primary sludge flow processed (47,320 gallons per day) over the three days.

2. The collected grit material contains approximately 30 percent total solids, of which 49 percent is organic (volatile material) and 51 percent is inert or can be considered to be grit.

3. The estimated grit content of the primary sludge, on a volume basis, is 61.7 gallons of grit per million gallons of primary sludge, or approximately 0.006 percent.

4. Following a rain event, the amount of grit collected from the primary sludge increased approximately two times over the two days that were sampled prior to the rain.

5. The grit particle size showed about 50 percent of the mass smaller than 150 µm for the dry weather condition and only 22 percent smaller than 150 µm for the wet weather condition.

6. Only 6 percent of the grit had a particle size of 425 µm or larger for the dry weather days and 12 percent for the wet weather day.

Calumet WRP Results and Discussion. Samples of the grit material separated from the primary sludge were collected on May 18, 19, and 20, 2005. The operational information and details of the sludge flows processed and material collected are summarized in Table II-21. The average volume of the grit material collected (2.56 gallons) was approximately 0.009 percent of the average sludge volume processed (27,000 gallons). A substantial rainfall occurred during the nighttime hours of May 18-19, 2005, resulting in higher flows to the Calumet WRP. The daily average plant flow on May 19, 2005, was over 2 1/2 times that of each of the other two days. This resulted in an increased volume of material collected on May 19, 2005, 5.09 gallons of grit collected from 27,000 gallons processed, or 0.019 percent of the volume of sludge processed on that day.

Total Solids and Volatile Solids of Primary Sludge and Collected Grit Material. The percent total solids and percent volatile solids of the primary sludge fed to the Eutek unit and of the material collected by the Eutek unit are presented in Table II-22. The total solids of the feed sludge to the Eutek unit averaged 0.84 percent for the three days. The volatile solids of the feed sludge averaged 62.6 percent. On average, the collected material had 47.2 percent total solids, of which 25 percent was organic and 75 percent was inert or grit. The higher percent total solids on May 20, 2005, may be a result of a more efficient decanting off of the liquid from the collected solids.

An estimate of the volume of grit in the Calumet WRP's primary sludge was calculated following the procedure used for the North Side WRP. At Calumet WRP, an average of 2.56 gallons of material was collected per run, with total solids of 47.2 percent, inorganic solids 75 percent. Assuming that all of the collected material solids had a specific gravity of 2.65, the specific gravity of the collected material was estimated to be 1.78, and the volume of the grit portion of the collected material would be 0.51 gallons of grit, or 18.9 gallons of grit/MG sludge. This is assuming that all of the inorganic matter is classified as grit.

Sieve Analysis of Grit. After incineration at 550°C, the material was subjected to sieve analysis. The results of the sieve analysis for each of the sample periods are presented in Table II-23 as percent of material retained on each sieve, and in Table II-24 as a cumulative percentage. The size distributions were very similar on all three days.

The fraction with the largest percentage of material retained was 150 µm, averaging 33 percent for the three days. The next largest fraction was 212 µm, averaging 22.1 percent. At a grit particle size of 150 µm, approximately 39 and 34 percent was smaller for the May 18 and 19, 2005, samples. The May 20, 2005, samples had only 21 percent smaller than 150 µm.

Conclusions. The following conclusions are drawn based on the pilot-scale tests conducted on the preliminary sludge at the Calumet WRP.

1. Grit was found in the primary sludge at the Calumet WRP.

2. The grit material collected (average of 2.56 gallons) was approximately 0.0095 percent by volume of the average primary sludge flow processed (27,000 gallons per day) over the three days.

3. The collected grit material contains approximately 47 percent total solids, of which 25 percent is organic (volatile material) and 75 percent is inert or can be considered to be grit.

4. The estimated grit content of the primary sludge, on a volume basis, is 18.9 gallons of grit per million gallons of primary sludge, or approximately 0.002 percent.

5. Following a rain event, the amount of grit material collected from the primary sludge increased approximately four times over the day before and the day after the rain event.

6. The mass of grit particles smaller than 150 µm averaged 31 percent of the total particle mass for the three days, although the percentage of these finer particles decreased over the three days, and was not related to plant flow.

7. In contrast to the North Side WRP sampling results, the particle size distribution of the grit did not appear to vary between wet and dry weather sampling events.

Stickney WRP Results and Discussion. The operational information and details of the sludge flows processed and material collected are summarized in Table II-25. The average volume of the material collected by the SCS™ mobile unit (0.277 gallons) was approximately 0.0006 percent of the average sludge volume processed (48,510 gallons). There was no rainfall over the three-day period with the daily influent flow to the Southwest part of the Stickney WRP varying between 242 and 289 MGD.

Total Solids and Volatile Solids of Preliminary Sludge and Collected Grit Material. The percent total solids and percent volatile solids of the preliminary sludge fed to the Eutek unit and the material collected by the Eutek unit are presented in Table II-26. The total solids of the feed sludge to the Eutek unit averaged 0.47 percent for the three days. The volatile solids and inorganic (ash) solids of the feed sludge averaged 54.6 percent and 45.4 percent, respectively.

On average, the collected material had 28.6 percent total solids, of which 43.6 percent was organic and 56.4 percent was inert or grit. There is a wide variation in the total solids of the collected material from the Eutek unit on a given day, within a range of 17.9 to 44.3 percent total solids. The higher percent total solids on May 25, 2005, may be a result of a more efficient decanting of the liquid from the collected solids. This may also account for the higher percent ash content of the May 25, 2005, sample.

An estimate of the volume of grit in the Stickney WRP's primary sludge was made following the procedure used for the North Side WRP grit study and using the average values of 0.277 gallons of material collected per run, total solids of 28.6 percent, inorganic solids 56.4 percent, and assuming that all of the collected material solids had a specific gravity of 2.65. Based upon the percentage of water and solids, the specific gravity of the collected material was estimated to be 1.53, and the volume of the grit portion of the collected material was calculated to be 0.029 gallons of grit, or 0.598 gallons of grit/MG sludge. This is assuming that all of the inorganic matter is classified as grit.

Sieve Analysis of Grit. After incineration at 550°C, the material was subjected to sieve analysis. The results of the sieve analysis for each of the sample periods are presented in Table II-27 as percent of material retained on each sieve, and in Table II-28 as a cumulative percentage. The size distributions were very similar on all three days, with the majority of the material between 150 and 425 µm in size. The fraction with the largest percentage of material retained was 212 µm, averaging 28.4 percent for the three days. The next largest fraction was 150 µm, averaging 20.1 percent. On the average, 12 percent of the grit had particle size of 425 µm or greater.

Conclusions. The following conclusions are drawn based on the pilot-scale tests conducted on the preliminary sludge at the Stickney WRP.

1. Compared to the North Side and Calumet WRPs, a much smaller amount of grit was found in the preliminary sludge at the Stickney WRP. However, all samples were collected in dry weather flow conditions.

2. The total volume of grit material collected (average of 0.277 gallons) was approximately 0.0006 percent of the daily average preliminary sludge volume processed (48,510 gallons per day) over the three days.

3. The material collected from the Eutek unit contains approximately 29 percent total solids, of which 44 percent is organic (volatile material) and 56 percent is inert or can be considered to be grit.

4. The estimated content of grit particles in the preliminary sludge, on a volume basis, is 0.6 gallons of grit particles per million gallons of preliminary sludge, or approximately 0.00006 percent.

5. The mass of grit particles smaller than 150 µm averaged 21.8 percent of the total particle mass for the three days.

6. The percentage of the grit with a particle size of 425 µm or larger was relatively constant over the three days, averaging 12.1 percent.

North Side Combined Sludge Results and Discussion. The operational information and details of the sludge flows processed and material collected over the three days of operation are summarized in Table II-29. The sludge flow was set at the beginning of each run and assumed to remain constant during the period of operation. The average volume of the material collected (0.684 gallons) was approximately 0.004 percent of the average sludge volume processed (16,500 gallons).

Total Solids and Volatile Solids of North Side Sludge and Collected Grit Material. The percent total solids and percent volatile solids of the North Side sludge fed to the Eutek unit and collected material separated from the North Side sludge are presented in Table II-30. The total solids of the feed sludge to the Eutek unit averaged 1.26 percent for the three days. The volatile solids and inorganic (ash) solids of the feed sludge averaged 74.6 percent and 25.4 percent, respectively. On average, the collected material had 43.6 percent total solids, of which 37.5 percent was organic in nature and 62.5 percent was inert or grit. The total solids of the collected material from the Eutek unit only slightly varied over the three days. The average percent ash content (76.5 percent) of the June 30, 2005 sample was higher than the other two days (57.7 and 63.4 percent). This may be a result of a more efficient decanting and washing of the collected solids.

An estimate of the volume of grit particles in the North Side WRP's combined sludge was made following the procedure used for the North Side WRP primary sludge using the average values of 0.684 gallons of material collected per run, total solids of 43.6 percent, inorganic solids 62.5 percent, and assuming that all of the collected material solids had a specific gravity of 2.65. Based upon the percentage of water and solids, the specific gravity of the collected material was estimated to be 1.72, and the volume of the grit portion of the collected material would be 0.108 gallons of grit, or 6.54 gallons of grit per million gallons of combined sludge, or 0.00065 percent by volume. This is assuming that all of the inorganic matter is classified as grit.

Sieve Analysis of Grit. After incineration at 550°C, the material was subjected to sieve analysis. The results of the sieve analysis for each of the sample periods are presented in Table II-31 as percent of material retained on each sieve, and in Table II-32 as a cumulative percentage.

The material collected on June 30, 2005, was split into two portions and analyzed separately to determine the variability in analysis. The results for the two samples, June 30, 2005, A and June 30, 2005, B, show excellent agreement (Table II-30). Therefore, in computing the averages over the three days only sample A was used for the June 30, 2005, values.

The size distributions were similar on all three days with the majority of the material (69.7 percent by weight) equal to or greater than 300 µm in size.

The fraction with the largest percentage of material retained was 425 µm, averaging 22.1 percent for the three days. The next largest fraction was 600 µm, averaging 18.3 percent. At a grit particle size of 150 µm, only 8.1 percent was smaller. This was much lower than the percentages found for the Southwest preliminary sludge (18 percent) collected May 25 through May 27, 2005, and the North Side primary sludge (40 percent) collected May 9 through May 11, 2005. On the average, 54.4 percent of the grit had particle size of 425 µm or greater. This is higher than what was found in both the Southwest preliminary sludge (12 percent) and the North Side primary sludge (10 percent).

Conclusions. The following conclusions are drawn based on the pilot-scale tests conducted on the North Side WRP combined sludge.

1. Very little grit was found in the North Side sludge received at the Stickney WRP under the dry weather flow conditions during the study.

2. The total volume of material collected from the Eutek unit (average of 0.684 gallons) was approximately 0.004 percent of the daily average North Side sludge volume processed (16,500 gallons per day) over the three days.

3. The material collected from the Eutek unit contains approximately 44 percent total solids, of which 35 percent is organic (volatile material) and 65 percent is inert or can be considered to be grit.

4. The estimated content of grit particles in the North Side sludge at the Stickney WRP, on a volume basis, is 6.54 gallons of grit particles per million gallons of sludge, or approximately 0.0007 percent.

5. The mass of grit particles smaller than 150 µm averaged 8.1 percent of the total particle mass for the three days.

6. The percentage of the grit with a particle size of 425 µm or larger averaged 54.4 percent, which is higher than the percentage observed in the North Side primary sludge and the Stickney preliminary sludge.

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 part 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-1). 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.

During the warmer months of 2005, June through October, the hydrogen sulfide monitors recorded an average of 1.198 ppb at the north monitoring location and 0.17 ppb at the south monitor. The south monitor developed mechanical and flow problems in August and was taken out of service for repair. The monthly maximum ranged from 19.8 ppb to 90 ppb during the warmer months. The hydrogen sulfide monitors did not detect ambient hydrogen sulfide concentrations above the human odor threshold during the first five months of 2005. January through May show good agreement between the north and south hydrogen sulfide concentration data. Both had an average concentration of 0.01 ppb. The mean of cool month monthly maximums was higher at the north monitoring location, 1.56 ppb for the south vs. 6.12 ppb for the north monitor. A summary of the 2005 hydrogen sulfide ambient concentration data is shown Table II-33.

The analyzers will continue to run for further evaluation of low level hydrogen sulfide concentration near the Calumet WRP.

Model Development for Kirie Biological Nutrient Reduction

The removal of phosphorus at the Kirie WRP will be evaluated using Hydromantis, Inc. GPS-X version 4.12 software. The Kirie WRP effluent phosphorus concentration is considerably lower than other District WRPs. The Kirie WRP process model development has been initiated, assuming that phosphorus is removed by enhanced biological phosphorus uptake, presumably due to the flow being stored in TARP prior to treatment. The model incorporates the TARP storage tunnel and the secondary treatment unit processes. The physical dimensions and 2004 historical data were used in combination with GPS-X software defaults.

The calibrated model will be used to investigate the mechanisms of biological phosphorus removal in the tunnel directly upstream of the Kirie plant. If enhanced biological phosphorus removal is occurring, it is advantageous to understand the mechanism in order to maximize phosphorus uptake and possibly use the same mechanism at other District facilities, potentially resulting in a low cost phosphorus removal option.

The M&O Facility Handbook, January 2002, was used for sizing the unit processes in the model. The tunnel dimensions were not included in the handbook, so a correlation curve between tunnel level and volume was used. The process and flow information for the final clarifiers and aeration tanks are shown in Tables II-34 and II-35, respectively.

For the purpose of model calibration, the tunnel is represented by a typical aeration battery. The anaerobic environment in the tunnel is modeled by setting the oxygen transfer coefficient to zero. The software includes all of the phosphorus kinetic equations needed to model biological phosphorus metabolism.

The secondary treatment consists of a conventional activated sludge process with nitrification and denitrification. The model was simplified by modeling parallel processes as a single unit. Figure II-2 shows a schematic of the layout.

The analytical data from 2004 were reviewed and analyzed to identify current flow and pollutant load conditions at the Kirie WRP. A preliminary check of 2004 historical data was performed using mass balances and other reliability checks. The 2004 annual average data with the high flow events filtered out were used for the initial calibration. The 2004 data are summarized in Table II-36. The phosphorus mass balance indicated reliable historical data; the total phosphorus into the system was 0.55 tpd and the total phosphorus out of the system was 0.57 tpd.

The operating parameters entered into the model were determined from the 2004 Kirie Monthly Operating Reports and the Kirie WRP Operation Manual. Additional information was collected during conversations with the Kirie WRP operations staff. On a typical dry weather day, the day shift, beginning at 6:30 AM, increases the influent pumping from about 22 MGD up to about 28 MGD. This results in the complete draw down of the tunnel level at roughly 9:00 AM. After the draw down the pump speed is reduced back to about 22 MGD. Figure II-3 shows the variation of volume in the tunnel for a typical dry weather day.

The secondary treatment process is operated with a sludge retention time between 8 and 10 days. The mixed liquor suspended solids (SS) is generally approximately 3,000 mg/L. The oxygen is controlled to maintain 2.65 mg/L of dissolved oxygen throughout the aeration tanks. The waste sludge, 0.71 MGD annual average, is pumped to the Egan WRP for anaerobic digestion.

The secondary clarifier input to the model was calibrated so the model output approximated the actual plant data. The aeration tanks were added to the model and the parameters were adjusted until the output approximated the actual plant data. Finally, the anaerobic process, the effluent storage in TARP, was added to the model ahead of the aeration battery. The calibration results for the final clarifier and the aeration tanks are shown in Tables II-34 and II-35.

The model development of the Kirie WRP has been partially completed. The initial calibration shows good agreement with historical data. Calibrating the anaerobic process in the tunnel will be more challenging to model. An intensive wastewater sampling and fractional analysis program will add considerably to the model development. The tunnel model will be developed with the assumption enhanced biological uptake is occurring in the aeration tank.

Additional Digestion Tests for Calumet WRP

This project was initiated to evaluate if 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 Regulations. 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 2-step anaerobic digestion all year round.

In 2005, conducting additional anaerobic digestion tests was incorporated into routine monitoring by the WTPR Section of the EM&RD for the biosolids program at the Calumet WRP. These tests were conducted once or twice a month in the R&D WTPR laboratory at the Cecil Lue-Hing Research and Development Complex. The test procedure proposed in Appendix D of the White House Document by the USEPA (EPA/625/R-92/013, Revised October 1999 and 2003) was generally followed in each test. The digester draw sample used in the tests was a mixture of the digester draw from the four second step digesters.

Fifteen replicate samples of 50-mL digester draw each in a 125-mL flask were prepared. On Day 0, five replicates were randomly selected and sent to ALD to determine the contents of total and volatile solids, and the remaining ten samples were stored in a shaking incubator at a temperature of 35.5°C (about 96°F). Total and volatile solids were determined for five replicate samples on day 20 and on day 40 of the experiments. The mean values of the five replicates were used in data analysis.

A total of 14 tests were conducted in 2005. The total and volatile solids contents of the Calumet digester draw samples ranged from 1.77 to 2.17 percent with an average of 2.04 percent and from 55.1 to 59.6 percent with an average of 57.1 percent, respectively. These values were comparable to the plant daily monitoring values for the digester draw, indicating that the digester draw samples collected for the additional digestion tests were representative of the actual digester draw at the plant. The standard errors of the mean values calculated from the replicates were relatively small in these tests, ranging from 0.14 to 5.88 percent with average of 1.15 percent for total solids analysis and from 0.25 to 12.0 percent with an average of 1.66 percent for total volatile solids.

The volatile solids reduction through the additional digestion test was calculated using both Van Kleeck equation and mass balance method. The 40-day additional volatile solids reduction from the fourteen additional digestion tests conducted in 2005 for the Calumet WRP is presented in Table II-37. As can be seen, of the fourteen tests conducted in 2005, the additional volatile solids reduction in 11 tests was less than 17 percent. The three tests, in which the additional volatile solids reduction was slightly greater than 17 percent, were conducted in March, July and October of 2005. However, the plant monitoring data indicated that volatile solids reduction of 38 percent was achieved in those three months, as shown in Table II-38.

North Side WRP Master Plan Project

This project was a study conducted by a consultant team on the future infrastructure and process needs for the North Side WRP, referred to as the North Side Master Plan Study. The project involved attending workshops, which were held by the consultant team, to discuss and evaluate the alternatives for improving and updating infrastructure and process facilities of the North Side WRP to meet the future needs. Another major portion of the project was to review the documents generated by the consultant team from the North Side Master Plan Study, check the accuracy and suitability of documents pertinent to the study, and to make comments on the documents.

In addition, another study was conducted to evaluate water quality improvement alternatives for the Chicago Area Waterways (CAWs). Both studies are conducted by the same consultant team and incorporated into the NSWRP Master Plan project. In the Master Plan Study, the consultant team assesses the conditions and capacities of existing infrastructure and treatment processes at the North Side WRP, projects the changes in future sewage flow, pollutant loadings and regulatory requirements, and identifies the needs for modification and addition of infrastructure and process to meet the projected changes for the next 40 years. In the water quality study, the alternatives for improving water quality in the CAWs, proposed by a Use Attainability Analysis (UAA) for the CAWs by IEPA, are technically and economically evaluated. In particular, the following areas were to be assessed in the Master Plan Study:

- General Background and Existing Condition
- GPS-X Modeling Assessment
- Current Capacity and Future Requirements
- Collection System
- Liquid Handling Processes
- Solids Handling Processes
- Energy Management and Plant Support Systems

The following water quality improvement alternatives were to be evaluated for the North Shore Channel (NSC), North Branch of the Chicago River (downstream of confluence with the NSC), the Chicago River, South Branch of the Chicago River and Bubbly Creek in the water quality study:

- Disinfection of Final Effluent of Three Large District WRPs
- Nutrient Removal at NSWRP
- CSO On-Site Treatment
- Supplemental Aeration
- Flow Augmentation

The WTPR Section of the R&D Department actively participated in the North Side Master Plan project by providing some of the plant monitoring data, conducting special sampling for characterizing the sewage, attending workshops and reviewing the documents generated for the project. In the workshops conducted by the consultant team, the alternatives for improving and updating infrastructure and process facilities of the North Side WRP to meet the future needs and the technologies used for improving water quality in the CAWs were critiqued and discussed by the participants from the District's Engineering, M&O and R&D Departments. In 2005, twelve workshops given by the consultant team under the North Side Master Plan project were attended, and eight reports were generated by the consultant team. The WTPR Section provided comments on each report for accuracy and provided suggestions to improve the quality of the studies.

Full-Scale Nutrient Removal Testing at the Egan WRP

This project pertains to the District's commitment to the WERF Project No. 02-CTS-1, Sustainable Technologies for Achieving Low Nitrogen and Phosphorus Effluents. To this end, full-scale tests using step-feed biological nutrient removal process for nitrogen removal and chemical precipitation with ferric chloride for phosphorus removal were conducted at the Egan WRP in 2005. The Egan WRP has two aeration batteries, north and south aeration batteries, operated in parallel. Each battery has two identical 3-pass aeration tanks and four secondary clarifiers. The full-scale tests were carried out in aeration tank 1 of the north aeration battery, along with two designated secondary clarifiers.

Aeration tank 1 of the north aeration battery at the Egan WRP was selected for the full scale study because of the availability of a flexible zone equipped with baffle walls and mechanical mixers at the beginning of this tank. Aeration tank 2 and two of the four secondary clarifiers at the north aeration battery were not used during the study. Because the average design flow for the plant is 30 MGD, a constant flow of 7.5 MGD primary effluent was fed to the study tank with a returned sludge flow of about 5.0 MGD from the secondary settling tanks. A typical dry weather flow to the plant was about 23 MGD and the remaining flow was sent to the south aeration battery with both aeration tanks in operation. The plant traditionally operates the aeration tanks with MLSS of 2,000 to 2,500 mg/L, SRT of 10 to 15 days and relatively constant return flow at a rate of about 60 to 70 percent of inflow. SRT is controlled through adjusting the flow of waste activated sludge. This operational strategy was adopted for both aeration batteries during the full-scale study.

The full scale study was conducted once in winter/spring and once in summer/fall to determine the effects of temperature and differences in wastewater characteristics. In each test period, the study was carried out in four phases. In Phase I, step feed was not applied, and one anoxic zone was created at the beginning of the aeration tank using mechanical mixing. In Phase II, feed to the aeration tank was split 60 percent to the beginning and 40 percent to the end of Pass I. A second anoxic zone was created by reducing the air flow to maintain near zero dissolved oxygen (DO) concentration and sufficient mixing of mixed liquor solids. A transition zone about 12 m (40 ft) long immediately upstream of the second anoxic zone was created to minimize the oxygen impact on the anoxic zone. In Phase III, feed to the aeration tank was split 40, 40 and 20 percent to three locations: 40 percent each to the beginning and end of Pass 1, 20 percent to the beginning of Pass 3, as shown in <u>Figure II-4</u>. A third anoxic zone and a transition zone were created downstream and upstream of the third feed point, respectively, using the same method used for creating the second anoxic zone. In Phase IV, ferric chloride was added to the effluent end of Pass 3 before the overflow weir of the aeration tank to precipitate P in the mixed liquor in the secondary clarifiers. Phase II configuration for nitrogen removal was used during the Phase IV study in both testing periods. Each of Phases I and II was operated for 4 weeks during both seasonal tests. Phase III was run for two weeks in the winter/spring test due to the concern of rising SVI and four weeks in the summer/fall test. Phase IV was operated for 10 days in the winter/spring test and 20 days in the summer/fall test.

Consistent with routine plant operation, daily composite samples of combined secondary effluent were collected and analyzed for SS and four different species of nitrogen. For the study, the secondary effluent from the test battery was separately monitored for N, P, BOD_5, and SS by collecting 24-hour composite samples from the effluent of one of the secondary clarifiers. Additionally, grab samples along the study aeration tank were occasionally collected in each phase to monitor the profiles of N, P, DO, and oxygen uptake rate along the tank.

The test results showed that creating anoxic zones in the aeration tank and operating the tank in a step feed mode increased total nitrogen (TN) removal from about 33 percent to up to 69 percent. TN removal efficiency increased as number of step-feed locations and respective anoxic zones increased. Total phosphorus (TP) removal to less than 0.5 mg/L in the final effluent was achieved by adding 35 to 44 mg/L of ferric chloride to the mixed liquor at the effluent end of the aeration tank. Temperature in the range of 53 - 74 °F (11.7 - 23.2°C) had no apparent effect on the denitrification in the anoxic zones and on the chemical phosphorus removal using ferric chloride. Some operational problems were observed during the test, such as rising SVI in the test aeration battery and dewatering problems because the GBTs clogged, presumably due to ferric chloride addition. These problems need to be further investigated.

Unsteady Flow Water Quality Modeling for the Chicago Area Waterways

An unsteady flow water quality model was developed by Marquette University for the CAWs to study the effects of flow and pollutant loading variations on water quality in the CAWs during both wet and dry weather conditions. The calibrated and verified model was delivered to the R&D Department in August 2005. The model has been used to simulate various scenarios proposed to potentially improve the water quality. The water quality model for the CAWs was built on the platform of Duflow modeling studio. The model was calibrated and verified using part of the 2001 and 2002 hydraulic and water quality monitoring data, respectively.

There were a number of water quality improvement alternatives proposed by the UAA study for the CAWs. The District agreed to evaluate these alternatives and incorporated this evaluation into the NSWRP Master Plan project. Water quality improvement alternatives included evaluation of the impact of CSO treatment, operation of two existing in-stream aeration stations, addition of new supplemental aeration stations and flow augmentation to Bubbly Creek and reduction of nutrient levels in the final effluent of NSWRP. The model simulations were performed by the WTPR Section personnel and the simulation results were provided to the consultant team for the NSWRP Master Plan project for further evaluation. The four time periods used for the simulations were July 12 to September 14 and September 15 to November 9 of 2001 and May 1 to August 11 and August 12 to September 23 of 2002, except where specifically noted.

CSO Treatment. Over 200 CSO discharge locations in the drainage basin of the CAWs were consolidated into 28 locations in the CAWs water quality model to make the model manageable. In the study area of the NSWRP Master Plan project, including the drainage areas for the upper and lower NSC, North Branch of the Chicago River (NBCR), the Chicago River and South Branch of the Chicago River (SBCR), the model has 12 of the consolidated CSO discharge locations, which are numbered from 1 to 12 and are listed in Table II-39. On-site CSO treatment was assumed to achieve 30 percent BOD_5 and 50 percent SS reduction. Based on the land availability in the corresponding stretches of the CAWs, the percentage of CSO treatment is determined as: 100 percent for the Upper and Lower NSC, 56 percent for the NBCR and SBCR, and 0 percent for the Chicago River. For the purpose of model simulation, the consultant team decided that 8 of the 12 CSO locations will receive 100 percent treatment, while the remaining 4 CSO locations receive no treatment, this information is also presented in Table II-39.

Two simulations were performed for each of four different simulation time periods referenced above. One simulation is defined as "Baseline," and the second simulation, conducted with reduced BOD_5 and SS concentrations at the selected CSO locations, is called "CSO Treatment" to simulate the condition after treatment of CSO at these locations. All other parameters, boundary and initial conditions, and input loadings, including the waste loadings from the NSWRP and oxygen loadings from the two existing in-stream aeration stations, remain unchanged.

Evaluation of In-Stream Aeration Stations. There are two existing in-stream aeration stations located near Devon Avenue in the lower NSC and Webster Street in the NBCR. Each in-stream aeration station has four blowers; operations vary from one to three blowers running simultaneously at each of these stations. The DO concentrations upstream of an in-stream aeration station affect the oxygen transfer at the station, thereby affecting the downstream DO concentrations (Polls et al., 1982).

The CAW Water Quality Model was used to evaluate the effects of the number of blowers in operation at these two existing in-stream aeration stations on the DO concentrations in the study stretches of the CAWs. A combination of 9 simulations, listed in Table II-40, were performed for each of 4 different time periods previously referenced. It is assumed that the same relationship developed by Polls et al. in 1982 between the percent DO increase, upstream DO percent saturation and number of working blowers can be applied to both stations. The amount of supplemental DO added at an in-stream aeration station was then calculated based on percent DO increase, upstream DO and flow rate at the aeration station. This was then used as the oxygen load input at the station in the model simulations.

Generally, downstream DO increases as more blowers are put in service at each station. However, the increase in DO is not linearly related to the number of blowers in service.

Supplemental Aeration and Flow Augmentation in Bubbly Creek. Supplemental aeration and flow augmentation were proposed to improve the water quality in Bubbly Creek. Model simulation was conducted by WTPR using the CAW water quality model to generate data to evaluate the application of these options separately and/or in combination. The main objective of this modeling exercise was to determine the quantity of supplemental aeration in pounds of oxygen per day with or without flow augmentation in million gallons per day to achieve DO levels above 5 mg/L, 90 percent of the time in Bubbly Creek. The technologies that would be used to achieve the DO target and the availability of space for implementing the selected technologies were not considered in the modeling exercise.

A trial-and-error approach was used during the modeling exercise. The trial process started from the upstream end of Bubbly Creek in one simulation period from July 12 to September 14, 2001. Supplemental aeration stations were added along Bubbly Creek in the model and the oxygen loads at the stations were arbitrarily selected. Then, a model simulation under the chosen condition was performed and the hourly DO concentrations from the simulation were examined. If the target DO level was not achieved, the oxygen loads were increased in the next simulation. If the DO concentrations near a selected supplemental aeration station were above the saturation values, but downstream DO concentrations could not meet the target level of 5 mg/L 90 percent of the time, the oxygen load at the existing station would be reduced and a new supplemental aeration station at a downstream location would be added in the next simulation. The trial-and-error process was repeated until the target DO level was achieved. With the selected oxygen loads at the selected locations, model simulations were performed for the other three periods used in all of the simulations. The simulation results indicated that the DO target level could be achieved in the other three periods, using the selected oxygen loads at the selected locations.

The model simulation results indicate that flow augmentation alone would not achieve the target DO level at 5 mg/L or higher 90 percent of the time; three or four supplemental aeration stations along Bubbly Creek are needed to meet the target. In the study, simulations were performed for various combinations of different oxygen loads at different locations with and without flow augmentation that could be used to achieve the same target. It was also found that the conditions selected in the simulation period from July 12 to September 14, 2001 were satisfactory in the other three simulation periods. The simulation results were provided to the consultant team for evaluation.

Reduction of Nutrient Level in the NSWRP Final Effluent. The nutrients included in the CAW Water Quality Model are ammonia nitrogen (NH_3-N), nitrate nitrogen (NO_3-N) and organic nitrogen (Org-N = TKN - NH_3-N), and total inorganic phosphorus (Inorg-P), which is approximated using soluble phosphorus (Sol-P), which are monitored routinely by the District, and total organic phosphorus (Org-P), which is estimated using TP minus Sol-P, for the phosphorus species. Four different nutrient levels in the final effluent of the NSWRP were assumed for the purpose of this study, and each nutrient level was considered as a scenario. The four scenarios used in the model simulations are shown in Table II-41.

Model simulations were performed for each of the four scenarios and each of the four different time periods. All other parameters, boundary and initial conditions, and input loadings, including the BOD_5 and SS loadings from the NSWRP and all waste loadings from CSOs, remained unchanged in all scenarios, except for the oxygen loadings from the two existing in-stream aeration stations. The oxygen loading from an existing in-stream aeration station was calculated based on percent DO concentration increase, upstream DO concentration, flow rate at the aeration station, and the number of working blowers and the relationship among these parameters developed by Polls et al. in 1982. The information on number of working blowers at the aeration stations was obtained from the operation records of the M&O Department.

The model simulation results show that ammonia nitrogen concentrations in the final effluent of the NSWRP have the greatest impact on the DO concentrations in the waterway downstream of the NSWRP. The DO concentrations in the waterway downstream of the NSWRP under the Base scenario are the highest among the four scenarios listed in Table II-41, because the daily mean ammonia concentrations in the final effluent of NSWRP were the lowest under the Base scenario (approximately 0.5 mg/L on average). TP concentrations in the final effluent of the NSWRP have little impact on the DO in the waterway downstream of the NSWRP. The simulated DO concentrations from the Permit scenario (approximately mean TP concentration of 1.1 mg/L) were compared with the corresponding DO concentrations from the Case 1 scenario (mean TP concentration of 0.5 mg/L), and very little or no difference in DO concentrations in the waterway downstream of the NSWRP was observed.

Settleability Tests for District WRPs

To collect data on settling characteristics of mixed liquor at the District WRPs, settling tests with the mixed liquor samples from aeration tanks of the District WRPs were performed in a six-foot tall and eight-inch diameter column set up in the pilot plant room of the R&D WTPR laboratory in the Cecil Lue-Hing Research and Development Complex. The six-foot settling column is equipped with a vertical bar mixer that turns at about 1 rpm (revolution per minute) and a recirculation pump that can generate upwards velocities ranging from 50 to 400 fpd (feet per day). The dynamic conditions in a secondary clarifier can be simulated in the settling column and interfacial settling velocities can be measured. Interfacial settling velocity is a useful parameter for modeling process operations.

To conduct the tests, 25 gallons of mixed liquor freshly collected from the effluent end of an aeration tank were mixed in a big drum. Temperature and DO of the mixed liquor were measured and MLSS and MLVSS were analyzed. The mixed liquor was pumped into the settling column and allowed to settle quiescently for sixty minutes. Then, the recirculation pump was turned on to generate an upwards flow in the column. The same recirculation flow was maintained until reaching steady state, which is defined by a constant height of the sludge blanket indicated by three identical height measurements within five minutes. The height of the sludge blanket was measured with a measuring tape and the recirculation flow was measured by volumetric cylinders and a timer. A mixed liquor sample of about 100 mL was collected from the middle of the sludge blanket under this steady-state condition. Then, the recirculation pump was adjusted to a different flow rate and the procedure was repeated for different upflow velocities. Five to six different upflow velocities were typically employed in each test.

In 2005, 30 tests were conducted for the mixed liquor samples from Stickney, Calumet, North Side, Egan and Lemont WRPs. For the settling test, mixed liquor samples from different batteries or tanks were collected under dry weather conditions. For each aeration battery or tank tested, duplicate tests were normally performed on two separate days. The settling tests will continue in 2006 for the other two WRPs.

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 combined sewer overflows (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 in the Calumet, Mainstream, Des Plaines, Upper Des Plaines and Chicagoland Underflow Plan (CUP) Reservoir systems anchoring the Upper Des Plaines and Calumet TARP systems (Figure II-5). 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 CUP 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 sampled.

The Illinois Environmental Protection Agency (IEPA) gave the District permission to sample the TARP System Wells at the following frequency. Mainstream TARP System Wells QM-53, QM-56, QM-58, QM-61, QM-68 through QM-77 (excluding well QM-75), and QM-81 are being sampled at a rate of three times per year. Wells QM-62 through QM-65, QM-67, QM-75 and QM-78 through QM-80 and QM-82 are being sampled at the rate of six times per year. The Calumet System Wells QC-2.1, QC-2.2, and QC-3 through QC-19, QC-21, QC-22, QC-25, QC-27 and QC-28 are being sampled at the rate of six times per year. Wells QC-1, QC-2, QC-20, QC-23, QC-24, QC-26, and QC-29 through QC-37 are being sampled at the rate of six times per year. Des Plaines TARP System wells QD-26, QD-39 through QD-49, and QD-52 through QD-60 are being sampled at the rate of three times per year. Wells QD-21 through QD-25, QD-27 through QD-38, QD-50, and QD-51 are being sampled at the rate of six times per year. The Upper Des Plaines TARP System Well MW-1 is sampled at a rate of six times per year. Wells MW-2 through MW-9 are being sampled at the rate of six times per year. Sampling at the TARP System Observation Wells for the Mainstream TARP system is done once every two months, and for the Calumet TARP systems it is done once every two weeks.

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 routinely 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 local groundwater system.

Pollutants Captured by TARP

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

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

Tables II-42, II-43, and II-44 contain data pertaining to CSO volume captured, total SS, and oxygen demanding substances removed, respectively, by the TARP systems during the period of 1982 through 2005. As can be seen from these tables, during 2005 the Stickney WRP treated 21.43 billion gallons of CSO captured in the Stickney WRP TARP system, resulting in the removal of 51.14 million pounds of SS and 25.88 million pounds of oxygen demanding substances (both carbonaceous and nitrogenous). The Calumet WRP treated 12.95 billion gallons of CSO captured in the Calumet WRP TARP system, resulting in the removal of 21.33 million pounds of SS and 19.22 million pounds of oxygen demanding substances (both carbonaceous and nitrogenous). The Kirie WRP diverted 1.11 billion gallons of CSO into the Kirie TARP system, resulting in the removal of 1.63 million pounds of SS and 2.14 million pounds of oxygen demanding substances (both carbonaceous and nitrogenous).

Again, referring to Tables II-42, II-43, and II-44 it can be seen that since TARP went on line, a total of 823.71 billion gallons of CSO, 1.60 billion pounds of SS, and 845.90 million pounds of oxygen demanding substances (both carbonaceous and nitrogenous) have been removed due to the TARP system which otherwise would have been discharged into the CAW. Broken down by TARP system, during 1982 through 2005, the Stickney WRP has treated a total of 554.78 billion gallons, the Calumet WRP has treated a total of 204.99 billion gallons, and the Kirie WRP has treated a total of 63.94 billion gallons of CSO. During the same period, the Stickney WRP removed a total of 1.27 billion pounds of SS, the Calumet WRP removed 263.44 million pounds of SS, and the Kirie WRP has removed a total of 68.07 million pounds of SS. Again during 1982 through 2005, the Stickney WRP has removed a total of 549.92 million pounds of oxygen demanding substances, the Calumet WRP has removed 221.89 million pounds of oxygen demanding substances, and the Kirie WRP has removed a total of 74.09 million pounds of oxygen demanding substances.

Monitoring of the Thornton Transitional Reservoir

Introduction. The purpose of this monitoring is to meet the reporting requirements of the IEPA relative to annual flood control utilization for the Thornton Transitional Flood Control Reservoir (Reservoir) for 2005. The specific informational requirements are described in the June 26, 2001, Scope of Work (SOW) for Groundwater Quality Monitoring of the reservoir. The SOW was approved in a letter from the IEPA dated August 6, 2001.

The reporting requirements are found in Section 7 of the SOW. The requirements for the annual flood control utilization of the reservoir shall include:

1. The year's monitoring wells sample analysis results.

2. Reservoir content grab sample results.

3. Detailed review and comparison of the monitoring well sampling analysis results, utilizing the monitoring well statistical background determinations.

Objective. The objective of collecting groundwater samples from the four monitoring wells (QT-1 through QT-4) and reservoir content grab samples is to assess any possible contamination of the groundwater which may result from the seepage from the reservoir during the fill event. The pertinent water quality parameters are listed in Table 2 of the SOW (Table II-45).

Project Description. The Thornton Reservoir is in the West Lobe of the Thornton Quarry, southeast of the intersection of the Tri-State Tollway and Halsted Street in Thornton, Illinois (Figure II-6). The reservoir is the final structure constructed for the Little Calumet River Watershed under the Natural Resources Conservation Service (NRCS) Little Calumet Watershed Plan of November 1998. The reservoir will provide 3.1 billion gallons of floodwater storage, which represents the capture of the 100-year storm event from Thorn Creek in the vicinity south of the Tri-State Tollway.

Field Sampling. There were two fill events at the Thornton Transitional Reservoir during 2005, January 12, 2005, and February 14, 2005.

The January fill event began on January 12, 2005, resulting in storage of 1.49 billion gallons in the reservoir. On February 14, 2005, with 4 to 6 feet of CSO water elevation in the reservoir from the January 12, 2005, fill event, another diversion occurred. This event resulted in an additional 356 million gallons of stormwater diverted to the reservoir.

During these fill events, in accordance with the SOW, samples were collected from the four monitoring wells surrounding the reservoir and grab samples were taken from the reservoir.

Discussion of Results. During the January 12, 2005, and February 14, 2005, fill events, the 95 percent upper confidence limit from the background concentration was exceeded for the following parameters in the following wells: QT-2 iron and manganese, QT-3 chloride and copper, and QT-4 cyanide. Well QT-1 showed no water quality exceedances from background concentrations. Following the fill events, when the reservoir was dry, except for chloride in QT-3, there were no significant changes to background concentrations at any of the monitoring wells.

TABLE II-1: CENTRIFUGE COMPLEX WINTER POLYMER TEST RESULTS AT THE STICKNEY WRP—FEBRUARY 2005

Number of Vendors Involved in Tests	6
Number of Polymers Submitted for Testing	12
Number of Polymers Qualified for Bidding	11
Polymer Selected	Polydyne CE 659
Polymer Dosage, lbs/dry ton	354.5

TABLE II-2: CENTRIFUGE COMPLEX SUMMER POLYMER TEST RESULTS AT THE STICKNEY WRP—AUGUST 2005

Number of Vendors Involved in Tests	5
Number of Polymers Submitted for Testing	10
Number of Polymers Qualified for Bidding	9
Polymer Selected	Polydyne CE 770
Polymer Dosage, lbs/dry ton	283.2

TABLE II-3: POLYMER TEST RESULTS AT THE CALUMET WRP CENTRIFUGE COMPLEX USING $FeCl_3$ AS A PRECONDITIONER—APRIL 2005

Number of Vendors Involved in Tests	4
Number of Polymers Submitted for Testing	8
Number of Polymers Qualified for Bidding	8
Polymer Selected	Polydyne CE 702
Polymer Dosage, lbs/dry ton	223.4

TABLE II-4: POLYMER TEST RESULTS FOR CALUMET WRP GRAVITY CONCENTRATION TANKS—SEPTEMBER 2005

Number of Vendors Involved in Tests	5
Number of Polymers Submitted for Testing	11
Number of Polymers Qualified for Bidding	7
Polymer Selected	Polydyne CE 804
Polymer Dosage, lbs/dry ton	85.35

TABLE II-5: GRAVITY BELT THICKENER POLYMER TEST RESULTS AT THE HANOVER PARK WRP—JUNE 2005

Number of Vendors Involved in Tests	4
Number of Polymers Submitted for Testing	8
Number of Polymers Qualified for Bidding	6
Polymer Selected	Ciba Zetag 8816
Polymer Dosage, lbs/dry ton	4.69

TABLE II-6: ODOR MONITORING AT THE HASMA, VULCAN, AND MARATHON SOLIDS DRYING AREAS AND THE LASMA SOLIDS PROCESSING AREA—2005

Month	Percent of Visits Odors Were Observed			Total Number of Observations
	Easily Noticeable	Strong	Very Strong	
January	16.6	0.0	0.0	145
February	11.9	0.0	0.0	118
March	11.3	0.5	0.0	195
April	21.1	0.0	0.0	180
May	31.3	2.5	0.0	198
June	37.6	2.4	0.0	210
July	44.9	4.3	0.0	187
August	50.2	0.9	0.0	219
September	50.2	0.9	0.0	221
October	37.2	0.5	0.0	215
November	35.8	0.0	0.0	162
December	19.8	0.0	0.0	131
Yearly Total	26.8	0.8	0.0	2,181

TABLE II-7: ODOR MONITORING AT THE CALUMET WRP—2005

Month	Percent of Visits Odors Were Observed Easily Noticeable	 Strong	 Very Strong	Total Number of Observations
January	11.9	1.0	0.0	193
February	19.3	0.5	0.0	187
March	17.9	0.4	0.0	273
April	26.0	0.4	0.0	273
May	23.1	1.5	0.0	260
June	29.7	2.2	0.0	273
July	16.5	1.9	0.0	260
August	19.4	0.9	0.0	324
September	18.8	2.3	0.0	260
October	15.9	3.3	0.0	270
November	17.8	0.4	0.0	270
December	14.4	0.5	0.0	209
Yearly Total	19.5	1.3	0.0	3,052

TABLE II-8: ODOR MONITORING AT THE CALUMET SOLIDS DRYING AREAS—2005

Month	Percent of Visits Odors Were Observed			Total Number of Observations
	Easily Noticeable	Strong	Very Strong	
January	3.7	0.0	0.0	135
February	11.9	0.0	0.0	134
March	21.9	0.0	0.0	187
April	23.8	0.5	0.5	189
May	22.2	1.7	0.0	180
June	19.0	0.0	0.0	189
July	17.2	0.0	0.0	180
August	17.8	0.0	0.0	225
September	16.1	1.1	0.0	180
October	15.9	0.0	0.0	189
November	12.8	0.0	0.0	172
December	2.1	0.0	0.0	143
Yearly Total	16.1	0.3	0.05	2,103

TABLE II-9: ODOR MONITORING AT THE RASMA SOLIDS DRYING AREA—2005

Month	Percent of Visits Odors Were Observed			Total Number of Observations
	Easily Noticeable	Strong	Very Strong	
January	0.0	0.0	0.0	8
February	8.3	0.0	0.0	12
March	0.0	0.0	0.0	20
April	0.0	0.0	0.0	16
May	5.0	5.0	0.0	20
June	12.5	0.0	0.0	16
July	0.0	0.0	0.0	16
August	35.0	0.0	0.0	20
September	31.3	12.5	0.0	16
October	18.8	0.0	0.0	16
November	20.0	0.0	0.0	20
December	0.0	0.0	0.0	9
Yearly Total	14.8	2.1	0.0	189

TABLE II-10: ODOR MONITORING AT THE STONY ISLAND SOLIDS DRYING AREA—2005

Month	Percent of Visits Odors Were Observed			Total Number of Observations
	Easily Noticeable	Strong	Very Strong	
January	0.0	0.0	0.0	4
February	0.0	0.0	0.0	17
March	20.8	0.0	0.0	24
April	30.6	0.0	0.0	36
May	21.9	0.0	0.0	32
June	38.9	2.8	0.0	36
July	32.1	3.6	0.0	28
August	52.8	2.8	0.0	36
September	37.5	15.6	0.0	32
October	47.2	2.8	0.0	36
November	35.7	0.0	0.0	28
December	18.8	0.0	0.0	16
Yearly Total	32.9	2.8	0.0	325

TABLE II-11: ODOR MONITORING AT THE JOHN E. EGAN WRP—2005

Month	Percent of Visits Odors Were Observed			Total Number of Observations
	Easily Noticeable	Strong	Very Strong	
January	23.8	0.0	0.0	21
February	3.7	0.0	0.0	27
March	14.3	0.0	0.0	35
April	14.3	0.0	0.0	28
May	25.0	0.0	0.0	28
June	14.3	0.0	0.0	35
July	25.0	0.0	0.0	35
August	17.1	0.0	0.0	35
September	25.0	0.0	0.0	28
October	21.4	0.0	0.0	28
November	22.9	0.0	0.0	35
December	19.0	0.0	0.0	21
Yearly Total	18.6	0.0	0.0	349

TABLE II-12: ODOR MONITORING AT THE STICKNEY WRP—2005

Month	Percent of Visits Odors Were Observed			Total Number of Observations
	Easily Noticeable	Strong	Very Strong	
January	22.8	0.0	0.0	413
February	25.1	0.0	0.0	386
March	25.7	0.9	0.0	455
April	27.6	1.1	0.0	453
May	27.9	2.3	0.2	473
June	25.6	0.6	0.2	473
July	29.4	1.5	0.2	411
August	22.1	2.3	0.2	430
September	27.5	2.0	0.0	455
October	25.2	3.5	0.0	456
November	32.6	3.9	0.0	304
December	21.9	0.9	0.0	429
Yearly Total	26.0	1.6	0.1	5,138

TABLE II-13: ODOR MONITORING AT THE JAMES C. KIRIE WRP—2005

Month	Percent of Visits Odors Were Observed			Total Number of Observations
	Easily Noticeable	Strong	Very Strong	
January	16.0	0.0	0.0	50
February	11.9	0.0	0.0	67
March	19.8	0.0	0.0	86
April	26.2	0.0	0.0	65
May	16.2	0.0	0.0	68
June	2.2	0.0	0.0	1,156
July	0.8	0.0	0.0	1,360
August	1.3	0.0	0.0	1,428
September	1.8	0.0	0.0	1,563
October	2.4	0.0	0.0	1,567
November	4.5	0.0	0.0	916
December	24.5	0.0	0.0	49
Yearly Total	2.8	0.0	0.0	8,375

TABLE II-14: ODOR MONITORING AT THE NORTH SIDE WRP—2005

Month	Percent of Visits Odors Were Observed			Total Number of Observations
	Easily Noticeable	Strong	Very Strong	
January	26.3	0.0	0.0	38
February	19.6	0.0	0.0	51
March	23.1	0.0	0.0	65
April	34.6	0.0	0.0	52
May	40.4	1.9	0.0	52
June	38.5	3.1	0.0	65
July	32.7	3.8	0.0	52
August	41.5	1.5	0.0	65
September	46.2	0.0	0.0	52
October	44.2	0.0	0.0	52
November	36.9	0.0	0.0	65
December	34.3	0.0	0.0	35
Yearly Total	35.1	0.9	0.0	644

TABLE II-15: INFLUENT HAZARDOUS AIR POLLUTANT CONCENTRATIONS AT THE DISTRICT'S MAJOR WRPs IN 2005

HAP Organic Compound	Concentrations in µg/L[1]		
	Stickney	Calumet	North Side
Dichloromethane	5	6.8	17.2
Chloroform	1.9	2.25	2.7
Trichloroethene	NF	NF	NF
Benzene	NF	3	NF
Tetrachloroethene	1.25	2	14
Toluene	14.20	30	2.6
Ethylbenzene	0.5	NF	NF
Carbon disulfide	NF	NF	NF
Methyl ethyl ketone	12.5	21	NF
Styrene	0.5	NF	1.4
Xylene (total)	0.75	NF	NF
Cresol (total)	2	3.5	NF
Acetophenone	NF	28	NF
Cumene	NF	15	NF
2,2,4-Trimethylpentane	0.75	NF	NF
Hexane	NF	NF	NF
Acetaldehyde	NF	NF	NF

[1]Average results of the two influent samples collected in February and August 2005.
NF = Not found.

TABLE II-16: HAZARDOUS AIR POLLUTANT EMISSIONS FROM THE DISTRICT'S MAJOR WRPs IN 2005[1]

HAP Organic Compound	Emissions in tons/yr		
	Stickney	Calumet	North Side
Dichloromethane	0.54	0.26	0.66
Chloroform	0.18	0.08	0.09
Trichloroethene	0	0	0
Benzene	0	0.10	0
Tetrachloroethene	0.33	0.18	1.27
Toluene	1.19	0.95	0.08
Ethylbenzene	0.04	0	0
Carbon disulfide	0	0	0
Methyl ethyl ketone	0.13	0.06	0
Styrene	0.03	0	0.03
Xylene (total)	0.06	0	0
Cresol (total)	0.01	0	0
Acetophenone	0	0.02	0
Cumene	0	0.49	0
2,2,4-Trimethylpentane	0.79	0	0
Hexane	0	0	0
Acetaldehyde	0	0	0
Total	3.30	2.14	2.13

[1]Emissions estimated using the BASTE model.

TABLE II-17: NORTH SIDE WRP PRIMARY SLUDGE GRIT STUDY
EUTEK GRIT SNAIL OPERATIONAL DATA

	5/9/05	5/10/05	5/11/05	Average
Run Time	9:00 a.m.-1:30 p.m.	7:30 a.m.-11:30 a.m.	8:00 a.m.-11:20 a.m.	—
Hours Sampling	4.5	4.0	3.33	3.94
Sludge Feed Rate, gpm	200	200	200	200
Volume of Sludge Processed, gallons	54,000	48,000	39,960	47,320
Volume of "Snail Grit" Collected, ft^3	0.98	3.6	7.0	3.86
Volume of "Snail Grit" Collected, gallons	7.33	26.93	52.37	28.88
Plant Flow, MGD	238	201	480	306

TABLE II-18: PERCENT SOLIDS OF THE GRIT MATERIAL COLLECTED FROM NORTH SIDE WRP USING THE SCS™ UNIT

Sample Date	%TS	%TVS	%Ash
5/9/05	18.6	72.4	27.6
5/10/05	30.1	37.9	62.1
5/11/05	40.6	38.0	62.0
Average	29.8	49.4	50.6

TABLE II-19: SIEVE ANALYSIS OF GRIT SAMPLES COLLECTED FROM NORTH SIDE WRP PRIMARY SLUDGES ON 5/9/05 THROUGH 5/11/05

Sieve Size, mm (No.)	5/9/05 A*	5/9/05 B*	5/10/05	5/11/05	Average**
	Percent Retained				
1000 (18)	0.8	0.8	1.2	1.6	1.2
600 (30)	2.1	2.1	1.9	3.2	2.4
425 (40)	2.9	3.0	4.0	7.2	4.7
300 (50)	5.5	5.6	6.6	13.4	8.5
212 (70)	12.1	12.6	13.3	25.5	17.0
150 (100)	26.0	26.5	24.1	27.0	25.7
106 (140)	14.8	14.8	13.8	10.2	38.8
75 (200)	16.5	17.0	16.4	7.0	13.3
Pan	19.1	17.4	18.7	5.1	14.3

*Two split samples, identified as A and B, were taken on 5/9/05 and analyzed separately.
**Includes 5/9/05 A, 5/10/05, and 5/11/05 results.

TABLE II-20: SIEVE ANALYSIS AS CUMULATIVE PERCENT GRIT SAMPLES COLLECTED FROM NORTH SIDE WRP PRIMARY SLUDGES ON 5/9/05 THROUGH 5/11/05

Sieve Size,	5/9/05 A*		5/9/05 B*		5/10/05		5/11/05	
mm (No.)	Retained	Passing	Retained	Passing	Retained	Passing	Retained	Passing
1000 (18)	0.8	99.2	0.8	99.2	1.2	98.8	1.6	98.4
600 (30)	2.9	97.0	2.9	97.1	3.1	96.9	5.8	95.2
425 (40)	5.8	94.1	5.9	94.1	7.1	92.9	12.0	88.0
300 (50)	11.4	88.6	11.5	88.5	13.7	86.3	25.4	74.6
212 (70)	23.5	76.5	24.1	75.8	27.0	73.0	50.9	49.1
150 (100)	49.5	50.5	50.6	49.3	51.1	48.9	77.9	22.2
106 (140)	64.3	35.7	65.4	34.4	64.9	35.1	88.1	12.0
75 (200)	80.8	19.1	82.4	17.4	81.3	18.7	95.1	5.0
Pan	99.9		99.8		100.0		100.2	

*Two split samples, identified as A and B, were taken on 5/9/05 and analyzed separately.

TABLE II-21: CALUMET WRP PRIMARY SLUDGE GRIT STUDY
EUTEK GRIT SNAIL OPERATIONAL DATA

	5/18/05	5/19/05	5/20/05	Average
Run Time	9:20 a.m.-12:20 p.m.	7:30 a.m.-10:30 a.m.	7:50 a.m.-10:50 a.m.	—
Hours Sampling	3.0	3.0	3.0	3.0
Sludge Feed Rate, gpm	150	150	150	150
Volume of Sludge Processed, gallons	27,000	27,000	27,000	27,000
Volume of Snail Grit Collected, cu. ft.	0.108	0.681	0.239	0.342
Volume of Snail Grit Collected, gallons	0.81	5.09	1.79	2.56
Plant Flow, MGD	159	450	171	260

TABLE II-22: CALUMET WRP PRIMARY SLUDGE STUDY PERCENT TOTAL AND VOLATILE SOLIDS

Sample Date	%TS	%TVS	%Ash
Primary Sludge			
5/18/05	1.2	68.4	31.6
5/19/05	0.61	58.6	41.4
5/20/05	0.72	60.7	39.3
Average	0.84	62.6	37.4
Collected Grit Material From SCS™ Unit			
5/18/05	26.6	26.1	73.9
5/19/05	33.7	32.5	67.5
5/20/05	81.3	16.5	83.5
Average	47.2	25.0	75.0

TABLE II-23: SIEVE ANALYSIS OF GRIT SAMPLES COLLECTED FROM CALUMET WRP PRIMARY SLUDGE ON 5/18/05 THROUGH 5/20/05

Sieve Size, µm (No.)	5/18/05	5/19/05	5/20/05	Average
	Percent Retained			
1000 (18)	0.6	0.4	0.4	0.5
600 (30)	0.8	1.3	1.2	1.1
425 (40)	2.4	3.3	4.1	3.3
300 (50)	7.3	7.4	11.6	8.8
212 (70)	17.7	19.2	29.5	22.1
150 (100)	32.3	34.5	32.2	33.0
106 (140)	19.8	18.0	13.0	16.9
75 (200)	11.0	7.8	4.4	7.7
Pan	8.2	8.1	3.6	6.6

TABLE II-24: SIEVE ANALYSIS AS CUMULATIVE PERCENT FOR GRIT SAMPLES COLLECTED FROM CALUMET WRP PRIMARY SLUDGES ON 5/18/05 THROUGH 5/20/05

Sieve Size, μm (No.)	5/18/05		5/19/05		5/20/05	
	Retained	Passing	Retained	Passing	Retained	Passing
1000 (18)	0.6	99.4	0.4	99.6	0.4	99.6
600 (30)	1.4	98.6	1.7	98.2	1.6	98.4
425 (40)	3.8	96.2	5.0	95.0	5.7	94.3
300 (50)	11.1	89.0	12.4	87.6	17.3	82.7
212 (70)	28.8	71.3	31.6	68.4	46.8	53.2
150 (100)	61.1	39.0	66.1	33.9	79.0	21.0
106 (140)	80.9	19.2	84.1	15.9	92.0	8.0
75 (200)	91.9	8.2	91.9	8.1	96.4	3.6
Pan	100.1	0.0	100.0	0.0	100.0	0.0

TABLE II-25: STICKNEY WRP PRELIMINARY SLUDGE GRIT STUDY
EUTEK GRIT SNAIL OPERATIONAL DATA

	5/25/05	5/26/05	5/27/05	Average
Run Time	9:00 a.m.-10:15 a.m. 11:20 a.m.-3:00 p.m.	8:00 a.m.-2:00 p.m.	8:15 a.m.-1:30 p.m.	
Hours Sampling	4.92	6.0	5.25	5.39
Sludge Feed Rate, gpm	150	150	150	150
Volume of Sludge Processed, gallons	44,280	54,000	47,250	48,510
Volume of Snail Grit Collected, cu. ft.	0.031	0.032	0.048	0.037
Volume of Snail Grit Collected, gallons	0.235	0.238	0.359	0.277
Southwest Plant flow, MGD	242	289	265	265

TABLE II-26: STICKNEY WRP PRELIMINARY SLUDGE STUDY
PERCENT TOTAL AND VOLATILE SOLIDS

Sample Date	%TS	%TVS	%Ash
Preliminary Sludge			
5/25/05	0.78	51.4	48.6
5/26/05	0.28	58.5	41.5
5/27/05	0.34	53.9	46.1
Average	0.47	54.6	45.4
Collected Grit Material From Eutek Unit			
5/25/05	44.3	28.8	71.2
5/26/05	23.7	53.8	46.2
5/27/05	17.9	48.2	51.8
Average	28.6	43.6	56.4

TABLE II-27: SIEVE ANALYSIS OF GRIT SAMPLES COLLECTED FROM STICKNEY WRP PRIMARY SLUDGES ON 5/25/05 THROUGH 5/27/05

Sieve Size, µm (No.)	5/25/05	5/26/05	5/27/05	Average
	Percent Retained			
1000 (18)	3.7	1.3	0.7	1.9
600 (30)	2.5	2.8	2.8	2.7
425 (40)	6.7	7.9	7.8	7.5
300 (50)	15.3	19.5	19.3	18.0
212 (70)	27.7	33.2	24.4	28.4
150 (100)	23.5	18.4	18.3	20.1
106 (140)	8.0	6.2	8.0	7.4
75 (200)	5.6	5.1	8.0	6.2
Pan	7.0	5.7	10.8	7.8

TABLE II-28: SIEVE ANALYSIS AS CUMULATIVE PERCENT FOR GRIT SAMPLES COLLECTED FROM STICKNEY WRP PRELIMINARY SLUDGES ON 5/25/05 THROUGH 5/27/05

Sieve Size,	5/25/05		5/26/05		5/27/05		Average	
µm (No.)	Retained	Passing	Retained	Passing	Retained	Passing	Retained	Passing
1000 (18)	3.7	96.3	1.3	98.7	0.7	99.3	1.9	98.1
600 (30)	6.2	93.8	4.2	95.8	3.5	96.5	4.6	95.4
425 (40)	12.9	87.1	12.0	88.0	11.3	88.7	12.1	87.9
300 (50)	28.1	71.9	31.5	68.5	30.6	69.5	30.1	70.0
212 (70)	55.9	44.1	64.7	35.3	54.9	45.1	58.5	41.5
150 (100)	79.4	20.6	83.1	16.9	73.2	26.8	78.6	21.4
106 (140)	87.4	12.6	89.3	10.7	81.2	18.8	86.0	14.0
75 (200)	93.0	7.0	94.3	5.7	89.2	10.8	92.2	7.8
Pan	100.0	0.0	100.0	0.0	100.0	0.0	100.0	0.0

TABLE II-29: NORTH SIDE WRP COMBINED SLUDGE GRIT STUDY
EUTEK GRIT SNAIL OPERATIONAL DATA

	6/30/05	7/1/05	7/5/05	Average
Run Time	8:20 a.m. - 10:20 a.m.	7:50 a.m. - 9:20 a.m. 10:00 a.m. - 11:30 a.m.	7:40 a.m. - 8:55 a.m. 9:10 a.m. - 9:25 a.m.	
Hours Sampling	2.0	3.0	1.5	2.27
Sludge Feed Rate, gpm	120	120	150	140
Volume of Sludge Processed, gallons	14,400	21,600	13,500	16,500
Volume of Snail Grit Collected, cu. ft.	0.143	0.060	0.072	0.092
Volume of Snail Grit Collected, gallons	1.072	0.447	0.532	0.684

TABLE II-30: NORTH SIDE WRP COMBINED SLUDGE
PERCENT TOTAL AND VOLATILE SOLIDS

Sample Date	%TS	%TVS	%Ash
North Side Combined Sludge			
6/30/05	0.95	76.9	23.1
7/1/05	0.84	75.8	24.2
7/5/05	1.98	71.0	29.0
Average	1.26	74.6	25.4
Collected Grit Material			
6/30/05 A*	42.47	26.98	73.02
6/30/05 B*	46.04	19.99	80.01
7/1/05	46.28	42.33	57.67
7/5/05	40.36	46.65	63.35
Average**	43.6	37.5	62.5

*Two split samples, identified as A and B, were taken on 6/30/05 and analyzed separately.
**Used average of 6/30/05 A and B values in calculating overall averages.

TABLE II-31: SIEVE ANALYSIS OF GRIT SAMPLES COLLECTED FROM NORTH SIDE WRP COMBINED SLUDGES ON 6/30/05 THROUGH 7/5/05

Sieve Size, µm (No.)	6/30/05 A*	6/30/05 B*	7/1/05	7/5/05	Average**
	Percent Retained				
1000 (18)	14.9	14.9	12.4	14.5	13.9
600 (30)	15.2	14.9	18.6	21.2	18.3
425 (40)	19.4	19.6	23.1	23.9	22.1
300 (50)	17.5	17.7	16.2	12.5	15.4
212 (70)	18.9	19.1	13.5	10.3	14.2
150 (100)	7.9	7.6	8.0	7.6	7.8
106 (140)	2.1	2.0	3.1	3.4	2.9
75 (200)	1.5	1.5	1.9	2.5	2.0
Pan	2.6	2.7	3.2	4.1	3.3

*Two split samples, identified as A and B, were taken on 6/30/05 and analyzed separately.
**Includes 6/30/05 A, 7/1/05, and 7/5/05 results.

TABLE II-32: SIEVE ANALYSIS AS CUMULATIVE PERCENT GRIT SAMPLES COLLECTED FROM NORTH SIDE WRP COMBINED SLUDGES ON 6/30/05 THROUGH 7/5/05

Sieve Size,	6/30/05 A*		6/30/05 B*		7/1/05		7/5/05		Average	
mm (No.)	Retained	Passing	Retained	Passing	Retained	Passing	Retained	Passing	Retained	Passing
1000 (18)	14.9	85.1	14.9	85.1	12.4	87.6	14.5	85.5	13.9	86.1
600 (30)	30.1	69.9	29.8	70.2	31.0	69.0	35.7	64.3	32.3	67.8
425 (40)	49.5	50.5	49.4	50.6	54.1	45.9	59.6	40.4	54.4	45.6
300 (50)	70.0	33.0	67.1	32.9	70.3	29.7	72.1	27.9	69.8	30.2
212 (70)	85.9	14.1	86.2	13.8	83.8	16.2	82.4	17.6	84.0	16.0
150 (100)	93.8	6.2	93.8	6.2	91.8	8.2	90.0	10.0	91.9	8.1
106 (140)	95.9	4.1	95.8	4.2	94.9	5.1	93.4	6.7	94.7	5.3
75 (200)	97.4	2.6	97.3	2.7	96.8	3.2	95.9	4.1	96.7	3.3
Pan	100.0	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	0.0

*Two split samples, identified as A and B, were taken on 6/30/05 and analyzed separately.
**Includes 6/30/05 A, 7/1/05, and 7/5/05 results.

TABLE II-33: SUMMARY OF CALUMET HYDROGEN SULFIDE MONITORING—2005

Month	H_2S, ppb North Monitor Mean	North Monitor Maximum	South Monitor Mean	South Monitor Maximum
January	0.02	1.80	0.00	0.10
February	0.01	3.20	0.00	4.60
March	0.00	1.80	0.02	9.90
April	0.00	0.00	0.01	8.50
May	0.00	1.00	0.02	7.50
June	0.14	39.00	0.14	25.20
July	0.92	39.00	0.20	41.60
August	1.78	41.40	OS*	OS
September	2.35	90.00	OS	OS
October	0.80	19.80	OS	OS
November	0.01	1.40	OS	OS
December	0.01	1.01	OS	OS

*Out of service.

TABLE II-34: KIRIE WRP DATA FOR CALIBRATION OF CLARIFIER PORTION OF GPS-X MODEL

Clarifier Model	New General
Library	cnplib
Clarifier Type	round, flat bottom
Data Source	2004 dry weather annual average
Physical Sizing	
Diameter, ft	153
Surface area, ft^2	110,256
Depth, ft	15
Operational Parameters	
Plant Flow, MGD	30.29
RAS, MGD	26.55
Total Flow into Clarifier, MGD	56.34
Return Flow/ Plant Flow, %	0.86
RSSS, mg/L	6,468
RSVSS, mg/L	4,941
RSSS/RSVSS,	1.31
SVI	92.99
Hydraulic Loading, gal/ft^2 day	274.72
Solids Loading, lb/ft^2 day	13.30
Clarifier Influent	
MLSS, mg/L	3,093
CBOD, mg/L	3.13
SS, mg/L	2.75
Clarifier Effluent, Plant Data	
CBOD, mg/L	1.65
SS, mg/L	0.90
Clarifier Effluent, Model Output	
CBOD, mg/L	1.69
SS, mg/L	0.88

TABLE II-35: KIRIE WRP DATA FOR CALIBRATION OF AERATION PORTION OF GPS-X MODEL

Aeration Tank Model	New General
Library	cnplib
Data Source	2004 dry weather annual average
Reactors in Series	12
Volume, 10^6 gal	13.734
Operational Parameters	
Plant Flow, MGD	30.29
Aeration Pass One, CFM	650
Aeration Pass Two, CFM	2,200
Aeration Pass Three, CFM	0
MLSS, mg/L	3,093
MLVSS, mg/L	2,370
Total airflow, scfm	18,260
HRT, hours	10.88
SRT, days	9.62
F:Mv	0.077
F:M	0.059
DO, mg/L	2.65
Aeration Tank Influent	
Influent BOD_5, mg/L	181.5
Influent SS, mg/L	203.0
influent TKN, mg/L	28.5
Influent Total P, mg/L	4.5
Secondary Effluent, Plant Data	
$CBOD_5$, mg/L	3.4
SS, mg/L	2.7
TKN. Mg/L	1.5
Total P, mg/L	1.00
Secondary Effluent, Model Output	
$CBOD_5$, mg/L	2.1
SS, mg/L	6.5
TKN. Mg/L	3.7
Total P, mg/L	1.2

TABLE II-36: 2004 DRY WEATHER ANNUAL AVERAGE ANALYTICAL DATA FOR THE KIRIE WRP

Influent BOD_5, mg/L	181.5
Influent TS, mg/L	965.5
Influent SS, mg/L	203.0
Influent TKN, mg/L	28.5
Influent NH_3-N, mg/L	15.1
Influent NO_2-N, mg/L	0.1
Influent NO_3-N, mg/L	0.3
Influent P-TOT, mg/L	4.5
Influent P-SOL, mg/L	1.9
Influent CN_WAD, mg/L	0.001
Influent CN, mg/L	0.013
Influent Temperature, °F	63.31
MLSS,mg/L	3,093
MLVSS, mg/L	2,370
RSSS, mg/L	6,468
RSVSS, mg/L	4,941
Final Effluent pH	7.31
Final Effluent BOD_5, mg/L	3.75
Final Effluent $CBOD_5$, mg/L	3.44
Final Effluent SS, mg/L	2.70
Final Effluent TKN, mg/L	1.50
Final Effluent NH_3-N, mg/L	0.30
Final Effluent NO_2-N, mg/L	0.23
Final Effluent NO_3-N, mg/L	5.68
Final Effluent P-TOT, mg/L	0.97
Final Effluent P-SOL, mg/L	0.90
Final Effluent Temperature, °F	62.14

TABLE II-37: RESULTS OF ADDITIONAL ANAEROBIC DIGESTION TESTS FOR CALUMET WRP IN 2005

Test Start	Before Test		After Test[1]		Volatile Solids Reduction (%)	
Date	TS (%)	%VTS (%)	TS (%)	%VTS (%)	By Equation[2]	By Mass
1/13/2005	1.77	57.66	1.61	55.48	8.5	12.4
2/3/2005	2.13	56.44	1.91	52.69	14.0	16.2
3/16/2005	2.13	56.11	1.94	51.10	18.3	16.8
4/6/2005	2.17	56.56	1.99	53.23	12.6	13.5
5/5/2005	2.15	59.04	1.98	55.51	13.5	13.4
5/19/2005	2.12	59.55	1.94	55.29	16.0	15.1
6/9/2005	2.08	58.14	1.88	54.50	13.8	15.2
7/7/2005	2.10	57.08	1.98	52.45	17.1	13.5
8/4/2005	2.06	56.33	1.93	53.76	9.8	10.5
8/17/2005	1.94	56.18	1.85	53.90	8.8	8.7
9/8/2005	1.77	56.90	1.66	53.85	11.6	11.1
10/6/2005	2.02	56.30	1.83	51.34	18.1	17.3
11/2/2005	2.13	55.12	1.98	52.88	8.6	11.0
12/1/2005	2.01	58.54	1.87	55.72	10.9	11.3
Mean	2.04	57.14	1.88	53.69	13.0	13.3
Min.	1.77	55.12	1.61	51.10	8.5	8.7
Max.	2.17	59.55	1.99	55.72	18.3	17.3

[1]After 40 day of incubation at 35.5°C in bench-scale reactors.
[2]The Van Kleeck Equation was used in calculations.

TABLE II-38: MONTHLY MEAN VOLATILE SOLIDS REDUCTION THROUGH 2-STEP ANAEROBIC DIGESTION AT CALUMET WRP IN 2005

	Digester Feed		Digester Draw		VS Reduction (%)
Month	TS (%)	%VTS (%)	TS (%)	%VTS (%)	By Equation[1]
Jan	3.76	68.5	1.89	57.2	38.4
Feb	3.81	69.4	2.04	54.1	48.0
Mar	3.59	71.7	2.18	54.9	52.0
Apr	3.4	72.1	2.22	56.6	49.5
May	3.02	71.7	2.13	58.1	45.3
Jun	3.43	70.1	2.10	56.5	44.6
Jul	2.97	69.6	2.10	56.7	42.8
Aug	2.82	67.8	1.99	55.5	40.8
Sep	2.94	67.5	1.91	56.4	37.7
Oct	3.04	66.5	2.04	54.3	40.1
Nov	3.06	70.4	2.19	54.6	49.4
Dec	3.09	73.7	1.98	58.1	50.5
Mean	3.24	69.9	2.06	56.1	44.9
Min.	2.82	66.5	1.89	54.1	37.7
Max.	3.81	73.7	2.22	58.1	52.0

[1]The Van Kleeck Equation was used in calculations.

TABLE II-39: CSO STATIONS BUILT IN THE DUFLOW MODEL FOR THE CAWs

CSO Locations	Drainage Area For and Discharge To	CSO Treatment
CSO 1	Upper North Shore Channel (upstream of NSWRP)	Yes
CSO 2	Upper North Shore Channel (upstream of NSWRP)	Yes
CSO 3	Lower North Shore Channel (downstream of NSWRP)	Yes
CSO 4	Lower North Shore Channel (downstream of NSWRP)	Yes
CSO 5	North Branch of Chicago River	No
CSO 6	North Branch of Chicago River	Yes
CSO 7	North Branch of Chicago River	No
CSO 8	North Branch of Chicago River	Yes
CSO 9	North Branch of Chicago River	Yes
CSO 10	Chicago River Main Branch	No
CSO 11	South Branch of Chicago River	No
CSO 12	South Branch of Chicago River	Yes

TABLE II-40: SIMULATION RUNS FOR EVALUATION OF EXISTING IN-STREAM AERATION STATIONS

Simulation Run	Description of Aeration Station Operations
D1W1	Using 1 blower at Devon Station and 1 blower at Webster Station
D1W2	Using 1 blower at Devon Station and 2 blower at Webster Station
D1W3	Using 1 blower at Devon Station and 3 blower at Webster Station
D2W1	Using 2 blower at Devon Station and 1 blower at Webster Station
D2W2	Using 2 blower at Devon Station and 2 blower at Webster Station
D2W3	Using 2 blower at Devon Station and 3 blower at Webster Station
D3W1	Using 3 blower at Devon Station and 1 blower at Webster Station
D3W2	Using 3 blower at Devon Station and 2 blower at Webster Station
D3W3	Using 3 blower at Devon Station and 3 blower at Webster Station

TABLE II-41: SCENARIOS USED IN MODEL SIMULATIONS FOR EVALUATING NUTRIENT IMPACT

Scenario	Content	Description of Effluent Nutrient Concentrations
Base	Using monitoring data in 2001 and 2002	Daily mean concentrations of NH_3-N, NO_3-N, Org-N, TP and Sol-P were used.
Permit	Using current NPDES permit values	NH_3-N only. Constant daily mean concentrations of 2.5/4.0 mg/L (summer/winter) were used. Other N and P species were the same as Base.
Case 1	Assuming TP = 0.5 mg/L and TN = 8.0 mg/L	All concentrations were daily mean values and were constant during simulations. (Inorg-P = 0.4 mg/L, NH_3-N = 2.5/4.0 mg/L, NO_3-N = 4.5/3.0 mg/L, and Org-N = 1.0 mg/L, respectively)
Case 2	Assuming TP = 0.5 mg/L and TN = 5.0 mg/L	All concentrations were daily mean values and were constant during simulations. (Inorg-P = 0.4 mg/L, NH_3-N = 1.5/3.0 mg/L, NO_3-N = 3.0/1.5 mg/L, and Org-N = 0.5 mg/L, respectively)

TABLE II-42: FLOW REMOVED BY TARP BY SYSTEM

Date	Mainstream[1] Flow (10^9 gallons)	Calumet[2] Flow (10^9 gallons)	Kirie[2] Flow (10^9 gallons)	Total Flow (10^9 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	2.39	54.71
2003	27.22	14.88	1.48	43.58
2004	28.05	15.55	2.67	46.27
2005	21.43	12.95	1.11	35.49
Total	554.78	204.99	63.94	823.71

[1]Stickney and Calumet Data calculated from TARP Pumpback reports.
[2]Kirie TARP is calculated using an average dry weather flow.
Kirie data is taken from KRRAW69 Report on LIMS.
[3]Data supplied by Engineering Department.

TABLE II-43: SUSPENDED SOLIDS REMOVED BY TARP BY SYSTEM[1]

Date	Mainstream[2] (10^6 lbs)	Calumet[2] (10^6 lbs)	Kirie[3] (10^6 lbs)	Total (10^6 lbs)
1982-1993[4]	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	4.26	84.29
2003	67.38	23.71	2.43	93.52
2004	62.89	18.55	4.42	85.86
2005	51.14	21.33	1.63	74.10
Total	1,271.24	263.44	68.07	1,602.75

[1]CBOD+(Ammonia*4.6), except Kirie which uses BOD + (Ammonia +4.6).
[2]Stickney and Calumet Data calculated from TARP Pumpback reports.
[3]Kirie TARP is calculated using an average dry weather flow.
Kirie data is taken from KRRAW69 Report on LIMS.
[4]Data supplied by Engineering Department.

TABLE II-44: OXYGEN DEMANDING SUBSTANCES REMOVED BY TARP[1]

Date	Mainstream[2] (10^6 lbs)	Calumet[2] (10^6 lbs)	Kirie[3] (10^6 lbs)	Total (10^6 lbs)
1982-1993[4]	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	4.71	71.61
2003	36.09	16.56	3.15	55.80
2004	28.22	16.72	5.47	50.41
2005	25.88	19.22	2.14	47.24
Total	549.92	221.89	74.09	845.90

[1]CBOD+(Ammonia*4.6), except Kirie which uses BOD + (Ammonia +4.6).
The Kirie WRP does not report CBOD.
[2]Stickney and Calumet Data calculated from TARP Pumpback reports.
[3]Kirie TARP is calculated using an average dry weather flow.
Kirie data is taken from KRRAW69 Report on LIMS.
[4]Data supplied by Engineering Department.

TABLE II-45: LIST OF PARAMETERS TO BE ANALYZED ACCORDING TO TABLE 2 FROM THE IEPA'S SCOPE OF WORK

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: LAYOUT OF CALUMET WATER RECLAMATION PLANT

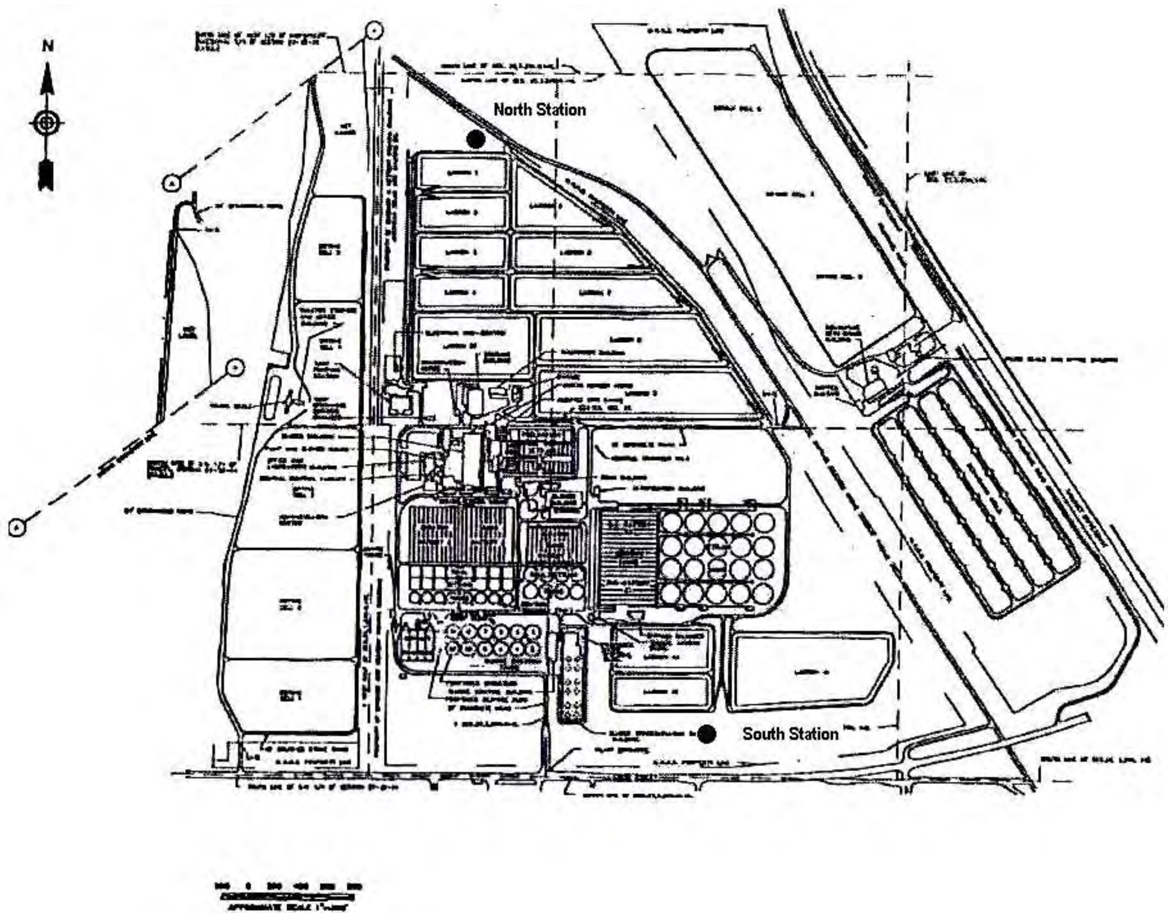


FIGURE II-2: KIRIE WRP BIOLOGICAL NUTRIENT REDUCTION MODEL LAYOUT

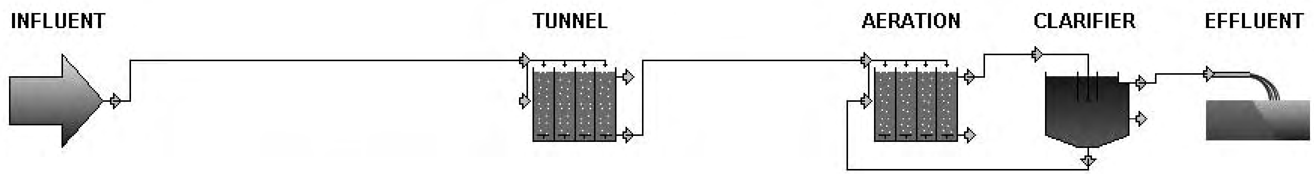


FIGURE II-3: DAILY VOLUME VARIATION OF KIRIE TUNNEL IN DRY WEATHER

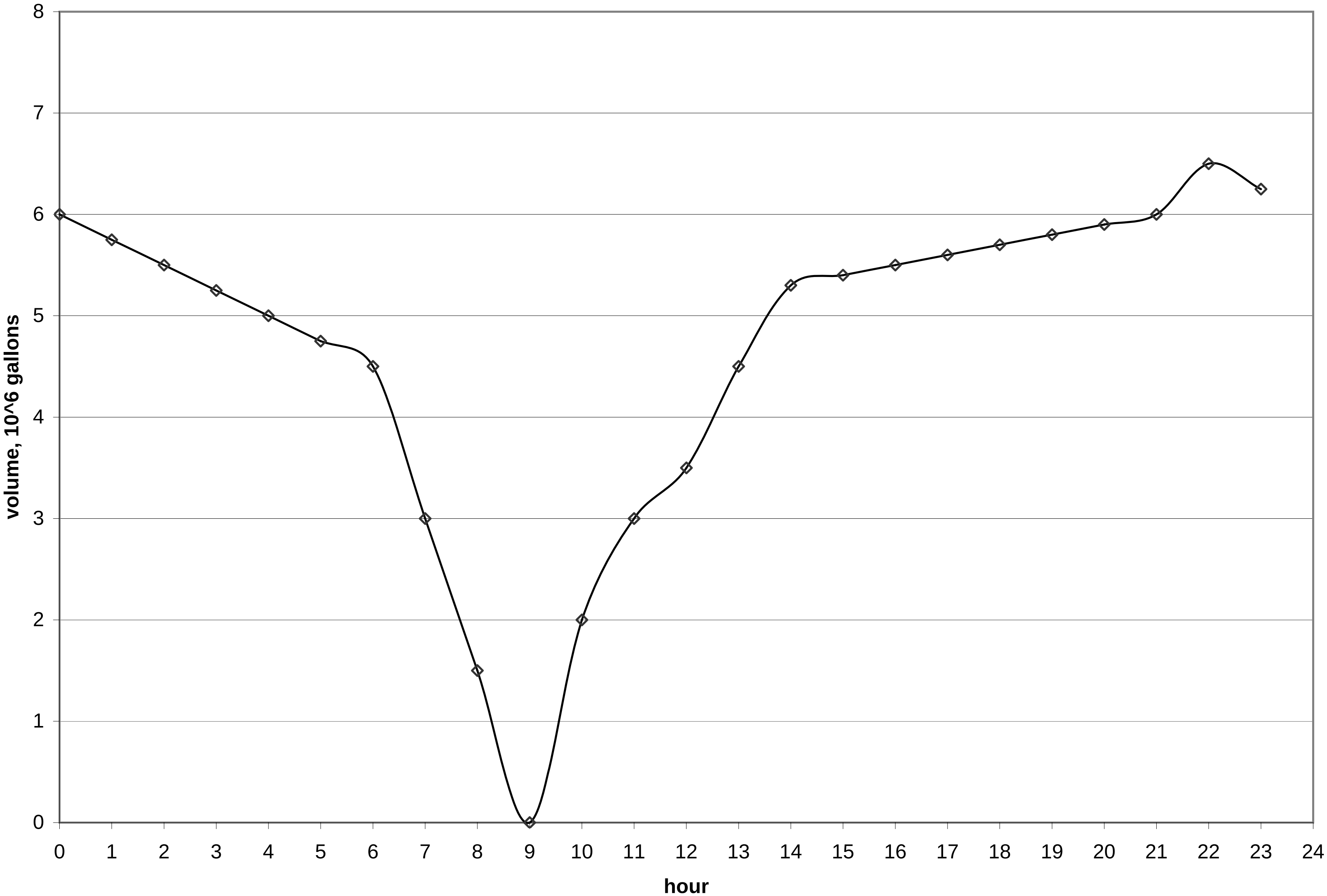
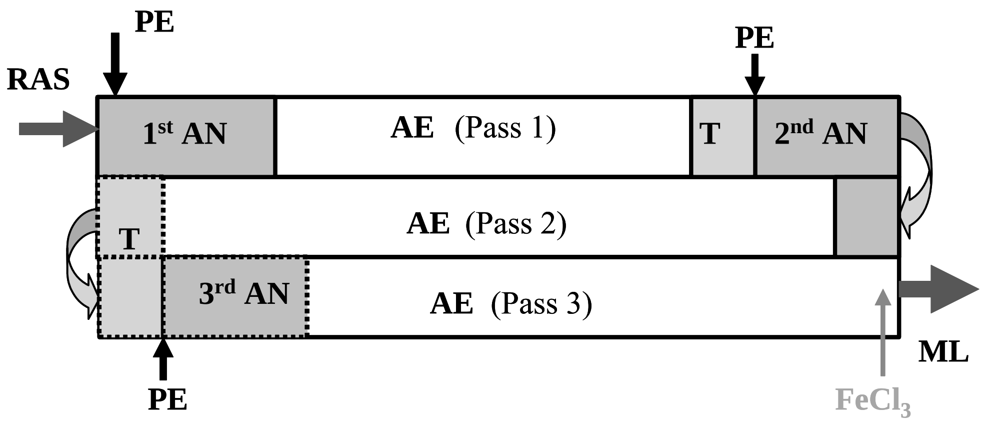


FIGURE II-4: SCHEMATIC OF THE AERATION TANK USED IN THE NUTRIENT REMOVAL STUDY AT THE EGAN WRP

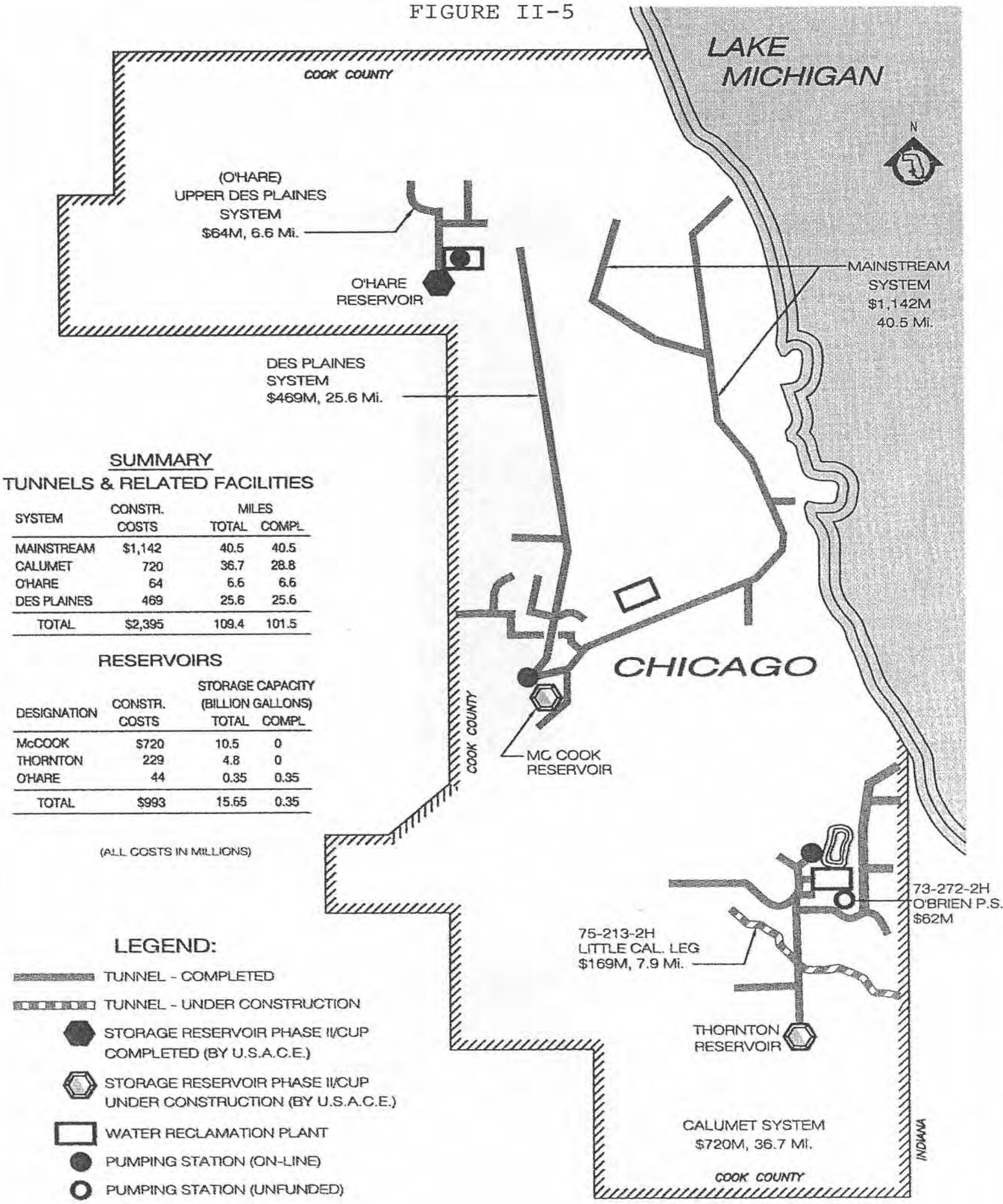


Note: Drawing is not on scale. Each Pass is 375 feet long and 25 feet wide.

PE = Primary effluent; RAS = Return sludge; ML = Mixed liquor

AE = Aerobic zone; AN = Anoxic zone; T = Transition zone,

FIGURE II-5



SUMMARY

TUNNELS & RELATED FACILITIES

SYSTEM	CONSTR. COSTS	MILES TOTAL	MILES COMPL.
MAINSTREAM	$1,142	40.5	40.5
CALUMET	720	36.7	28.8
O'HARE	64	6.6	6.6
DES PLAINES	469	25.6	25.6
TOTAL	$2,395	109.4	101.5

RESERVOIRS

DESIGNATION	CONSTR. COSTS	STORAGE CAPACITY (BILLION GALLONS) TOTAL	COMPL.
McCOOK	$720	10.5	0
THORNTON	229	4.8	0
O'HARE	44	0.35	0.35
TOTAL	$993	15.65	0.35

(ALL COSTS IN MILLIONS)

TUNNEL AND RESERVOIR PLAN PROJECT STATUS

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
ENGINEERING DEPARTMENT
2-04 TARP WSS:JJK

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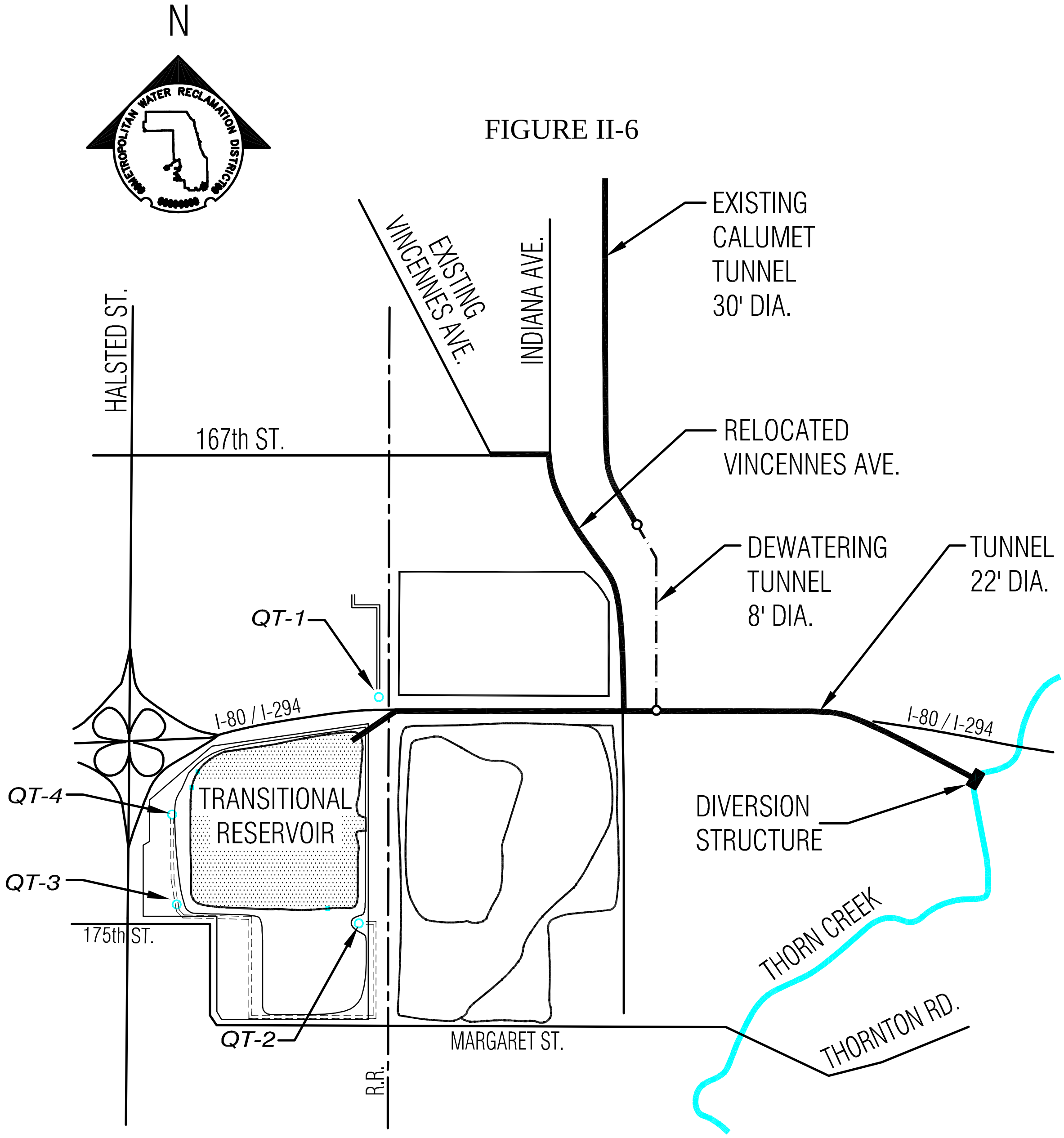
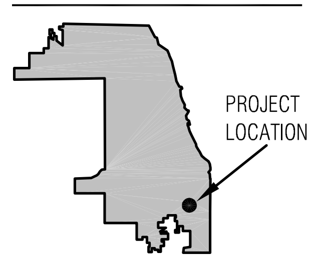
FIGURE II-6



LOCATION MAP
Scale: NTS



LEGEND
- Monitoring Well
- New Access Road
- Existing Access Road (to be improved)

THORNTON TRANSITIONAL RESERVOIR
MONITORING WELL LOCATIONS

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
ENGINEERING DEPARTMENT
11-03 PLANNING JJK

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BIOSOLIDS UTILIZATION AND SOIL SCIENCE SECTION

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 biosolids. 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 responsible for providing technical support for biosolids marketing and oversight of technical aspects of biosolids land application contracts. The section also provides technical support to the native landscape conversions at the District's water reclamation plants.

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. Approximately 600 hectares (1,483 acres) were sold through auction in fall 2004. 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 biosolids were applied to Fulton County fields during 2005. Supernatant was last applied in 1995 and biosolids were last applied in 2004.

During 2005, 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 10 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.
- 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 42 fields in 2005 for chemical analysis. Plant tissue samples were collected from 6 hay fields, 25 soybean fields, and 37 corn fields. Chemical analyses were performed on these samples during 2005. 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 2005. The crops planted on these fields and yields for 2005 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 2005 corn grain, corn leaf, hay, and soybean grain are shown in Tables III-3 through 6, 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. The original pH of Acid-Mine Lake water 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-7). 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 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 project that the District recently conducted at the USX property on Chicago's southern lakefront.

Water was collected from the coal refuse pile lysimeters on a quarterly basis in 2005. Yearly means of four selected chemical parameters for 2001 through 2005 are presented in Tables III-8 through 10 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 through 2006. 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. 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. The databases are made available for public access on the District's web site as they are completed.

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 33 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-11, along with the cumulative totals of biosolids applied per plot through 2005. Table III-12 shows a four-year comparison (2002-2005) of soil data from the experimental plots. Table III-13 shows the nutrient and metal concentrations in corn grain for the four treatments. Table III-14 shows the comparison of the corn grain and stover yields for 2002 through 2005.

Phosphorus Studies. As part of the studies that are conducted to address biosolids phosphorus in 2005, work was done on the Biosolids P Runoff Study located in Field 63 and the Biosolids P Availability Study located in Field 83 at the Fulton County site. Details on this work are 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 biosolids generated at 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 (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 2005 included the cultivation of corn in the 12 biosolids-treated fields. However, due to severe drought during the growing season, no corn was harvested. A total of 7.37 million gallons (MG) of biosolids was applied to the fields in 2005, as opposed to 12.98 MG in 2004. Of the total amount, 5.91 MG were applied during the spring season, as opposed to 3.81 MG in the spring of 2004. In addition, under a supplemental permit issued by the IEPA, sediment that was excavated from combined sewer overflow retention ponds at the Hanover Park WRP was applied to Fields 1, 2, and 3 at a rate of approximately 200 dry Mg/ha (89 dry tons/acre).

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 2005. The data show that, overall, the application of biosolids for twenty-six years has not significantly affected groundwater quality at the Hanover Park Fischer Farm site.

Two shallow wells (W-1 and W-3) located adjacent 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 2005.

In 2004, several fields were reconfigured by removing the berm between adjacent fields to create new fields as designated in Figure III-1. The five experimental fields were reconfigured to create three separate fields. Seven new farm fields were created and designated 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 Quality Monitoring at Solids Management Areas (SMA's)

Groundwater Quality Monitoring at the John E. Egan WRP SMA. 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 ≥60%. However, since all biosolids generated at the Egan WRP are currently utilized as fresh centrifuge cake through the farmland application program, the Egan drying site is no longer being used. The IEPA operating permit (No. 2005-AO-4282) for this drying facility does not require groundwater monitoring unless drying resumes at the site. 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.

Groundwater Quality Monitoring at the Calumet WRP SMA. In 1986, a paved solids drying area, the Calumet West 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 (No. 2005-AO-4281) for these facilities requires 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.

In May 2005, a replacement lysimeter (L-1N) was installed south of the original device (L-1) at the Calumet East SMA. Both devices are being sampled simultaneously since June 2005 to validate the performance of L-1N. The data collected so far indicated that L-1N is functioning as desired. After one year of simultaneous monitoring, a request will be submitted to the IEPA for approval to abandon the old lysimeter, L-1.

During 2005, samples were taken once per month at both Calumet drying sites. Analytical data for water samples taken in 2005 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.

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 agitating the biosolids to enhance drying until the solids content is $\geq$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 (No. 2005-AO-4283) 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 was 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).

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 the designated replacement for monthly monitoring.

In May 2005, lysimeters L-6, L-7, and L-8 at the LASMA site were replaced with devices L-6N, L-7N, and L-8N, respectively. In December 2005, three additional lysimeters, L-3, L-4, and L-5, were replaced with L-3N, L-4N, and L-5N, respectively. The old and new lysimeters are monitored simultaneously to validate the performance of the new devices. After one year of simultaneous monitoring, a request will be submitted to the IEPA for approval to abandon the old lysimeters.

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 2005 were submitted to the IEPA in quarterly monitoring reports.

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 (No. 2005-AO-4283) 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.

In May 2005, new lysimeters L-1N, L-2N, and L-3N were installed as replacements for L-1, L-2, and L-3, respectively. In December 2005, L-4N was installed as a replacement for L-4. The old and new lysimeters are monitored simultaneously to validate the performance of the new devices. After one year of simultaneous monitoring, a request will be submitted to the IEPA for approval to abandon the old lysimeters.

The current IEPA operating permit requires biweekly monitoring of 25 groundwater parameters. Analytical results for the lysimeter samples collected during 2005 at this site were submitted to the IEPA in quarterly monitoring reports. Within the last year, there was no significant change in groundwater quality in comparison with that of previous years.

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 (No. 2004-AO-2591) requires biweekly groundwater monitoring. Three lysimeters were initially installed for sampling groundwater 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 NH_4-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 new lysimeter, L-1N-1, was installed in May 2005 as a replacement for L-1N to determine if the high NH_4-N concentrations are due to localized contamination at L-1N. The old and new lysimeters are monitored simultaneously to validate the performance of the new device. After one year of simultaneous monitoring, a request will be submitted to the IEPA for approval to abandon the old lysimeter. Analytical data for water sampled from the four lysimeters in 2005 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 2005, the site was used to dry centrifuged, digested biosolids from the Stickney and Egan WRPs. The dried biosolids were utilized at landfills as daily and final cover to enhance vegetative growth at these sites.

The IEPA operating permit for this drying facility (No. 2005-AO-4283) 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 2005 from the four lysimeters at this drying facility were submitted to the IEPA in quarterly monitoring reports. In 2005, groundwater quality was similar to that of the previous years.

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. The P-based rates may substantially reduce the viability of land application programs in Illinois, because the low application rates of biosolids could prove 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 2005, work was conducted on the following studies:

- Bioavailability of P in District biosolids - Greenhouse study
- Bioavailability of P in District biosolids - Field 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 started in 2004. The 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 (Objective 1). 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. In order to deplete all pots of the applied P, as indicated by consistent P deficiency levels in the harvested foliage, this sequence of alternating wheat and ryegrass cropping was continued through 2005. A total of 12 foliage clippings were done by the end of 2005.

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 effect of P added through the application of the Class A and Class B biosolids and the TSP on cumulative P uptake in the foliage clippings for the three successive wheat and rye cropping sequences (twelve total clippings) completed by the end of 2005 are presented in Figure III-8. The data obtained so far show that for each of the three cropping sequences, the cumulative P uptake from the three P sources was similar up to the 50 mg P/kg (350 mg P/pot) application rate. At the higher application rates, cumulative P uptake during the first sequence (Clippings 1-4) was much lower in the biosolids treatments than in the TSP treatment. The data in Figure III-8 show that subsequently (Clippings 5-8 and 9-12), less additional P was taken up in the fertilizer treatments compared to the biosolids treatments, such that cumulative P uptake in the biosolids treatments tended to approach the uptake observed in the TSP treatments. These data indicate that immediately following application at rates above approximately 50 mg P/kg to a P-deficient soil, fertilizer P is more bioavailable than biosolids P and levels in the soil are depleted faster over time. The bioavailability of biosolids P is lower, but is sustained over a longer period.

Bioavailability of P in District Biosolids – Field Study. A study was initiated in 2005 at the District's Fulton County site at Field 83, which consists of non-mined soil, to test the bioavailability of biosolids P under field conditions (Objective 1). Before starting the study, the field was cropped for three years without fertilizer P application to deplete the soil to a P-deficient level (less than 20 mg P/kg Bray P1 soil test level). This study will evaluate crop P uptake in soil amended with two P sources: Class A air-dried biosolids from the Calumet WRP and TSP fertilizer. The experimental layout is a randomized complete block design with four blocks of 10 treatments. The treatments include a control of zero application, sets of four each TSP and biosolids application established based on the total P loadings associated with biosolids application rates, ranging up to 22.4 Mg/ha (10 dry tons/ac), and a high biosolids rate of 33.6 Mg/ha (15 dry tons/ac). The 10 dry tons/ac rate is equivalent to the average agronomic rate of Class B biosolids utilized in the District's farmland application program. The high biosolids rate of 15 dry tons/ac was used based on the preliminary results from the greenhouse component of the bioavailability study, which indicated that the bioavailability of the biosolids P is much lower than TSP fertilizer P. In November 2005, the treatments (biosolids and TSP fertilizer) were applied to plots 90 feet wide by 120 feet long (0.25 acres) and incorporated into the plough layer (approximately 6 inches). Corn will be planted as test crop in the spring of 2006, 2007 and 2008, with only application of supplemental K and N fertilizer, and no additional application of biosolids or TSP treatments. Soil samples will be collected at the beginning of each growing season to measure soil P concentration. Crop samples will be collected to measure grain and dry matter yields and tissue P concentration.

Potential for Phosphorus Runoff in Biosolids Amended Soils. This study was conducted as a laboratory module to address Objective 2, to estimate the critical biosolids P application rate that is protective of surface waters. The P runoff experiment was done using the protocol of the National P Research Project (NPRP) which was established by the Southern Extension Research Activity (SERA-17) with specific goals to determine threshold soil P levels in benchmark soils throughout the USA. The SERA-17 group was organized through the Cooperative State Research, Education, and Extension Service of the US Department of Agriculture (USDA). The group consists of scientists from Land Grant Universities and the USDA Agricultural Research Service.

Archived soil samples from 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 biosolids application and samples collected in 2004 were selected 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:

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

In 2005, a simulated P runoff experiment was conducted on 11 of the 44 soil samples. Three replicates of each soil were packed at 5 cm deep in metal trays (100-cm long x 20-cm wide x 7.5-cm high), then wetted to saturation and placed on racks at a 5 percent slope under a rainfall simulator canopy. Simulated rainfall was applied as reverse osmosis water through a TeeJet 1/2 HH SS 50 WSQ nozzle at a rate of 7.0 cm/hr. The runoff generated during a 30-min period was collected and the trays were stored. A total of three rainfall events were conducted on each tray, on days 1, 3, and 7 after the initial wetting. Samples of the runoff water was analyzed for dissolved P and total P content.

Figure III-9 shows the relationships between WSP and PSI in 44 soils (Figure III-9A), and between WSP, runoff dissolved P, and PSI in 11 soils (Figure III-9B). The data show that trends for the relationship between concentrations of dissolved runoff P generated through simulated rainfall and WSP versus PSI were quite similar. The trend for the relationship between WSP and PSI showed that as PSI increased up to an inflection point at a value of approximately 18, there was no effect on dissolved runoff P and WSP levels. Further increase in PSI above this inflection point coincided with a sharp increase in dissolved runoff P and WSP. This inflection point is indicative of the level of saturation of P binding sites in the soil above which the potential for soluble P runoff from biosolids-amended soil would tend to increase significantly. The strong correlation between WSP and dissolved runoff P (Figure III-9B) suggests that WSP measurement in the biosolids-amended soil can be used to estimate the concentrations of dissolved P in runoff water. These relationships also indicate that the degree of P saturation of the P-binding sites in the amended soils may be a major factor effecting environmental impact thresholds or the potential for P runoff in biosolids-amended soils and should be considered in developing P-based land application rules.

Biosolids P Runoff Field Study. This study was designed to address Objective 3, to evaluate the effectiveness of different 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 (*Medicago sativa L.*) and bromegrass (*Bromus inermis*) on the entire 61-m length of the downslope 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 61 m.

In spring 2005, biosolids were applied to the up-slope half of eight of the subplots at two loading rates of 11.25 and 22.5 Mg/ha (5 and 10 dry tons/ac), such that there were four replicates of each amended plot and two unamended control plots. The 22.5 Mg/ha biosolids rate represent the typical N-based application rate of District biosolids. Due to the dry conditions during 2005, only a few runoff samples were collected. The study is planned to continue through 2008.

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, the practice of Class B biosolids application to farmland remains controversial and has been persistently attacked by the environmentalists. Most of the concerns stem from misinformation about the potential human health and environmental risks 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 application to farmland program.

In the fall of 2004, the District began a research and demonstration project on farmers' fields in Will and Kankakee Counties to demonstrate the safety of farmland application of Class B centrifuge cake biosolids and to improve the overall public perception and understanding of communities residing in the vicinities of biosolids-amended farmlands. A large proportion of the District's Class B biosolids is currently being applied to farmlands in these two counties.

Plots 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 impact of biosolids application on subsurface water quality. Details of plot layout, treatments, and location of lysimeters are given in Figure III-11. The anticipated duration of the research and demonstration project is three years.

Following the conventional practices in each county, the biosolids and fertilizer treatments are applied in the fall at the Will County site and in the spring just before planting at the Kankakee County site each year. The fall application in Will County is done to reduce the amount of field work required in the spring because the heavy textured soils drainage slowly, and tend to stay wet for longer periods of time, which may leave only a narrow window for completing the required field work before planting. The treatments will be applied similarly each year for the duration of the project.

Sampling and Analyses. Details of sampling schedule and analysis of soil, plant tissues, and water samples are given in Table III-15. Soil sampling was done at both sites prior to application of biosolids and after harvesting corn in the fall. 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.

Soil Fertility Parameters and Nutrients. The results of soil analysis for the 0- to 6-inch depth for both the Will and Kankakee County plots are presented in Table III-16.

In the Will County plots, the mean soil pH showed very little change compared to the pH values observed before the application of treatments. The mean soil EC increased slightly in the biosolids plots and most of the fertilizer plots. The inorganic N levels tended to increase after application of biosolids and fertilizers, but with no well-defined trend among the treatments (Table III-16).

In the Kankakee County plots, there was only little change in mean soil pH and EC after application of treatments. The data in Table III-16 show that most of the applied N was removed from the plow layer (0 to 6 inches). The relatively low levels of residual inorganic N observed in soil compared to the amount of N applied, indicate that most of the applied N was utilized by the crop, especially at the Will county site where very little movement of inorganic N below the 0- to 6-inch depth is expected (Table III-16).

Nutrients, Trace Metals, and Other Water Quality Parameters. The mean concentrations of nutrients and trace metals in the subsurface water samples collected from lysimeters in the Will County plots during October 2004 through November 2005 and in Kankakee County plots during December 2004 through November 2005 are presented in Tables III-17 and III-18, respectively. In the Will County plots, there was no noteworthy trend in NO_3-N and total P concentrations in lysimeter samples over time. The highest NO_3-N value was observed in the lysimeters from the 40 wet tons/ac biosolids and 260 lbs/ac N plots (Table III-17). Interestingly, the mean NO_3-N in the lysimeter from the 80 wet ton/ac biosolids plot was considerably lower than in the 40 wet tons/ac biosolids and 260 lbs/ac N fertilizer plots.

In the Kankakee County lysimeters, there were no noteworthy trends in NO_3-N and total P concentrations over time. The mean NO_3-N concentrations ranged from 4.6 to 13.0 mg/L and the highest value was observed in the lysimeters from 30 wet tons/ac biosolids and 160 lbs/ac N fertilizer plots (Table III-18).

The mean trace metal concentrations observed for most of the lysimeters at both Will and Kankakee County plots were very low and were either below or close to the detection limits (Tables III-17 and III-18). There was no trend among the plots amended with various rates of fertilizers and biosolids. The data suggest that there was no leaching of trace metals from biosolids-amended soils.

Grain Yield. The corn yield response to application rates of fertilizer N and biosolids in the Will and Kankakee County plots are presented in Figure III-12. For the biosolids treatments, the amount of plant available nitrogen was calculated using the conventional formula. At the Will County plots, corn grain yields generally increased with increasing rates of fertilizer N and biosolids (Figure III-12A). The highest corn grain yield in the fertilizer treatments (150 bu/ac) was observed in the 260 lbs/ac N plot, and the highest corn yield in the biosolids treatments (200 bu/ac) was observed in the 80 wet ton/ac biosolids plot.

In the Kankakee County plots, the corn grain yield generally increased with application of fertilizer N and biosolids, except for the 30, 40, and 60 wet ton/ac biosolids plots, in which yields were similar to that in the 10 wet ton/ac biosolids treatment (Figure III-12B). This was due most likely to lack of moisture, because all plots were irrigated, except the three biosolids plots that were outside the irrigation pivot coverage.

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 soil conditioner 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 2005, 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 2005 include:

1. Rehabilitation of fairways using biosolids as a soil conditioner and topsoil substitute at the Challet Hills, Longwood Country Club, and Cinder Ridge golf courses.

2. Reclamation of coal refuse lands at Cinder Ridge golf course.

3. Development of athletic fields using biosolids as a soil conditioner by St. Charles School District, Valley View School District, Oakbrook Park District, and Great Lakes Youth Sports Events, LLC.

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 on field and rainfall simulation studies at Fulton County and in the greenhouse at Stickney to evaluate the environmental impacts of phosphorus in land applied biosolids.

7. 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.

8. Continue negotiations with the city of Chicago to promote the use of biosolids for development of parks and recreational areas in Chicago. This effort included collaboration with the city to conduct a risk assessment to evaluate the use of biosolids at recreational areas based on the Tiered Approach to Corrective Action Objectives as required by the city.

9. 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 the M&O Department.

Technical Support for Native Landscaping

During 2005, the section provided technical support for installation and maintenance of native prairie landscaping at the District's WRPs. The activities included review of contracts prepared by the M&O Department, project-planning meetings with M&O and contractors, herbicide application, and onsite visits to assist in conducting performance evaluation of the native landscaping. The section also produced a document that outlines a cost-efficient approach for establishment of low maintenance prairie-like landscaping at the District's facilities.

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 2005[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
	Mg/ha	tons/acre		(dS/m)	(%)										
1	1,735	775	6.7	0.72	5.37	6,429	10,952	5.45	106	1,121	67.3	628	862	126	270
2	1,816	810	6.7	0.42	5.89	6,186	12,309	3.20	42.0	1,256	71.7	678	905	127	299
3	1,814	810	6.4	0.95	6.28	6,638	9,938	3.90	124	1,069	54.7	599	737	107	247
4	1,522	680	6.7	0.40	6.13	5,573	9,778	1.20	40.1	1,019	53.2	551	693	109	226
5	1,562	698	6.8	0.39	6.04	5,505	10,133	3.15	29.4	989	51.4	549	687	103	233
6	614	274	7.4	0.24	3.37	2,482	2,734	0.00	7.04	318	19.5	170	266	53	79
7E	1,494	667	7.0	0.29	4.84	4,272	7,586	0.85	18.5	924	58.9	547	779	113	234
7W	1,494	667	7.3	0.21	3.43	2,659	4,234	0.95	12.8	459	27.0	250	361	64	112
8	1,320	589	7.0	0.28	4.87	4,526	9,217	4.20	20.7	1,105	70.7	679	946	124	284
9	1,602	716	6.9	0.39	5.73	4,611	8,458	7.55	18.5	878	48.3	520	665	101	208
10	1,073	479	6.7	0.28	5.21	5,247	11,972	11.3	26.8	1,289	89.8	849	1,220	150	356
11	1,485	663	6.9	0.25	4.87	3,839	7,527	7.50	18.6	927	62.1	553	830	120	259
12	1,398	624	7.1	0.31	4.47	4,112	8,572	7.30	20.2	1,031	63.2	468	760	112	255
13	1,367	610	6.6	0.67	4.99	4,754	9,119	11.4	109	1,148	71.0	536	859	118	281
14	1,473	657	6.8	0.70	5.08	5,133	9,663	10.6	107	1,150	62.7	488	755	113	262
15	1,482	662	6.7	0.81	5.17	5,437	9,079	8.85	108	1,077	52.2	453	628	96	230
16E	1,510	674	6.9	0.19	4.13	3,015	5,434	7.40	11.7	874	55.6	387	663	95	218
16W	1,510	674	6.9	0.24	4.50	3,621	7,364	8.10	14.4	1,016	64.1	464	767	107	247
17	1,722	770	6.9	0.35	5.76	5,759	11,193	12.3	20.3	1,242	68.9	569	843	125	288
19	644	287	6.8	0.17	3.21	2,471	4,578	5.45	7.46	761	52.6	339	621	83	218
20	531	237	6.6	0.44	3.83	3,103	4,494	5.15	68.5	721	47.4	331	581	81	193

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 2005[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
	Mg/ha	tons/acre		(dS/m)	(%)										
21	618	276	6.9	0.19	3.37	2,447	5,232	6.05	7.70	729	48.8	320	571	77	191
22	455	203	6.9	0.25	3.49	2,758	5,719	4.50	22.4	737	49.6	343	591	78	197
23	473	211	6.8	0.20	3.15	2,658	4,827	4.05	18.3	688	45.6	319	551	74	181
25	869	388	6.6	1.59	4.81	3,409	5,479	3.35	96.7	740	39.0	299	463	75	165
26	1,086	485	6.8	0.79	3.98	3,547	6,304	3.50	107	781	43.3	324	511	84	171
27	847	378	6.9	1.07	4.70	4,161	7,756	6.75	120	911	50.4	393	616	91	214
28	903	403	6.8	0.68	4.58	4,310	7,497	6.90	107	852	51.2	424	642	103	207
30	1,169	522	7.1	0.71	4.46	3,928	6,938	6.45	107	777	41.3	346	509	86	172
31	557	249	6.9	0.19	2.51	2,202	4,495	5.60	16.1	585	37.7	280	463	70	150
32	601	269	6.7	0.74	4.75	4,717	7,203	12.2	94.5	680	33.7	310	423	76	147
33	1,109	495	6.8	0.77	5.45	3,893	8,814	11.3	94.4	870	49.2	434	619	96	198
34	566	253	7.0	0.19	2.73	5,190	4,700	11.3	17.7	545	36.8	268	454	65	148
35	1,048	468	6.6	0.81	4.01	2,218	6,990	13.8	146	801	46.0	362	571	79	184
36	1,083	483	6.9	0.65	3.68	3,683	6,172	15.0	112	724	42.6	328	520	75	167
37	801	358	6.6	0.62	3.16	3,324	5,368	13.5	104	630	36.8	283	455	69	143
39	646	288	7.0	0.46	3.68	4,125	6,073	19.4	26.7	566	26.4	240	331	61	114
40	497	222	6.9	0.17	3.65	3,062	5,730	14.8	7.38	699	46.4	341	569	80	177
41	979	437	6.8	0.85	4.66	4,560	7,482	27.2	75.5	742	38.6	340	472	73	161
42	858	384	7.0	0.35	3.95	3,755	7,110	19.4	21.8	801	49.0	381	594	86	192
43	984	439	6.9	0.91	5.85	6,279	9,483	38.6	131	750	30.8	336	386	66	146
44	806	360	6.8	0.93	4.26	4,196	6,847	40.6	107	691	40.3	333	493	78	158

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 2005[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
	Mg/ha	tons/acre		(dS/m)	(%)										
45	1,659	741	6.8	0.85	4.78	4,680	7,956	15.4	50.2	693	35.1	341	427	67	150
47	1,122	500	6.5	1.37	5.95	6,775	11,563	65.2	199	1,110	56.6	538	694	101	230

[1]Sampling depth 0-15 cm.
[2]Through 2005.
[3]1-M KCl-extractable.

TABLE III-2: 2005 FULTON COUNTY CROP YIELD DATA

Field Number	Soil Type[1]	Cumulative Biosolids Applied[2]		Corn	Soybeans
		------------------Dry Solids------------------		bu/acre	bu/acre
		Mg/ha	tons/acre		
1	MS	1,736	775	12	
2	MS	1,816	811		27
3	MS	1,814	810	11	
4	MS	1,522	679		27
5	MS	1,562	698	35	30
7E	MS	1,494	667	35	
7W	MS	1,494	667	35	
8	MS	1,320	589		
9	MS	1,602	716		30
11	MS	1,485	663		25
12	MS	1,398	624		25
13	MS	1,366	610	17	
14	MS	1,472	657	20	
15	MS	1,483	662	25	
16E	1/4 MS	1,510	674		42
16W	1/4 MS	1,510	674		40
17	MS	1,722	770		30
18	1/2 MS	1	0.46	66	
19	PL	644	287	148	
20	PL	531	237	100	
21	PL	618	276	148	

TABLE III-2 (Continued): 2005 FULTON COUNTY CROP YIELD DATA

Field Number	Soil Type[1]	Cumulative Biosolids Applied[2]		Corn	Soybeans
		--------Dry Solids--------		bu/acre	bu/acre
		Mg/ha	tons/acre		
22	PL	455	203	148	
23	PL	473	211	148	
24	MS	1	0.5		32
25	MS	869	388	0	
26	MS	1,086	485	0	
27	2/3 MS	847	378	0	
28	MS	903	403	3	
29	MS	1	0.5		
30	MS	1,169	522	3	
31	PL	557	249	148	
32	MS	600	268	12	
33	MS	1,109	495	18	
34	PL	566	253	148	
35	PL	1,048	468	93	
36	PL	1,083	483	90	
37	PL	801	358	90	
38A	MS	9	4	37	
38C	MS	9	4		28
39	MS	645	288		36
40	1/2 MS	497	222	75	
41	MS	979	437	15	

TABLE III-2 (Continued): 2005 FULTON COUNTY CROP YIELD DATA

Field Number	Soil Type[1]	Cumulative Biosolids Applied[2]		Corn	Soybeans
		--------Dry Solids--------		bu/acre	bu/acre
		Mg/ha	tons/acre		
42	MS	858	384	50	
43	MS	983	439		18
44	MS	804	359	38	
45	3/4 MS	844	377	45	
47	MS	1,120	500	40	
50	5/6 MS	7	3		31
51	1/4 MS	46	20		28
52	MS	9	4		30
54	MS	14	6		20
55	MS	7	3		30
56	MS	13	6		31
59	PL	2	1		42
60	MS	3	1.5		20
61	MS	2	1		20
63-1-1	MS	22	10		20
63-8-1[3]	MS	22	10	ND	
63-8	MS	22	10		35
64	MS	2	0.7		22
65	MS	0	0.17		18
75	MS	336	150		ND
80	PL	0	0	108	

TABLE III-2 (Continued): 2005 FULTON COUNTY CROP YIELD DATA

Field Number	Soil Type[1]	Cumulative Biosolids Applied[2]		Corn	Soybeans
		--------------------Dry Solids--------------------		bu/acre	bu/acre
		Mg/ha	tons/acre		
82	PL	0	0	108	
83	PL	0	0	32	
84	MS	0	0	42	

[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.
[3]Portion of field used for biosolids P runoff study.
ND = Not determined.

TABLE III-3: MEAN CONCENTRATIONS OF METALS IN CORN GRAIN SAMPLED AT THE FULTON COUNTY RECLAMATION SITE IN 2005

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	mg/kg								
1	41	<0.01	2.1	0.13	1.3	<0.15	3,281	31	1,399
3	46	<0.01	2.4	0.12	1.3	<0.15	3,521	36	1,464
7E	26	<0.01	1.9	<0.10	0.39	<0.15	3,109	33	1,236
7W	34	<0.01	2.1	<0.10	0.92	<0.15	3,286	30	1,278
8	27	<0.01	1.4	<0.10	0.33	<0.15	3,435	31	1,320
13	36	<0.01	1.7	<0.10	1.0	<0.15	3,186	37	1,363
14	32	<0.01	1.6	0.17	0.56	<0.15	3,134	43	1,316
15	37	<0.01	2.3	<0.10	0.36	<0.15	3,493	34	1,413
18	21	<0.01	1.3	0.16	0.50	<0.15	3,451	52	1,252
19	42	0.03	2.3	0.12	1.3	<0.15	3,300	66	1,546
20	28	<0.01	1.9	<0.10	1.1	<0.15	3,191	31	1,161
21	34	<0.01	2.3	0.77	1.2	<0.15	3,028	44	1,380
22	28	<0.01	1.8	<0.10	0.90	<0.15	3,276	32	1,359
23	27	<0.01	1.7	0.13	0.89	<0.15	3,127	27	1,288
25	37	<0.01	1.5	0.12	0.84	<0.15	3,442	19	1,318
26	38	<0.01	1.9	0.12	1.0	<0.15	3,506	26	1,331
27	36	<0.01	2.1	<0.10	0.87	<0.15	3,442	34	1,245
28	38	<0.01	1.9	<0.10	0.66	<0.15	3,493	24	1,404
30	34	<0.01	1.5	<0.10	0.82	<0.15	3,350	38	1,217
31	27	<0.01	1.6	0.14	0.66	<0.15	3,159	37	1,223
32	35	<0.01	1.9	<0.10	0.70	0.2	3,331	40	1,374

TABLE III-3 (Continued): MEAN CONCENTRATIONS OF METALS IN CORN GRAIN SAMPLED AT THE FULTON COUNTY RECLAMATION SITE IN 2005

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	--mg/kg--								
33	34	<0.01	2.2	<0.10	0.65	<0.15	3,256	43	1,336
34	30	<0.01	1.9	1.03	1.30	<0.15	3,578	38	1,450
35	36	<0.01	1.3	0.13	0.84	<0.15	3,465	32	1,290
36	38	<0.01	1.6	0.12	0.88	<0.15	3,688	32	1,382
37	30	<0.01	1.7	0.16	0.74	<0.15	3,520	41	1,269
38A	28	<0.01	2.4	<0.10	0.54	<0.15	3,105	50	1,038
40	39	<0.01	1.9	0.12	0.88	<0.15	3,694	35	1,401
41	35	<0.01	1.9	0.11	0.37	<0.15	3,458	49	1,502
42	32	<0.01	1.9	<0.10	0.57	<0.15	3,377	44	1,307
44	38	<0.01	2.8	0.23	0.53	<0.15	3,505	41	1,352
45	33	<0.01	2.3	<0.10	0.59	<0.15	3,383	46	1,320
47	36	<0.01	2.5	0.11	0.27	<0.15	3,479	40	1,362
63-8-1[1]	ND	ND	ND	ND	ND	ND	ND	ND	ND
80	25	<0.01	1.9	<0.10	0.70	<0.15	3,262	39	1,247
82	24	<0.01	2.3	<0.10	0.42	<0.15	3,221	37	1,127
83	25	<0.01	1.4	0.16	0.83	<0.15	3,879	50	1,200
84	29	<0.01	1.6	0.16	0.43	<0.15	3,856	57	1,421

[1]Proportions of field used for biosolids P runoff study.
ND = Not determined.

TABLE III-4: MEAN CONCENTRATIONS OF METALS IN CORN LEAF SAMPLES COLLECTED AT THE FULTON COUNTY RECLAMATION SITE IN 2005

Field Number[1]	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	mg/kg								
1	117	2.1	10	0.31	0.36	<0.3	21,447	5,150	2,868
3	124	4.4	9	0.32	0.45	<0.3	23,369	4,411	2,348
7E	94	3.1	10	0.33	0.41	<0.3	21,381	5,576	4,183
7W	48	0.73	11	0.30	0.22	<0.3	12,288	7,471	6,414
8	92	3.4	12	0.33	0.35	<0.3	19,378	5,846	4,576
13	134	3.4	13	0.33	0.53	<0.3	15,882	6,838	5,305
14	112	2.3	12	0.31	0.35	<0.3	13,098	6,711	6,331
15	122	3.9	12	0.35	0.29	<0.3	15,313	6,847	5,524
18	32	<0.02	9	0.31	0.35	<0.3	11,087	9,142	8,693
19-1	77	6.3	10	0.54	0.74	<0.3	22,216	7,312	2,902
19-2	54	5.4	11	0.57	0.44	<0.3	16,549	8,015	5,490
20-1	59	1.3	9	0.34	0.31	<0.3	14,030	7,126	6,427
20-2	62	1.5	10	0.61	0.26	<0.3	11,760	8,445	7,098
21-1	59	6.3	10	0.91	0.46	<0.3	22,555	6,957	3,159
21-2	49	4.7	11	0.99	0.29	<0.3	11,619	7,805	7,027
22-1	42	0.85	11	0.97	0.21	<0.3	10,197	8,517	8,215
22-2	63	1.4	10	0.82	0.25	<0.3	16,171	6,512	4,735
23-1	36	0.98	8	0.84	<0.20	<0.3	6,641	6,700	8,160
23-2	49	1.4	9	0.80	0.24	<0.3	14,964	5,718	4,686
25	73	2.8	8	0.76	<0.20	<0.3	19,612	5,235	4,198
26	103	2.4	11	0.32	0.27	<0.3	16,278	6,623	7,073
27	85	2.9	11	0.26	0.39	<0.3	20,482	5,283	3,603
28	79	0.87	10	<0.20	0.28	<0.3	21,914	5,109	4,217
30	86	1.4	12	0.21	0.26	<0.3	22,134	5,629	4,477
31-1	33	1.1	12	0.28	0.24	<0.3	5,491	6,855	10,078
31-2	90	4.9	13	0.25	0.41	<0.3	11,157	6,238	5,808

TABLE III-4 (Continued): MEAN CONCENTRATIONS OF METALS IN CORN LEAF SAMPLES COLLECTED AT THE FULTON COUNTY RECLAMATION SITE IN 2005

Field Number[1]	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	mg/kg								
32	67	0.61	11	0.32	0.53	<0.3	16,297	4,489	4,049
33	130	3.1	13	0.33	0.38	<0.3	21,861	5,816	3,419
34-1	65	4.5	14	0.36	0.40	<0.3	7,683	8,224	7,893
34-2	54	2.4	11	0.23	0.22	<0.3	12,766	4,857	6,601
35	118	1.0	11	0.27	0.35	<0.3	20,140	6,713	4,647
36	131	1.5	12	0.23	0.43	<0.3	23,357	5,559	3,845
37	56	2.0	11	0.75	0.38	<0.3	11,742	7,450	7,059
38A	42	0.08	9	0.23	0.22	<0.3	10,133	6,107	6,013
40-1	63	0.43	10	0.33	0.23	<0.3	8,798	7,378	10,325
40-2	141	1.2	8	0.24	0.52	<0.3	14,721	8,278	6,020
41	66	1.9	8	0.63	0.71	<0.3	20,269	3,670	2,568
42	83	2.6	8	0.24	0.21	<0.3	20,510	5,776	4,123
44	110	3.2	9	0.24	0.24	<0.3	20,393	5,294	3,289
45	66	1.1	7	0.31	<0.20	<0.3	17,266	5,863	5,082
47	105	2.8	10	0.39	0.33	<0.3	22,015	5,194	2,545
63-8-1	49	<0.02	14	0.71	0.61	<0.3	9,530	6,433	6,138
80	23	<0.02	7	<0.20	0.35	<0.3	17,650	3,697	2,578
82	22	<0.02	9	0.26	0.33	<0.3	17,336	5,874	3,528
83	31	<0.02	8	0.25	0.32	<0.3	17,529	4,509	3,286
84	17	<0.02	5	<0.20	<0.20	<0.3	14,728	4,807	3,586

[1]Field numbers with designations '-1' and '-2' were sampled as two sections.

TABLE III-5: MEAN CONCENTRATIONS OF METALS IN HAY SAMPLES COLLECTED AT THE FULTON COUNTY RECLAMATION SITE IN 2005

Field Number[1]	Cutting	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	---------- mg/kg ----------									
10-1	1	75	2.9	8.6	1.6	7.2	<0.15	15,410	10,804	2,460
10-2	1	74	1.6	6.6	0.93	1.9	<0.15	17,459	3,792	1,437
29-1	1	20	0.03	6.9	0.73	0.94	<0.15	11,210	7,836	3,161
29-2	1	13	<0.01	6.4	0.24	0.54	<0.15	16,818	6,937	2,915
62-1	1	15	<0.01	7.7	0.23	1.0	<0.15	16,137	13,792	2,811
62-2	1	10	<0.01	7.8	0.24	0.51	<0.15	11,314	11,537	3,356
63-1-2	1	12	<0.01	5.4	0.23	0.58	<0.15	16,274	6,110	2,054
63-2-1	1	15	<0.01	5.2	0.19	0.72	<0.15	21,701	4,312	2,169
63-2-2	1	15	<0.01	6.0	0.13	0.72	<0.15	23,099	4,491	2,121
63-3-1	1	11	<0.01	3.3	0.22	0.14	<0.15	15,634	2,809	1,165
63-3-2	1	13	<0.01	6.7	0.20	0.95	<0.15	16,166	9,706	2,388
63-4-1	1	11	<0.01	5.2	0.18	0.46	<0.15	13,945	9,146	2,138
63-4-2	1	15	0.05	5.9	0.32	0.97	<0.15	13,749	8,854	2,578
63-5-1	1	14	<0.01	3.6	0.23	0.23	<0.15	17,060	3,387	1,432
63-5-2	1	16	<0.01	5.1	0.19	0.31	<0.15	16,606	6,026	2,001
63-6-1	1	13	<0.01	6.3	0.22	0.56	<0.15	15,004	9,145	2,578
63-6-2	1	15	<0.01	5.2	0.29	0.59	<0.15	16,122	6,700	2,363
63-7-1	1	12	<0.01	5.5	0.15	0.40	<0.15	12,395	6,825	2,234
63-7-2	1	14	<0.01	6.3	0.14	0.88	<0.15	13,806	11,577	2,573
73-1	1	15	<0.01	3.6	0.20	0.61	<0.15	17,956	3,333	1,674

TABLE III-5 (Continued): MEAN CONCENTRATIONS OF METALS IN HAY SAMPLES COLLECTED AT THE FULTON COUNTY RECLAMATION SITE IN 2005

Field Number[1]	Cutting	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	----------	----------	----------	----------	mg/kg	----------	----------	----------	----------	----------
73-2	1	15	<0.01	2.7	0.19	0.18	<0.15	16,057	3,272	1,115
76-1	1	17	0.02	5.8	0.34	0.62	<0.15	13,532	9,602	2,285
76-2	1	15	<0.01	6.6	0.36	1.3	<0.15	11,850	11,729	2,862
10-1	2	61	2.8	6.1	0.94	8.5	<0.15	11,307	7,405	2,424
62-1	2	21	<0.01	8.4	0.18	0.63	<0.15	15,601	7,953	2,626
62-2	2	20	<0.01	6.4	0.18	0.57	<0.15	15,744	8,451	2,702
63-2-1	2	17	<0.01	7	0.22	0.85	<0.15	15,252	10,982	3,108
63-2-2	2	16	<0.01	8	0.24	0.67	<0.15	14,443	10,321	3,190
63-4-1	2	18	<0.01	7	0.13	0.71	<0.15	17,756	10,350	2,392
63-4-2	2	17	<0.01	7	0.14	0.88	<0.15	17,920	9,497	2,366
63-5-2	2	16	0.0	5	0.13	0.65	<0.15	21,565	8,332	1,963
63-6-1	2	14	<0.01	6	0.17	0.72	<0.15	14,823	10,872	3,118
63-6-2	2	15	<0.01	6	0.14	0.69	<0.15	14,948	9,834	3,061
63-7-1	2	18	<0.01	3	0.18	1.09	<0.15	14,672	9,703	3,104
63-7-2	2	15	<0.01	2	0.13	0.60	<0.15	14,102	9,175	2,159
76-1	2	22	<0.01	3.8	0.20	0.87	<0.15	16,631	9,445	3,130
76-2	2	19	<0.01	8.9	0.18	0.89	<0.15	12,152	10,036	3,593
63-2-1	3	26	<0.01	11	0.16	0.84	<0.15	20,770	10,694	2,869
63-2-2	3	25	<0.01	10	0.17	0.96	<0.15	23,809	9,568	3,024

TABLE III-6: MEAN CONCENTRATIONS OF METALS IN SOYBEAN GRAIN SAMPLES COLLECTED AT THE FULTON COUNTY RECLAMATION SITE IN 2005

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	---	---	---	---	mg/kg	---	---	---	---
2	69	0.40	15	0.67	8.6	<0.15	21,520	2,771	2,599
4	63	0.30	15	0.72	9.2	<0.15	20,387	2,869	2,579
5	67	0.91	15	0.60	7.9	<0.15	19,504	3,555	2,950
9	71	0.42	16	1.11	10.2	<0.15	20,792	3,294	2,973
11	65	0.87	15	0.60	7.9	<0.15	19,742	3,474	2,923
12	67	0.92	15	0.58	8.2	<0.15	19,515	3,480	2,914
16E	65	0.67	14	0.53	8.5	<0.15	18,265	3,582	2,992
16W	65	0.65	15	0.54	8.6	<0.15	18,735	3,514	3,001
17	76	0.46	17	1.24	10.6	<0.15	20,776	3,359	2,974
24	52	0.19	15	0.53	2.7	<0.15	19,481	3,274	2,761
38C	48	<0.01	15	0.30	7.1	<0.15	19,030	3,317	2,827
39	66	0.41	13	0.33	5.4	<0.15	21,177	2,917	2,810
43	66	0.43	13	0.37	5.5	<0.15	20,926	2,819	2,774
50	44	<0.01	16	0.36	2.6	<0.15	19,789	3,264	2,518
51	46	<0.01	13	0.28	9.7	<0.15	18,669	3,522	2,696
52	44	<0.01	14	0.23	3.3	<0.15	19,418	3,108	2,529
54	53	<0.01	15	0.22	2.8	<0.15	19,064	3,058	2,275
55	51	<0.01	16	0.34	3.9	<0.15	20,444	3,252	2,520
56	47	<0.01	13	0.19	2.5	<0.15	18,584	3,154	2,279
59	42	<0.01	14	0.45	5.0	<0.15	17,590	3,217	3,093
60	46	<0.01	17	0.25	2.4	<0.15	18,167	4,116	3,077
61	49	<0.01	18	0.55	2.1	<0.15	19,900	4,647	3,607

TABLE III-6 (Continued): MEAN CONCENTRATIONS OF METALS IN SOYBEAN GRAIN SAMPLES COLLECTED AT THE FULTON COUNTY RECLAMATION SITE IN 2005

Field Number	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	----------------	----------------	----------------	----------------	-----mg/kg-----	----------------	----------------	----------------	----------------
63-1-1	50	<0.01	18	0.27	2.6	<0.15	19,997	4,474	3,173
63-8-2	52	<0.01	20	0.20	2.6	<0.15	19,836	3,686	2,773
64	56	<0.01	17	0.20	3.2	<0.15	21,153	3,542	2,514
65	54	<0.01	17	0.29	5.6	<0.15	22,145	3,654	2,565
75	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND = Not determined.

TABLE III-7: AMENDMENTS USED IN RECLAMATION OF COAL REFUSE AT ST. DAVID, ILLINOIS

Plot Number	Treatment Composition[1]					
	Biosolids		Lime		Clay	
	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.

TABLE III-8: YEARLY MEAN CONCENTRATIONS OF CHEMICAL PARAMETERS IN WATER FROM LYSIMETERS AT THE ST. DAVID, ILLINOIS, COAL REFUSE PILE RECLAMATION SITE 2001 - 2005

Chemical Parameters	Year	Plot Number 1	2	3	4	5	6	7	8	9	10
pH	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[1]	7.6	7.6	NA
	2004	7.5	7.8	7.0	7.7	7.2	8.0	NA	NA	8.0	NA
	2005	NA	7.6	6.9	7.0	7.6	NA	7.6	NA	NA	NA
		mg/L									
$SO_4^{=}$	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
	2005	NA	2,046	965	1,632	1,499	NA	1,178	NA	NA	NA
NH_4-N	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
	2005	NA	0.08	0.11	0.09	0.04	NA	0.02	NA	NA	NA
NO_2+NO_3-N	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
	2005	NA	1.51	0.23	2.19	4.57	NA	6.72	NA	NA	NA

[1]NA = No samples available, due to insufficient precipitation.
[2]From 2003 onward, lysimeters were sampled quarterly, rather than monthly.

TABLE III-9: YEARLY MEAN CONCENTRATIONS OF CHEMICAL PARAMETERS IN WATER FROM LYSIMETERS AT THE MORGAN MINE COAL REFUSE RECLAMATION SITE 2001 - 2005

Chemical Parameters	Year	Lysimeter Number 1	2	3
pH	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
	2005	7.0	7.1	NA[2]
		--------------------------------mg/L--------------------------------		
$SO_4^{=}$	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
	2005	1,361	1,842	NA
NH_4-N	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
	2005	0.32	1.98	NA
NO_2+NO_3-N	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
	2005	6.32	12.63	NA

[1]From 2003 onward, lysimeters were sampled quarterly, rather than monthly.
[2]NA = No samples available, due to low precipitation.

TABLE III-10: YEARLY MEAN CONCENTRATIONS OF CHEMICAL PARAMETERS IN WATER FROM LYSIMETERS AT THE UNITED ELECTRIC COAL REFUSE PILE RECLAMATION SITE 2001 - 2005

Chemical Parameters	Year	Lysimeter Number 1	2	3	4	5	6	7	8	9	10
pH	2001	NA[1]	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
	2005	NA	NA	NA	NA	NA	NA	NA	NA	7.3	NA
						-mg/L-					
$SO_4^=$	2001	NA	987	1,684	2,189	2,077	1,677	1,606	3,424	2,873	NA
	2002	NA	978	1,675	2,323	2,057	1,541	1,929	4,076	3,140	NA
	2003	NA	1,439	1,751	2,089	2,063	1,415	1,736	3,772	2,722	NA
	2004	NA	1,446	1,428	2,244	1,918	NA	1,698	3,780	2,585	NA
	2005	NA	NA	NA	NA	NA	NA	NA	NA	3,322	NA
NH_4-N	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
	2005	NA	NA	NA	NA	NA	NA	7.6	NA	0.36	NA
NO_2+NO_3-N	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
	2005	NA	NA	NA	NA	NA	NA	7.6	NA	0.73	NA

[1]NA = No samples available, due to low precipitation.

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

TABLE III-11: FULTON COUNTY RESEARCH AND DEVELOPMENT LABORATORY
2005 UICF BIOSOLIDS APPLICATION RATES

Treatment[1]	Biosolids Application Rate (Dry Weight Basis)			
	Annual		Cumulative	
	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	1,044	466
Max	67.2	30.0	2,085	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-12. 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 2002 - 2005

					0.1N HCl Extracted						Concentrated HNO_3 Extracted							
Plot[2]	Year	pH	EC	Organic Carbon	Zn	Cd	Cu	Cr	Ni	Pb	Zn	Cd	Cu	Cr	Ni	Pb	TKN	Tot-P
			dS/m	%	mg/kg													
Check	2002	7.2	0.43	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	0.50	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	0.68	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
	2005	7.4	0.36	1.51	200	13.6	79.1	22.4	11.3	28.1	254	12.1	123	174	44.4	54.7	1,728	2,828
1/4	2002	7.6	0.21	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	0.19	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	0.23	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
	2005	7.4	0.40	2.39	366	25.1	143	41.7	18.6	46.5	435	24.1	212	306	58.5	96.1	2,465	4,536
1/2	2002	7.4	0.20	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	0.30	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	0.33	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
	2005	7.1	0.59	2.64	446	28.5	163	44.1	21.7	37.3	486	27.1	248	344	62.9	110	2,945	6,169
Max	2002	7.1	0.28	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	0.31	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	0.49	3.73	613	38.1	240	68.7	31.9	56.6	622	34.0	314	430	73.1	133	3,046	5,847
	2005	7.2	0.53	3.48	562	35.9	206	58.8	27.6	49.2	629	35.5	320	446	72.8	140	3,531	7,362

[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-13. MEAN CONCENTRATIONS OF TKN, PHOSPHORUS, AND METALS IN 33P69 HYBRID CORN GRAIN COLLECTED FROM THE CORN FERTILITY EXPERIMENTAL PLOTS AT THE FULTON COUNTY RECLAMATION SITE IN 2005

Analyte[2]	Treatment[1]			
	Control	1/4-Max	1/2-Max	Max
	mg/kg			
TKN	16,460	15,591	19,328	22,050
P	2,690	2,732	2,426	3,179
Zn	30.4	37.8	34.3	34.1
Cd	<0.010	<0.010	<0.010	0.020
Cu	0.85	1.31	0.97	1.25
Cr	0.415	0.413	1.02	0.509
Ni	0.72	0.96	1.12	0.93
Pb	0.20	<0.15	0.18	0.28
K	3,739	4,023	3,722	3,650
Ca	49.3	52.4	49.8	50.5
Mg	1,447	1,662	1,553	1,572

[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.

TABLE III-14: AVERAGE CORN GRAIN AND CORN STOVER YIELDS FOR HYBRID 33P69 GROWN AT THE CORN FERTILITY EXPERIMENTAL PLOTS FROM 2003 - 2005

		Treatment[1]											
		Control			1/4-Max			1/2-Max			Max		
Harvested Tissue	Unit	2003	2004	2005[2]	2003	2004	2005	2003	2004	2005	2003	2004	2005
Grain	bu/acre	22	38	6.8	21	61	9.4	40	72	6.4	51	83	6.8
	Mg/ha	1.4	2.4	0.43	1.3	3.8	0.59	2.5	4.5	0.40	3.2	5.2	0.43
Stover	tons/acre	1.2	1.7	1.1	0.9	1.7	0.81	1.5	0.8	0.92	1.6	0.9	1.1
	Mg/ha	2.7	3.9	2.4	2.0	3.9	1.8	3.4	1.7	2.1	3.6	2.0	2.6

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

TABLE III-15: SAMPLING SCHEDULE AND ANALYSES OF SOIL, PLANT TISSUES, AND SUBSURFACE WATER SAMPLES FOR THE FARMLAND APPLICATION OF CLASS B 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, and OC
2	Shallow soil cores	KCl-ext. (NO_3-N, NH_3-N) and 2:1 H_2O-ext. (NH_3-N, NO_3-N)
3	Leaf tissues	TKN
4	Stover, stalk, and grain tissues	TKN, P, S, and HNO_3 acid-metals
5	Subsurface water	pH, P, 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, and Co

*Sampling Event 1 first occurred before biosolids application and then repeats every year after crop harvesting; Sampling Event 2 occurs approximately two weeks after planting the corn and repeats every month until the silking stage; Sampling Event 3 occurs approximately one month after planting and repeats every month until the silking stage; Sampling Event 4 occurs at the time of harvesting; Sampling Event 5 occurs every month or after a 1 to 2-inch rainfall event.

TABLE III-16: MEAN LEVELS OF SOIL FERTILITY PARAMETERS IN SURFACE (0- TO 6-INCH) SOIL LAYER OF THE WILL AND KANKAKEE COUNTY RESEARCH AND DEMONSTRATION FIELDS BEFORE APPLICATION OF BIOSOLIDS AND INORGANIC FERTILIZERS, AND IN THE INDIVIDUAL PLOTS IN 2005 AFTER HARVESTING CORN

Treatment[1]	Will County Plots				Kankakee County Plots			
	pH[2]	EC[2]	Avail. P[3]	Inorg. N[4]	pH[2]	EC[2]	Avail. P[3]	Inorg. N[4]
		dS/m	mg/kg	mg/kg		dS/m	mg/kg	mg/kg
Before[5]	7.1	0.10	14	9.1	6.6	0.04	70	3.4
Control	7.1	0.13	125	7.4	6.7	0.04	91	2.2
BS-1	6.7	0.12	227	10.1	6.9	0.05	51	2.4
BS-2	6.5	0.21	307	21.3	6.8	0.14	50	2.4
BS-3	6.7	0.20	286	17.3	6.7	0.04	56	3.5
BS-4	6.6	0.21	470	16.6	6.5	0.04	78	5.1
BS-5	6.7	0.27	361	20.1	6.2	0.09	109	10.5
F-1	7.0	0.11	156	8.2	6.7	0.05	91	2.0
F-2	6.7	0.12	222	8.5	6.4	0.06	93	3.8
F-3	6.5	0.13	161	11.3	6.1	0.04	93	2.4
F-4	7.0	0.23	108	10.5	6.0	0.10	94	1.6
F-5	7.2	0.13	116	9.0	6.3	0.05	75	1.6
F-6	7.2	0.20	199	21.2	6.5	0.04	62	1.1

[1]Control = no N and recommended rate of P. For Will County plots, BS-1 to BS-5 = 20, 30, 40, 50, and 80 wet tons biosolids per acre; and F-1 to F-6 = 72, 118, 210, 260, 300, and 370 lbs N per acre. For Kankakee County plots, BS-1 to BS-5 = 10, 20, 30, 40 and 60 wet tons biosolids per acre; and F-1 to F-6 = 54, 77, 128, 160, 192, and 238 lbs N per acre. Nitrogen was applied as polymer-coated urea in Will County and as urea in Kankakee County. All plots received K at the recommended agronomic rate.

[2]1:2 (soil:water) ratio.

[3]Bray P1 method.

[4]Sum of KCl-extractable NH_4-N, NO_2-N, and NO_3-N.

[5]Soil samples were collected prior to application of biosolids and fertilizers in November 2004 in Will County and March 2005 in Kankakee County.

TABLE III-17: MEAN CONCENTRATIONS OF NUTRIENTS AND TRACE METALS[1] IN WATER SAMPLES TAKEN FROM THE LYSIMETERS[2] IN WILL COUNTY RESEARCH AND DEMONSTRATION PLOTS DURING 2004 THROUGH 2005

		Treatment			
Parameter	Unit	Control[3]	40 wet tons biosolids/ac[4]	260 lbs N/ac[5]	80 wet tons biosolids/ac[4]
TKN	mg/L	0.47	0.43	0.41	0.54
NH_3-N	”	0.07	0.05	0.03	0.07
NO_3-N[6]	”	0.3	5.8	12.3	1.4
Total P	”	0.06	0.06	0.05	0.06
Hg	µg/L	0.07	0.06	0.07	0.08
As	mg/L	0.004	0.003	0.003	0.002
Ba	”	0.142	0.186	0.129	0.140
Cd	”	0.0005	0.0005	0.0005	0.0005
Cr	”	0.001	0.001	0.001	0.001
Cu	”	0.004	0.004	0.003	0.003
Mn	”	0.051	0.051	0.008	0.119
Mo	”	0.014	0.015	0.022	0.014
Ni	”	0.003	0.010	0.003	0.006
Pb	”	0.003	0.004	0.003	0.004
Sb	”	0.022	0.027	0.024	0.031
Se	”	0.008	0.006	0.007	0.006
Tl	”	0.005	0.006	0.006	0.007
V	”	0.047	0.042	0.039	0.026
Zn	”	0.020	0.012	0.007	0.016

[1]In calculating mean concentrations of trace metals, method detection limits were used in placed of non-detectable levels.
[2]Lysimeters were installed at 3.5-ft depth.
[3]Received no N and recommended agronomic rate of P and K.
[4]Received recommended agronomic rate of K.
[5]Received recommended agronomic rate of P and K. Nitrogen was applied as polymer-coated urea.
[6]Sum of NO_2-N and NO_3-N.

TABLE III-18: MEAN CONCENTRATIONS OF NUTRIENTS AND TRACE METALS[1]
IN WATER SAMPLES TAKEN FROM THE LYSIMETERS IN THE KANKAKEE COUNTY RESEARCH AND DEMONSTRATION PLOTS DURING 2004 - 2005

		Treatment/Sampling Depth					
		Control[2]		160 lbs N/ac[3]		30 wet tons biosolids/ac[4]	
Parameter	Unit	5 ft	10 ft	5 ft	10 ft	5 ft	10 ft
TKN	mg/L	0.80	0.28	0.38	0.32	1.59	0.43
NH_3-N	”	0.04	0.04	0.03	0.04	1.05	0.12
NO_3-N+NO_2-N	”	5.3	7.3	12.1	7.9	12.9	8.2
Total P	”	0.10	0.05	0.07	0.06	0.22	0.14
Hg	µg/L	0.09	0.06	0.06	0.06	0.09	0.06
As	mg/L	0.004	0.002	0.003	0.003	0.003	0.003
Ba	”	0.085	0.067	0.102	0.061	0.121	0.042
Cd	”	0.0006	0.0004	0.0004	0.0004	0.0004	0.0004
Cr	”	0.011	0.001	0.001	0.001	0.007	0.003
Cu	”	0.009	0.002	0.003	0.002	0.004	0.002
Mn	”	0.001	0.002	0.012	0.009	0.005	0.001
Mo	”	0.011	0.004	0.006	0.004	0.003	0.008
Ni	”	0.004	0.002	0.004	0.002	0.004	0.002
Pb	”	0.005	0.002	0.003	0.003	0.003	0.004
Sb	”	0.019	0.012	0.015	0.013	0.010	0.016
Se	”	0.008	0.004	0.005	0.004	0.004	0.005
Tl	”	0.006	0.004	0.005	0.004	0.005	0.005
V	”	0.041	0.027	0.025	0.029	0.028	0.025
Zn	”	0.053	0.026	0.007	0.006	0.019	0.006

[1]In calculating mean concentrations of trace metals, method detection limits were used in place of non-detectable levels.
[2]Received no N and recommended agronomic rate of P and K.
[3]Received recommended agronomic rate of P and K. Nitrogen was applied as urea.
[4]Received recommended agronomic rate of K.

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

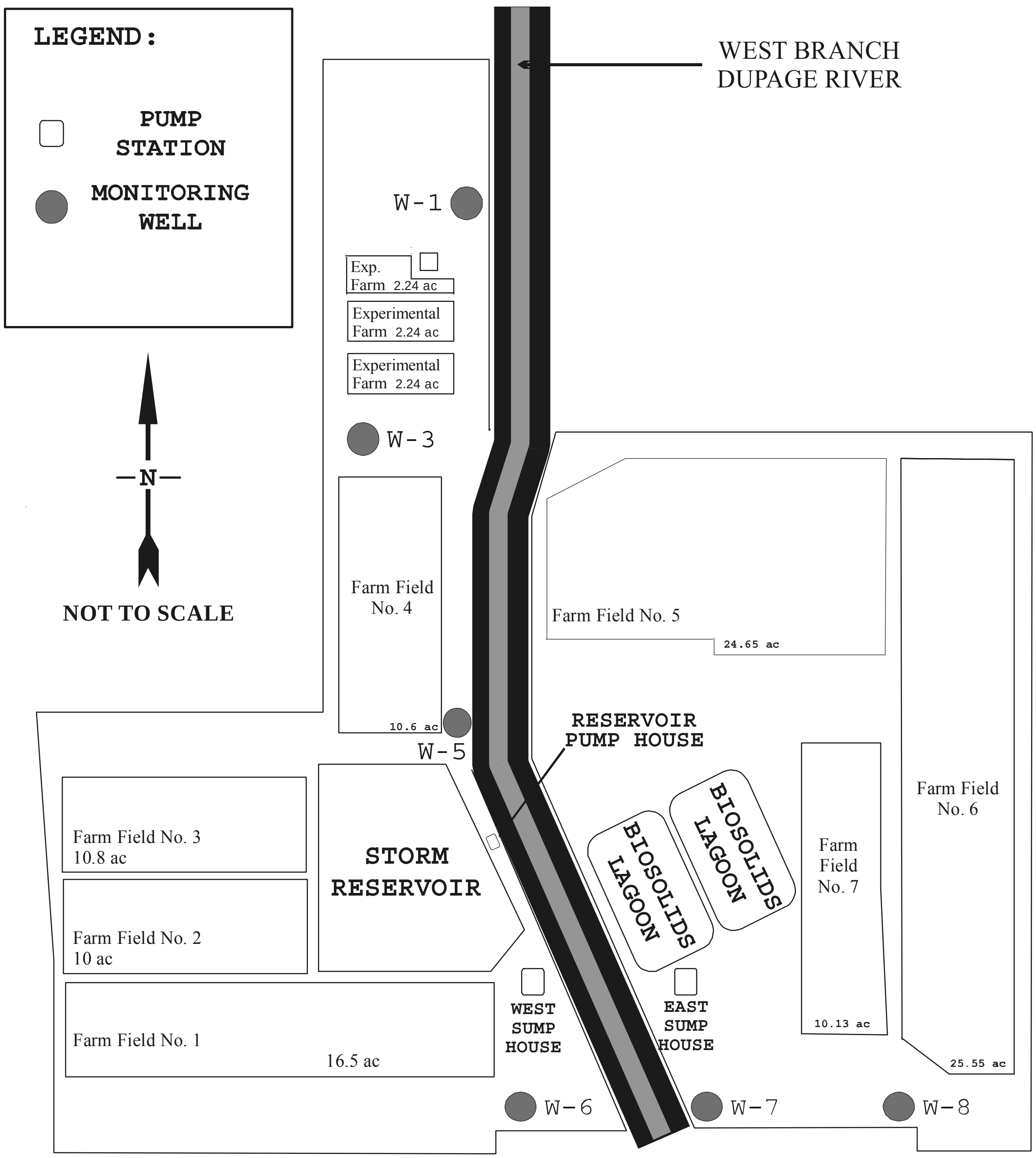


FIGURE III-2. LOCATION OF THE LYSIMETERS AT THE CALUMET EAST SOLIDS MANAGEMENT AREA

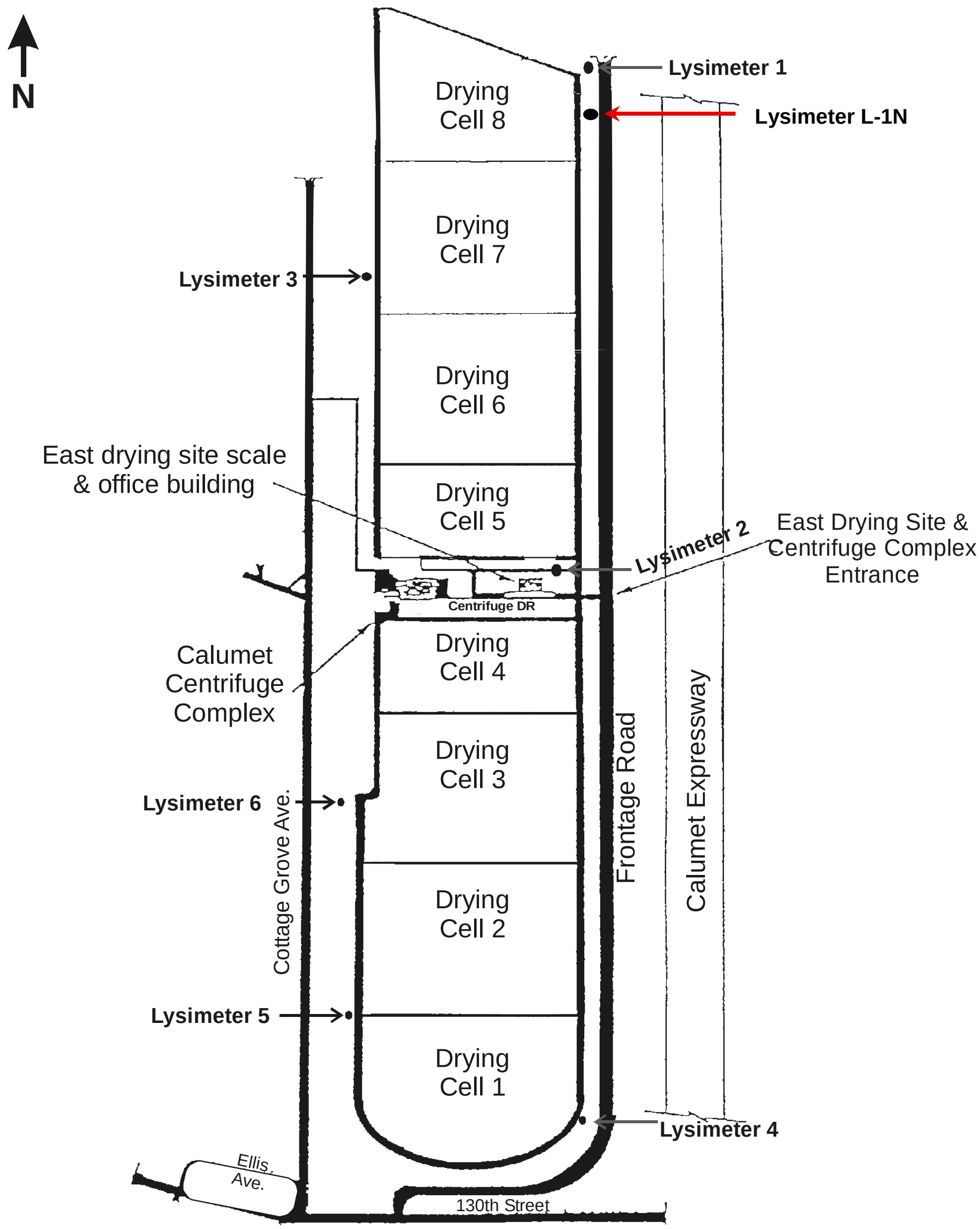


FIGURE III-3. LOCATION OF THE LYSIMETERS AT THE CALUMET WEST SOLIDS MANAGEMENT AREA

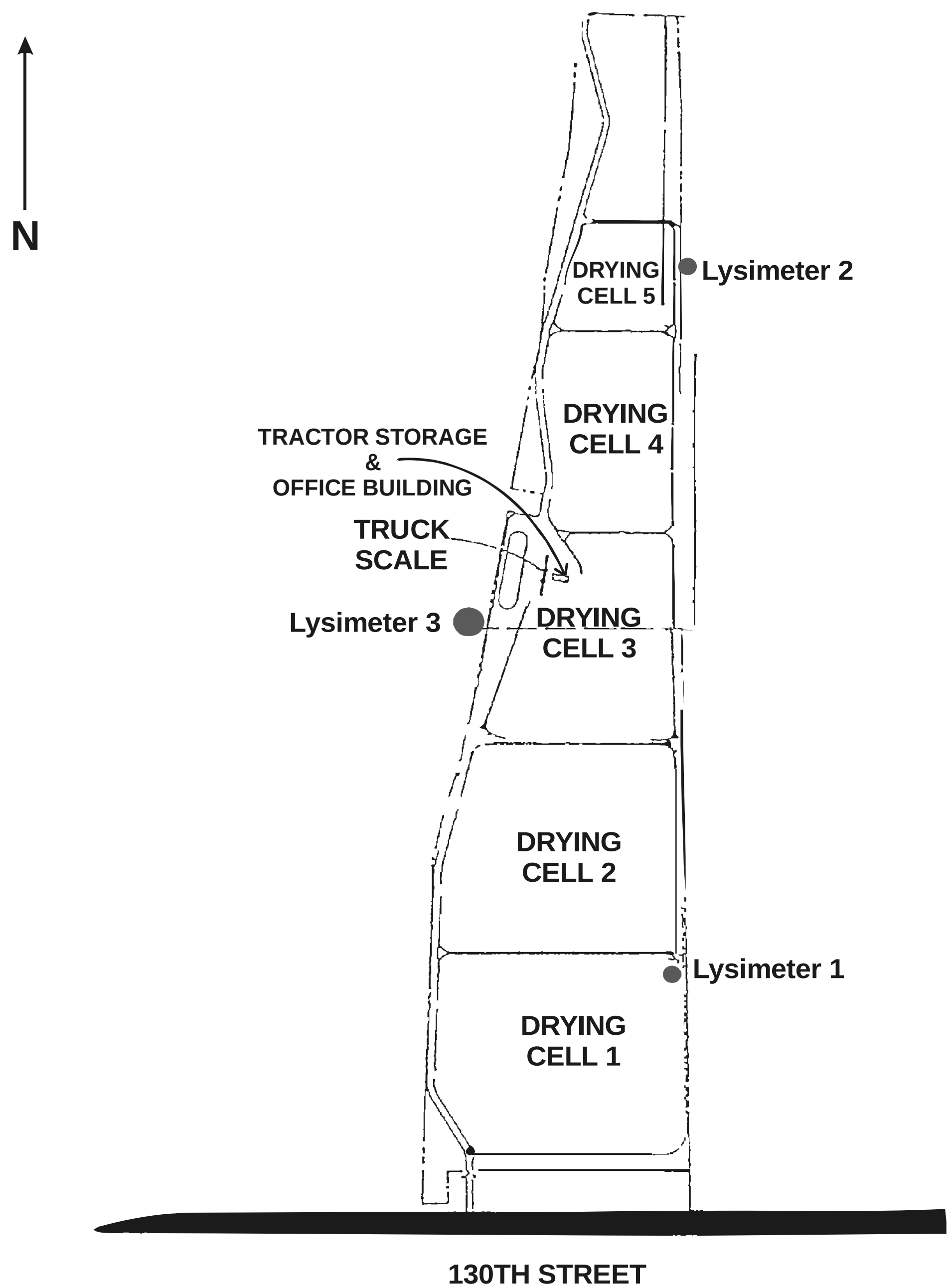


FIGURE III-4. LOCATION OF THE MONITORING WELLS AND LYSIMETERS AT LASMA

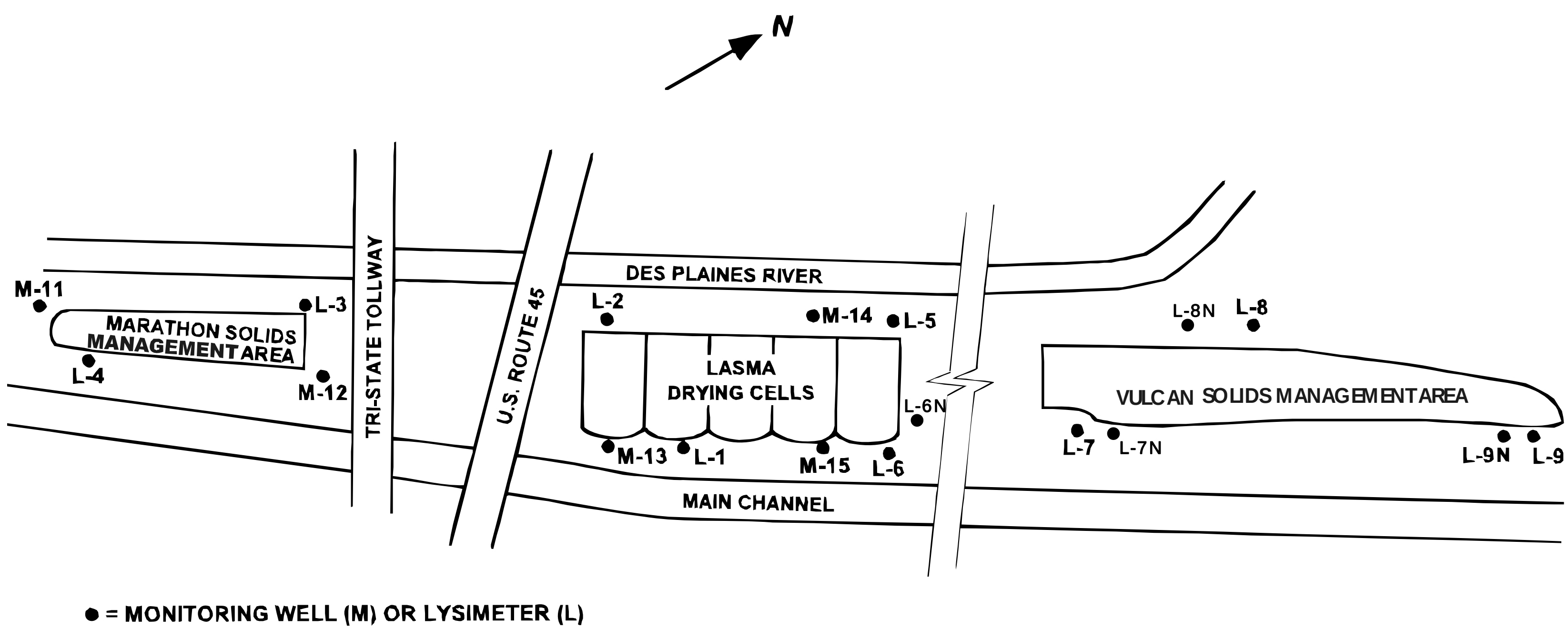


FIGURE III-5. LOCATION OF THE LYSIMETERS AT RASMA

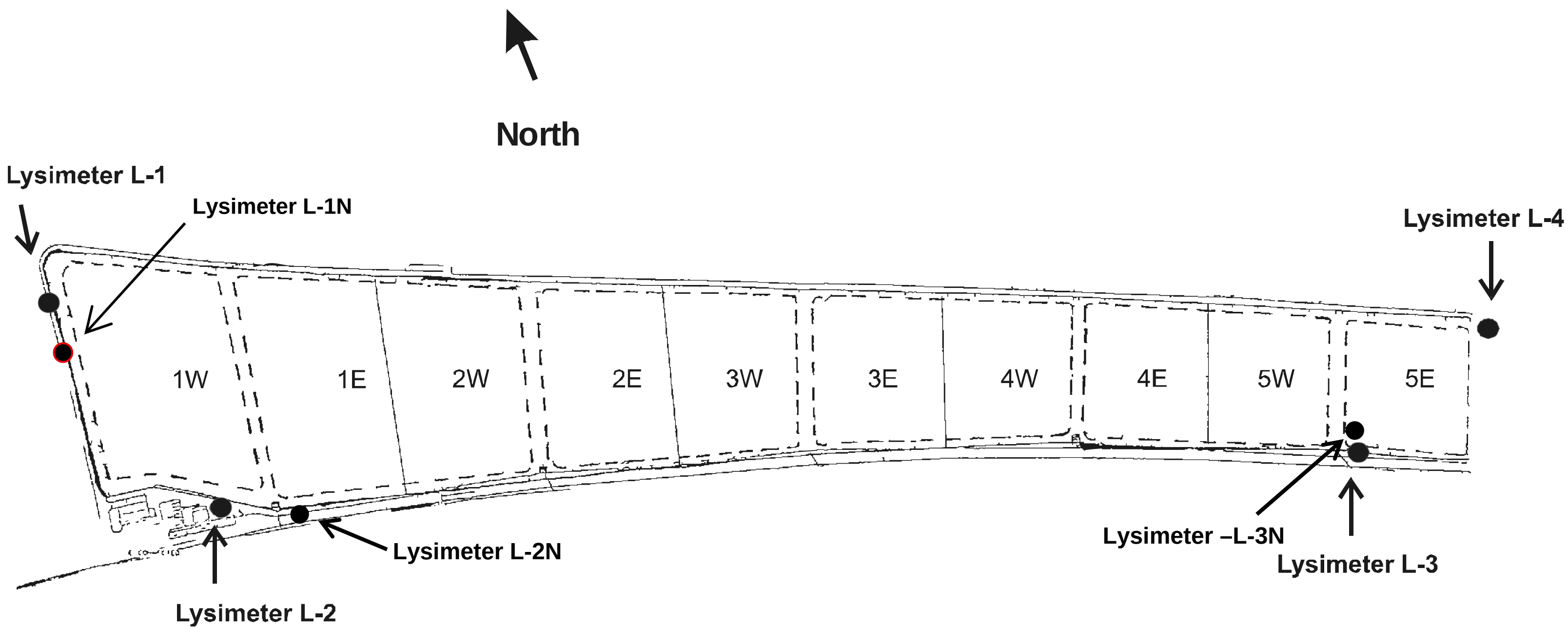


FIGURE III-6. LOCATION OF THE LYSIMETERS AT HASMA

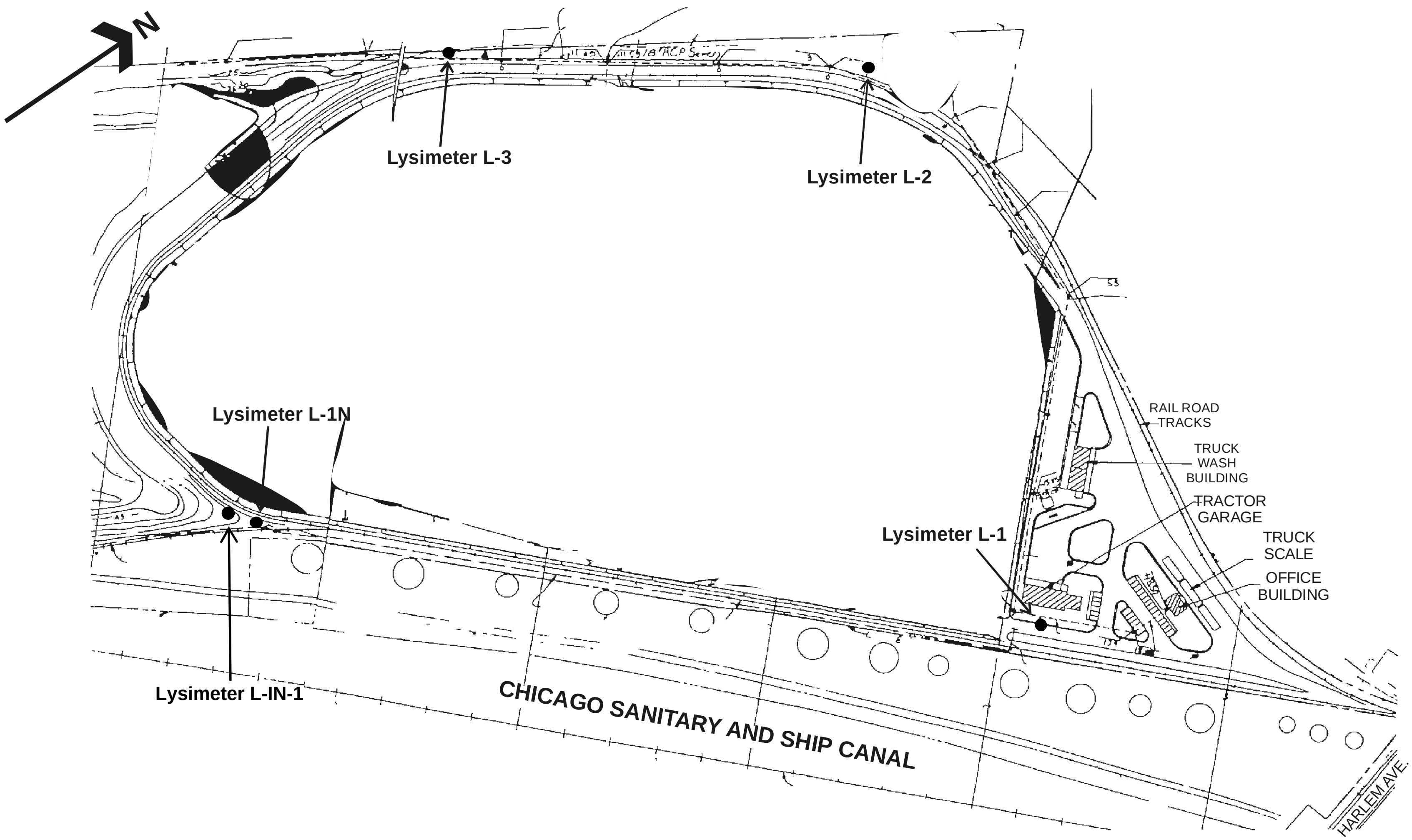


FIGURE III-7. LOCATION OF THE LYSIMETERS AT THE STONY ISLAND AVENUE SOLIDS MANAGEMENT AREA

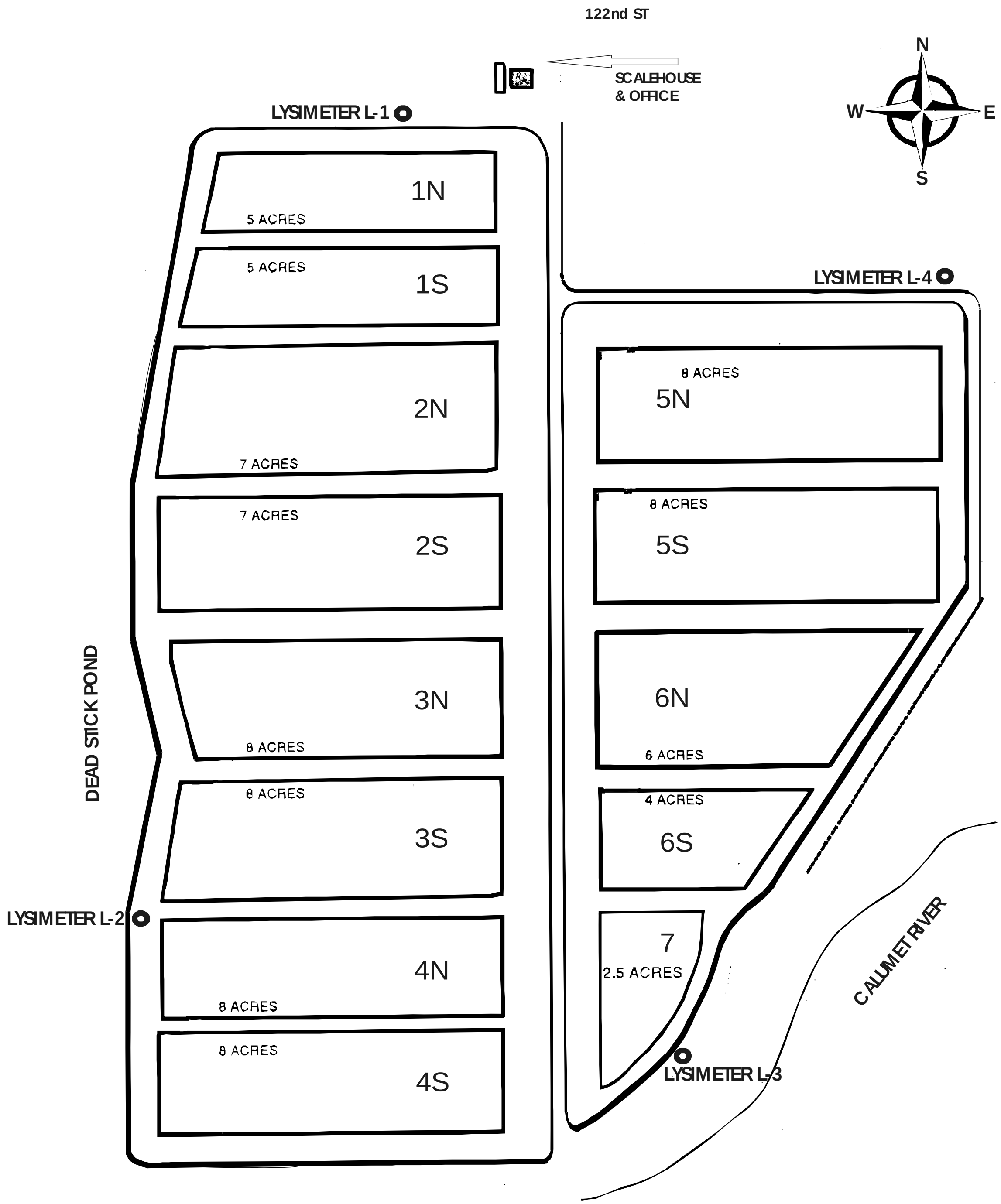
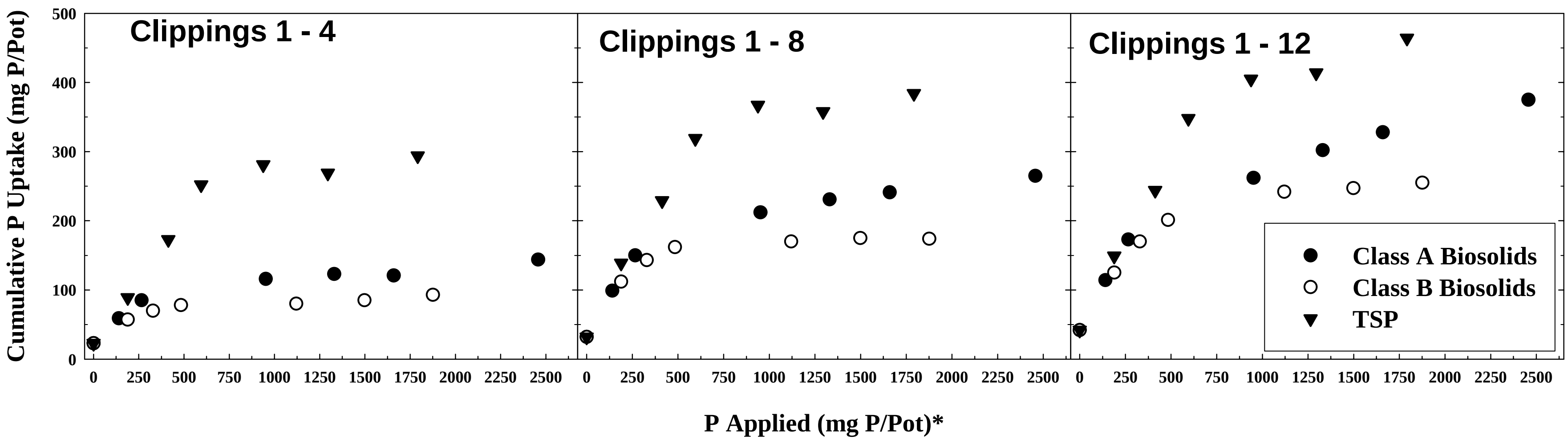


FIGURE III-8. CUMULATIVE P UPTAKE IN TWELVE CONSECUTIVE FOLIAGE CLIPPINGS GROWN AS FOUR ALTERNATING SERIES OF WHEAT (CLIPPINGS 1-4, AND 9-12) AND PERENNIAL RYEGRASS (CLIPPING 5-8) CROPS IN THE GREENHOUSE IN SOIL AMENDED WITH SIX TOTAL P RATES APPLIED THROUGH CLASS A AND CLASS B BIOSOLIDS AND TRIPLE SUPERPHOSPHATE (TSP)



*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 P SATURATION INDEX (PSI) IN 44 SOIL SAMPLES (A) AND DISSOLVED RUNOFF P (SIMULATED RAINFALL) AND PSI IN 11 SOIL SAMPLES (B) FROM THE FULTON COUNTY SITE AMENDED WITH VARIOUS RATES OF BIOSOLIDS

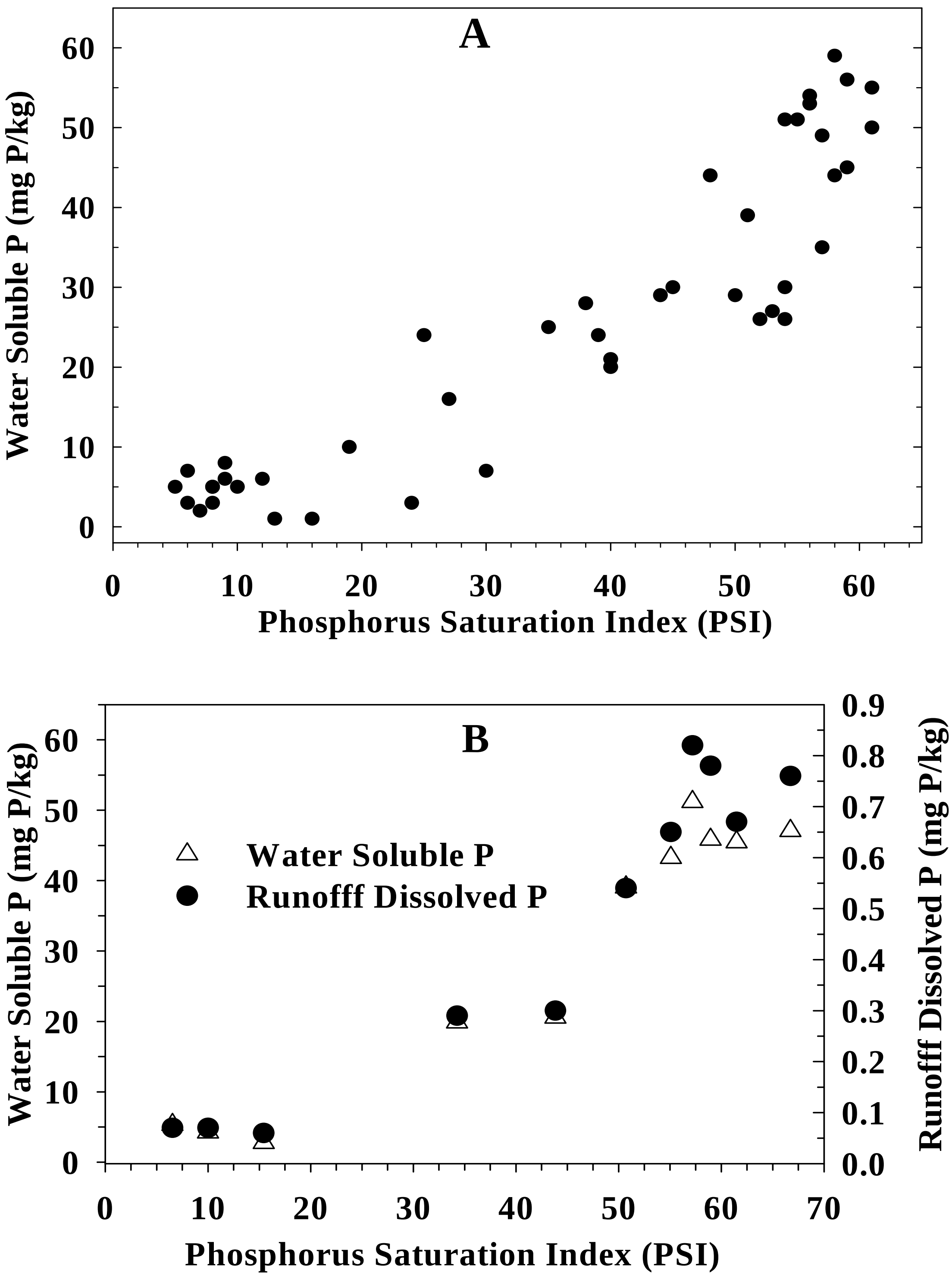


FIGURE III-10. SKETCH OF TYPICAL DESIGN OF MAIN PLOT, SUBPLOT, AND LOCATION OF RUNOFF COLLECTION DEVICES IN THE BIOSOLIDS P RUNOFF FIELD STUDY

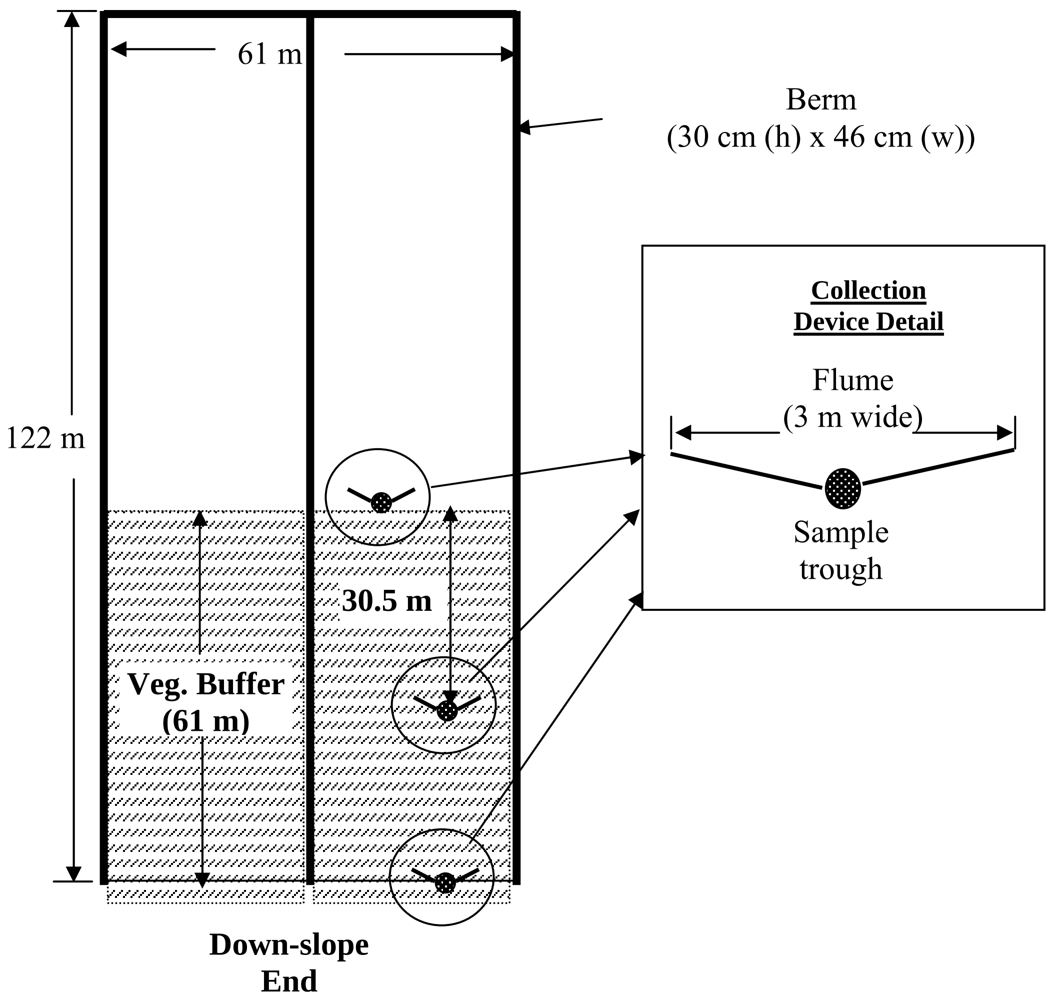


FIGURE III-11: SCHEMATIC OF THE RESEARCH PLOTS LOCATED IN WILL (A) AND KANKAKEE (B) COUNTIES SHOWING THE TREATMENTS AND LOCATIONS OF LYSIMETERS

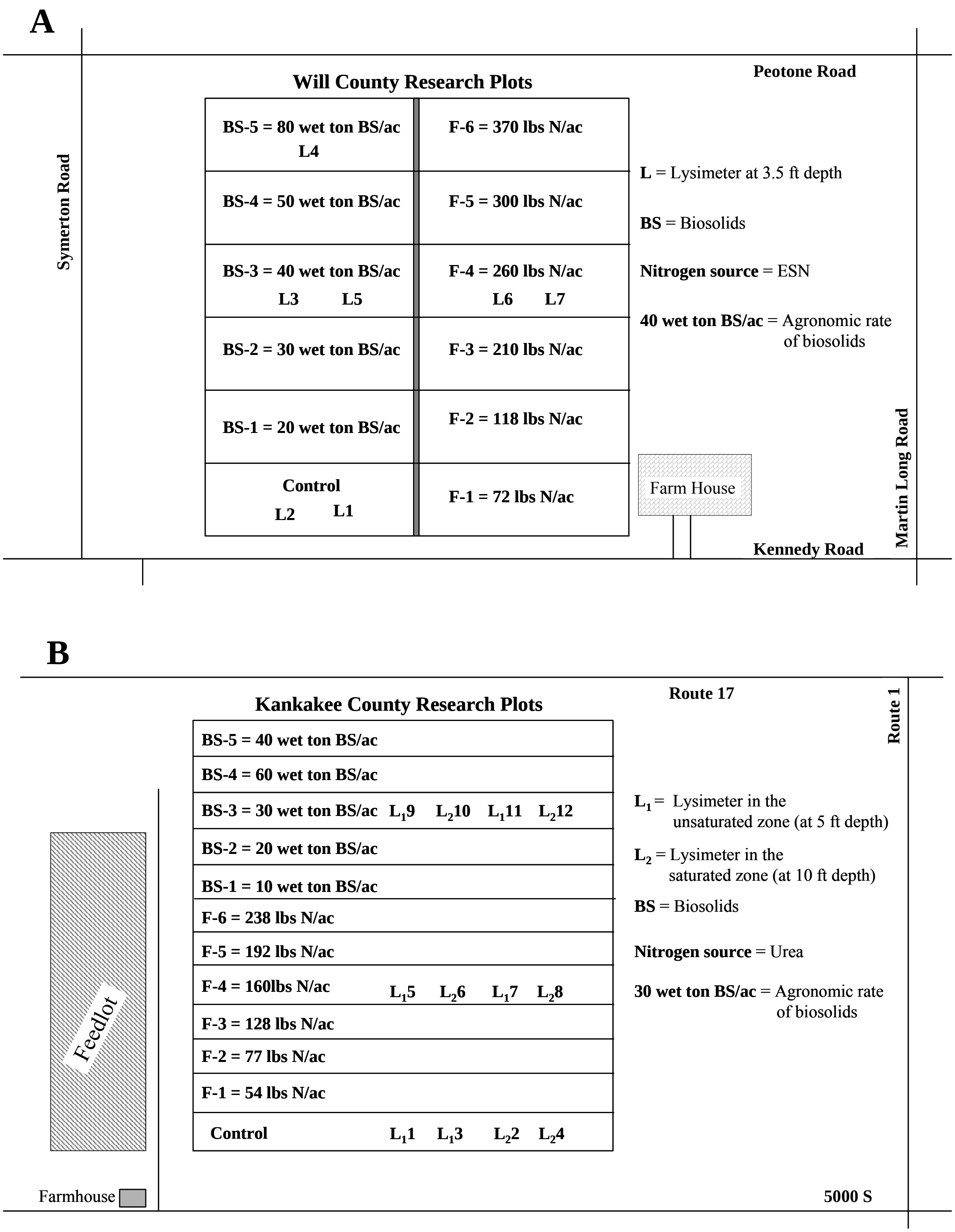
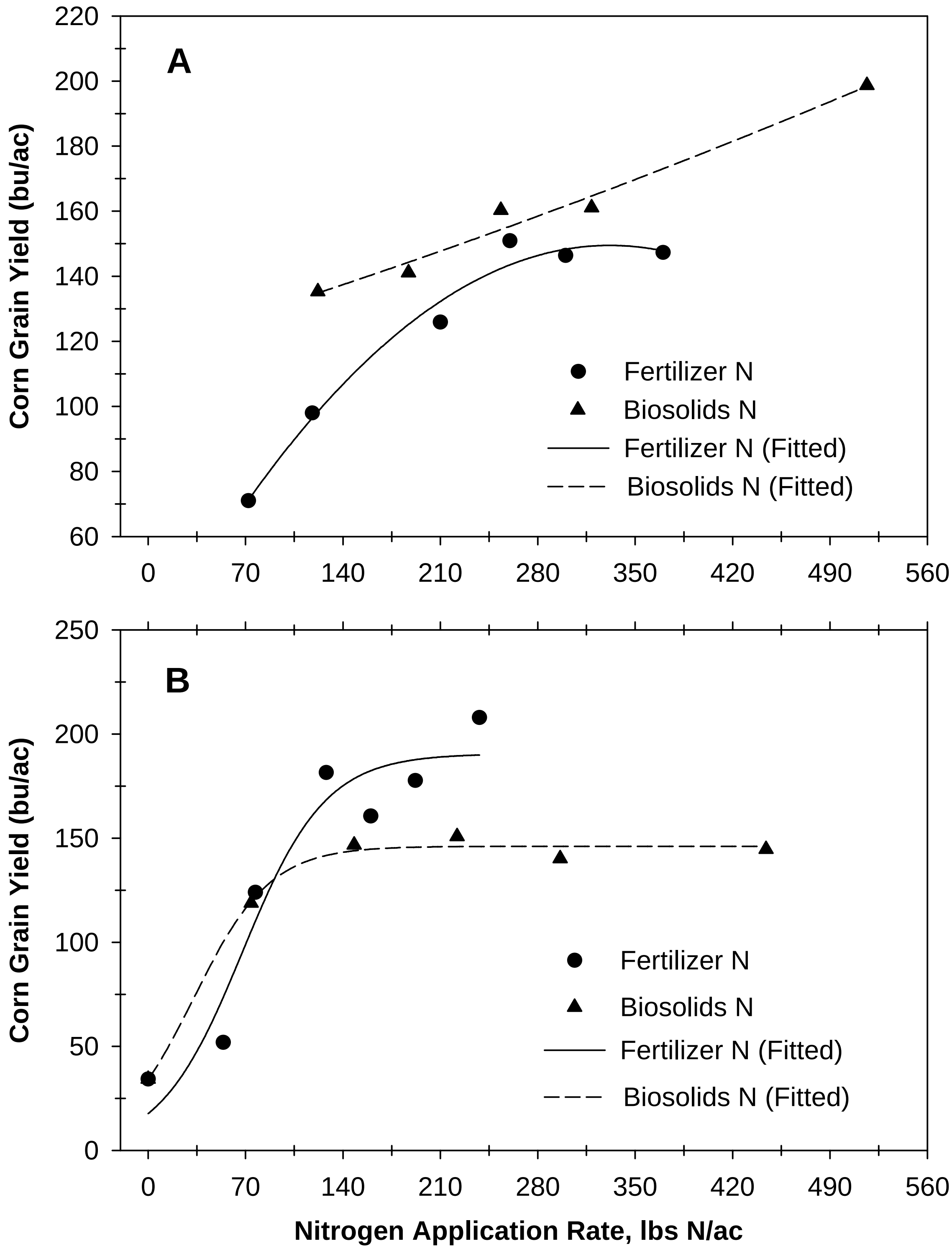


FIGURE III-12: CORN GRAIN YIELD FROM THE RESEARCH AND DEMONSTRATION PLOTS AT THE WILL (A) AND KANKAKEE (B) COUNTY SITES IN 2005.



ANALYTICAL MICROBIOLOGY AND BIOMONITORING SECTION

ANALYTICAL MICROBIOLOGY AND BIOMONITORING SECTION

The Analytical Microbiology and Biomonitoring Section is comprised of four professional and 12 technical personnel and are organized into four groups, which perform specific monitoring or research activities. These 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 (whole effluent toxicity) methodology.
- Microbial processes.
- Enumeration of viral, microbial, and parasitic indicators.
- Enumeration of specific pathogens.
- The microbiology of specific wastewater or biosolids treatment options.
- Emerging organic contaminants including endocrine disrupters, pharmaceuticals, and personal care products.

Overview of Section Activities

In 2005, personnel in the Section participated in a variety of monitoring and research activities. Listed below are the most important of these activities and the group with the most direct participation.

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 Waterways System (CWS). 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 handling sites in Cook County.

e. Part 503 Compliance Monitoring. Analysis of Class A and B biosolids for FC.

f. Biosolids Beneficial Use Support. Monitoring bacterial (FC and *Salmonella* spp.) densities in farm soil after application of biosolids.

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

h. Study of Antibiotic Resistant Bacteria (ARB). Monitoring of ARB in Wastewater and the CWS.

i. Disinfection Study. Bacterial density monitoring at three major WRPs.

j. Research Study. Dry weather risk assessment of human health impacts of disinfection vs. no disinfection of the CWS.

k. Reviews. Review of the USEPA Water Quality Criteria for Bacteria. Review research reports and proposed regulations to determine the 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 PFRP treatment processes consistently produce Class A biosolids as defined in the Part 503 Regulations.

c. Monitoring of Biosolids for Coliphages (Somatic and Male-specific RNA). Research on the use of coliphages as indicators for enteric viruses in biosolids.

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

e. Establishment of Molecular Microbiology Laboratory. Polymerase Chain Reaction (PCR) technology capability to meet the future demands for microbial source tracking, pathogen monitoring, and genetic analysis of ARB.

f. Reviews. Review research reports and proposed regulations for any 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 PFRP 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 for any impact on District operations.

Biomonitoring Group.

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

b. The Algal Growth Test (AGT). To assess the Salt Creek nutrient reduction demonstration project at Egan WRP.

c. Reviews. Review research reports and proposed regulations for any impact on District operations.

Analytical Microbiology Group Responsibilities

The Analytical Microbiology Laboratory has been certified by the Illinois Department of Public Health (IDPH) for the bacterial analysis of water since 1979. Monitoring the densities of FC bacteria in WRP effluents was first mandated by NPDES permits in 1972; at present, the Analytical Microbiology Group is responsible for all bacterial population density analyses used in WRP effluent monitoring. Monitoring of the Chicago beaches is conducted when river reversals to Lake Michigan occur following large amounts of rainfall. In 2005, 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 types of analyses performed by the Analytical Microbiology Group in 2005. Bacterial analyses for total coliforms (TC), FC, and *Escherichia coli (*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 are 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 [MMO-MUG]).

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 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 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 flow due to storms exceeds the design maximum treatment capacities of the WRPs. These storms can cause the WRPs to divert a portion of their influent, which is then given minimal treatment before being delivered to the receiving stream. These storm-related excess flow discharges must be monitored for the FC bacteria levels. In 2005, the Analytical Microbiology Group performed nine analyses of FC bacteria on four storm-related excess flow discharge events: 1) the Egan WRP service area on January 13; 2) the Calumet WRP service area on July 26; 3) the North Side WRP service area on July 26; and 4) the North Side WRP service area on August 20.

Part 503 Compliance Monitoring. In 2005, the Analytical Microbiology Group performed MPN analyses for FC bacteria on 30 samples of biosolids to determine if they met the Class A pathogen requirement of less than 1,000 FC MPN/g (dry weight) specified in the Part 503 Regulations. The results were reported to the Maintenance and Operations (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 Farm Soil. In 2005, the Analytical Microbiology Laboratory continued monitoring FC and *Salmonella* spp. 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.

Study of Antibiotic Resistant Bacteria (ARB) in Wastewater. In 2005, the District continued a study of the effect of secondary wastewater treatment on the total numbers, percentages, and resistance patterns of antibiotic resistant FC in raw sewage (RS) entering and final effluent (FE) discharged from the District's seven WRPs. The density of antibiotic resistant FC were determined on m-FC agar containing ampicillin (AMP-R: 16 μg/mL), gentamicin (GEN-R: 8 μg/mL), tetracycline (TET-R: 8 μg/mL), or a mixture of all three antibiotics. The study was undertaken to determine whether secondary wastewater treatment at the District WRPs reduces the quantity of antibiotic resistant FC bacteria.

The numbers of antibiotic resistant (AMP-R, TET-R, GEN-R, and AMP/TET/GEN-R) FC observed in RS ranged from 2.0×10^5 to 1.1×10^7, 2.0×10^5 to 2.15×10^6, 95 to 1.45×10^4, and 90 to 9.5×10^3 per 100 mL, respectively. Secondary wastewater treatment without disinfection was shown to reduce the number of antibiotic resistant FC by two to three orders of magnitude. The relative percentages of antibiotic resistant FC observed in FE followed the same trend observed in RS: $FC_{AMP-R} > FC_{TET-R} > FC_{GEN-R} > FC_{AMP/TET/GEN-R}$. The study indicated that the multiple-antibiotic resistant FC bacteria were eliminated by secondary wastewater treatment. The results of univariate and multivariate regression analysis showed that the percentages of antibiotic resistant FC in the FE from all seven District WRPs were lower than the percentages of these organisms in RS ($p < 0.01$). These results support the conclusion that secondary sewage treatment in the District effectively reduces the number of antibiotic resistant FC and that the environments of the District's seven WRPs are not conducive to the propagation or survival of antibiotic resistant fecal coliform bacteria. The results of this work is summarized in Research and Development (R&D) Report No. 06-32 titled, "The Effect of Secondary Sewage Treatment on the Total Numbers and Percentages of Antibiotic Resistant Fecal Coliforms in Raw Sewage Entering the Seven Water Reclamation Plants of the Metropolitan Water Reclamation District of Greater Chicago."

Study of ARB in Chicago Waterways System (CWS). The District has expanded the ARB study to survey the CWS. This study is intended to determine whether ARB present in the final effluent of the Stickney, Calumet, and North Side WRPs are affecting the number and spatial distribution of ARB in the CWS. An experimental plan, titled "Monitoring the Total Numbers, Percentages, and Antibiotic Resistance Patterns of Antibiotic Resistant Fecal Coliforms in the Chicago Waterways System" was written, and the study commenced in December 2005.

Disinfection Study. In 2005, the District was involved in monitoring bacterial densities to assess its future disinfection needs at the Stickney, Calumet, and North Side WRPs. The District performed 509 analyses of the TC, FC, and EC content of 236 WRP final effluent samples.

Review of the USEPA Water Quality Criteria for Bacteria. As part of the Use Attainability Analysis (UAA) study of the CWS, the District commissioned an Expert Review Panel (Panel) comprised of Drs. Herbert E. Allen, Abdel El-Shaarawi, Charles N. Haas, and Joan B. Rose, to conduct a review of the USEPA November 2003 Implementation Guidance for Ambient Water Quality Criteria. The Panel was charged with determining whether the 2003 Guidance provides the proper scientific/technical basis for establishing bacterial water quality standards for the CWS. Dr. Haas served as the chairperson of the Panel, assigned specific tasks to the other members of the Panel, compiled and edited contributions from other members of the Panel, and prepared the final report. A report titled, "Expert Review Report Regarding the United States Environmental Protection Agency's Water Quality Criteria for Bacteria – 1986: Application to Secondary Contact Recreation," R&D Report No. 2006-38 was published.

Dry Weather Risk Assessment of Human Health Impacts of Disinfection vs. No Disinfection of the Chicago Waterways System (CWS). As part of the Use Attainability Analysis (UAA) study of the CWS, the District, working with consultants, is evaluating the human health impact of disinfecting versus not disinfecting effluents from the District's Calumet, North Side, and Stickney WRPs, which discharge into the CWS. The consultant is the GeoSyntec Team (GST), which includes GeoSyntec Consulting and its subcontractors; Patterson Environmental Consultants; Cecil Lue-Hing & Associates; Dr. Charles Gerba of the University of Arizona; Dr. John Colford, M.D., of the University of California at Berkeley; Hoosier Microbiological Laboratory, Inc.; and Clancy Environmental Consultants.

The main objectives of the study were to: 1) prepare a sampling and analysis plan (SAP) and Quality Assurance Project Plan (QAPP) for generating microbial analytical results that would form the basis of the microbial risk assessment; 2) provide field training to District's sampling personnel; 3) perform a literature review of pathogen disinfection effectiveness; 4) perform a microbial exposure assessment by literature review; 5) perform a microbial infection dose-response analysis by literature review; 6) perform a microbial risk characterization of three waterway segments in the vicinity of the North Side, Stickney, and Calumet WRPs. Sampling and monitoring activities associated with the dry weather assessment of the study were completed between July and September of 2005. An interim report on the dry weather risk assessment study is scheduled to be completed in 2006.

Support to Other Sections. The Analytical Microbiology Group supported a variety of Environmental Monitoring and Research and Industrial Waste Division programs in 2005: effluent analysis, land reclamation and sludge indicator organism densities, District waterway surveys, Lake Michigan monitoring, WRP monitoring, TARP monitoring, research support, industrial waste surveys, the Illinois waterway survey, and other miscellaneous samples. Table IV-2 is a summary of the major programs receiving support from 2004 through 2005 and the number of analyses performed for each program.

Virology Group Activities

In 2005, the Virology Group analyzed 18 biosolids samples for site-specific Processes to Further Reduce Pathogens (PFRP) equivalency monitoring and for compliance with the Part 503 biosolids regulations. Enteric virus densities in all samples of biosolids produced by the District's codified PFRP processing trains 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 77 percent. Recoveries ranged from 36.2 to 96.6 percent and were dependent upon the sample spiked. Results of these analyses are shown in Table IV-3.

The analytical method used by the District for determining the density of enteric viruses in biosolids was published and approved by the USEPA (Appendix H, EPA/625/R-92/013). 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 (FRNA and Somatic). The USEPA coliphage method was modified and adapted in the District to determine coliphage concentrations in Class A and B biosolids. Research is currently being conducted to evaluate the usefulness of coliphages as an alternative indicator for the presence of enteric viruses in biosolids. In 18 samples of biosolids produced by the District's codified process, the concentrations of coliphages were determined to be below the detectable limit (less than one plaque forming unit [PFU] per gram total solids [dry weight basis]). Results of these analyses are shown in Tables IV-4.

Data collected to date suggest that coliphages are a good alternate indicator for predicting the presence or absence of enteric viruses in biosolids.

Monitoring Virus Densities in Farm Soil. In 2005, the Virology Laboratory continued monitoring virus densities 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.

Establishment of Molecular Microbiology Laboratory. The District will construct a molecular microbiology research laboratory at the Cecil Lue-Hing R&D Complex to meet the future demands for microbial source tracking, pathogen monitoring, and genetic analysis of ARB.

Parasitology Group Activities

In 2005, the Parasitology Group analyzed 18 biosolids samples for site-specific PFRP equivalency monitoring and for compliance with the Part 503 biosolids regulations. Viable *Ascaris* ova densities in all samples of biosolids produced by the District's codified PFRP sludge processing trains were determined to be below the detectable limit, which is less than one viable *Ascaris* ovum per four grams of total solids (dry weight basis). Results of these analyses are shown in Table IV-5. 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 biosolids regulations, all biosolids produced by the District's codified PFRP sludge processing trains have been in compliance with the Class A criteria for shipment and use under the District's Controlled Solids Distribution Program.

The analytical method used by the District for enumerating Viable *Ascaris* ova in sludge was published and approved by the USEPA (Appendix I, EPA/625/R-92/013). 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 2005, the Parasitology Laboratory continued monitoring viable *Ascaris* ova 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 monitor 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-1). Digital images are stored and analyzed using the MetaMorph™ imaging system. The MIA system has proven 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; and 4) sample identification number. A series of digital video images is recorded for each ovum examined when larval movement is observed in order to document viable *Ascaris* ova.

Biomonitoring Group Activities

NPDES Compliance Biomonitoring. In 2005, acute whole effluent toxicity (WET) tests with fish (*Pimephales promelas)* and daphnids (*Ceriodaphnia dubia)* were conducted on effluent samples from the Stickney, Calumet, North Side, Egan, and Lemont WRPs 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-6. Biomonitoring reports for these 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 (No. 06-23) titled, "Biomonitoring Report 2002-2004: Chronic Whole Effluent Toxicity (WET) Assessment of Effluents from the Stickney, North Side, and Calumet Water Reclamation Plants, 2002-2004, Conducted by the Metropolitan Water Reclamation District of Greater Chicago (District), the United States Environmental Protection Agency (USEPA), Region V, and the Illinois Environmental Protection Agency (IEPA)," is posted on the District website.

The Algal Growth Test (AGT). The *Selenastrum capricornutum* Printz Algal Assay Bottle Test (AGT) was developed by the USEPA to determine algal growth potential and nutrient limitation in natural waters (EPA-600/9-78-018). By measuring the algal growth potential of water, a differentiation can be made between the total nutrient in the sample (as determined by chemical analysis) and the nutrient forms that are actually available for algal growth. The District initiated AGT research primarily to study the biological available phosphorus (BP) in the Egan WRP final effluent and in Salt Creek upstream and downstream of the Egan WRP, in conjunction with a planned demonstration project to study stream response to phosphorus reduction at the Egan WRP. In 2005, the capability to conduct the AGT was developed using a standard test organism *Pseudokirchneriella subcapitata*, formerly known as *Selenastrum capricornutum*. Four valid AGTs were conducted to measure BP in effluent samples from the Egan WRP and samples from three monitoring stations on Salt Creek (Busse Reservoir Dam, Kennedy Blvd., and Thorndale Ave). The samples were collected and analyzed once each quarter. The AGT results (Figure IV-2) showed that the mean BP (mg/L) values measured in the Egan WRP effluent samples and the two downstream monitoring stations on Salt Creek were lower than the total phosphorus (mg/L) measured chemically. The results of the AGTs are important in the District's effort to maintain the biotic integrity of Salt Creek and the IEPA's effort to develop nutrient standards for the State of Illinois.

TABLE IV-1: ANALYTICAL MICROBIOLOGY GROUP SAMPLES AND ANALYSES 2004 AND 2005

		Analysis or Test Performed[1]										
Year	Samples	TC	FC	FS	PA	SAL	HPC	EC	ENT	IQC	ID-CONF	Total
2004	2,737	120	2,611	0	0	16	43	356	0	7,875	274	11,295
2005	2,787	135	2,748	0	0	14	33	485	0	7,796	113	11,324

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

TABLE IV-2: INDICATOR BACTERIA ANALYSES PERFORMED BY THE ANALYTICAL MICROBIOLOGY GROUP FOR VARIOUS DISTRICT PROGRAMS 2004 THROUGH 2005

Program	Total Coliform		Fecal Coliform		*Escherichia coli*	
	2004	2005	2004	2005	2004	2005
Effluent Analysis	12	12	717	703	20	-
Land Reclamation	-[a]	-	-	181	-	-
Biosolids Indicator Organism Density	-	-	70	59	-	-
District Waterway Surveys	-	-	904	847	228	217
Industrial Waste Surveys	-	-	3	5	-	5
Research -Support	-	41	199	68	-	41
Lake Michigan Monitoring[1]	77	-	10	-	90	-
Major Treatment Facility Monitoring[2]	-	1	13	300	-	192
Illinois Waterway	-	-	-	-	-	-
TARP	-	-	750	566	-	-
Other[3]	66	43	-	-	18	-
Total	155	97	2,811	2,729	356	455

[a]No samples analyzed.
[1]Includes festivals and District bypasses to Lake Michigan.
[2]Includes disinfection study and support to plant operations.
[3]Includes drinking water.

TABLE IV-3: VIROLOGICAL ANALYSIS OF CLASS A BIOSOLIDS IN 2005[1]

WRP Sample Location	Number Samples Positive/Number Samples Collected	Total Number of Samples that Meet Class A Pathogen Requirement[2]	PFU/4 Gram Dry Weight Range [3,4]	Percent Recovery of Seeded Viruses[5] Range
Calumet				
East and West	0/9	9	<0.7886 - <0.8001	51.8 – 96.6
Stickney				
LASMA[5]	0/6	6	<0.7998 - <0.8003	36.2 – 91.1
Marathon	0/3	3	<0.7997 - <0.8001	67.4 – 87.7

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

TABLE IV-4: COLIPHAGE (SOMATIC [SP] & F SPECIFIC RNA [FRNA]) ANALYSIS OF CLASS A BIOSOLIDS IN 2005[1]

WRP/Sample Location	Range of TS[2]	Total Number of Samples Collected	Range of Coliphage MPN per Gram Dry Wt[3,4] SP	FRNA
Calumet				
East and West	62.26 – 94.94	9	<0.1053 - <0.1606	<0.1053 - <0.1606
Stickney				
LASMA[6]	70.19 – 94.90	6	<0.1054 - <0.1425	<0.1054 - <0.1425
Marathon	75.15 – 79.41	3	<0.1259 - <0.1331	<0.1259 - <0.1331

[1]The coliphages were enumerated according to the USEPA Method 1601: Male -specific (F+) and Somatic Coliphage in Water by Two-step Enrichment Procedure (EPA/821-R-01-030). The method was modified to increase the sensitivity of the method for biosolids monitoring.
[2]TS=Percent Total Solids.
[3]Failure to detect coliphages in biosolids is recorded as less than (<) the limit of test sensitivity.
[4]Most Probable Number of FRNA and SP Based on Dry Weight of 1 g of as-received Biosolids.

TABLE IV-5: VIABLE *ASCARIS* OVA ANALYSIS OF CLASS A BIOSOLIDS IN 2005[1]

WRP Sample Location	Sample Dry Weight for Analysis[2]	Number Samples Positive/Number Samples Collected	Total Number of Samples that Meet Class A Pathogen Requirement[3]	Range of Total Viable *Ascaris* Ova per 4 Gram Dry Weight[4]
Calumet				
East and West	50g, 300g	0/9	9	<0.0133 – 0.0800
Stickney				
LASMA[5]	50g, 300g	0/6	6	<0.0133 – 0.0933
Marathon	50g, 300g	0/3	3	<0.0800 – 0.1600

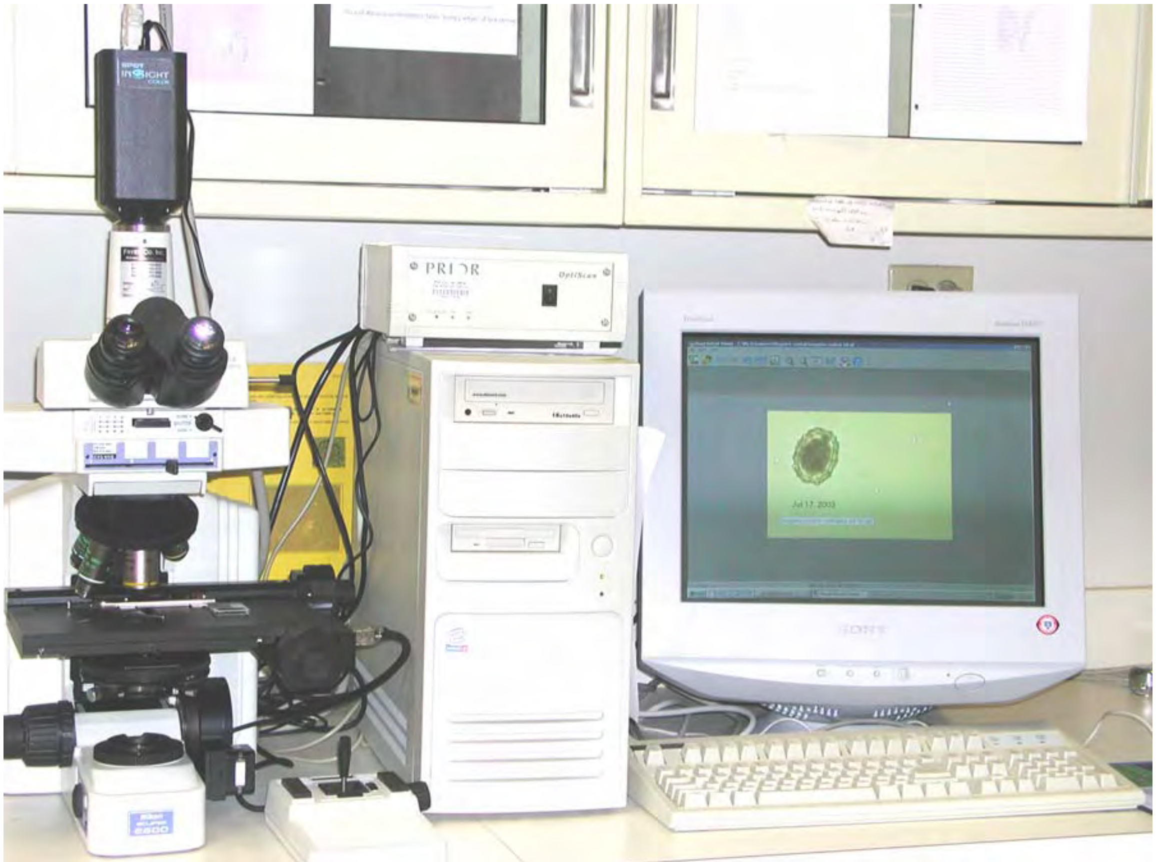
[1]Test Method for Detecting, Enumerating, and Determining the Viability of *Ascaris* Ova in Sludge, Appendix I, Environmental Regulations and Technology, EPA/625/R-92/013, Revised 2003.
[2]USEPA, Region V, has approved the practice of analyzing 50g dry weight samples of biosolids for the determination of *Ascaris* ova densities with every sixth sample being 300g dry weight as required in the District's site-specific PFRP compliance monitoring.
[3]Viable *Ascaris* ova are less than 1 viable *Ascaris* ovum per 4g total dry solids.
[4]Failure to detect viable ova in biosolids is recorded as less than (<) the limit of test sensitivity.
[5]Lawndale Avenue Solids Management Area.

TABLE IV-6: RESULTS OF WHOLE EFFLUENT TOXICITY (WET) TESTS CONDUCTED ON WATER RECLAMATION PLANT EFFLUENTS FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT COMPLIANCE DURING 2005

Effluent Tested	Sample Collection Date (s)	WET Test[1]		Result[2]
Stickney WRP	04/04 - 05/05	Acute *C. dubia*	(Survival)	NTE
Hanover Park WRP	04/11 - 16/05	Chronic *P. promelas*	(Survival)	NTE
			(Growth)	NTE
		Chronic *C. dubia*	(Survival)	NTE
			(Reproduction)	NTE
Calumet WRP	04/25 - 26/05	Acute *C. dubia*	(Survival)	NTE
Calumet WRP	05/23 - 24/05	Acute *C. dubia*	(Survival)	NTE
North Side WRP	07/25 - 26/05	Acute *C. dubia*	(Survival)	NTE
Egan WRP	08/08 - 09/05	Acute *P. promelas*	(Survival)	NTE
		Acute *C. dubia*	(Survival)	NTE
Stickney WRP	08/15 - 16/05	Acute *C. dubia*	(Survival)	NTE
North Side WRP	09/12 - 13/05	Acute *C. dubia*	(Survival)	NTE
Egan WRP	11/14 - 15/05	Acute *P. promelas*	(Survival)	NTE
		Acute *C. dubia*	(Survival)	NTE
Lemont WRP	12/05 - 06/05	Acute *P. promelas*	(Survival)	NTE
		Acute *C. dubia*	(Survival)	NTE

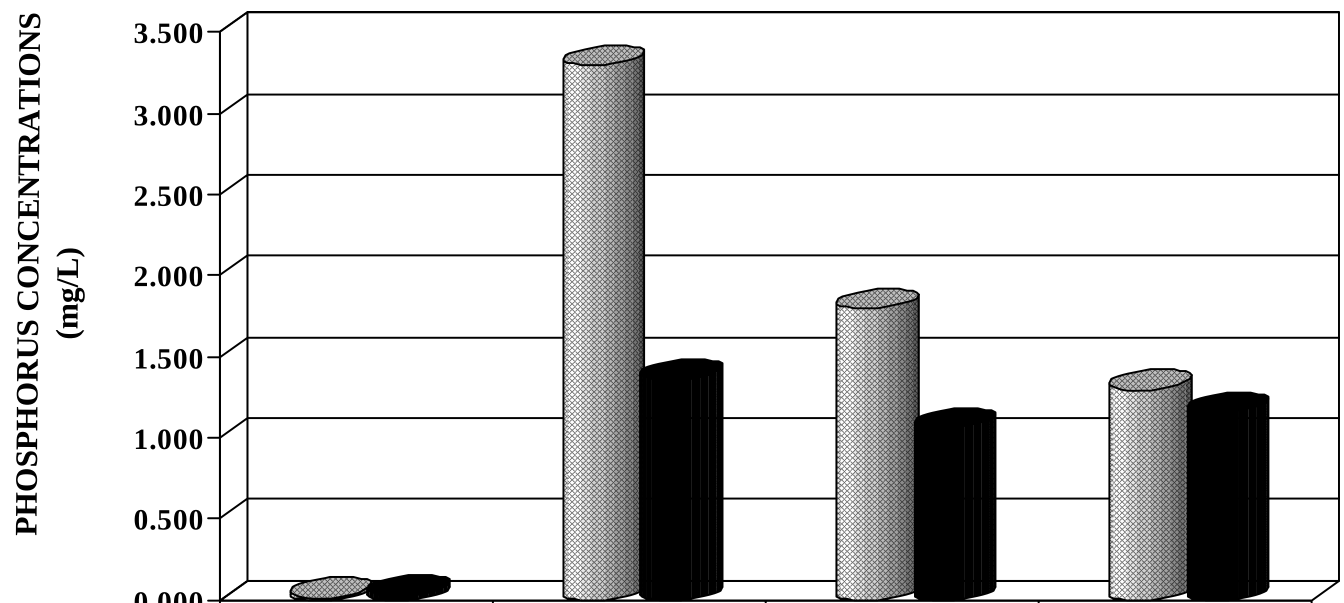
[1]WET Tests: Acute *Pimephales promelas* (Survival) and Acute *Ceriodaphnia dubia* (Survival), EPA 821-R-02-012, (Fifth Edition), 2002; Chronic *Pimephales promelas* (Survival, Growth), and Chronic *Ceriodaphnia dubia* (Survival, Reproduction), EPA 821/R-02/013, (Fourth Edition), 2002.
[2]Results: NTE = no toxic effect.

FIGURE IV-1: 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-2: MEAN CONCENTRATIONS OF BIOLOGICAL AVAILABLE PHOSPHORUS (BP) AND TOTAL PHOSPHORUS IN EGAN WRP FINAL EFFLUENT AND SALT CREEK LOCATIONS



	Busse Reservoir Dam	Egan WRP Final Effluent	Salt Creek Kennedy Blvd.	Salt Creek Thorndale Ave.
Total Phosphate	0.015	3.296	1.803	1.298
Biological Available Phosphorus	0.027	1.358	1.059	1.161

AQUATIC ECOLOGY AND WATER QUALITY SECTION

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 (wadeable) 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 Chicago Waterway System (CWS). 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 CWS (Figure 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 Maintenance and Operations (M&O) and Engineering Departments.

Fish Monitoring 2005

During July through October of 2005, fish were collected by electrofishing and seining at 27 biological monitoring stations on the CWS, plus three stations on Bubbly Creek and at each of the Sidestream Elevated Pool Aeration (SEPA) Stations. In 2005, 7,892 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 1 for the deep-draft waterways and in Table 2 for the shallow waterways. The most abundant species in the deep-draft waterways included gizzard shad, carp, largemouth bass, bluntnose minnow, and emerald shiner. In the shallow waterways, blackstripe topminnow and green sunfish were the most abundant.

Chlorophyll Monitoring 2005

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 from 2005 are shown in Table 3. The highest mean values of chlorophyll *a* occurred at Burnham Avenue (58 µg/L) on the Grand Calumet River, Stephen Street (49 µg/L) on the Des Plaines River, and Springinsguth Road (60 µg/L) on the West Branch DuPage River.

Illinois Waterway Monitoring

In 1984, the 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 is to assess the chemical and microbiological quality of the water and to characterize the chemical quality of the sediments.

In 2005, water samples were collected during May, August, and October from each of the 49 sampling stations (Figure 2 and 3). During October, sediment samples were collected at 14 selected stations. Data for these sampling events are compiled in R&D Report Number 06-48 entitled, "Water and Sediment Quality Along the Illinois Waterway from the Lockport Lock to the Peoria Lock During 2005."

Council on 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 water quality 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, and once in December through March (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 from 2005 CFAR sampling are shown in Table 4. 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.

Salt Creek Nutrient Reduction Demonstration Project

Baseline chemical and biological monitoring began in 2005 in advance of plans to lower total phosphorus in effluent from the John E. Egan (Egan) WRP during 2006. Chemical phosphorus removal will be operated at the Egan WRP throughout 2007 and impacts on water quality in Salt Creek will be monitored. Water samples collected from one station upstream of the Egan WRP (Busse Reservoir Dam) and two stations downstream (J. F. Kennedy Boulevard and Thorndale Avenue) were analyzed for 16 relevant water quality constituents, including chlorophyll *a*. These samples were collected twice per month during April through November, once per month in January through March and December, and for four sequential days following rain events, which occurred in July and October of 2005. Biological monitoring including fish and macroinvertebrate collection and a physical habitat assessment was performed once at each station during 2005, along with sediment chemistry analysis. An interim report, including all background monitoring that will be conducted through 2006 is scheduled for completion in March 2007.

Continuous Monitoring of Dissolved Oxygen

In order to gain a better understanding of the oxygen dynamics in deep-draft sections of the CWS, the EM&R Division developed a comprehensive continuous DO monitoring program beginning in August 1998 in the Chicago River System, July 2001 in the Calumet River System, and in the Des Plaines River System in July 2005.

Dissolved oxygen was measured hourly using remote (in-situ) water quality monitors deployed in protective stainless steel housing enclosures. As shown in Figure 1, in the Chicago River System the monitors were located at 14 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 nine stations on the Calumet River, Grand Calumet River, Little Calumet River, and the Calumet-Sag Channel. Nine stations were located in the Des Plaines River System on the Des Plaines River and Salt Creek.

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 2005 that were above the Illinois Pollution Control Board (IPCB) DO standards, are presented in Table 5. All of the DO results for 2005 can be located in the reports entitled, "Continuous Dissolved Oxygen Monitoring in the Deep-Draft Waterways of the Chicago Waterway System During 2005" and "Continuous Dissolved Oxygen Monitoring in the Wadeable Streams of the Chicago Waterway System During 2005."

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 fecal coliform (FC) bacteria in District waterways relative to issues raised by the CWS Use Attainability Analysis. The FC density was measured at each of 12 locations in two segments of the CWS, 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 4.

The Industrial Waste Division (IWD) collected water samples twice a month between April 1 and December 31, 2005. Water samples were collected 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. Samples were also collected 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 2005 at the North and South Area stations as part of the AWQM Program were also included as dry weather data in this study. Water samples were analyzed for FC by the Analytical Microbiology and Biomonitoring Section of the EM&R Division using the FC membrane filter procedure. Because 2005 was such a dry year, with few rainfall events, this study was continued in 2006. A final report will be completed in 2007.

TABLE V-1: FISH COLLECTED FROM DEEP-DRAFT WATERWAYS DURING 2005

Station No.	Location	Number of Fish Collected	Weight (Lbs.) of Total Catch	Number of Fish Species	Number of Game Fish Species	Most Abundant Fish Species
		North Shore Channel				
35	Central Street	139	352	10	5	Carp
102	Oakton Street	151	46	17	9	Golden shiner
36	Touhy Avenue	276	227	9	4	Gizzard shad
101	Foster Avenue	273	108	15	7	Gizzard shad
		North Branch Chicago River				
37	Wilson Avenue	122	374	11	5	Carp
73	Diversey Parkway	164	156	12	6	Golden shiner
46	Grand Avenue	77	31	5	3	Gizzard shad
		Bubbly Creek				
-	Racine Avenue Pumping Station	516	76	4	2	Gizzard shad
-	35th Street	114	15	4	1	Gizzard shad
-	Illinois Highway 55	139	18	5	2	Gizzard shad
		Chicago Sanitary and Ship Canal				
75	Cicero Avenue	184	131	7	3	Gizzard shad
41	Harlem Avenue	758	213	13	4	Gizzard shad
92	16th St., Lockport	179	45	9	3	Gizzard shad
		Calumet River				
SEPA 1	Torrence Avenue	119	65	14	8	Largemouth bass
55	130th Street	380	226	16	7	Largemouth bass
		Little Calumet River				
SEPA 2	127th Street	530	40	16	6	Emerald shiner
76	Halsted Street	913	276	18	9	Gizzard shad
		Calumet-Sag Channel				
SEPA 3	Western Avenue	253	127	16	6	Emerald shiner, Gizzard shad
59	Cicero Avenue	63	6	10	5	Emerald shiner
SEPA 4	Harlem Avenue	663	47	14	4	Emerald shiner, Gizzard shad
SEPA 5	Junction CSSC/Calumet-Sag Channel	749	78	17	9	Emerald shiner, Gizzard shad

TABLE V-2: FISH COLLECTED FROM SHALLOW WATERWAYS DURING 2005

Station No.	Location	Number of Fish Collected	Weight (Lbs.) o Total Catch	Number of Fish Species	Number of Game Fish Species	Most Abundant Fish Species
			West Fork North Branch Chicago River			
106	Dundee Road	5	<1	3	1	Carp
103	Golf Road	6	<1	4	3	Green sunfish
			Middle Fork North Branch Chicago River			
31	Lake-Cook Road	14	1	4	2	Green sunfish
			Skokie River			
32	Lake-Cook Road	34	12	4	2	Bluegill, Green sunfish
105	Frontage Road	39	2	3	2	Green sunfish
			North Branch Chicago River (Shallow Portion)			
104	Glenview Road	10	1	3	2	Green sunfish
34	Dempster Street	13	1	5	2	Carp
96	Albany Avenue	6	<1	3	1	Carp
			Higgins Creek			
78	Wille Road	30	<1	6	1	White sucker
			Des Plaines River			
13	Lake-Cook Road	125	5	10	5	Green sunfish
22	Ogden Avenue	39	3	10	3	White sucker
91	Material Services Road	129	1	12	3	Bluntnose minnow
			Salt Creek			
18	Devon Avenue	49	7	8	4	Green sunfish
			West Branch DuPage River			
64	Lake Street	64	4	7	3	Green sunfish

TABLE V-3: MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM THE CHICAGO WATERWAY SYSTEM DURING 2005

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 Road	4	15	4	22	8
103	Golf Road	10	29	5	123	36
	Middle Fork North Branch Chicago River					
31	Lake-Cook Road	10	8	1	19	5
	Skokie River					
32	Lake-Cook Road	11	12	2	55	17
105	Frontage Road	12	15	1	34	11
	North Branch Chicago River (Wadeable Portion)					
104	Glenview Road	12	10	1	30	10
34	Dempster Street	11	24	3	96	27
96	Albany Avenue	11	36	3	157	47
	North Shore Channel					
35	Central Street	9	4	1	21	7
102	Oakton Street	12	8	1	40	12
36	Touhy Avenue	12	2	<1	5	2
101	Foster Avenue	12	2	<1	13	3
	North Branch Chicago River (Deep-Draft Portion)					
37	Wilson Avenue	12	3	1	6	1
73	Diversey Avenue	12	3	1	6	1
46	Grand Avenue	12	4	2	8	2
	Chicago River					
74	Lake Shore Drive	10	3	<1	16	5
100	Wells Street	12	3	1	11	3
	South Branch Chicago River					
39	Madison Street	12	4	1	11	3
108	Loomis Street	10	5	<1	13	4
	Bubbly Creek (South Fork South Branch Chicago River)					
99	Archer Avenue	11	22	2	130	37

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM THE CHICAGO WATERWAY SYSTEM DURING 2005

Station No.	Station Name	Number of Samples	Mean (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Standard Deviation (µg/L)
		Chicago Sanitary and Ship Canal				
40	Damen Avenue	12	14	1	76	22
75	Cicero Avenue	12	7	2	21	5
41	Harlem Avenue	12	4	1	9	3
42	Route 83	11	6	1	20	7
48	Stephen Street	11	5	1	18	5
92	Lockport	52	5	1	19	4
		Calumet River				
49	Ewing Avenue	11	1	<1	1	<1
55	130th Street	11	3	1	6	2
		Wolf Lake				
50	Burnham Avenue	12	7	3	18	4
		Grand Calumet River				
86	Burnham Avenue	10	58	5	207	70
		Little Calumet River (Deep-Draft Portion)				
56	Indiana Avenue	9	16	2	38	12
76	Halsted Street	12	7	<1	21	7
		Thorn Creek				
54	Joe Orr Road	8	12	2	59	19
97	170th Street	11	8	3	18	5
		Little Calumet River (Wadeable Portion)				
52	Wentworth Avenue	11	6	2	17	5
57	Ashland Avenue	11	9	4	20	6
		Calumet-Sag Channel				
58	Ashland Avenue	12	10	1	29	10
59	Cicero Avenue	12	8	1	19	6
43	Route 83	11	9	2	29	9
		Buffalo Creek				
12	Lake-Cook Road	7	31	15	51	14

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM THE CHICAGO WATERWAY SYSTEM DURING 2005

Station No.	Station Name	Number of Samples	Mean (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Standard Deviation (µg/L)
			Higgins Creek			
77	Elmhurst Road	4	14	9	19	4
78	Wille Road	12	3	<1	5	1
			Des Plaines River			
13	Lake-Cook Road	12	28	8	92	28
17	Oakton Street	12	34	1	150	54
19	Belmont Avenue	12	23	1	108	33
20	Roosevelt Road	12	23	2	99	36
22	Ogden Avenue	12	19	2	69	22
23	Willow Springs Road	12	29	4	177	49
29	Stephen Street	12	49	4	225	64
91	Material Service Road	12	35	6	164	43
			Salt Creek			
79	Higgins Road	9	31	17	44	9
80	Arlington Hts. Road	12	12	2	34	10
18	Devon Avenue	12	15	4	36	10
24	Wolf Road	12	11	1	33	10
109	Brookfield Avenue	12	11	1	31	10
			West Branch DuPage River			
110	Springinsguth Road	11	60	4	266	91
89	Walnut Lane	12	9	1	31	10
64	Lake Street	12	25	6	53	16
			Poplar Creek			
90	Route 19	11	13	2	31	8

TABLE V-4: 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 2005 FOR CFAR PROJECT

Station Name	Sampling Date	Chl. *a* (µg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	TKN (mg/L)	TN (mg/L)	Ortho-Phosphate (mg/L)	TP (mg/L)	TSS (mg/L)	Turbidity (NTU)
Fullerton Ave.	1/5/05	2	0.36	5.182	0.637	1.31	7.13	0.55	0.48	<3	6.2
	2/2/05	1	2.28	5.662	0.238	2.93	8.83	1.21	1.18	6	9.3
	3/2/05	3	3.08	4.075	0.216	4.27	8.56	0.84	0.71	7	5.6
	4/6/05	3	2.41	4.483	0.470	3.76	8.71	1.27	1.36	9	4.6
	4/20/05	14	2.44	5.121	0.857	3.72	9.70	1.60	1.87	7	8.2
	5/4/05	2	1.68	4.924	0.487	2.28	7.69	1.19	1.25	7	5.3
	5/18/05	2	1.42	4.224	0.476	2.55	7.25	1.49	1.43	7	7.1
	6/1/05	1	1.78	5.022	0.338	2.65	8.01	1.45	1.49	8	5.9
	6/15/05	3	0.74	5.080	0.327	2.40	7.81	1.60	1.29	12	11.8
	7/6/05	4	0.48	3.300	0.305	2.89	6.50	0.69	0.85	3	8.7
	7/20/05	8	0.61	3.976	0.473	1.44	5.89	0.46	0.67	6	6.8
	7/26/05*	21	0.58	4.306	0.412	1.42	6.14	0.68	0.78	13	11.0
	7/27/05*	10	2.14	3.757	0.893	3.62	8.27	1.49	1.81	4	6.7
	7/28/05*	13	0.35	3.829	0.089	1.12	5.04	0.46	0.59	15	13.0
	7/29/05*	3	0.32	5.161	0.262	1.08	6.50	0.66	0.86	6	9.5
	8/3/05	3	0.19	9.012	0.064	1.14	10.22	0.53	0.55	10	12.6
	8/17/05	1	0.62	5.287	0.159	1.16	6.61	0.66	0.78	12	11.3
	9/7/05	1	0.50	4.971	0.103	1.20	6.27	0.80	1.01	5	12.7
	9/21/05	1	0.22	3.989	0.076	1.13	5.20	0.37	0.49	6	9.3
	10/5/05	1	0.27	5.429	0.094	1.23	6.75	0.89	0.88	10	8.6
	10/19/05	1	0.33	6.733	0.182	1.27	8.19	1.14	1.22	20	14.0
	10/25/05*	1	0.21	5.353	0.134	1.33	6.82	0.31	0.41	16	12.6
	10/26/05*	1	0.10	3.163	0.044	0.97	4.18	0.40	0.57	10	8.7
	10/27/05*	1	0.47	5.129	0.154	1.53	6.81	0.61	1.17	21	8.9
	10/28/05*	1	1.41	5.950	0.385	2.25	8.59	1.11	1.19	5	5.1
	11/2/05	1	1.29	7.184	0.340	2.02	9.54	1.57	1.64	5	5.2
	11/16/05	3	0.53	6.056	0.136	1.67	7.86	0.95	1.10	7	8.0
	12/7/05	5	0.82	8.086	0.300	2.03	10.42	1.29	1.33	<3	3.9

TABLE V-4 (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 2005 FOR CFAR PROJECT

Station Name	Sampling Date	Chl. *a* (µg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	TKN (mg/L)	TN (mg/L)	Ortho-Phosphate (mg/L)	TP (mg/L)	TSS (mg/L)	Turbidity (NTU)
Irving Park Road	1/5/05	12	0.19	4.841	0.030	1.29	6.16	0.78	0.72	17	20.5
	2/2/05	4	0.31	6.564	0.060	1.17	7.79	0.95	0.79	14	15.1
	3/2/05	6	0.14	3.911	0.024	1.04	4.98	0.61	0.45	22	14.4
	4/6/05	24	0.10	3.667	0.022	0.97	4.66	0.28	0.37	21	9.7
	4/20/05	13	0.17	5.395	0.034	1.19	6.62	0.76	0.78	25	13.9
	5/4/05	119	0.39	5.852	0.026	1.41	7.29	0.77	0.97	30	15.1
	5/18/05	37	0.19	4.536	0.030	1.20	5.77	0.73	0.66	30	15.1
	6/1/05	83	0.07	6.177	0.042	1.05	7.27	0.99	1.06	37	23.2
	6/15/05	4	0.41	7.059	0.128	1.12	8.31	1.87	1.50	20	15.3
	7/6/05	2	0.25	5.536	0.071	1.21	6.82	1.57	1.86	5	8.0
	7/20/05	1	0.23	8.522	0.083	1.22	9.83	1.86	2.08	<3	8.9
	7/26/05*	2	0.19	4.722	0.076	1.13	5.93	1.06	1.42	14	13.0
	7/27/05*	4	0.37	2.884	0.067	1.37	4.32	0.69	0.90	14	15.0
	7/28/05*	1	0.39	4.173	0.067	1.16	5.40	0.94	1.18	12	8.3
	7/29/05*	1	0.20	5.499	0.066	1.11	6.68	1.21	1.31	4	6.3
	8/3/05	1	0.37	4.657	0.206	1.06	5.92	1.74	1.91	7	8.4
	8/17/05	2	0.34	7.206	0.043	0.89	8.14	1.35	1.54	27	18.5
	9/7/05	1	0.11	13.214	0.051	1.84	15.11	2.21	2.50	16	20.2
	9/21/05	2	0.10	8.124	0.047	1.08	9.25	1.44	1.70	20	18.0
	10/5/05	2	0.09	5.839	0.057	1.07	6.97	1.24	1.27	19	16.7
	10/19/05	1	0.14	10.063	0.088	1.13	11.28	1.90	2.06	17	13.1
	10/25/05*	2	0.06	10.457	0.103	1.26	11.82	1.61	1.81	20	15.3
	10/26/05*	1	0.07	10.612	0.089	1.13	11.83	1.61	1.95	9	10.0
	10/27/05*	1	0.32	10.031	0.100	1.22	11.35	1.77	2.03	14	9.7
	10/28/05*	1	0.11	10.070	0.086	1.05	11.21	1.99	2.00	11	11.6
	11/2/05	1	0.18	11.060	0.084	0.91	12.05	2.05	2.11	6	12.7
	11/16/05	3	0.26	6.932	0.091	1.47	8.49	1.15	1.31	8	12.9
	12/7/05	8	0.48	8.897	0.101	1.75	10.75	1.31	1.07	12	12.7

TABLE V-4 (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 2005 FOR CFAR PROJECT

Station Name	Sampling Date	Chl. *a* (µg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	TKN (mg/L)	TN (mg/L)	Ortho-Phosphate (mg/L)	TP (mg/L)	TSS (mg/L)	Turbidity (NTU)
JFK Boulevard	1/5/05	15	0.05	4.026	0.016	1.03	5.07	0.62	0.61	<3	10.5
	2/2/05	7	0.25	10.575	0.022	1.07	11.67	2.30	2.29	10	15.7
	3/2/05	11	0.14	6.096	0.022	0.94	7.06	1.14	0.97	10	3.7
	4/6/05	29	0.09	4.678	0.032	1.00	5.71	0.72	0.88	15	5.6
	4/20/05	17	0.11	9.516	0.005	1.16	10.68	1.41	1.42	10	6.8
	5/4/05	7	0.13	13.303	0.010	1.02	14.33	2.44	2.37	4	3.9
	5/18/05	7	0.17	12.230	0.020	1.30	13.55	2.50	2.54	9	3.9
	6/1/05	4	0.18	13.888	0.019	0.77	14.68	3.09	3.13	6	2.8
	6/15/05	8	0.43	16.703	0.024	1.00	17.73	4.28	3.87	26	10.6
	7/6/05	15	0.23	9.349	0.034	1.33	10.71	2.40	2.78	3	3.2
	7/20/05	3	0.17	16.686	0.037	1.66	18.38	3.49	3.85	<3	3.9
	7/26/05*	17	0.32	8.366	0.080	1.46	9.91	1.87	2.17	7	5.8
	7/27/05*	28	0.09	8.580	0.027	1.48	10.09	1.75	2.15	12	7.6
	7/28/05*	27	0.05	10.214	0.022	1.43	11.67	2.18	2.64	11	6.5
	7/29/05*	21	0.16	12.893	0.025	1.25	14.17	2.59	3.17	5	7.1
	8/3/05	5	0.08	16.136	0.024	1.09	17.25	3.01	3.55	<3	3.0
	8/17/05	7	0.01	12.413	0.013	1.15	13.58	2.84	3.21	9	3.8
.	9/7/05	6	0.05	13.936	0.024	1.61	15.57	2.87	3.33	6	9.5
	9/21/05	12	0.06	12.271	0.021	1.16	13.45	3.00	3.24	<3	7.0
	10/5/05	23	0.04	6.933	0.016	1.17	8.12	1.07	1.14	11	8.5
	10/19/05	4	0.10	17.167	0.028	1.32	18.52	3.08	3.49	10	4.9
	10/25/05*	15	0.08	16.118	0.020	1.76	17.90	3.36	3.73	41	13.9
	10/26/05*	3	0.03	19.593	0.013	1.20	20.81	3.86	4.82	7	5.1
	10/27/05*	3	0.25	19.929	0.014	1.27	21.21	4.01	5.07	3	6.6
	10/28/05*	2	0.08	19.830	0.015	1.09	20.94	4.17	5.31	3	6.6
	11/2/05	4	0.07	20.832	0.072	1.31	22.21	4.22	4.64	<3	8.5
	11/16/05	20	0.18	8.986	0.042	1.50	10.53	1.99	2.35	4	7.2
	12/7/05	5	0.07	15.164	0.025	1.39	16.58	3.32	3.47	5	9.6

TABLE V-4 (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 2005 FOR CFAR PROJECT

Station Name	Sampling Date	Chl. *a* (µg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	TKN (mg/L)	TN (mg/L)	Ortho-Phosphate (mg/L)	TP (mg/L)	TSS (mg/L)	Turbidity (NTU)
Ogden Avenue	1/5/05	14	0.21	4.063	0.042	1.26	5.37	0.81	0.67	15	19.4
	2/2/05	5	0.32	6.840	0.080	0.98	7.90	1.13	1.00	<3	16.4
	3/2/05	10	0.27	3.876	0.031	1.23	5.14	0.71	0.55	14	15.8
	4/6/05	28	0.06	3.260	0.023	0.99	4.27	0.29	0.41	23	15.4
	4/20/05	12	0.19	5.336	0.044	0.88	6.26	0.77	0.77	13	10.7
	5/4/05	135	0.22	6.164	0.028	1.07	7.26	0.89	0.91	16	10.7
	5/18/05	51	0.22	4.586	0.043	1.35	5.98	0.80	0.75	26	14.2
	6/1/05	87	0.14	6.009	0.046	1.10	7.16	1.06	1.12	41	25.3
	6/15/05	4	0.27	7.459	0.111	1.43	9.00	2.26	1.86	12	19.3
	7/6/05	5	0.14	5.579	0.086	1.34	7.01	1.92	2.16	26	18.1
	7/20/05	3	0.13	8.150	0.047	1.32	9.52	2.06	2.16	19	14.8
	7/26/05*	3	0.27	5.325	0.068	1.14	6.53	1.43	1.78	22	19.2
	7/27/05*	8	0.29	4.071	0.077	1.24	5.39	0.88	1.30	84	64.2
	7/28/05*	4	0.28	3.515	0.052	1.22	4.79	0.80	0.93	20	19.4
	7/29/05*	7	0.13	3.821	0.047	1.02	4.89	0.95	1.14	12	17.7
	8/3/05	4	0.17	7.913	0.046	0.98	8.94	1.61	2.18	19	17.6
	8/17/05	2	0.20	6.487	0.033	0.79	7.31	1.48	1.65	29	19.7
	9/7/05	2	0.10	12.308	0.043	0.98	13.33	1.91	2.29	19	10.6
	9/21/05	2	0.12	7.301	0.053	1.09	8.44	1.46	1.64	23	18.1
	10/5/05	4	0.26	4.244	0.068	1.20	5.51	0.88	0.89	37	24.6
	10/19/05	2	ND	ND	ND	ND	ND	1.69	ND	ND	26.4
	10/25/05*	1	0.22	10.869	0.162	1.71	12.74	1.92	2.16	6	17.2
	10/26/05*	1	0.25	11.400	0.103	1.15	12.65	1.84	2.26	7	9.2
	10/27/05*	1	0.37	11.559	0.130	1.30	12.99	1.93	2.22	6	10.9
	10/28/05*	1	0.15	12.317	0.076	1.06	13.45	1.98	2.20	12	11.7
	11/2/05	1	0.06	12.208	0.052	0.66	12.92	2.32	2.31	15	10.7
	11/16/05	6	0.19	6.426	0.090	1.39	7.91	1.36	1.56	13	12.7
	12/7/05	13	0.33	8.944	0.071	1.56	10.58	1.52	1.48	12	8.5

TABLE V-4 (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 2005 FOR CFAR PROJECT

Station Name	Sampling Date	Chl. *a* (µg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	TKN (mg/L)	TN (mg/L)	Ortho-Phosphate (mg/L)	TP (mg/L)	TSS (mg/L)	Turbidity (NTU)
Wolf Road	1/5/05	11	0.19	3.961	0.203	1.08	5.24	0.73	0.71	20	24.8
	2/2/05	5	0.19	9.533	0.388	0.88	10.80	2.06	2.03	14	16.6
	3/2/05	10	0.14	4.970	0.024	1.23	6.22	0.93	0.79	15	9.9
	4/6/05	19	0.16	3.809	0.030	0.93	4.77	0.56	0.55	20	6.1
	4/20/05	29	0.27	6.613	0.073	0.95	7.64	1.22	1.27	28	15.4
	5/4/05	3	0.21	9.733	0.048	1.22	11.00	1.91	2.02	13	4.3
	5/18/05	3	0.31	8.723	0.121	1.26	10.10	2.07	2.06	12	6.8
	6/1/05	2	0.24	11.392	0.093	1.21	12.70	2.34	2.44	14	7.1
	6/15/05	2	0.26	10.977	0.122	0.93	12.03	3.08	2.85	10	7.9
	7/6/05	2	0.24	8.757	0.178	1.40	10.34	3.08	3.38	12	7.1
	7/20/05	1	0.13	13.103	0.072	1.10	14.28	3.32	3.70	<3	7.3
	7/26/05*	4	0.10	7.796	0.056	1.22	9.07	1.92	2.30	23	19.9
	7/27/05*	12	0.35	3.721	0.058	1.17	4.95	0.85	1.16	42	34.2
	7/28/05*	6	0.48	4.822	0.067	1.08	5.97	1.11	1.32	20	18.7
	7/29/05*	10	0.10	6.432	0.037	1.34	7.81	1.39	1.66	10	15.2
	8/3/05	2	0.17	12.217	0.061	0.82	13.10	2.67	2.95	10	9.8
	8/17/05	4	0.10	7.784	0.034	0.88	8.70	1.82	2.09	35	20.5
	9/7/05	1	0.08	15.114	0.070	1.28	16.46	1.97	3.78	8	11.2
	9/21/05	2	0.11	10.310	0.056	1.14	11.51	2.42	2.67	26	18.8
	10/5/05	21	0.16	3.682	0.057	1.26	5.00	0.81	0.86	49	31.7
	10/19/05	2	0.13	16.188	0.074	1.12	17.38	2.67	2.62	37	28.0
	10/25/05*	4	0.14	16.436	0.082	1.67	18.19	3.11	3.46	20	16.7
	10/26/05*	2	0.15	17.543	0.066	1.27	18.88	3.19	3.71	23	15.9
	10/27/05*	2	0.30	16.779	0.064	1.24	18.08	3.04	3.54	17	17.5
	10/28/05*	3	0.10	16.045	0.045	1.61	17.70	2.85	3.53	55	37.5
	11/2/05	2	0.11	17.695	0.060	0.98	18.74	3.63	3.99	29	23.2
	11/16/05	37	0.18	9.507	0.040	1.66	11.21	2.14	2.73	17	17.6
	12/7/05	17	0.40	12.448	0.048	2.04	14.54	2.68	2.69	20	13.4

*Denotes rain event sampling.
ND=No data.

TABLE V-5: NUMBER AND PERCENT OF DISSOLVED OXYGEN VALUES MEASURED ABOVE THE ILLINOIS POLLUTION CONTROL BOARD (IPCB) WATER QUALITY STANDARD[1]

Monitoring Station	Waterway	IPCB DO Standard	Total Number DO Values	Number Above IPCB Standard	Percent Above IPCB Standard
		Chicago River System			
Main Street	North Shore Channel	5	8,139	7,104	87
Foster Avenue	North Shore Channel	4	8,389	8,386	>99
Central Park Avenue	North Branch Chicago River	5	4,285	4,029	94
Addison Street	North Branch Chicago River	4	8,445	8,273	98
Fullerton Avenue	North Branch Chicago River	4	7,870	7,353	93
Kinzie Street	North Branch Chicago River	4	8,728	8,418	96
Clark Street	Chicago River	5	8,652	8,652	100
Loomis Street	South Branch Chicago River	4	8,757	8,741	>99
36th Street	Bubbly Creek	4	7,670	4,832	63
Interstate Hwy. 55	Bubbly Creek	4	7,963	7,079	89
Cicero Avenue	Chicago Sanitary and Ship Canal	4	6,209	5,608	90
B&O Central R.R.	Chicago Sanitary and Ship Canal	4	8,107	8,062	99
Route 83	Chicago Sanitary and Ship Canal	4	7,026	5,831	83
Lockport Powerhouse	Chicago Sanitary and Ship Canal	4	8,313	6,818	82
		Calumet River System			
Hohman Avenue	Grand Calumet River	5	1,683	270	16
Torrence Avenue	Grand Calumet River	4	6,547	5,356	82
C&W Indiana R.R.	Little Calumet River	4	7,866	7,779	99
Halsted Street	Little Calumet River	4	8,254	8,208	99
Wentworth Avenue	Little Calumet River	5	3,527	1,575	45
Ashland Avenue	Little Calumet River	5	8,754	5,031	57
Cicero Avenue	Calumet-Sag Channel	3	8,757	8,732	>99
104th Avenue	Calumet-Sag Channel	3	6,738	6,714	>99
Route 83	Calumet-Sag Channel	3	8,397	8,274	99
		Des Plaines River System			
Busse Lake Dam	Salt Creek	5	1,547	1,547	100
JFK Boulevard	Salt Creek	5	4,058	3,764	93
Thorndale Avenue	Salt Creek	5	4,135	3,834	93
Wolf Road	Salt Creek	5	4,247	4,022	95
Devon Avenue	Des Plaines River	5	1,594	1,594	100
Irving Park Road	Des Plaines River	5	4,120	2,985	72
Ogden Avenue	Des Plaines River	5	4,122	4,108	>99
Material Service Road	Des Plaines River	5	1,029	1,029	100
Jefferson Street	Des Plaines River	4	8,059	7,356	91

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

FIGURE V-1: AMBIENT WATER QUALITY MONITORING AND CONTINUOUS DISSOLVED OXYGEN MONITORING SAMPLE STATIONS

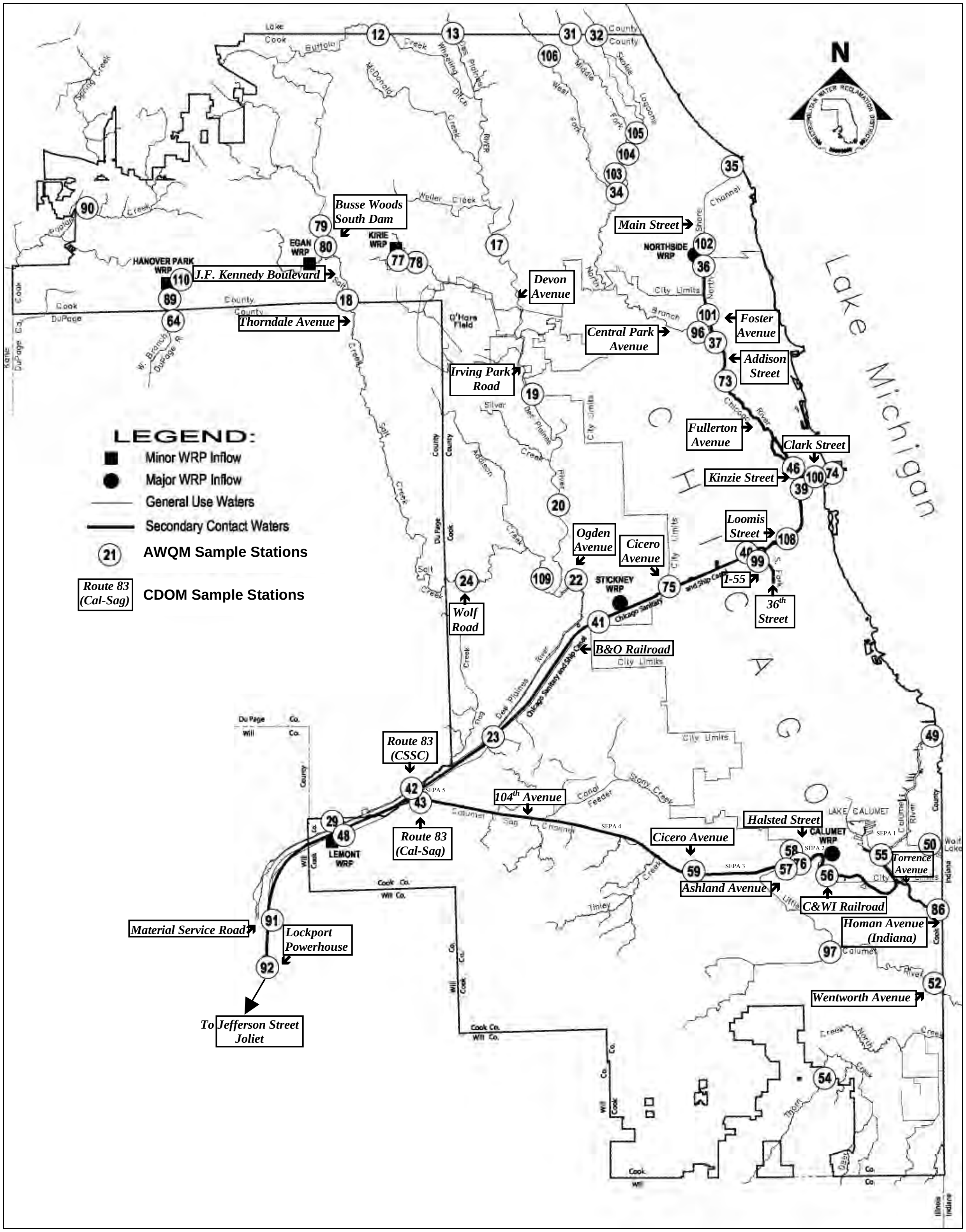


FIGURE V-2: MAP OF THE ILLINOIS WATERWAY FROM LOCKPORT TO MARSEILLES SHOWING SAMPLING STATIONS 1 TO 21

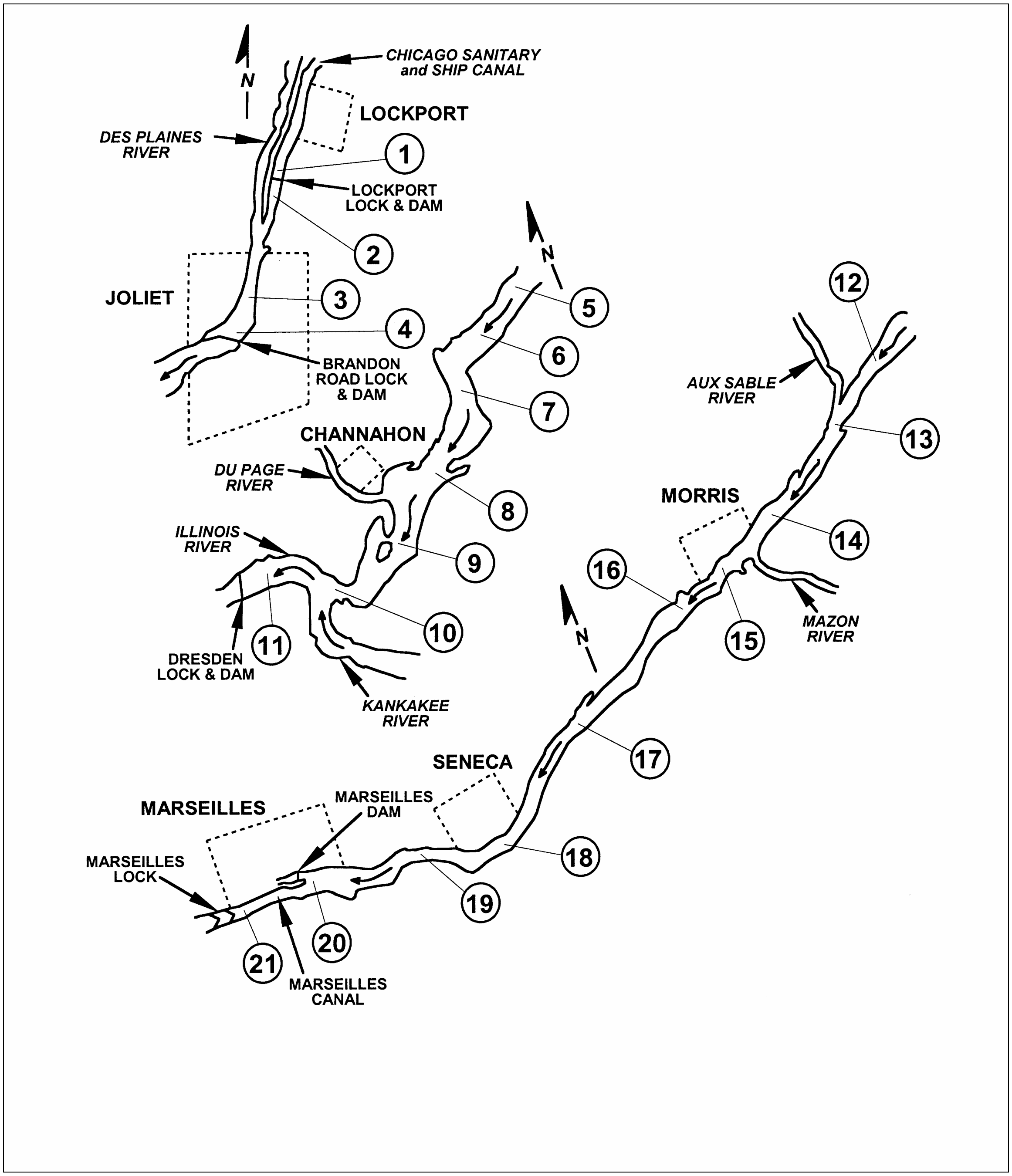


FIGURE V-3: MAP OF THE ILLINOIS WATERWAY FROM OTTAWA TO PEORIA SHOWING SAMPLING STATIONS 22 TO 49

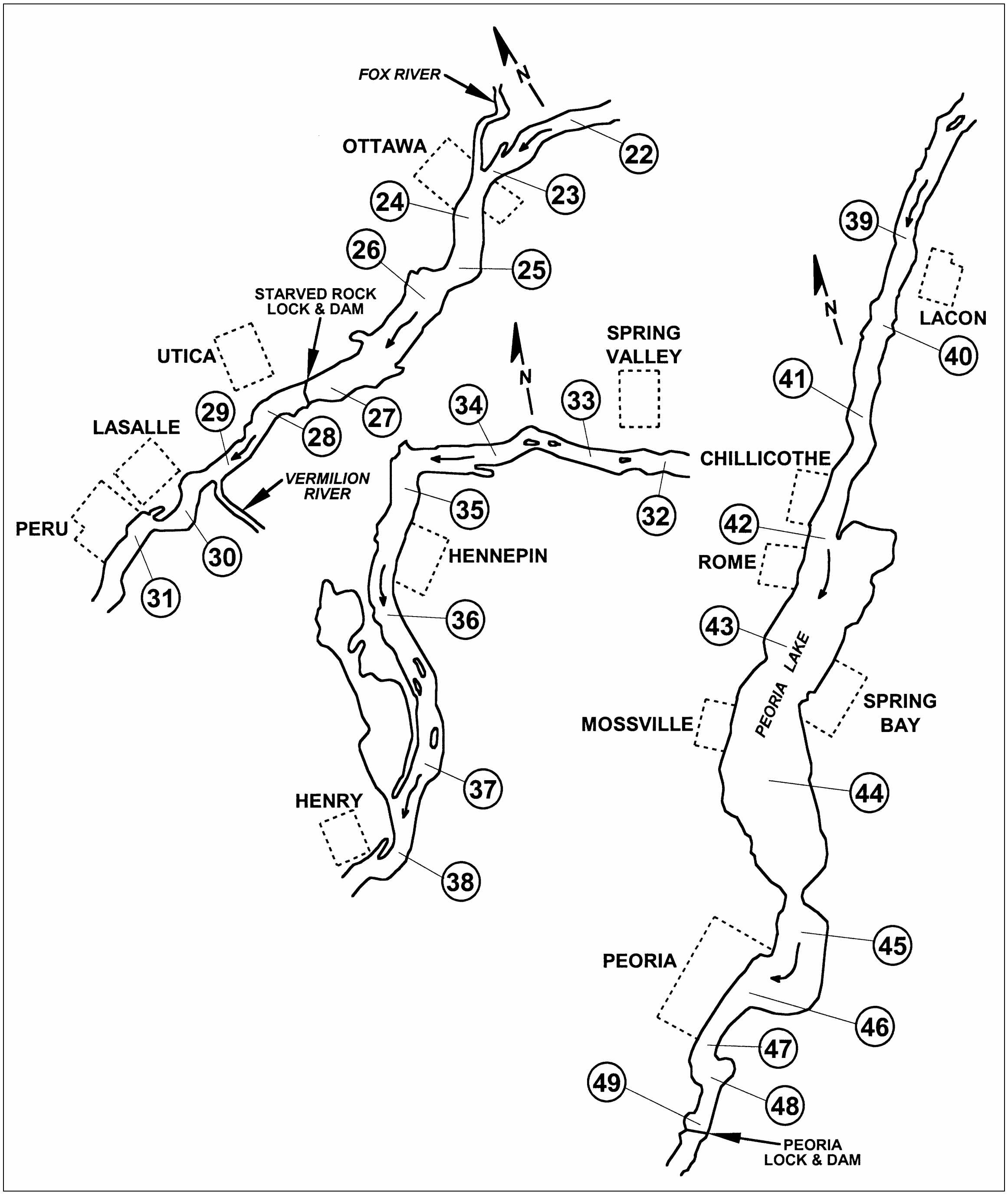
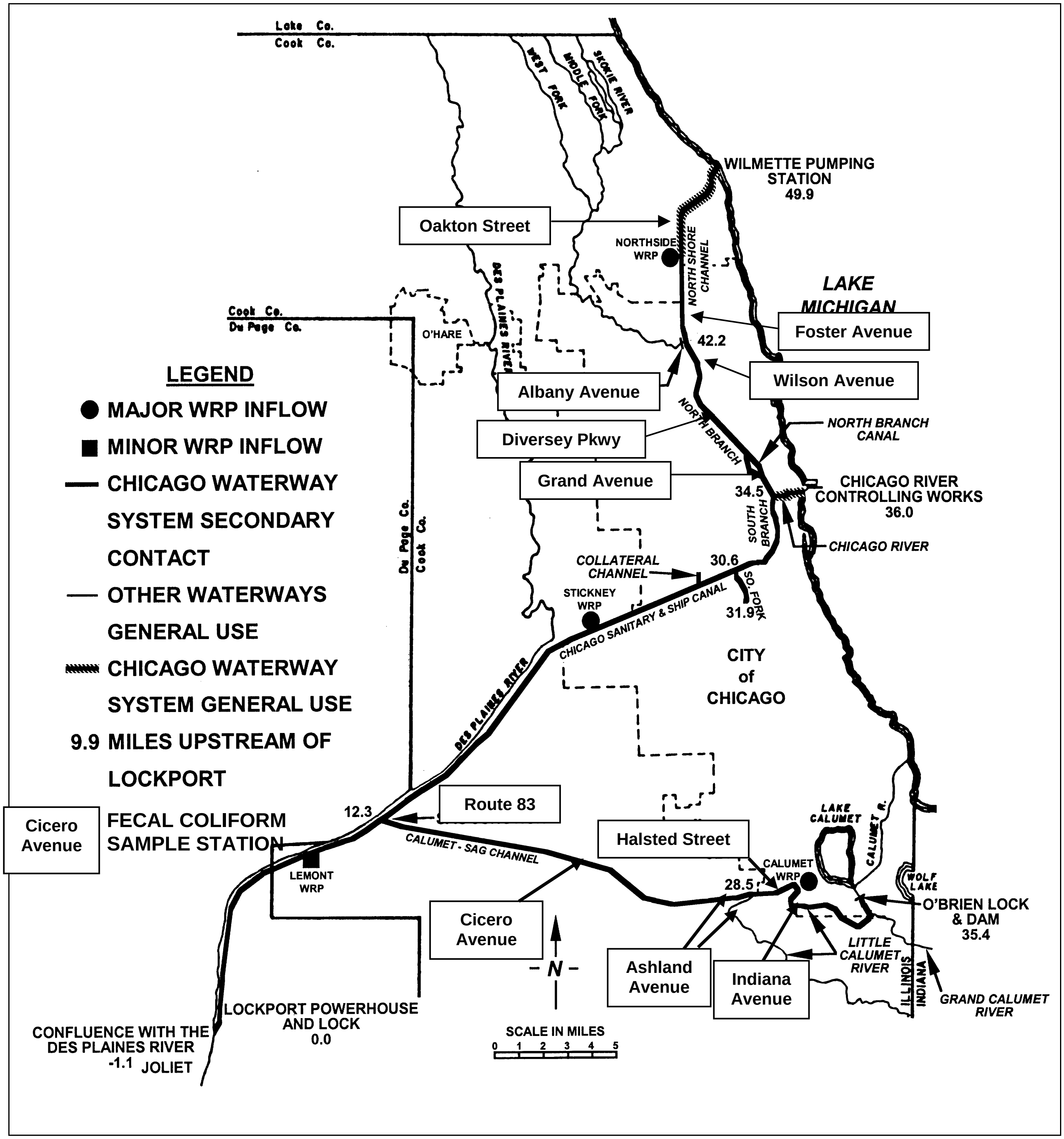


FIGURE V-4: CHICAGO WATERWAY SYSTEM SAMPLE STATIONS FOR FECAL COLIFORM DENSITY STUDY



RADIOCHEMISTRY SECTION

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 section also maintains a radioactive material license issued by the Illinois Emergency Management Agency, Division of Nuclear Safety (IEMA-DNS), assuring that the activities involving use of radioactive material are conducted according to the license conditions and regulations.

The Radiochemistry Laboratory is certified by the IEMA-DNS and is approved for the examination of gross alpha/beta, tritium, and photon emitting radionuclides in public water supplies.

The laboratory participates in the Environmental Resource Associates (ERA) RadChem Proficiency Testing (PT) water study as required by the IEMA-DNS for maintaining laboratory certification. The section also participates in the ERA's MRad Multi-Media Radiochemistry PT Soil Study. This involvement contributes to the state of the profession and further validates the analysis performed by the laboratory.

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 has continued into 2005 since there are radioactivity parameters in the 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 expanded to include raw sludge and digested biosolids from District WRPs and air-dried biosolids ready for final use at all of the Stickney and Calumet solids management areas.

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

Radiation Safety

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

- maintaining the IEMA-DNS radioactive material license;

- managing low-level radioactive waste;
- monitoring personnel for radiation exposure;
- testing the operation of radiation survey meters;
- surveying of the Radiochemistry Laboratory work areas for radiation;
- leak testing the radioactive sealed sources; and
- maintaining a 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 and regulatory requirements of IEMA-DNS.

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 2005, 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 2005. No District employee 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 2005. 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 2005.

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 six detectors from three gas chromatographs in 2005. No leaks were discovered in any detectors used by the District.

Two leak tests each were performed in 2005 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 discovered 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 2005. No leaks were discovered in any of these gauges.

A physical inventory of the radioactive sealed sources possessed by the District was carried out twice in the year 2005. A record of this inventory was maintained as per license requirements.

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 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.

Participation in the ERA Proficiency Testing Program

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

During 2005, the Radiochemistry Section analyzed four water samples for gross alpha, gross beta, barium-133, cobalt-60, cesium-134, cesium-137, zinc-65 and tritium radioactivity. The section also analyzed two soil samples for actinium-228, bismuth-212, bismuth-214, cesium-137, lead-212, lead-214, and potassium-40. The analytical results were reported to the ERA. Acceptable results were obtained on all the samples, except for low cesium-134 activity on one PT water sample.

Regarding the cesium-134 excursion, historically, there has been a constant negative bias for cesium-134 in the USEPA PT studies. The ERA PT studies have shown the same negative bias for cesium-134 within the industry at-large.

According to ERA, the National Environmental Laboratory Accreditation Conference (NELAC) PT subcommittee is currently evaluating a revision of the USEPA National Standard Criteria Document radiochemistry section for acceptance limits to correct this and similar issues.

Levels of Radioactivity in Raw and Treated Wastewaters

Radiological monitoring of raw wastewaters and final effluents from the District's seven WRPs continued in 2005. 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 Illinois. According to IPCB regulations (Title 35, Chapter 1, Section 302.207) gross beta concentration shall not exceed 100 pCi/L, and the strontium-90 concentration must not exceed 2 pCi/L. The annual average radium-226 and 228 combined concentration must not exceed 3.75 pCi/L 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.

Table VI-1 presents the 2005 yearly averages of gross alpha radioactivity for the raw sewage and final effluent from the District's seven WRPs. Slightly elevated levels of radioactivity in Lemont raw sewage has been observed since 1989. This is because the Village of Lemont began utilizing a water treatment process to remove radium from their water supply and discharged the backwash water into the Lemont WRP. However, this backwash from the Lemont drinking water system does not pose a threat to the District's compliance status.

Table VI-2 presents the 2005 yearly averages for gross beta radioactivity in raw sewage and final effluent from the District's seven WRPs.

Levels of Radioactivity in Sludge and Biosolids

In 1993, the Radiochemistry Section revised and expanded its radiological 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 2005, 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. District sludges are analyzed from North Side, Kirie and Lemont WRPs; sludge from these plants are transported to other District facilities for further processing.

Sludge and biosolids samples were processed according to the *Standard Methods* (20th 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.

Table VI-3 presents the gross alpha and gross beta radioactivity data of the District’s sewage sludge an biosolids.

Table VI-4 presents the gross alpha and gross beta radioactivity data for air-dried biosolids from the District's solids management areas.

Sludge and biosolids samples were also processed for the determination of gamma-emitting radionuclides. The samples were dried on hot plates, 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 these elements were detected at measurable levels. The radium-226 activity concentration was calculated from the 186 keV photopeak, cesium-137 radioactivity concentration was calculated from the 661.6 keV photopeak, and potassium-40 radioactivity from the 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.

Table VI-6 presents the potassium-40, radium-226, and cesium-137 concentrations in the District's biosolids from the solids management areas.

Radiological Monitoring of the Chicago Waterways System

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 2005 average values for gross alpha and gross beta radioactivity for the CWS at each of the 45 sampling locations. 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 – 2005

WRP Type of Sample	Gross Alpha Radioactivity (pCi/L)
<u>Stickney</u>	
Raw (West Side)	<5.0
Raw (Southwest)	<7.6
Secondary – Final Effluent	<4.3
<u>Calumet</u>	
Raw	<5.3
Secondary – Final Effluent	<4.5
<u>North Side</u>	
Raw	<4.4
Secondary – Final Effluent	<3.8
<u>Hanover Park</u>	
Raw	<4.6
Tertiary – Final Effluent	<4.1
<u>John E. Egan</u>	
Raw	<4.8
Tertiary – Final Effluent	<4.2
<u>Lemont</u>	
Raw	24.2
Secondary – Final Effluent	<10.5
<u>James C. Kirie</u>	
Raw	<5.1
Tertiary – Final Effluent	<4.7

< = Less than the lower limit of detection.

TABLE VI–2: AVERAGE GROSS BETA RADIOACTIVITY IN RAW AND TREATED WASTEWATER FROM DISTRICT WRPs - 2005

WRP Type of Sample	Gross Beta Radioactivity (pCi/L)
Stickney	
Raw (West Side)	14.0
Raw (Southwest)	21.6
Secondary – Final Effluent	8.8
Calumet	
Raw	12.1
Secondary – Final Effluent	8.3
North Side	
Raw	10.3
Secondary – Final Effluent	7.4
Hanover Park	
Raw	13.3
Tertiary – Final Effluent	10.8
John E. Egan	
Raw	13.7
Tertiary – Final Effluent	10.9
Lemont	
Raw	34.9
Secondary – Final Effluent	24.9
James C. Kirie	
Raw	16.1
Tertiary – Final Effluent	15.2

TABLE VI–3: GROSS ALPHA AND GROSS BETA RADIOACTIVITY OF WRP SLUDGES AND BIOSOLIDS - 2005

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	13.6	10.9	16.3	23.2	19.3	26.6
John E. Egan Digester Draw	12	10.1	7.8	14.2	17.6	13.9	21.3
Lemont[1] Activated Sludge	11	110.4	72.4	167.9	68.6	42.4	110.4
Hanover Park Digester Draw	12	8.0	4.6	10.4	12.4	10.2	15.1
James C. Kirie[1] Activated Sludge	12	7.9	5.4	11.6	14.8	10.4	19.2
North Side[1] Activated Sludge	12	7.1	4.2	8.6	13.5	9.8	19.0
Stickney Digester Draw	12	11.3	6.8	16.2	23.2	14.2	28.6

[1]No digesters at this WRP.

TABLE VI–4: GROSS ALPHA AND GROSS BETA RADIOACTIVITY IN DISTRICT SOLIDS MANAGEMENT AREA BIOSOLIDS - 2005

Drying Site Location	No. of Samples	Gross Alpha (pCi/g DW)			Gross Beta (pCi/g DW)		
		Average	Minimum	Maximum	Average	Minimum	Maximum
LASMA	4	16.0	13.3	18.1	22.2	15.6	27.2
Calumet East	5	11.8	7.1	13.6	24.7	21.8	26.7
Calumet West	5	13.7	10.6	15.6	24.1	23.4	25.5
HASMA	5	17.8	13.5	24.4	26.8	21.5	30.6
Marathon	4	17.2	16.0	19.5	27.7	25.4	29.7
Stony Island	5	13.6	8.0	16.4	26.2	20.4	29.4
Vulcan	5	15.5	9.3	20.2	27.4	21.8	31.3
RASMA	5	15.3	10.9	20.7	26.6	23.2	31.4

TABLE VI–5: CONCENTRATION OF GAMMA-EMITTING RADIONUCLIDES IN WRP SLUDGE AND BIOSOLIDS – 2005

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	8.3	7.4	9.2	4.4	3.8	4.8	0.05	0.04	0.06
John E. Egan	4	6.9	6.2	7.6	3.9	3.6	4.6	ND	ND	ND
Hanover Park	4	4.7	3.8	5.3	3.1	2.4	3.7	ND	ND	ND
Stickney	4	9.9	8.5	11.5	3.5	3.3	3.8	0.06	0.05	0.06
Lemont	4	6.1	4.9	7.7	70.8	63.2	86.3	ND	ND	ND

ND – Not Detected

TABLE VI–6: CONCENTRATION OF GAMMA-EMITTING RADIONUCLIDES IN DISTRICT SOLIDS MANAGEMENT AREA BIOSOLIDS – 2005

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	8.0	7.3	9.4	4.7	4.2	5.2	0.06	0.06	0.07
Calumet West	5	9.7	7.4	12.6	4.3	3.7	5.2	0.06	ND	0.08
RASMA	5	9.9	9.5	10.4	3.8	3.6	4.0	0.07	0.06	0.09
Stony Island	5	8.8	7.8	9.3	4.0	3.6	4.3	0.07	0.06	0.08
HASMA	5	9.2	8.2	9.7	4.0	3.8	4.2	0.08	0.06	0.10
LASMA	4	8.6	3.4	11.1	3.7	3.4	3.9	0.06	ND	0.08
Marathon	4	10.0	9.3	11.3	3.8	3.6	4.0	0.08	0.07	0.08
Vulcan	5	9.9	8.3	12.6	3.7	3.4	3.9	0.07	0.06	0.08

ND – Not Detected

TABLE VI–7: AVERAGE GROSS ALPHA AND GROSS BETA RADIOACTIVITY FOR THE CHICAGO WATERWAYS SYSTEM - 2005

Location	Gross Alpha (pCi/L)	Gross Beta (pCi/L)
Lake-Cook Rd., Des Plaines River	<5.3	11.4
Oakton Street, Des Plaines River	<5.3	10.2
Belmont Ave., Des Plaines River	<5.4	11.6
Roosevelt Road, Des Plaines River	<5.0	10.9
Ogden Avenue, Des Plaines River	<5.1	11.0
Willow Springs Rd., Des Plaines River	<4.9	10.7
Stephen Street, Des Plaines River	<4.9	10.9
Material Service Rd., Des Plaines River	<5.7	12.3
Lake-Cook Rd., Buffalo Creek	<5.2	6.6
Elmhurst Rd., Higgins Creek	<7.8	11.2
Wille Rd., Higgins Creek	<4.8	15.4
Higgins Rd., Salt Creek	<6.3	8.3
Arlington Heights Rd., Salt Creek	<5.7	10.3
Devon Ave., Salt Creek	<5.8	11.0
Wolf Rd., Salt Creek	<4.8	11.4
Brookfield Ave., Salt Creek	<4.8	10.7
Route 19, Popular Creek	<5.2	6.8
Springinsguth Rd., W. Br. Dupage River	<6.5	8.5
Walnut Lane, W. Br. Dupage River	<4.8	10.6

TABLE VI-7: (Continued) AVERAGE GROSS ALPHA AND GROSS BETA RADIOACTIVITY FOR THE CHICAGO WATERWAYS SYSTEM - 2005

Location	Gross Alpha (pCi/L)	Gross Beta (pCi/L)
Lake St., W. Br. Dupage River	<5.1	10.9
Central St., N. Shore Channel	<3.3	4.3
Oakton St., N. Shore Channel	<4.1	6.9
Touhy Avenue, N. Shore Channel	<4.3	7.9
Dundee Rd., W. Fork N. Branch, Chicago River	<6.2	11.6
Golf Rd., W. Fork N. Branch, Chicago River	<7.1	11.0
Lake-Cook Rd., Middle Fork, N. Branch, Chicago River	<5.3	7.2
Glenview Rd., Middle Fork, N. Branch, Chicago River	<5.5	11.3
Lake-Cook Rd., Skokie River	<5.5	8.8
Frontage Rd., Skokie River	<5.0	10.8
Dempster St., N. Br., Chicago River	<5.9	11.5
Albany Ave., N. Br., Chicago River	<5.4	10.6
Lake Shore Dr., Chicago River	<3.2	4.3
Wells St., Chicago River	<3.6	5.6
Cicero Ave., Chicago Sanitary & Ship Canal	<4.2	7.4
Harlem Ave., Chicago Sanitary & Ship Canal	<4.3	8.0
Lockport, Chicago Sanitary and Ship Canal	<4.5	8.7
Ewing Ave., Calumet River	<3.0	5.0
130^{th} St., Calumet River	<3.5	6.1
Burnham Ave., Wolf Lake	<3.3	4.9

TABLE VI-7: (Continued) AVERAGE GROSS ALPHA AND GROSS BETA RADIOACTIVITY FOR THE CHICAGO WATERWAYS SYSTEM – 2005

Location	Gross Alpha (pCi/L)	Gross Beta (pCi/L)
Indiana Ave., Little Calumet River	<3.6	6.6
Halsted St., Little Calumet River	<4.7	9.1
Wentworth Ave., Little Calumet River	<4.9	10.9
Ashland Ave., Little Calumet River	<6.2	11.2
Joe Orr Road, Thorn Creek	<8.9	15.3
170^{th} St., Thorn Creek	<7.0	13.0

< = Less than the lower limit of detection.

APPENDIX I

APPENDIX I

MEETINGS AND SEMINARS 2005
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

1. Calumet Government Working Group, 2005 First Quarter Meeting, Chicago, Illinois, January 2005.

2. DuPage River, Salt Creek Watershed Workgroup Meeting, Elmhurst, Illinois, January 2005.

3. Evanston Board of Environment Meeting, Evanston, Illinois, January 2005.

4. Illinois Water Environment Association, Government Affairs in Water Pollution Control Seminar, Lisle, Illinois, January 2005.

5. Midwest Water Analysts Association, Winter Expo 2005, Kenosha, Wisconsin, January 2005.

6. United States Department of Agriculture, CSRS Regional Research Committee W-170 Annual Meeting, Las Vegas, Nevada, January 2005.

7. United States Environmental Protection Agency, Nutrient Mapping Workshop, Chicago, Illinois, January 2005.

8. DuPage River, Salt Creek Watershed Workgroup Monitoring Dissolved Oxygen Sub-committee Meeting, Downers Grove, Illinois, February 2005.

9. Illinois Environmental Protection Agency, Nutrient Standards Workgroup and Science Committee Meeting, Springfield, Illinois, February 2005.

10. Illinois Pollution Control Board, Hearing on Dissolved Oxygen Standards, Springfield, Illinois, February 2005.

11. Illinois Water Environment Association, Industrial Pretreatment and Hazardous Waste Winter Meeting, Lombard, Illinois, February 2005.

12. United States Environmental Protection Agency, Region V, 2005 Midwest Surface Water Monitoring and Standards Meeting, Chicago, Illinois, February 2005.

13. United States Geological Survey, Major Accomplishments and Future Directions in Public Health Microbiology Workshop, Columbus, Ohio, February 2005.

14. University of Illinois Chicago, Nitrogen Isotope Study, Chicago, Illinois, February 2005.

15. Water Environment Research Foundation, Specialty Conference Disinfection 2005, Mesa, Arizona, February 2005.

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MEETINGS AND SEMINARS 2005
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

16. Water Environment Research Foundation, Workshop on Microbial Source Tracking, San Antonio, Texas, February 2005.

17. DuPage River, Salt Creek Watershed Workgroup Meeting, Elmhurst, Illinois, March 2005.

18. Illinois Chapter of American Fisheries Society Meeting, Moline, Illinois, March 2005.

19. Illinois Water Environment Association, 26th Annual Conference, Rockford, Illinois, March 2005.

20. United States Environmental Protection Agency, Nutrient Regional Technical Assistance Group Meeting, Chicago, Illinois, March 2005.

21. Calumet Government Working Group, 2005 Second Quarter Meeting, Chicago, Illinois, April 2005.

22. Illinois Association of Pollution Control Operators, 2005 Annual Conference, Springfield, Illinois, April 2005.

23. Water Environment Federation, Joint Residuals and Biosolids Management Conference 2005, Nashville, Tennessee, April 2005.

24. DuPage River, Salt Creek Watershed Workgroup Meeting, Itasca, Illinois, May 2005.

25. North American Benthological Society, Annual Meeting, New Orleans, Louisiana, May 2005.

26. Soil Ecology Society, 2005 Conference, Argonne, Illinois, May 2005.

27. Water Environment Research Foundation, Biosolids Research Summit TCR Steering Committee Meeting, Washington, D. C., May 2005

28. American Society for Microbiology, 105th General Meeting on Infectious Diseases, Atlanta, Georgia, June 2005.

29. Aquatic Nuisance Species Dispersal Barrier Advisory Panel Meeting, Chicago, Illinois, June 2005.

30. Midwest Water Analysts Association, 2005 Spring Meeting, Dundee, Illinois, June 2005.

31. Water Environment Federation, 2005 Conference Series, Innovative Uses of Agricultural Animal Manure, Biosolids, and Paper Mill Residuals, Chicago, Illinois, June 2005.

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MEETINGS AND SEMINARS 2005
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

32. DuPage River, Salt Creek Watershed Workgroup Meeting, Itasca, Illinois, July 2005.

33. DuPage River, Salt Creek Watershed Workgroup Meeting, Downers Grove, Illinois, August 2005.

34. DuPage River, Salt Creek Watershed Workgroup Meeting, Oak Brook, Illinois, August 2005.

35. DuPage River, Salt Creek Watershed Workgroup Meeting, Elmhurst, Illinois, August 2005.

36. Illinois Environmental Protection Agency and Illinois Association of Wastewater Agencies, Dissolved Oxygen Meeting, Springfield, Illinois, August 2005.

37. Illinois Pollution Control Board, Hearing on Proposed Change in Dissolved Oxygen Standards, Chicago, Illinois, August 2005.

38. United States Environmental Protection Agency, Meeting on Pharmaceuticals in the Environment, Las Vegas, Nevada, August 2005.

39. United States Environmental Protection Agency, Region V, Mussel Toxicity Testing Workshop, Chicago, Illinois, August 2005.

40. DuPage River, Salt Creek Watershed Workgroup Meeting, Elmhurst, Illinois, September 2005.

41. Friends of the Chicago River, North Branch Dam Removal Meeting, Chicago, Illinois, September 2005.

42. Midwest Water Analysts Association, 2005 Fall Meeting, Glencoe, Illinois, September 2005.

43. Northwest Biosolids Management Association Conference, Chelan, Washington, September 2005.

44. United States Environmental Protection Agency, Eighth Conference on Air Quality Monitoring, Research Triangle Park, North Carolina, September 2005.

45. Upper Mississippi River, Sub-Basin Hypoxia Nutrient Committee Workshop, Ames, Iowa, September 2005.

46. Air and Waste Management Association, Lake Michigan Section, 2005 Air Quality Management Conference, Oak Brook, Illinois, October 2005.

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MEETINGS AND SEMINARS 2005
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

47. Calumet Government Working Group, 2005 Third Quarter Meeting, Chicago, Illinois, October 2005.

48. DuPage River, Salt Creek Watershed Workgroup Meeting, Downers Grove, Illinois, October 2005.

49. DuPage River, Salt Creek Watershed Workgroup Monitoring Dissolved Oxygen Sub-committee Meeting, Itasca, Illinois, October 2005.

50. DuPage River, Salt Creek Watershed Workgroup Meeting, Elmhurst, Illinois, October 2005.

51. Governors Conference on Management of the Illinois River, Peoria, Illinois, October 2005.

52. Illinois Association of Water Pollution Control Operators, Regional Wastewater Operators Conference, Aurora, Illinois, October 2005.

53. Illinois Environmental Protection Agency, Biocriteria Meeting, Springfield, Illinois, October 2005.

54. Mississippi River Nutrient Science Workgroup, St. Louis, Missouri, October 2005.

55. Radiobioassay and Radiochemical Measurements 51st Annual Conference, Stateline, Nevada, October 2005.

56. Water Environmental Federation, 78th Annual Technical Exhibition and Conference, Washington, D. C., October 2005.

57. Water Environment Research Foundation, Program Directed Research Initiative Meeting, Modeling of Activated Sludge Processes Workshop, Odor and Air Emissions Workshop, and Workshop on Biosolids Sampling and Handling Methods for United States Environmental Protection Agency Approved Microbial Detection Techniques, Washington, D.C., October 2005.

58. Great Lakes Beach Association, Lake Michigan: State of the Lake Meeting, Green Bay, Wisconsin, November 2005.

59. Industrial Water, Waste, and Sewage Group Dinner Meeting, Chicago, Illinois, November 2005.

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MEETINGS AND SEMINARS 2005
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

60. Society of Environmental Toxicology and Chemistry, North America 26^{th} Annual Meeting, Baltimore, Maryland, November 2005.

61. Soil Science Society of America, Annual Meeting, Salt Lake City, Utah, November 2005.

62. Calumet Government Working Group, 2005 Fourth Quarter Meeting, Chicago, Illinois, December 2005.

63. DuPage River, Salt Creek Watershed Workgroup Hydrolab Workshop, Woodridge, Illinois, December 2005.

64. DuPage River, Salt Creek Watershed Workgroup Monitoring Dissolved Oxygen Subcommittee Meeting, Downers Grove, Illinois, December 2005.

65. Illinois Environmental Protection Agency, Nutrient Standards Workgroup and Science Committee Meeting, Springfield, Illinois, December 2005.

APPENDIX II

APPENDIX II

PRESENTATIONS 2005
ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

1. "Chlorophyll and Nutrient Monitoring in Chicago's Urban Waterways." Presented at the Nutrient Regional Technical Assistance Group Meeting, Chicago, Illinois, by Jennifer Wasik, March 2005. PP

2. "Effect of Wastewater Biological Nutrient Removal on Biosolids Phosphorus." Presented at the Illinois Association of Pollution Control Operators Annual Conference, Springfield, Illinois, by Albert E. Cox and Thomas C. Granato, April 2005. PP

3. "Marketing Biosolids for Beneficial Use in the Chicago Metropolitan Area." Presented at the Water Environment Federation, Joint Residuals and Biosolids Management Conference 2005, Nashville, Tennessee, by Thomas C. Granato, Albert E. Cox, Lakhwinder Hundal, Bernard Sawyer, and Richard Lanyon, April 2005. B

4. "Evaluation of the Impact of Biosolids Application on Soil Microorganisms: Nitrifier and Denitrifier Populations." Presented at the Soil Ecology Society Conference, Argonne, Illinois, Guanglong Tian, Thomas C. Granato, Richard I. Pietz, and Albert E. Cox, May 2005. PP

5. "Comparison of Fecal Coliform Concentrations in Two Urban Rivers: The Chicago Sanitary and Ship Canal and the Des Plaines River." Presented at the American Society of Microbiology, 105th General Meeting of Infectious Diseases, Atlanta, Georgia, by Geeta K. Rijal, Zainul Abedin, James Zmuda, Richard Gore, Bernard Sawyer, and Richard Lanyon, June 2005. PS

6. "The Metropolitan Water Reclamation District of Greater Chicago's Efforts to Reduce Pharmaceuticals that Enter the Water Reclamation Plants." Presented at the United States Environmental Protection Agency, Meeting on Pharmaceuticals in the Environment, Las Vegas, Nevada, by Catherine O'Connor, Thomas C. Granato, and Richard Lanyon. August 2005. B

7. "Biosolids as a Resource for Managing Golf Course Turfgrasses." Presented at the Midwest Association of Golf Course Superintendents Meeting, Worth, Illinois, by Thomas C. Granato, Lakhwinder Hundal, Pauline V. Lindo, Guanglong Tian, Thomas Voigt, and Dan Dinelli. September 2005. PP

8. "Biosolids Management at the Metropolitan Water Reclamation District of Greater Chicago." Presented at the Northwest Biosolids Management Conference, Chelan, Washington, by Albert E. Cox and Thomas C. Granato, September 2005. PP

APPENDIX II

PRESENTATIONS 2005
ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

9. "Ambient Monitoring of Low Level Hydrogen Sulfide." Presented at the Water Environment Federation, 78th Annual Technical Exhibition and Conference, Washington, D.C., by Doris Bernstein, Jain S. Jain, and Bernard Sawyer, October 2005. B

10. "Chlorophyll a and Nutrient Monitoring in the Illinois Waterway." Presented at the Mississippi River Nutrient Science Workshop, St. Louis, Missouri, by Jennifer Wasik, October 2005. PP

11. "Radon Monitoring at the Metropolitan Water Reclamation District of Greater Chicago." Presented at the Radiobioassay and Radiochemical Measurements 51st Annual Conference, Stateline, Nevada, by Abdul Khalique, Richard I. Pietz, and Richard Lanyon, October 2005. PP

12. "Effect of Biosolids Land Application on Turfgrass Performance." Presented at the Soil Science Society of America Annual Meeting, Salt Lake City, Utah, by Pauline V. Lindo, Albert E. Cox, and Thomas C. Granato, November 2005. PS

13. "Innovative and Beneficial Uses of Biosolids – The Metropolitan Water Reclamation District of Greater Chicago Experience." Presented at the University of Toledo, Department of Civil Engineering Seminar Series, Toledo, Ohio, by Lakhwinder Hundal, November 2005. PP

14. "Long-term Biosolids Land Application on Potential for P Runoff Losses." Presented at the Soil Science Society of America Annual Meeting, Salt Lake City, Utah, by Albert E. Cox, Thomas C. Granato, Guanglong Tian, George O'Connor, and Herschel Elliott, November 2005. PP

15. "Continuous Dissolved Oxygen Monitoring in Chicago Area Waterways: Network Design and Operation." Presented at the DuPage, Salt Creek Watershed Workgroup Hydrolab Workshop, Woodridge, Illinois, by Michael Sopcak and Thomas Minarik, December 2005. 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 2005
ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

1. Bernstein, D., J. S. Jain, and B. Sawyer, "Ambient Monitoring of Low Level Hydrogen Sulfide." Proceedings of Water Environment Federation, 78th Annual Technical Exhibition and Conference, Washington, D.C., 2005.

2. Cox, A. E., T. C. Granato, G. Tian, G. O'Connor, and H. Elliott, "Long-term Biosolids Land Application on Potential for P Runoff Losses." Proceedings of the Soil Science Society of America, Annual Meeting, Salt Lake City, Utah, 2005.

3. Granato, T. C., A. E. Cox, L. Hundal, B. Sawyer, and R. Lanyon, "Marketing Biosolids for Beneficial Use in the Chicago Metropolitan Area." Proceedings of the Water Environment Federation, Joint Residuals and Biosolids Management Conference 2005, Nashville, Tennessee, 2005.

4. Khalique, A, R. I. Pietz, and R. Lanyon, "Radon Monitoring at the Metropolitan Water Reclamation District of Greater Chicago." Proceedings of the Radiobioassay and Radiochemical Measurements 51st Annual Conference, Stateline, Nevada, 2005.

4. Lindo, P., A. E. Cox, and T. C. Granato, "Effect of Biosolids Land Application on Turfgrass Performance." Proceedings of the Soil Science Society of America, Annual Meeting, Salt Lake City, Utah, 2005.

5. O'Connor, C., T. C. Granato, and R. Lanyon, "The Metropolitan Water Reclamation District of Greater Chicago's Efforts to Reduce Pharmaceuticals that Enter the Water Reclamation Plants." Proceedings of the United States Environmental Protection Agency, Meeting on Pharmaceuticals in the Environment, Las Vegas, Nevada, 2005.

6. Rijal, G. K., Z. Abedin, J. Zmuda, R. Gore, B. Sawyer, and R. Lanyon, "Comparison of Fecal Coliform Concentrations in Two Urban Rivers: The Chicago Sanitary and Ship Canal and the Des Plaines River." Proceedings of the American Society of Microbiology, 105th General Meeting of Infectious Diseases, Atlanta, Georgia, 2005.

7. Wasik, J., "Chlorophyll a and Nutrient Monitoring in the Illinois Waterways." Proceedings of the Mississippi River Nutrient Science Workshop, St. Louis, Missouri, 2005.

APPENDIX IV

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
RESEARCH AND DEVELOPMENT DEPARTMENT
2005 SEMINAR SERIES

Date	Subject
Friday **January 28, 2005**	***Ecosystem-Based Approach to Remediation of PCB Contaminated River Sediments: A Case Study*** Dr. Cecil Lue-Hing Cecil Lue-Hing & Associates, Chicago, Illinois
Friday **February 25, 2005**	***Mechanism Explaining Seasonal Biological Foaming in Activated Sludge*** Professor Lutgarde Raskin University of Illinois, Champaign, Illinois
Friday **March 18, 2005**	***Nutrients, Chlorophyll, and Dissolved Oxygen in Illinois Rivers and Streams*** Professor Mark David University of Illinois, Champaign, Illinois
Friday **April 22, 2005**	***Endocrine Disruptors and Other Trace Contaminants in Wastewater*** Professor Makram Suidan University of Cincinnatti, Cincinnatti, Ohio
Friday **May 20, 2005**	***Clean Air Act Issues Related to Wastewater Treatment Plants*** Mr. Jay Witherspoon, Director CH2M Hill, Oakland, California
Friday **June 24, 2005**	***Hydraulic Modeling of the Calumet TARP System*** Professor Arthur Schmidt University of Illinois, Champaign, Illinois

RESERVATIONS REQUIRED (at least 24 hours in advance)
CONTACT:
Mr. Bernard Sawyer, Assistant Director of Research and 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
2005 SEMINAR SERIES

Date	Subject
Friday **July 29, 2005**	***Calumet Water Reclamation Plant Master Plan*** Mr. Jeffrey Weber, Principal Mechanical Engineer Engineering Department Metropolitan Water Reclamation District of Greater Chicago (District), Chicago, Illinois Mr. Dean Schmidtke, Project Manager Metcalf and Eddy Engineers, Chicago, Illinois
Friday **August 26, 2005**	***Development of a Biosolids EMS*** Mr. Sergio Serafino, Supervising Civil Engineer Maintenance and Operations Department District, Chicago, Illinois
Friday **September 30, 2005**	***District/USEPA/IEPA Cooperative WET Testing Study*** Dr. James Zmuda, Microbiologist Research and Development Department District, Cicero, Illinois
Friday **October 21, 2005**	***A Review of Disinfection Technologies and their Applicability to Future District Needs*** Dr. David Zenz, Senior Associate CTE Engineers, Chicago, Illinois
Friday **November 18, 2005**	***Full Scale Nutrient Removal Test at Egan Water Reclamation Plant/WERF Nutrient Removal Project*** Dr. Heng Zhang, Research Scientist Research and Development Department District, Cicero, Illinois

RESERVATIONS REQUIRED (at least 24 hours in advance)
CONTACT:
Mr. Bernard Sawyer, Assistant Director of Research and 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

Granato, Thomas, Assistant Director of R&D (84059)
Messina, Deborah, Secretary (84264)
O'Connor, Catherine, Research Scientist 4 (84116)
Abedin, Zainul, Biostatistician (83672)
Urlacher, Nancy, Administrative Assistant (84176)

Section 122 – Wastewater Treatment Process Research Section	Section 123 – Biosolids Utilization and Soil Science Section	Section 124 – Analytical Microbiology and Biomonitoring Section
Jain, Jain, Research Scientist 3 (84068)	*Cox, Albert*, Soil Scientist 3 (84054)	*Zmuda, James*, Microbiologist 4 (84224)
Lordi, David, Research Scientist 3 (84072)	*Yarn, Sabina*, Prin. Office Support (83615)	*Griffith, Rhonda*, Prin. Office Support (84251)
Franklin, Laura, Prin. Office Support (83625)	*Hundal, Lakhwinder*, Soil Scientist 2 (84201)	*Rijal, Geeta*, Microbiologist 3 (83767)
Patel, Kamlesh, Research Scientist 2 (83735)	*Vacant*, Soil Scientist 2	*Gore, Richard*, Microbiologist 2 (84112)
Zhang, Heng, Research Scientist 2 (84069)	*Lindo, Pauline*, Soil Scientist 1 (84109)	*Yamanaka, Jon*, Biologist 1 (84225)
Bernstein, Doris, Research Scientist 1 (84108)	*Tian, Guanglong*, Soil Scientist 1 (83579)	*Billett, George*, Lab Tech 2 (83721)
Vacant, Research Scientist 1	*Dennison, Odona*, Sanitary Chemist 1 (84246)	*Jackowski, Kathleen*, Lab Tech 2 (83637)
MacDonald, Dale, Research Scientist 1 (83472)	*Patel, Minaxi*, Sanitary Chemist 1 (84066)	*Maka, Andrea*, Lab Tech 2 (83629)
Oskouie, Ali, Research Scientist 1 (84070)	*Mackoff, Ilyse*, Lab Tech 2 (83770)	*Rahman, Shafiq*, Lab Tech 2 (83775)
Haizel, Anthony, Lab Tech 2 (83577)	*Tate, Tiffany*, Lab Tech 2 (83655)	*Shukla, Hemangini*, Lab Tech 2 (84220)
Reddy, Thota, Lab Tech 2 (83736)	*Patel, Upendra*, Lab Tech 1 (83769)	*Hussaini, Syed*, Lab Tech 1 (84220)
Bodnar, Robert, Lab Tech 1 (83750)	*Shingles, Craig*, Lab Tech 1 (83796)	*Kaehn, James*, Lab Tech 1 (83775)
Byrnes, Marc, Lab Tech 1 (83750)	*Adams, Richard*, Lab Assistant (83765)	*Mangkorn, Damrong*, Lab Tech 1 (83721)
Vacant, Lab Tech 1	*Gadbois, Claire*, Lab Assistant (83766)	*Roberts, David*, Lab Tech 1 (83637)
Pierson, Rodney, Lab Tech 1 (83751)		*Burke, Michael*, Lab Assistant (83637)
Swies, Christopher, Lab Tech 1 (83750)		*Latimore, Thomas*, Lab Assistant (83713)

Section 125 – Land Reclamation and Soil Science - Fulton County (309-647-8200)	Section 126 – Aquatic Ecology and Water Quality Section	Section 128 – Radiochemistry Section
Boucek, Jr., Emil, Field and Lab Tech	*Dennison, Sam*, Biologist 4 (84060)	*Khalique, Abdul*, Radiation Chemist (84071)
DeWees, Josh, Field and Lab Tech	*Scrima, Joan*, Prin. Office Support (84168)	*Abdussalam, Tasneem*, San Chemist 1 (83324)
Swango, Rosalie, Field and Lab Tech	*Sopcak, Michael*, Biologist 3 (83748)	*Robinson, Harold*, Lab Tech 1 (83811)
	Wasik, Jennifer, Biologist 2 (84074)	
	Minarik, Thomas, Biologist 1 (84223)	
	Gallagher, Dustin, Lab Tech 2 (83798)	
	Rohe, Donald, Lab Tech 2 (83739)	
	Schackart, Richard, Lab Tech 2 (83744)	
	Vick, Justin, Lab Tech 2 (83764)	
	Lansiri, Panu, Lab Tech 1 (83749)	
	Whitington, Angel, Lab Tech 1 (83794)	

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