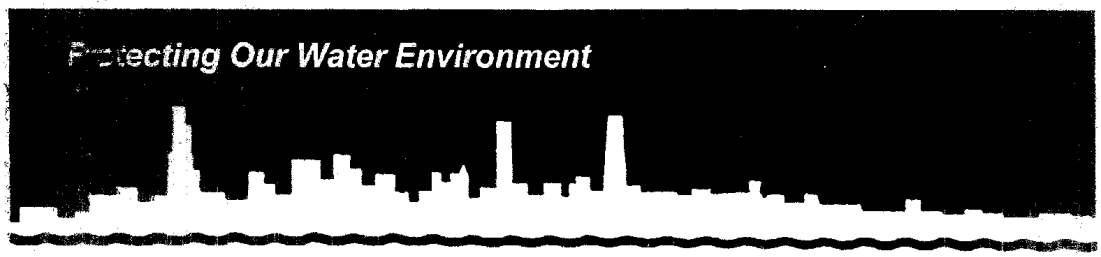

Metropolitan Water Reclamation District of Greater Chicago

RESEARCH AND DEVELOPMENT DEPARTMENT

REPORT NO. 01-7

RESEARCH AND DEVELOPMENT

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

1999

ANNUAL REPORT

March 2001

Metropolitan Water Reclamation District of Greater Chicago
100 East Erie Street Chicago, IL 60611-2803 (312) 751-5600

RESEARCH AND DEVELOPMENT

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

1999

ANNUAL REPORT

Research and Development Department
Richard Lanyon, Director

December 2000

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STRUCTURE AND RESPONSIBILITIES OF THE ENVIRONMENTAL MONITORING AND RESEARCH (EM&R) DIVISION

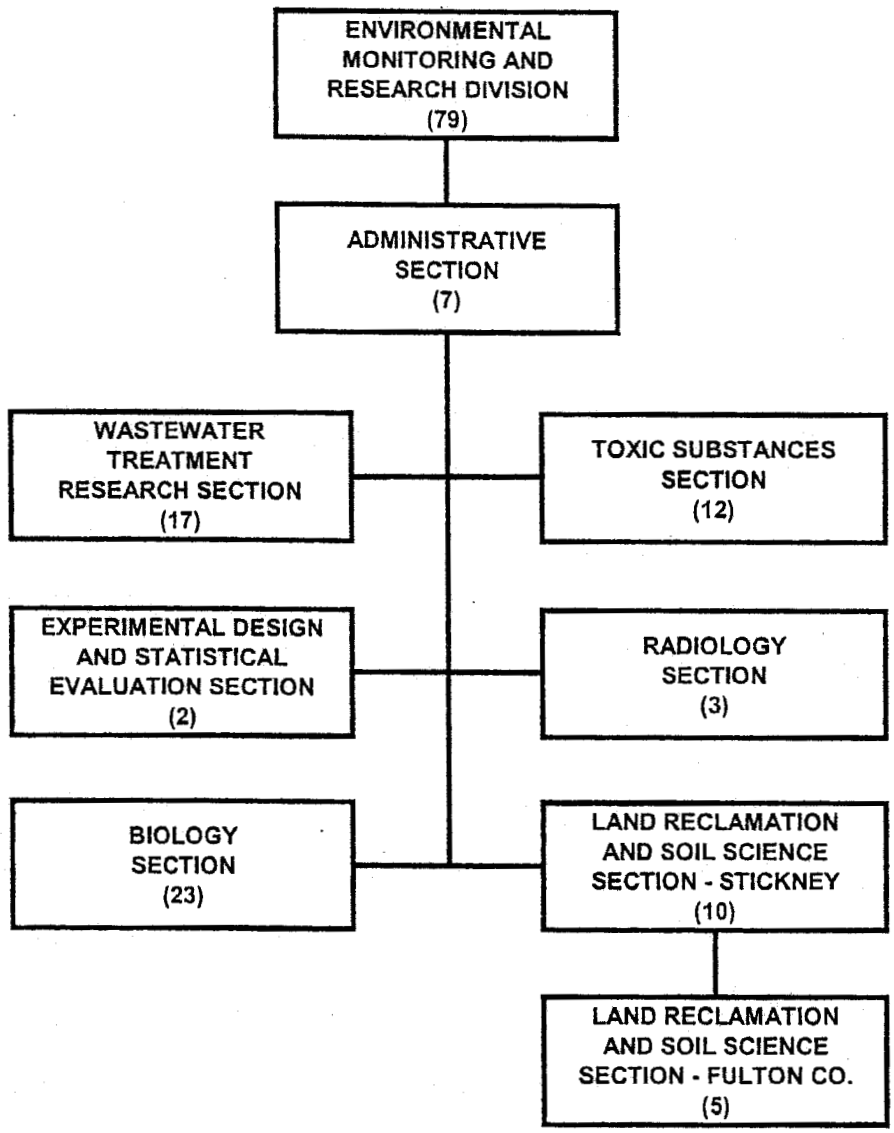
The EM&R Division has 79 employees and is comprised of seven Sections (Figure 1), viz.,

1. Administrative Section
2. Wastewater Treatment Research Section
3. Land Reclamation and Soil Science Section - Stickney & Fulton County
4. Biology
5. Toxic Substances Section
6. Radiochemistry Section
7. Experimental Design and Statistical Evaluation Section

- 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 operations problems;

Figure 1

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION ORGANIZATION CHART



- Providing technical assistance to other departments and agencies with respect to issues related to wastewater treatment, 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 activities;
- Assessing the impacts of new or proposed regulations on District activities.

The purpose of this report is to present the activities and contributions of these Sections during 1999.

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

Administrative Section

This Section consists of the Assistant Director of Research and Development, two Research Scientist IVs, and a clerical support staff. Its purpose is to oversee and coordinate the work of the sections comprising the EM&R Division.

Wastewater Treatment Research Section

The Wastewater Treatment Research (WTR) Section is responsible for conducting basic, applied, and problem solving research on various wastewater and sludge treatment processes currently utilized by the Metropolitan Water Reclamation District of Greater Chicago (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 investigation of current operations may originate 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 1999, the section was primarily concerned with studies relating to odor control, sludge treatment technologies, respirometry, and the Tunnel and Reservoir Plan (TARP) Systems. The chief projects performed by the section are summarized below.

POLYMER TESTING PROGRAM FOR THE DISTRICT CENTRIFUGE COMPLEXES

In March 1999, winter polymer testing 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 twice at Stickney, once in summer and once in winter, as sludge conditions during these seasons require different polymers at this WRP. Polymer testing was also carried out for centrifugal dewatering at the Calumet WRP during May 1999.

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 tests conducted at the Stickney WRP is presented in Table 1. The Calumet WRP test summary is in Table 2.

POLYMER TESTING PROGRAM FOR GRAVITY BELT THICKENERS AT THE HANOVER PARK WRP

In 1999, polymer testing was carried out at the Hanover Park WRP for the selection and purchase of polymers used in the gravity belt thickening of primary and 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 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

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 1

CENTRIFUGE COMPLEX POLYMER TEST RESULTS
AT THE STICKNEY WRP - MARCH 1999

Number of Vendors Involved in Tests	4
Number of Polymers Submitted for Testing	8
Number of Polymers Qualified for Bidding	7
Polymer Selected	Polydyne NW109

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 2

CENTRIFUGE COMPLEX POLYMER TEST RESULTS
AT THE CALUMET WRP - MAY 1999

Number of Vendors Involved in Tests	4
Number of Polymers Submitted for Testing	7
Number of Polymers Qualified for Bidding	7
Polymer Selected	Polydyne NW121

gravity belt thickener. 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 tests conducted during July 1999 at the Hanover Park WRP is presented in Table 3.

LABORATORY STUDY TO DETERMINE THE EFFECTS OF ADDITIONAL PUMPING ON THE POLYMER DEMAND OF DIGESTED SLUDGE

At the request of the Engineering Department, a laboratory study was initiated in 1998 to determine whether additional pumping of anaerobically digested sludge through a proposed loop distribution system for feeding the various centrifuges would adversely affect the polymer demand at the Stickney WRP. The final phase of the study was completed in 1999. The experimental plan was developed by Consoer Townsend Envirodyne (CTE) Engineers in discussions with personnel of the Environmental Monitoring and Research (EM&R) Division of the District.

Measurement of the capillary suction time (CST) of the digested sludge was used to determine the polymer dose needed to effectively condition the sludge for dewatering. A laboratory mixer with a two-inch diameter propeller, at a speed of 500 rpm, was used to mix separate aliquots of the digested sludge for periods ranging from 15 to 120 seconds to provide

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 3

GRAVITY BELT THICKENER POLYMER TEST RESULTS
AT THE HANOVER PARK WRP - JULY 1999

Number of Vendors Involved in Tests	3
Number of Polymers Submitted for Testing	5
Number of Polymers Qualified for Bidding	5
Polymer Selected	Aquaben 1850

various mixing energy and detention times. The experiments were carried out in September 1998 using digested "summer" sludge, and repeated in February 1999 using digested "winter" sludge.

The experiments were repeated on four separate days for each of the two time periods, for a total of 24 sets of dosage data for each type of sludge.

For the summer sludge, the polymer dose for 15- and 30-second mixing was not significantly different from the zero mixing polymer dose. However, the polymer dose of the digested summer sludge mixed for 120 seconds was significantly different from the dosage of the control sludge in all replicates, and was also significantly different in some of the replicates mixed for 90 and 60 seconds.

CTE Engineers estimated that the product of mixing energy and mixing detention times (GT value) for the full-scale additional sludge pumping is equivalent to the 60-second premixing treatment.

On the average, the dosage difference between the digested sludge samples mixed for 60 seconds and the control was 2.8 lbs/ton, or 0.9 percent of the control polymer dosage. When compared to the actual variability of ±6 lbs/ton obtained in full-scale polymer tests on the centrifuges, the mixing of

digested sludge at 60 seconds is considered to have no substantial impact on polymer dosage.

With the winter sludge, no increase in polymer dosage was observed at any of the premixing times in the range of 15 to 120 seconds.

Thus, it does not seem that the 60-second premixing treatment, which is expected to simulate the mixing energy that would be imparted to the digested sludge due to additional pumping through the proposed looped pipe distribution system, would have any significant impact on polymer dose for either summer or winter sludge. The results of this study were transmitted to the Engineering Department, and were also presented at the WEFTEC '99 annual conference in New Orleans, Louisiana.

ODOR MONITORING PROGRAM AT THE HASMA, VULCAN, LASMA, AND MARATHON SLUDGE PROCESSING SITES

As part of the District's continuous surveillance program, the EM&R Division conducts odor monitoring at the Harlem Avenue Sludge Management Area (HASMA), Vulcan, the Lawndale Avenue Sludge Management Area (LASMA), and Marathon air drying sites. This odor monitoring program was initiated in 1990.

Anaerobically digested sludge lagooned for two to three years is dried on paved drying cells to solids greater than 60

percent. The sludge drying process is enhanced by agitation using auger-equipped tractors.

The objective of this odor monitoring program is to identify potential sources of odors and use corrective action if needed.

This program consists of two components.

In the first component, R&D personnel visit 13 stations in the sludge drying areas at least three times a week. The odor monitoring personnel make subjective observations regarding the description and intensity of odors at the stations.

In the second component of the program, the amount of agitation applied to the sludge at each drying site is tabulated (Table 4). The drying sludge is continuously agitated with auger-equipped tractors. This process gradually releases odorous materials in the sludge and introduces oxygen into the drying sludge. Experience has indicated that agitation is important for drying the sludge in an odor-free manner.

Figure 2 is a chart summarizing the observations of odor monitoring personnel during 1999. For each month, average intensity data from the 13 stations monitored several days a week were plotted. The percentage of visits at which easily noticeable, strong, and very strong odors were observed were

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 4

MONTHLY AUGER MACHINE AGITATION DATA

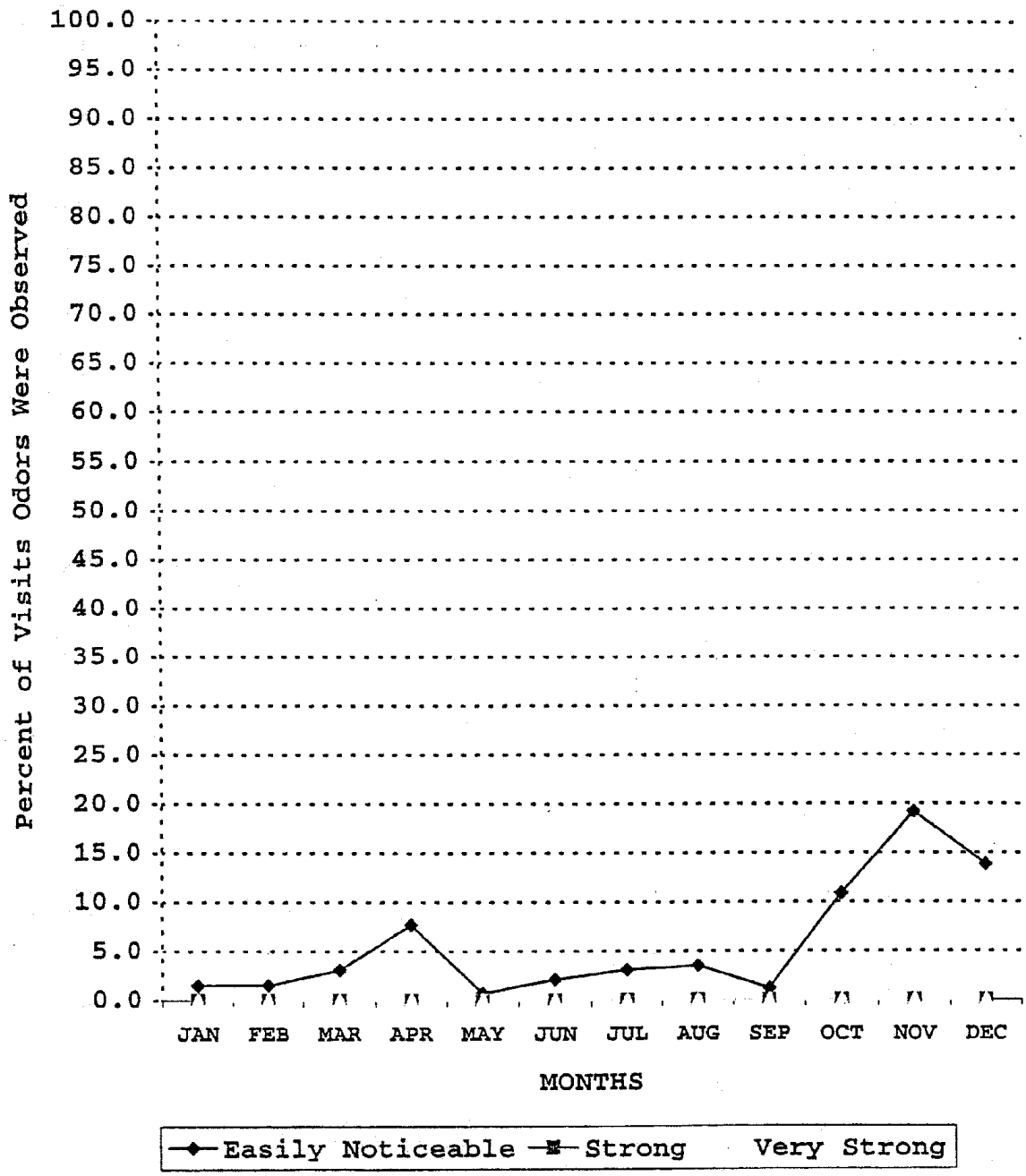
Date	LASMA	HASMA	Vulcan	Marathon
	Agitation (Hours/Acre/Week)			
January 1999	0	0	0	0
February 1999	0	0	0	0
March 1999	0	0	0	0
April 1999	1.2	0.8	0.7	0
May 1999	2.8	2.6	2.1	0.9
June 1999	1.9	3.1	2.7	1.5
July 1999	2.8	1.3	1.5	0.9
August 1999	0.8	2.1	4.2	1.2
September 1999	1.5	4.2	3.5	1.3
October 1999	1.4	4.1	2.8	1.9
November 1999	2.0	0.8	3.7	0.2
December 1999	0.2	0.1	0.6	0

0 = No agitation, will resume in spring 2000.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 2

ODOR OBSERVANCE ON DISTRICT PROPERTY AT HASMA, VULCAN, LASMA, AND MARATHON - 1999



plotted against the month of the year. Although there are peaks of easily noticeable odor observations during the year, the strong and very strong odor observations were low throughout the year.

The best indication of the District's success in processing sludge in an odor-free manner is the number of odor complaints from citizens in the vicinity of the processing operation. Table 5 shows that no odor complaints from citizens regarding the sludge processing facilities were reported in 1999.

ODOR MONITORING PROGRAM AT THE CALUMET WRP

The Calumet WRP odor monitoring program initiated in March 1992 is a cooperative effort of the R&D and M&O Departments. The objective of the program is to collect and maintain a database of odor levels within and around the WRP, and associated sludge processing areas, and to forewarn of potential odor problems at the WRP. The program is conducted in a manner similar to other District odor monitoring programs.

The Calumet odor monitoring program involves the daily visitation of 22 stations around the WRP and sludge processing areas. At each station, R&D or M&O personnel make observations regarding the character and intensity of odors. These

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 5

CITIZEN ODOR COMPLAINTS REGARDING THE HASMA, VULCAN, LASMA, AND MARATHON SLUDGE PROCESSING AREAS--1999

Complaints	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Number	0	0	0	0	0	0	0	0	0	0	0	0
Number Confirmed	0	0	0	0	0	0	0	0	0	0	0	0

observations are tabulated and reported on a monthly basis. Odors are described according to a list of descriptors, and the odor strength is ranked from 0 to 5, with 5 being the highest odor.

Figure 3 summarizes all of the observations made during 1999. As can be seen, odors were at very low levels in 1999.

Any citizen odor complaint regarding the Calumet WRP was immediately investigated, and corrective action was taken at the WRP if the complaint resulted from odor emissions from the WRP. Table 6 is a monthly listing of the total number of citizen complaints regarding the Calumet WRP. As can be seen, no odor complaints were received from the public regarding these facilities during 1999.

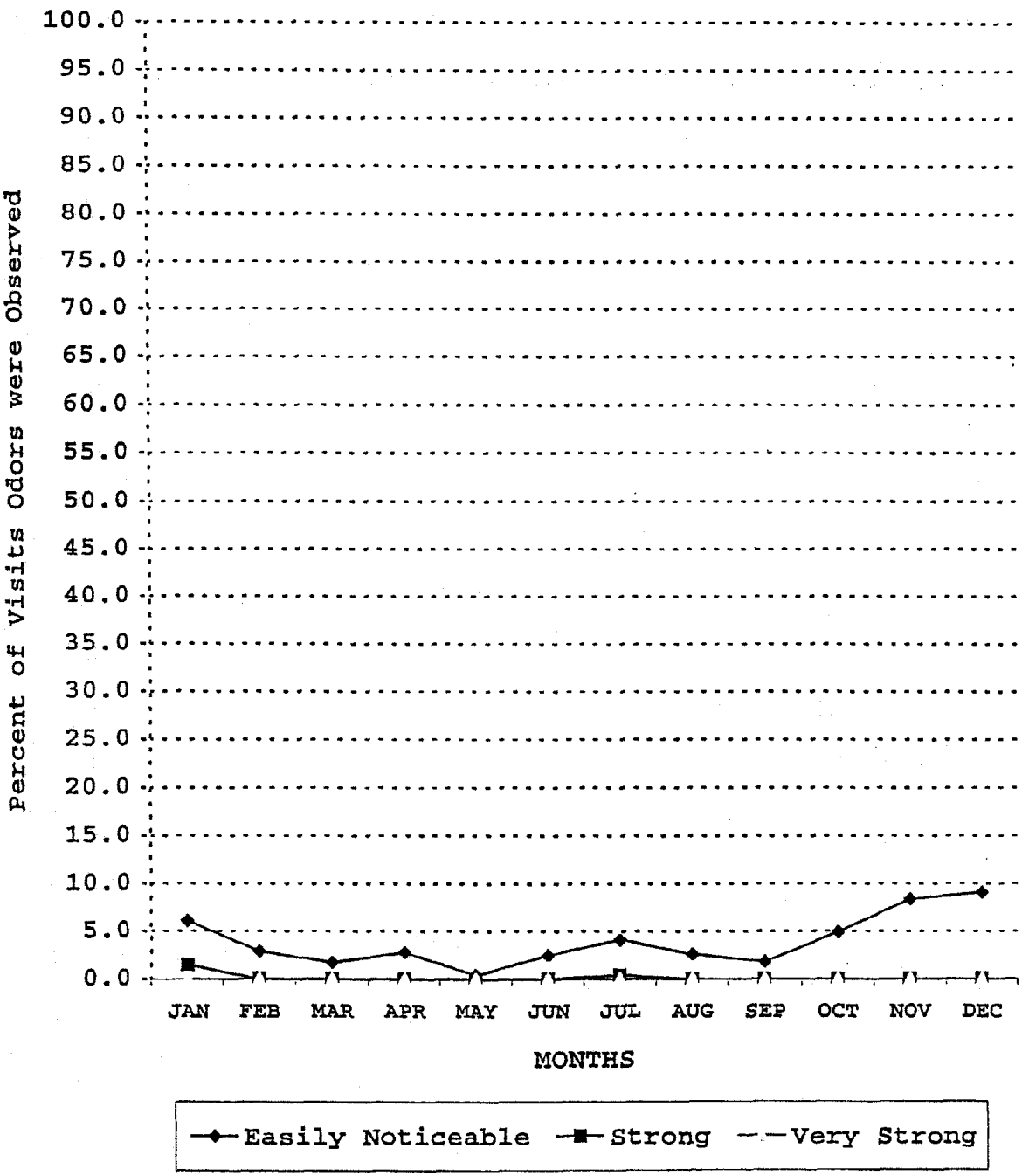
ODOR MONITORING AT THE JOHN E. EGAN WRP

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. As is the case for the other odor monitoring programs currently conducted within the District, the purpose of this program is to collect and maintain a database of odor levels within the WRP. The data is used to study the trends in odor levels associated with WRP operations, and to relate

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 3

CALUMET WRP ODOR OBSERVANCE WITHIN PLANT BOUNDARIES - 1999



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 6

CITIZEN ODOR COMPLAINTS REGARDING THE CALUMET WRP AND ADJACENT SLUDGE PROCESSING AREAS--1999

Complaints	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Number	0	0	0	0	0	0	0	0	0	0	0	0
Number Confirmed	0	0	0	0	0	0	0	0	0	0	0	0

odor levels to conditions unrelated to WRP operation or changing conditions within the WRP, such as installation of odor control equipment. Since several residential dwellings surround the John E. Egan WRP, the odor monitoring program is designed to provide early warning of odorous conditions that develop within the WRP, and to allow control of them before they come to the notice of the residents.

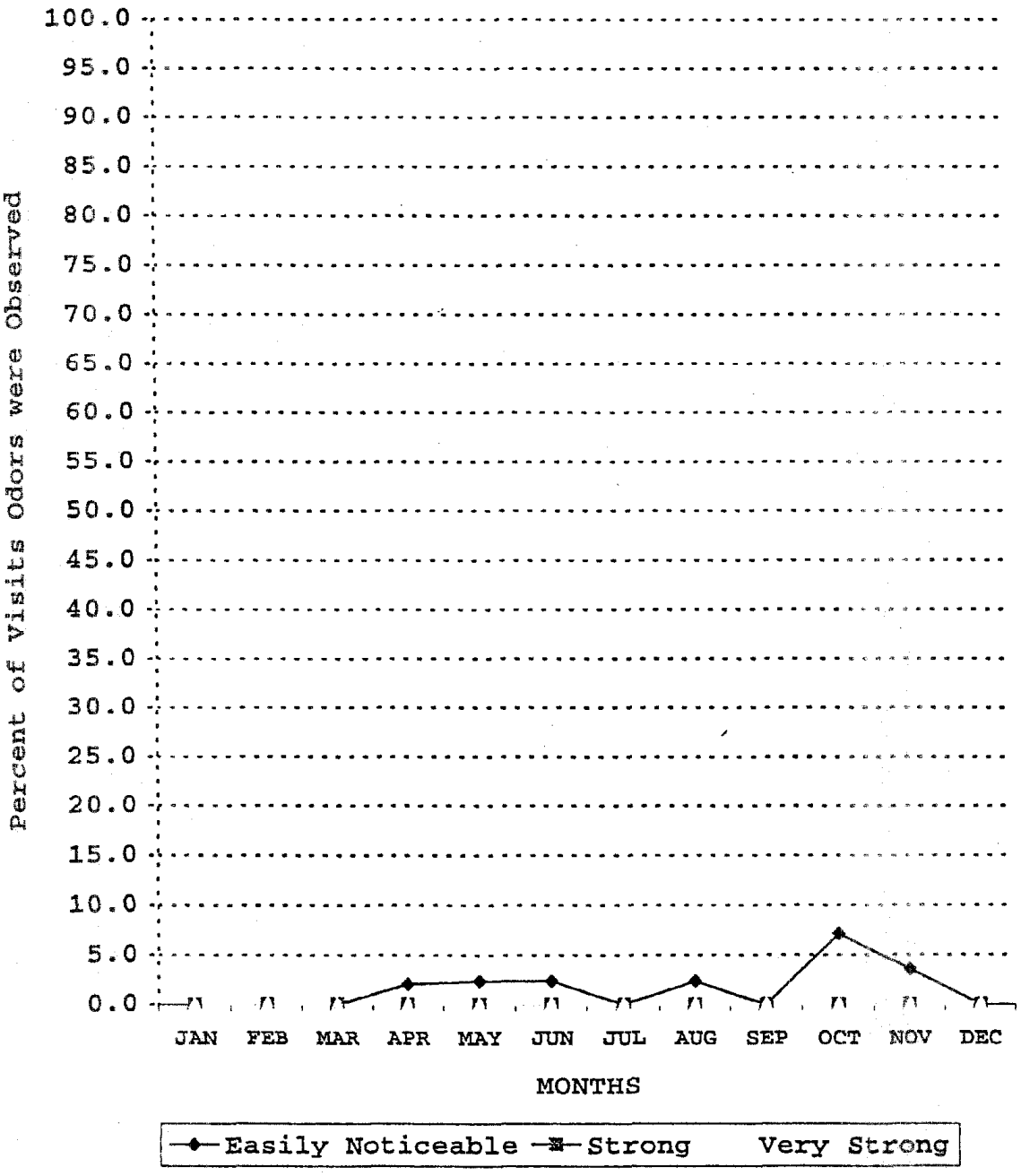
For the John E. Egan WRP odor monitoring program, seven stations within the WRP boundaries are visited on a daily basis by M&O and R&D personnel. As with the other programs, odors are characterized according to type and intensity. These data are tabulated on a monthly basis. Also, all odor-complaints regarding the WRP are investigated by M&O personnel. Upon investigation, they try to determine whether odor emissions from the John E. Egan WRP were responsible for the complaint. When it was likely that odor emissions at the WRP were responsible for the complaint, M&O personnel took action to ameliorate the causative conditions.

Figure 4 summarizes the observations of odor monitoring personnel during 1999. For each month, average intensity data from the seven stations monitored several times a week were plotted. The percentage of visits at which easily noticeable,

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 4

JOHN E. EGAN WRP ODOR OBSERVANCE WITHIN PLANT BOUNDARIES - 1999



strong, and very strong odors were observed was plotted against the month of the year. As was observed for other odor monitoring programs, odor was observed for a low percentage (<10%) of the visits made to the John E. Egan WRP.

Table 7 lists the total number of complaints from citizens regarding the WRP along with the number of complaints which, upon investigation, were confirmed by M&O personnel as possibly resulting from WRP odor emissions. During 1999, M&O did not report any odor complaints regarding this WRP.

ODOR MONITORING PROGRAM 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. The purpose of the program is to collect and maintain a database of odor levels within and around the WRP. Another objective of the program is to provide early warning of odorous conditions that develop within the WRP, and control them before they come to the notice of the residents around the WRP.

On alternate days (during six days of the week), either R&D or M&O personnel visit each of the 19 established stations within and around the WRP and subjectively describe and quantify odors and their strength at that location. Odors are

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 7

CITIZEN ODOR COMPLAINTS REGARDING THE JOHN E. EGAN WRP--1999

Complaints	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Number	0	0	0	0	0	0	0	0	0	0	0	0
Number Confirmed	0	0	0	0	0	0	0	0	0	0	0	0

described according to a list of descriptors, and the odor strength is ranked from 0 to 5, which corresponds to no odor for a rank of 0 to very strong odor for a rank of 5. On occasions when very strong odors are detected, M&O personnel are immediately notified so that corrective measures can be taken.

Treatment process operations are among the sites monitored, such as sludge dewatering and anaerobic digestion, which have been associated with odorous conditions. Also included are locations along the perimeter of the WRP where odors might be detected by the public.

Figure 5 summarizes the observations of odor monitoring personnel during 1999. For each month, average intensity data from the 19 stations, monitored six days a week, were plotted. The percentage of visits at which easily noticeable, strong, and very strong odors were observed and plotted against the month of the year. As can be seen from Figure 5, odors were observed less than 10 percent of the time for most part of the year. However, odors were observed 16 percent of the visits made during October 1999.

Any citizen odor complaint regarding the Stickney WRP was immediately investigated, and corrective action was taken at the WRP if the complaint resulted from odor emissions.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 5

STICKNEY WRP ODOR OBSERVANCE WITHIN PLANT BOUNDARIES - 1999

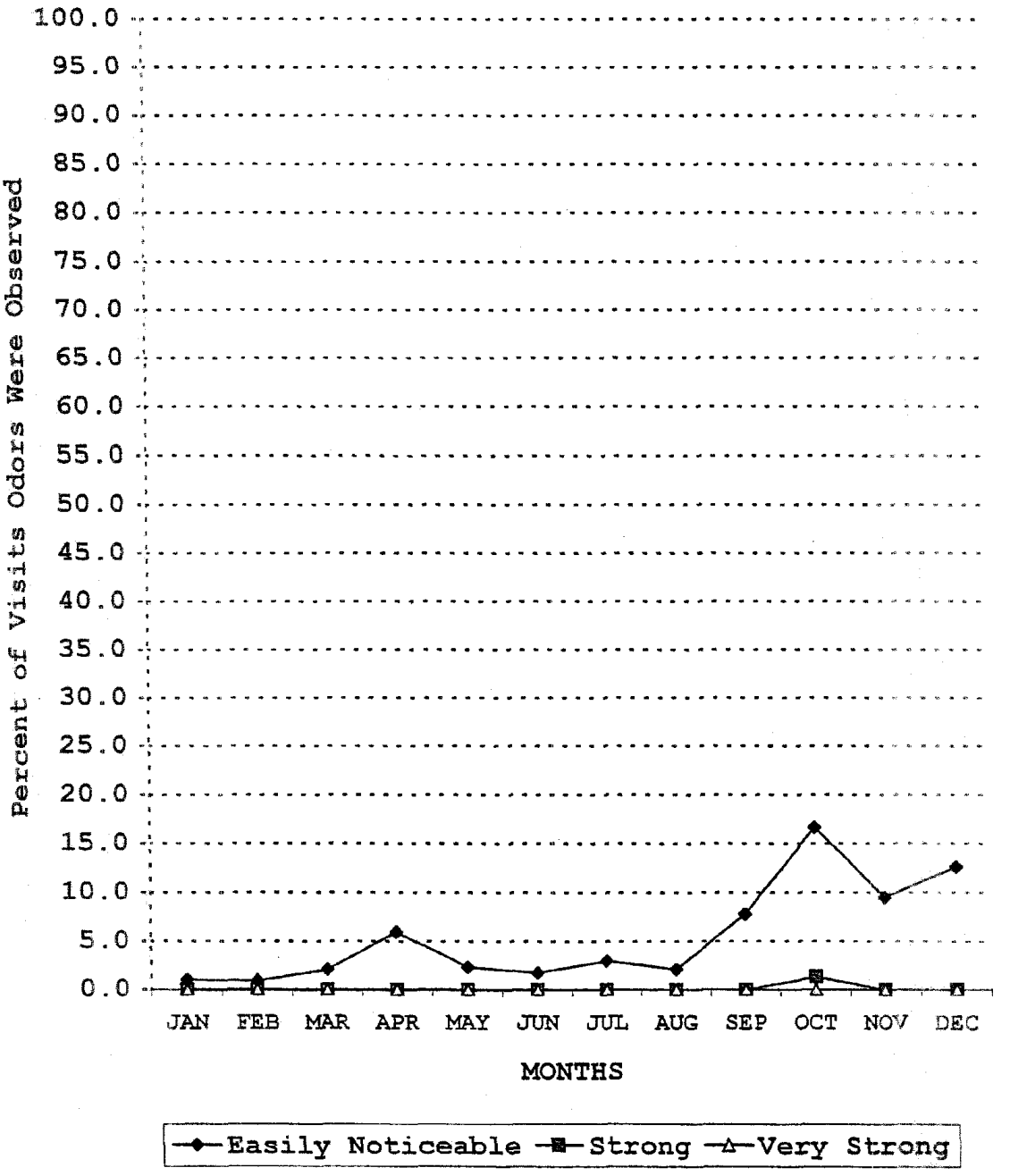


Table 8 is a monthly listing of the total number of citizen complaints received from the public regarding this WRP during 1999. As can be seen, no citizen complaints of odors were received in 1999.

ODOR MONITORING AT THE JAMES C. KIRIE WRP

The James C. Kirie odor monitoring program is a joint effort between the R&D and M&O Departments, and was initiated in September 1996. The program was developed and conducted for the same reasons that the other WRP programs are conducted. Basically, the same procedures are used in the Kirie WRP program as used in the other WRP odor monitoring programs.

Figure 6 summarizes the observations of odor monitoring personnel during 1999. As may be noted from the figure, the incidence of odors within the WRP was very low.

Table 9 lists the odor complaints received from the public, and the complaints which were confirmed after investigation by M&O personnel in 1999. During 1999, five confirmed odor complaints were noted, during September and October.

ODOR SURVEY OF THE NORTH SIDE WRP

The North Side WRP is sited in close proximity to residences and several light industrial facilities. There is

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 8

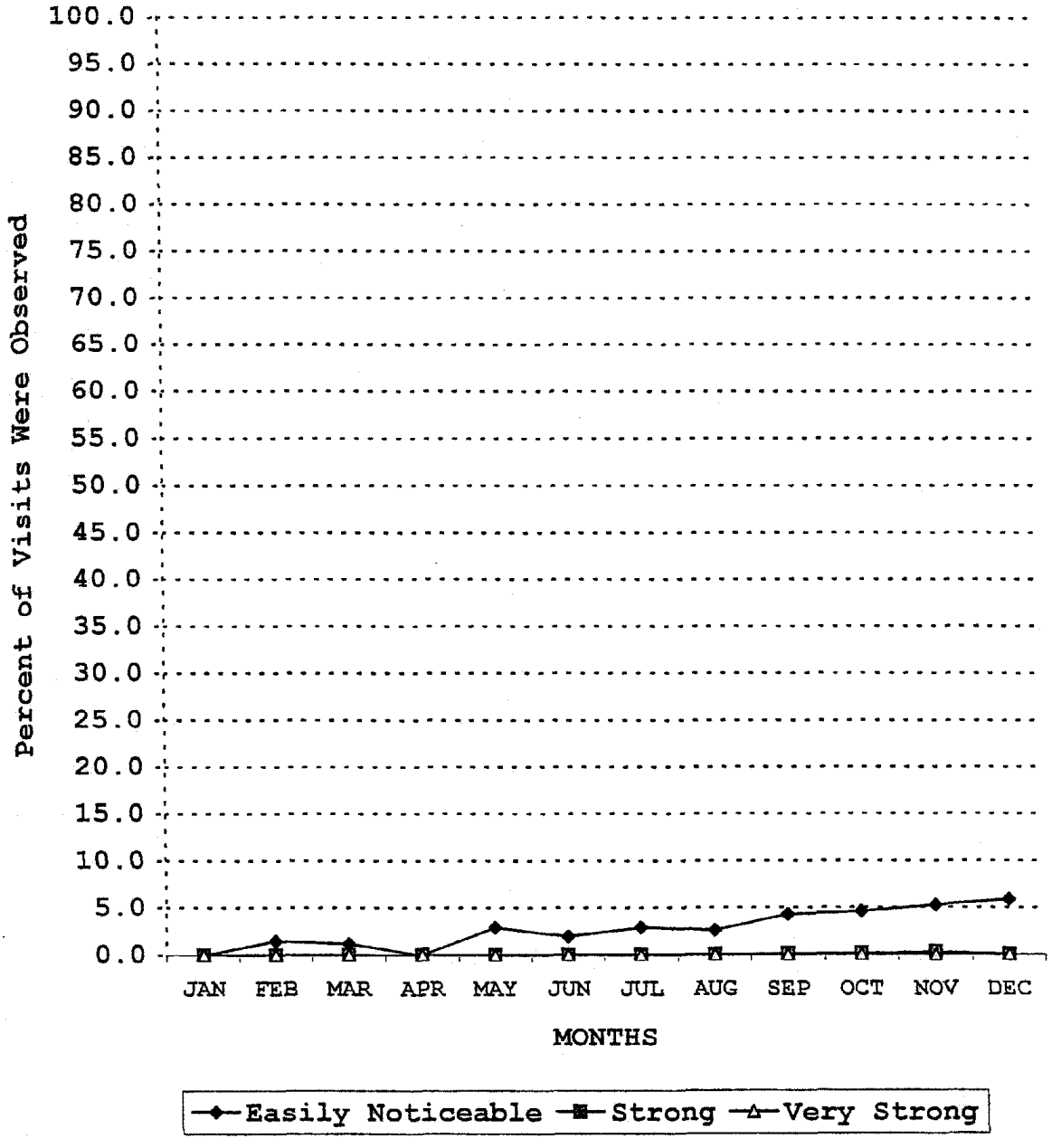
CITIZEN ODOR COMPLAINTS REGARDING THE STICKNEY WRP--1999

Complaints	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Number	0	0	0	0	0	0	0	0	0	0	0	0
Number Confirmed	0	0	0	0	0	0	0	0	0	0	0	0

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 6

JAMES C. KIRIE WRP ODOR OBSERVANCE WITHIN PLANT BOUNDARIES - 1999



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 9

CITIZEN ODOR COMPLAINTS REGARDING THE JAMES C. KIRIE WRP--1999

Complaints	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Number	0	0	0	0	0	0	0	0	1	4	0	0
Number Confirmed	0	0	0	0	0	0	0	0	1	4	0	0

little buffer between the WRP, residences, and industrial facilities, particularly along the Howard Street boundary of the WRP.

An odor survey of the North Side WRP was continued by the R&D Department, after the capital improvement construction was complete, in order to determine and document improvements in controlling odors generated at this WRP. The odor-related parameters monitored during this survey included:

1. Odor intensity and type, as determined by personnel visiting sites within and around the WRP boundaries and making subjective assessments.
2. H_2S concentrations in air as measured with a Jerome H_2S Analyzer, an instrument capable of detecting the gas in the parts per billion range.

The above parameters were determined at 13 stations within the WRP boundaries on a weekly basis.

R&D personnel visit 13 stations within and around WRP boundaries at least once a week. The odor monitoring personnel make subjective observations regarding the description and intensity of odors at the stations.

Figure 7 summarizes the observations of odor monitoring personnel from January through December 1999. For each month,

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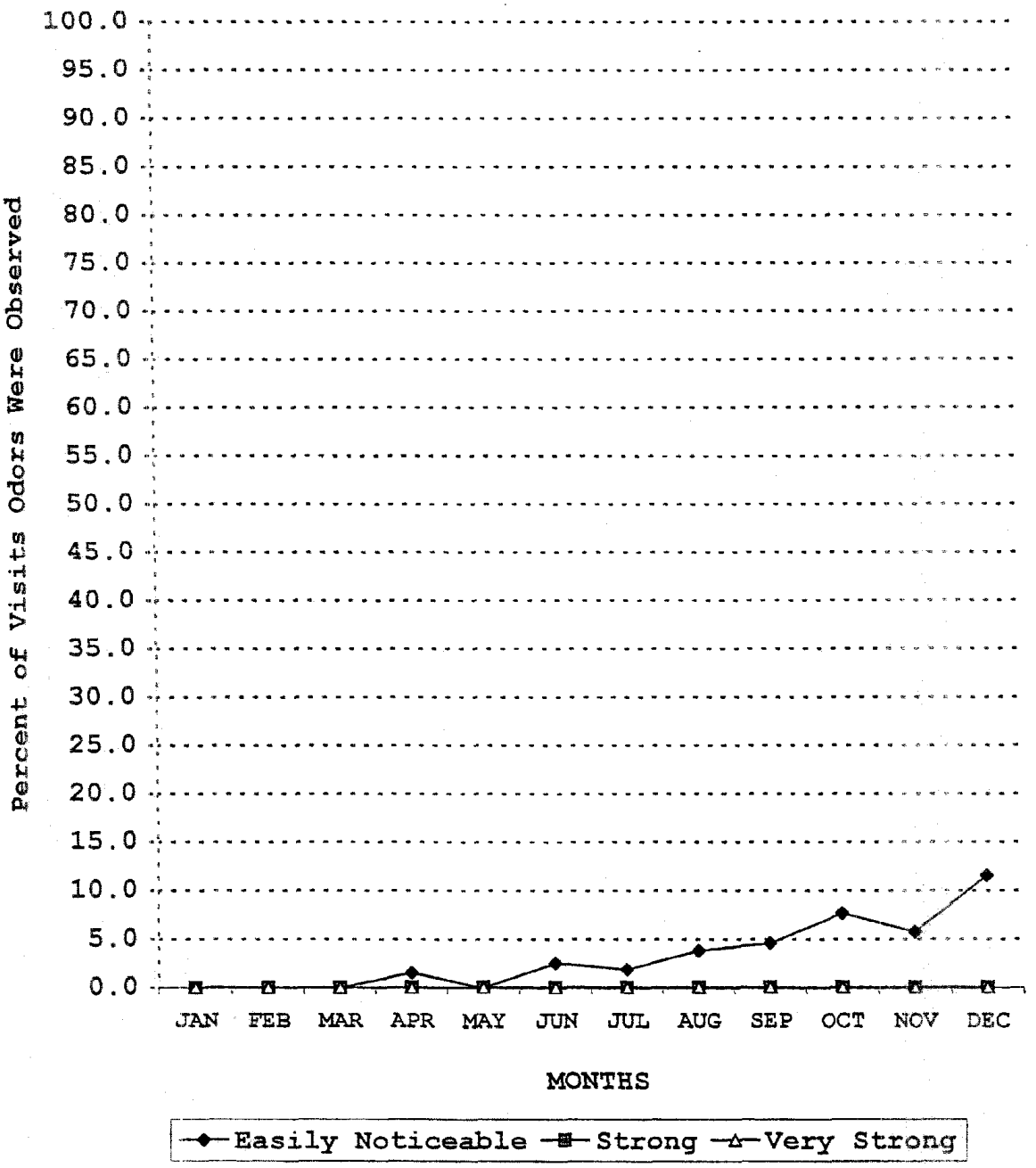
FIGURE 7

NORTH SIDE WRP ODOR OBSERVANCES - 1999



average intensity data from the 13 stations on District property were monitored one day a week and plotted. The percentage of visits at which easily noticeable, strong, and very strong odors were observed, were plotted against the month of the year.

There were no citizen odor complaints reported by the M&O Department during 1999, as shown in Table 10.

ODOR MONITORING STUDIES FOR AGED CENTRIFUGE CAKE

The results of an earlier study conducted by the R&D Department from 1990 through 1994 indicated that centrifuge cake aged for three years in a lagoon consistently yielded ED_{50} values below 300. An arbitrary ED_{50} value of less than 300 has been assigned to District sludges for land application in odor-sensitive areas. However, because the District plans to air-dry centrifuge cake at LASMA, additional odor monitoring of the aged centrifuge cake was requested by the M&O Department as to odor potential of centrifuge cake which was aged for 1 1/2 years in the lagoons. In addition, centrifuge cake which was not aged was also monitored. This will allow a comparison of the two cakes under the same weather and air-drying conditions.

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TABLE 10

CITIZEN ODOR COMPLAINTS REGARDING THE NORTH SIDE WRP--1999

Complaints	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Number	0	0	0	0	0	0	0	0	0	0	0	0
Number Confirmed	0	0	0	0	0	0	0	0	0	0	0	0

The unaged or 24-hour cake was applied to the drying cells at Stony Island during the spring and summer of 1999. The lagoon-aged centrifuge cake was applied to the drying cells from June through November 1999. The 1999 sampling program began April 6, 1999 and continued until December 21, 1999. Three samples from each of the drying cells studied were collected once a week. The cakes were monitored for odors using the ED_{50} test. The cakes were analyzed for TS, TVS, TKN, and NH_3-N on a weekly basis.

Table 11 lists results of the monitoring of the unaged 24-hour centrifuge cake. Table 12 lists results of the monitoring of the aged centrifuge cake. Each value is the average of three samples taken at random over the drying cell.

ZINC CONCENTRATIONS IN CALUMET WRP DIGESTED SLUDGE

The District has established an organizational policy to have its final sludge product qualify as an Exceptional Quality (EQ) sludge suitable for any beneficial use. This policy is in agreement with the USEPA Part 503 Regulations which establish specific risk-based pollutant limits for various heavy metals found in sewage sludge.

The USEPA alternate pollutant limit (APL) for zinc in the final sludge product is 2800 mg/Kg dry weight. The District

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 11

24-HOUR CENTRIFUGE CAKE AIR-DRIED AT STONY ISLAND DURING 1999*

Date	Sample	% TS	% TVS	NH_3-N (mg/L)	TKN (mg/L)	ED_{50}
4/6/99	24CK 2N	34.48	47.24	2,174	11,098	57
4/6/99	24CK 4N	36.26	46.43	2,063	12,295	71
4/13/99	24CK 2N	41.24	46.23	1,755	10,592	37
4/13/99	24CK 4N	33.50	46.69	2,014	9,480	85
4/20/99	24CK 2N	34.78	45.87	945	9,215	102
4/20/99	24CK 4N	31.08	47.36	782	9,383	60
4/27/99	24CK 2N	39.31	46.13	1,298	11,169	103
4/27/99	24CK 4N	34.29	49.65	1,102	10,969	70
5/4/99	24CK 2N	65.10	44.49	2,800	17,605	29
5/4/99	24CK 4N	39.55	45.26	2,141	14,049	198
5/11/99	24CK 2N	64.10	45.79	2,202	14,390	42
5/11/99	24CK 4N	72.46	45.78	2,900	20,352	59
5/18/99	24CK 2N	48.39	44.33	1,297	14,140	44
5/18/99	24CK 4N	48.27	45.92	1,341	14,567	243
5/25/99	24CK 2N	51.88	43.66	1,482	14,283	67
5/25/99	24CK 4N	43.14	44.16	1,263	13,277	78
6/1/99	24CK 2N	61.89	41.26	2,121	20,073	75
6/1/99	24CK 4N	70.49	40.16	818	20,748	135
6/8/99	24CK 2N	30.17	49.18	1,561	11,715	188
6/8/99	24CK 4N	71.79	45.88	1,857	17,384	195
6/15/99	24CK 2N	32.95	42.69	1,860	11,440	137
6/15/99	24CK 4N	57.63	42.67	959	12,574	191
6/22/99	24CK 4S	30.69	46.85	1,720	15,027	70
6/29/99	24CK 4S	29.69	45.33	1,862	12,037	86
7/6/99	24CK 4S	44.05	45.62	NA	14,050	86
7/13/99	24CK 4S	67.29	44.91	3,788	24,095	196
7/20/99	24CK 4S	27.30	48.82	792	11,550	396
7/27/99	24CK 4S	34.33	45.92	1,292	10,212	212
8/3/99	24CK 4S	58.18	44.36	3,096	19,012	110
8/10/99	24CK 4S	23.75	35.67	2,414	8,553	105
8/17/99	24CK 3N	50.28	43.90	2,626	16,172	183
8/24/99	24CK 3N	47.30	47.16	1,952	13,348	149

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 11 (Continued)

24-HOUR CENTRIFUGE CAKE AIR-DRIED AT STONY ISLAND DURING 1999*

Date	Sample	% TS	% TVS	NH_3-N (mg/L)	TKN (mg/L)	ED_{50}
8/31/99	24CK 3N	53.14	36.50	1,664	11,420	110
9/7/99	24CK 3N	84.08	40.33	15,927	9,310	88
9/14/99	24CK 3N	53.90	40.28	16,897	2,446	68
9/21/99	24CK 4N	25.57	48.87	604	9,404	219
9/28/99	24CK 4N	41.53	42.08	1,255	14,466	202
10/5/99	24CK 4N	35.76	46.58	760	12,187	147
10/12/99	24CK 4N	34.60	45.94	775	11,605	132
10/19/99	24CK 4N	28.99	47.27	1,060	12,249	90
10/26/99	24CK 4N	36.53	49.81	1,301	11,770	94
11/2/99	24CK 4N	43.22	49.86	2,526	15,408	51
11/9/99	24CK 4N(SP)	54.41	49.70	NA	20,133	117
11/16/99	24CK 4N	NA	51.11	1,714	12,458	146
11/23/99	24CK 4N	36.23	50.96	1,409	16,316	101
11/30/99	24CK 4N	29.98	50.44	1,643	15,045	40
12/7/99	24CK 4N	26.72	49.25	1,389	13,869	273
12/14/99	24CK 4N	33.11	48.82	813	10,446	324
12/21/99	24CK 4N	29.94	49.50	1,282	13,120	177

*Daily values are an average of three samples.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 12

AGED CENTRIFUGE CAKE AIR-DRIED AT STONY ISLAND
DURING 1999*

Date	Sample	% TS	% TVS	NH_3-N (mg/L)	TKN (mg/L)	ED_{50}
6/22/99	UA AGCK 5S	19.5	48.1	3,253	10,778	59
6/29/99	UA AGCK 5S	39.3	44.0	1,925	15,151	63
7/6/99	UA AGCK 5S	39.5	47.4	NA	12,398	63
7/13/99	UA AGCK 5S	83.0	46.7	4,207	27,909	89
7/20/99	UA AGCK 6N	28.4	41.3	2,385	10,846	380
7/27/99	UA AGCK 6N	34.1	48.5	1,521	11,859	86
8/3/99	UA AGCK 6N	58.4	43.7	2,302	16,068	52
8/10/99	UA AGCK 6N	71.5	43.6	3,532	22,493	125
8/17/99	UA AGCK 6N	60.0	43.3	1,549	16,510	110
8/24/99	UA AGCK 6N	36.9	56.2	1,546	7,865	125
8/31/99	UA AGCK 6N	35.2	29.4	1,812	9,437	64
9/7/99	UA AGCK 6N	47.3	31.2	NA	NA	55
9/7/99	UA AGCK 6N	47.3	31.2	13,141	2,050	55
9/14/99	UA AGCK 6N	45.2	30.6	12,581	2,262	116
9/21/99	UA AGCK 3N	39.6	25.4	2,119	8,588	184
9/28/99	UA AGCK 3N	39.6	25.4	2,119	8,588	184
10/5/99	UA AGCK 3N	46.1	25.1	1,271	9,122	239
10/12/99	UA AGCK 3N	51.1	26.6	1,020	10,817	93
10/12/99	AGCK 5S	36.7	34.6	1,522	8,639	93
10/19/99	UA AGCK 3N	52.6	34.5	1,602	15,805	82
10/19/99	AGCK 5S	40.3	31.6	1,874	10,438	132
10/26/99	AGCK 5S	43.2	31.0	2,493	9,031	85
11/2/99	AGCK 5S	54.2	33.0	2,384	11,511	56
11/9/99	AGCK 5S	87.2	35.2	NA	17,045	53
11/16/99	AGCK 5S	NA	35.1	2,913	17,825	61
11/23/99	AGCK 5S	93.7	37.2	3,424	25,385	26
11/30/99	AGCK 5S	21.1	46.5	1,888	10,589	29
12/7/99	AGCK 5S	55.3	33.0	1,054	16,184	239
12/14/99	AGCK 5S	60.7	33.3	1,249	12,365	139
12/21/99	AGCK 5S	45.7	37.6	1,397	13,046	176

*Daily values are an average of three samples.

had an established target level for zinc in the Calumet WRP digester draw of 1691 mg/Kg, so that the zinc concentration in the final air-dried biosolids would always be below the APL value.

The R&D and M&O Departments continually monitor sludge quality to ensure compliance with the Part 503 APLs.

In 1999, work was completed on a study begun in 1997 to determine the causes of increased zinc concentrations in the digester draw at the Calumet WRP. Through an intensive interceptor sewer sampling program conducted in conjunction with Industrial Waste Division field personnel, it was determined that previously unidentified industrial dischargers were one of the major sources of zinc entering the Calumet WRP. Various discussions and enforcement actions against these dischargers have resulted in the concentrations in Calumet WRP digester draw returning to levels below the District established zinc target level of 1691 mg/Kg dry weight.

This can be seen in Table 13, which presents monthly averages of zinc concentrations in Calumet WRP digester draw for 1998 and 1999.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 13

AVERAGE MONTHLY ZINC CONCENTRATION IN THE CALUMET DIGESTER DRAW SLUDGE DURING 1998 AND 1999

Date	Zinc Concentration* mg Zn/dry Kg
January 1998	1759
February 1998	1459
March 1998	1369
April 1998	1306
May 1998	1399
June 1998	1394
July 1998	1489
August 1998	1820
September 1998	1722
October 1998	1319
November 1998	1128
December 1998	1016
January 1999	956
February 1999	1027
March 1999	1150
April 1999	1056
May 1999	969
June 1999	954
July 1999	1108
August 1999	1246
September 1999	1118
October 1999	1114
November 1999	1170
December 1999	1129

*Note: Target level = 1691 mg Zn/dry Kg.

EVALUATION OF ON-LINE RESPIROMETRY FOR AERATION CONTROL AT THE JAMES C. KIRIE WRP

This project was undertaken to evaluate the application of on-line respirometry for aeration control of the activated sludge treatment process. Respirometry may be used to measure the biological response and oxygen requirement of sewage entering the aeration tank. Therefore, it can be used to predict and control the oxygen requirement of the sewage treated in an activated sludge treatment process, and thereby save the energy that would ordinarily be expended by delivering more air than necessary.

This joint project of the R&D and M&O Departments was conducted at the James C. Kirie WRP. The project was partially funded ($50,000) by the Community Environmental Center of the Electric Power Research Institute, St. Louis, Missouri.

The objective of this project was to evaluate the application of on-line respirometry to control the air supply to an activated sludge treatment process, in order to minimize the electrical energy used to operate the blowers. Under the original experimental plan, three of the six identical aeration tanks at the Kirie WRP were selected for this study. During this study, the air supply was originally proposed to be measured by three different means in three different tanks; namely, on-line respirometers, automatic dissolved oxygen

control, and manual control. In respirometric control, the air supply to the aeration tank would be based on the oxygen uptake rates (OURs) of the mixed liquor as determined by the on-line respirometers. In automatic dissolved oxygen control, the measurement of air supply would be based on the currently implemented District protocol and practices, whereas in manual control, the air supply to the test tank would be held constant without any automatic control systems. The results of the three simultaneous measurements were proposed to be compared for the electrical energy consumption needed to provide the air supply, and for a given level of wastewater treatment.

Since the start of the project in late 1995, severe problems of clogging hampered the progress of the project during 1995 and 1996. Finally, the clogging problems were corrected by the end of 1996. Minor software problems were also experienced and resolved by July 1997. Since then, no major hurdles were encountered.

The original test protocol was revised in order to collect additional data and to expeditiously conclude the study. The revised test protocol included reducing air supply to the experimental aeration tank on an incremental basis until nitrification failed, and ammonia level in the experimental tank effluent significantly exceeded the effluent ammonia level of the control tank. The gradual reduction in air to the

experimental aeration tank was in relation to the air fed to the control aeration tank.

Sufficient data were collected to develop and validate two mathematical models showing relationships between the air supply or oxygen input required, and the activated sludge aeration tank operating parameters, oxygen transfer efficiency (OTE), oxygen uptake rates, and the effluent ammonia concentration.

The study concluded that aeration control using the automated DO probe system at the Kirie WRP provides optimum air supply and, therefore, the potential for electrical energy savings using on-line respirometry at the Kirie WRP is not substantial. As a result, an application of the on-line respirometry is not advantageous for the Kirie WRP under current operating conditions. In a system where air supplied far exceeds the actual air demand, the opportunities for electrical energy savings using on-line respirometry are promising. Before using on-line respirometry for controlling air at WRPs, however, more work needs to be done using program logic controls, computer-coded algorithms, and blowers that can respond to such controls to actually demonstrate the applicability of on-line respirometry using the models developed in this study. The reliability of on-line respirometry from an operation and maintenance point of view should also be investigated.

A final report on this study will be submitted by early 2000.

TARP GROUNDWATER MONITORING PROGRAMS

The District's TARP Groundwater Monitoring Program was implemented in 1976 to assess the impact on groundwater quality and quantity. The TARP tunnels were constructed 100 to 350 feet underground, and function as a part of the regionwide pollution and flood control system capturing and temporarily storing combined sewer overflows (CSOs). The CSOs, which are mixtures of raw sewage and storm water runoff, are subsequently treated at District WRPs.

During normal dry weather conditions, a small amount of groundwater infiltrates the TARP tunnels due to a naturally higher pressure gradient favoring such infiltration. However, during a major storm, the TARP tunnels may become filled with CSOs producing an internal pressure that causes exfiltration of small amounts of CSOs into the surrounding groundwater. After the storm subsides and the TARP tunnels have dewatered, infiltration occurs, and small amounts of the surrounding groundwater are drawn into the tunnels. Groundwater monitoring wells have been installed to verify the infiltration/exfiltration/ infiltration process which may occur in strategic locations of the TARP tunnel operation, and verify

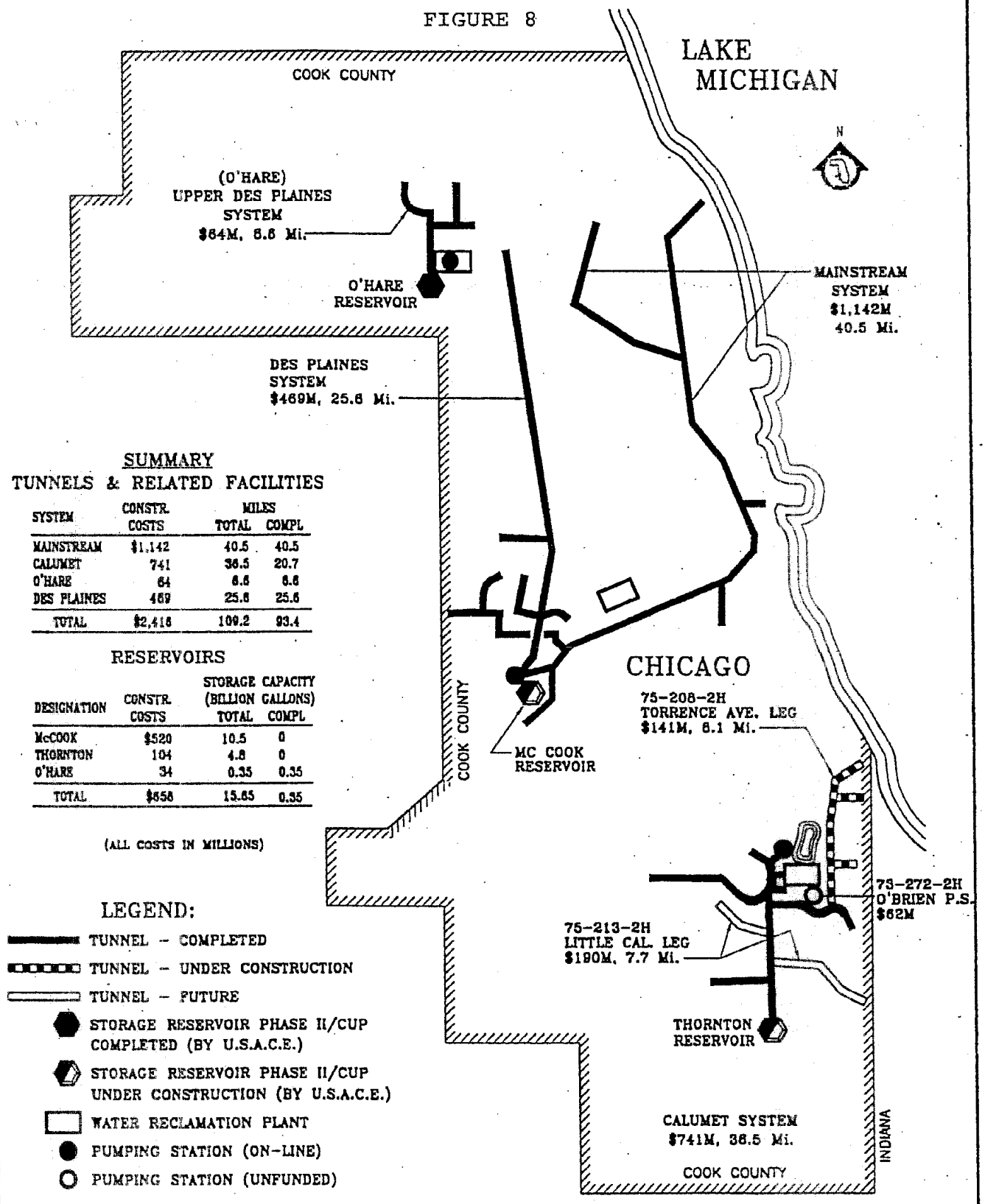
that the TARP system is not adversely affecting local groundwater.

There are a total of 111 water quality monitoring wells, and 34 observation wells in the Calumet, Mainstream, Des Plaines, and Upper Des Plaines systems. Of these 111 wells, 102 are currently being monitored. Six of the wells not being monitored (QM-51, QM-52, QM-54, QM-55, QM-60, and QM-66) are no longer required to be sampled by the IEPA and the other two wells (QM-59 and QC-8.1) are considered dry wells and are no longer being monitored. Monitoring well QM-57 was damaged by a crumbing seawall and has been abandoned. The TARP wells are located alongside completed portions of the TARP tunnels (Figure 8).

Four additional monitoring wells, QK-1 through QK-4, at the O'Hare Reservoir, were added to the TARP tunnel monitoring wells in 1998. Regular sampling of these wells began in February 1998.

The Illinois Environmental Protection Agency (IEPA) gave the District permission to monitor the Mainstream TARP System wells QM-53, QM-56, and QM-70 through QM-82 (excluding wells QM-72 and QM-81) at a reduced rate of twice per year from six times per year. The same reduced sampling frequency was also

FIGURE 8



SUMMARY
TUNNELS & RELATED FACILITIES

SYSTEM	CONSTR. COSTS	MILES TOTAL	MILES COMPL
MAINSTREAM	$1,142	40.5	40.5
CALUMET	741	36.5	20.7
O'HARE	64	6.6	6.6
DES PLAINES	469	25.6	25.6
TOTAL	$2,416	109.2	93.4

RESERVOIRS

DESIGNATION	CONSTR. COSTS	STORAGE CAPACITY (BILLION GALLONS) TOTAL	COMPL
McCOOK	$520	10.5	0
THORNTON	104	4.8	0
O'HARE	34	0.35	0.35
TOTAL	$658	15.65	0.35

(ALL COSTS IN MILLIONS)

LEGEND:

- TUNNEL – COMPLETED
- TUNNEL – UNDER CONSTRUCTION
- TUNNEL – FUTURE
- STORAGE RESERVOIR PHASE II/CUP COMPLETED (BY U.S.A.C.E.)
- STORAGE RESERVOIR PHASE II/CUP UNDER CONSTRUCTION (BY U.S.A.C.E.)
- WATER RECLAMATION PLANT
- PUMPING STATION (ON-LINE)
- PUMPING STATION (UNFUNDED)

TUNNEL AND RESERVOIR PLAN
PROJECT STATUS

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
ENGINEERING DEPARTMENT
1-00 SEWER DESIGN/TARP JRR:JJK

granted to Calumet TARP System wells QC-2.2, QC-9, QC-11 through QC-15, QC-17, and QC-18, and Des Plaines TARP system wells QD-34, QD-39 through QD-45, and QD-47 through QD-49.

The water quality monitoring wells are sampled for the following parameters: ammonia nitrogen (NH_4-N), electrical conductivity, fecal coliform concentration, hardness, pH, sulfate, temperature, total organic carbon, and total dissolved solids. Data collected from sampling TARP wells are submitted annually to the IEPA.

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

RESEARCH SERVICES TO THE U. S. ARMY CORPS OF ENGINEERS TO SUPPORT THE DESIGN OF THE AERATION AND WASH DOWN SYSTEMS FOR THE MCCOOK RESERVOIR

General Objective of the Project. The objective of this project is to provide research assistance, by the District and/or its subcontractors, to the U. S. Army Corps of Engineers (ACOE) to support the design of the Aeration and Wash Down Systems for the McCook Reservoir. The McCook Reservoir will eventually contain CSOs. This warrants an assessment of the potential for odors, and the impact of the reservoir contents on the ambient air quality.

Project Description. The McCook Reservoir will provide storage for CSOs from the Mainstream and Des Plaines TARP tunnel systems, thereby, reducing flood damages and minimizing release of untreated CSOs to area waterways. The Mainstream and Des Plaines TARP tunnels, constructed and operated by the District, will transport the CSOs to McCook Reservoir when flows exceed the capacity of the Stickney and North Side WRPs. To minimize the possibility of odor formation, and to maintain aerobic conditions, an aeration system will be designed to maintain 2 mg/L of dissolved oxygen (DO) in a completely mixed environment. The wash down system will be designed to remove solids and debris from the walls and floor of the reservoir between storm events to minimize odors, maintain air quality, and comply with the applicable air pollution regulations.

Overall Scope of the Research Assistance Services. The work will consist of research assistance services to support the design of full-scale aeration and wash down systems to be used at the McCook Reservoir.

Plans for laboratory, field, and/or pilot-scale tests will be developed for the Cryogenic Oxygen Barge (COB), and U-tube aeration systems. Tests to determine the oxygen transfer efficiency (OTE), size of the aeration system needed, and feasibility of utilizing a COB, and/or U-tube system in the

McCook Reservoir will be performed. If these systems are shown to be impractical, tests will be developed to evaluate air/O_2 injection systems for supplemental oxygenation of the McCook Reservoir especially during small events (less than 30 feet deep).

Similarly, plans for laboratory, field and/or pilot-scale tests will be developed for the wash down system to obtain information on odor formation.

However, before conducting any laboratory, field, and/or pilot-scale tests, a literature investigation was undertaken by a subcontractor, Mr. Parnell O'Brien, retained by the District to determine the technical, economic, and physical feasibility of incorporating the candidate systems into the design of the total aeration system. This research will include discussion with individuals who have designed and/or operated COB and U-tube aeration systems, and will include site visits to facilities utilizing COB or U-tubes as part of their aeration system. Basic considerations of the literature search will be to ascertain the availability of sufficiently large quantities of cryogenic oxygen on short notice, its storage, and the hydraulic and water quality considerations, physical layout and dimensional data of the tunnel and reservoir system, mixing considerations, and energy requirements. These,

and any other, concerns will be evaluated to help determine the feasibility of the systems under consideration.

The work under this project only includes conducting literature searches on aeration and wash down systems, summarizing the advantages and disadvantages of each system investigated, designing one laboratory test and one field or pilot test for each of the systems (COB, U-tube, and wash down), and discussing the possible variations of these tests. If COB or U-tube systems are shown to be impractical either under normal operating conditions or in shallow depths (less than 30 feet), laboratory test or field test will be developed to evaluate other injection systems for oxygenation of the reservoir.

The estimated cost of this project is approximately $180,000, which will be reimbursed to the District by the ACOE. During 1999, the first draft of the literature review was completed, and the feasibility of doing large scale pilot plant aeration tests was studied. Work will continue on this project in 2000.

OXYGEN TRANSFER EFFICIENCY (OTE)

The OTEs of the diffuser plates in the aeration tanks in several District WRPs have been measured since 1990, using an off-gas technique. The OTE measurements are called off-gas tests.

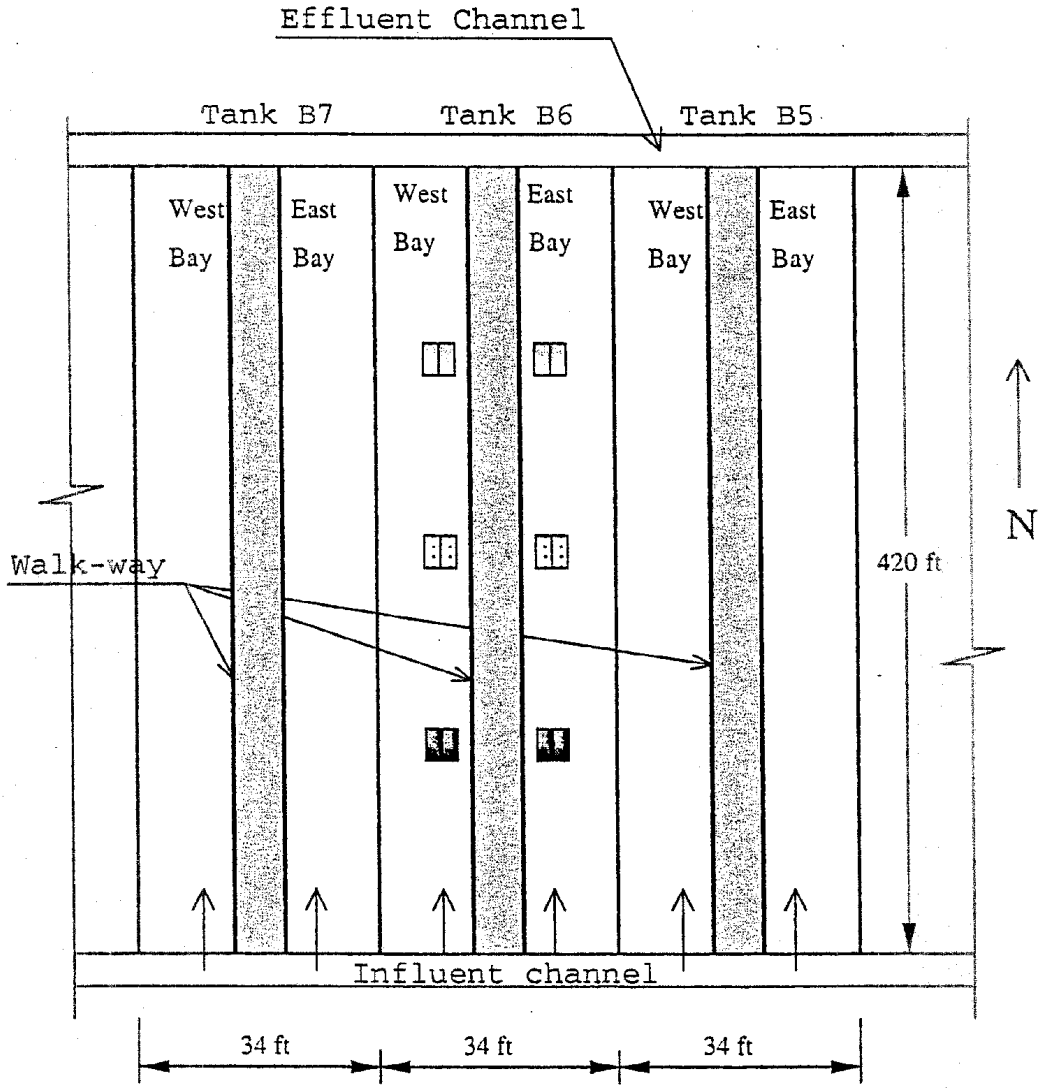
In 1999, in response to a request from the management of the North Side WRP (NSWRP), off-gas tests in the selected aeration tanks at the NSWRP were conducted. The main objectives of the off-gas tests conducted at the NSWRP were (1) to evaluate the effectiveness of cleaning the diffuser plates in the west bay of the aeration tank B6 in terms of improving the aeration efficiency, (2) evaluate the performance of the diffuser plates in selected tanks in Batteries A, B and C, and (3) to conduct off-gas tests in Battery D similar to the off-gas tests conducted in 1995.

In Batteries A, B and C, six test stations were set up in each test tank with three stations in each bay, except in the aeration tank C12. The three test stations were located at the 1/4, 1/2, and 3/4 points along the tank length from the influent end. Two hood positions next to each other at each test station were used to capture the maximum amount of the off-gas released under the hood. The off-gas hood was placed in a position parallel to the tank length and close to the walkway between the east and west bays of an aeration tank. Figure 9 shows a plan view of the off-gas test stations in Battery B which are similar to the test stations used in Batteries A and C. Figure 10 shows a cross-section view of two off-gas hood sections at the same off-gas test station. In

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 9

PLAN VIEW OF OFF-GAS TEST STATIONS IN AN AERATION TANK IN BATTERY B AT THE NSWRP



Off-gas hood station at 1/4 tank distance from influent end

Off-gas hood station at 1/2 tank distance from influent end

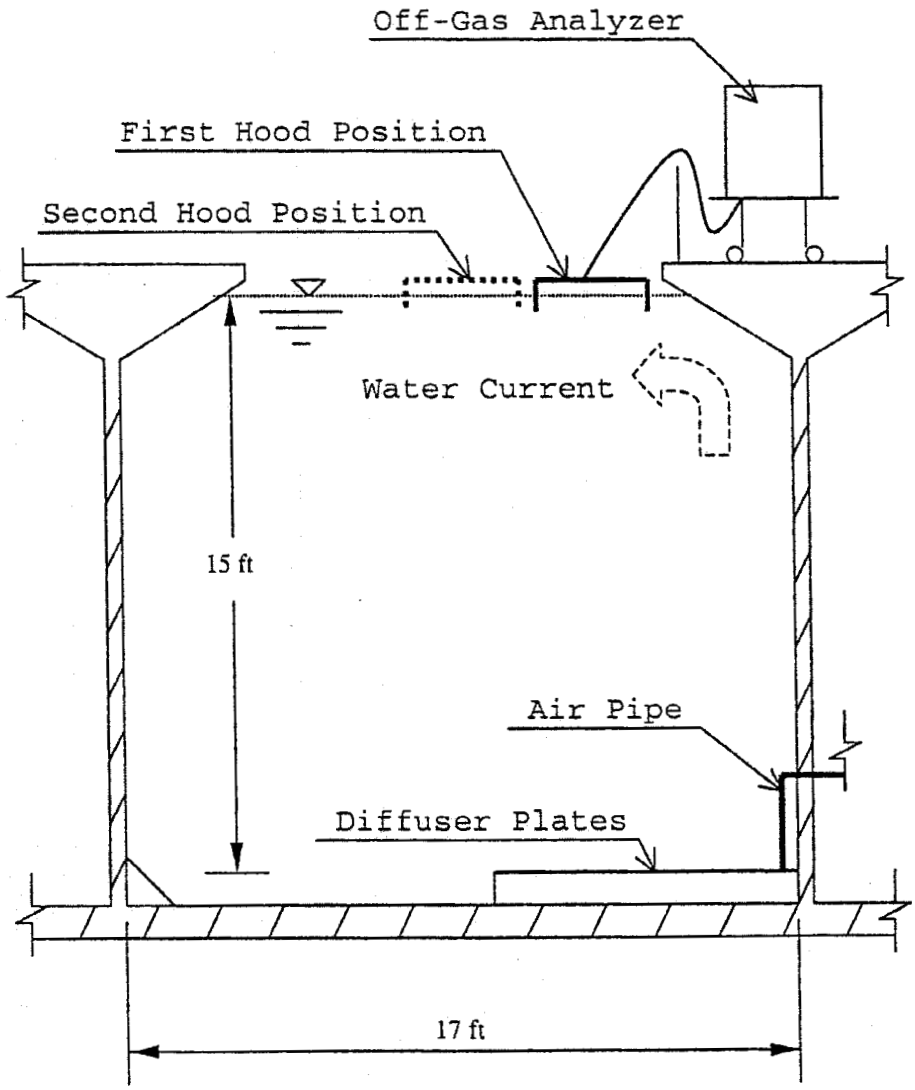
Off-gas hood station at 3/4 tank distance from influent end

Note: Not to scale.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 10

CROSS-SECTIONAL VIEW OF TWO OFF-GAS HOOD POSITIONS AT A TEST STATION IN BATTERIES A, B, AND C



Note: Not to scale.

Tank C12, as shown in Figure 11, there is only one bay with the basin width being twice of that of other bays in Batteries A, B and C. In Tank C12, three test stations were set up similar to Batteries A, B, and C. However, in Tank C12, taking advantage of its width, three or in some cases four hood positions were used at one station.

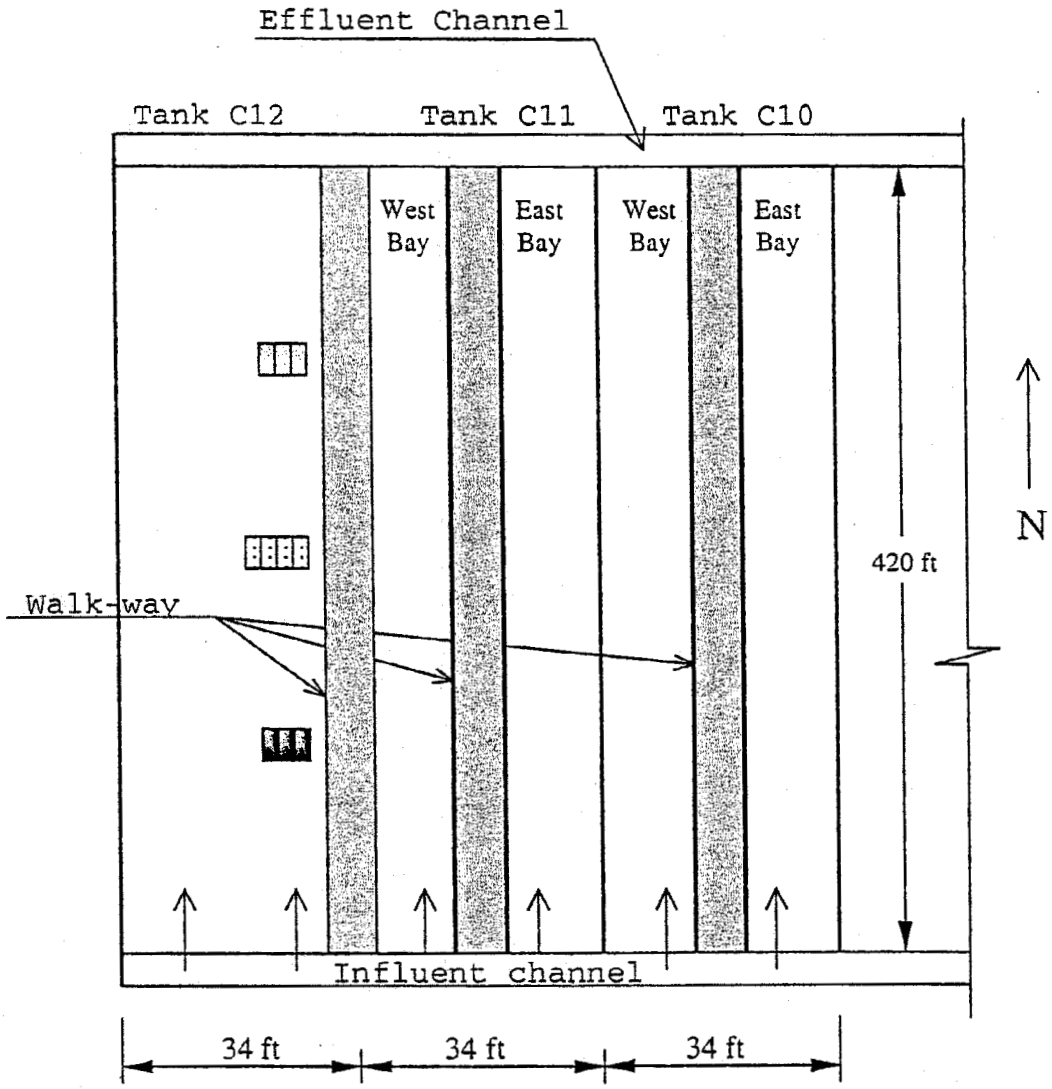
In Battery D, the number and location of off-gas test stations were the same as used in 1995. There were two test stations in each selected tank, and they were located at the 1/4 and 1/2 points along the tank length from the influent end, and only one hood position was used at each test station. The hood was placed parallel to the tank length and about two feet away from the walkway on the side of the diffuser plates.

All off-gas tests were conducted under controlled conditions. At the NSWRP, air flow to each aeration tank can be set and controlled, but the sewage flow can only be measured and adjusted for the entire battery. Throughout the off-gas tests, sewage flow to the test battery was adjusted to 50 MGD or close to it depending on the conditions of the plant operation on the day of the test. In Batteries A, B and C, the air flow to each test tank was set at 2100 scfm, unless otherwise noted. In Battery D, the air flow to each test tank was set at 2800 scfm without exception.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 11

PLAN VIEW OF OFF-GAS TEST STATIONS AND HOOD POSITIONS IN AERATION TANK C12 AT THE NSWRP



Off-gas hood station at 1/4 tank distance from influent end

Off-gas hood station at 1/2 tank distance from influent end

Off-gas hood station at 3/4 tank distance from influent end

Note: Not to scale.

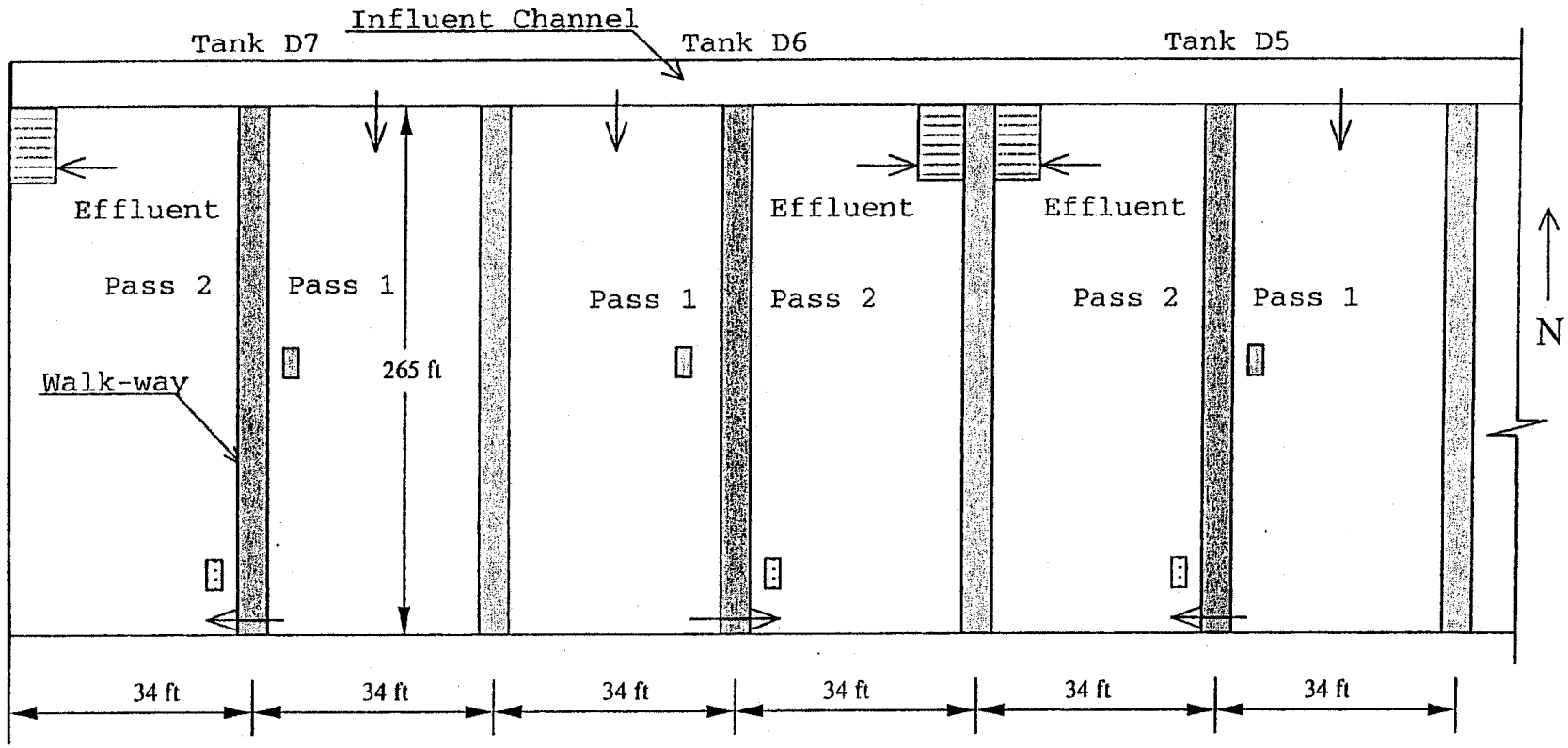
In order to account for daily variations, off-gas tests were repeated at the same test stations on different days. In Tank B6, off-gas tests were performed five times at almost all test stations, both before and after the diffuser plates in the west bay of Tank B6 were steam and/or hot water cleaned between August 10 to 16, 1999. In other selected tanks in Batteries A, B and C, off-gas tests were repeated twice at each test station on two different days. In Battery D, off-gas tests were conducted five times at each test station on five different days. Figure 12 shows a plan view of the off-gas test stations and hood positions in aeration tanks D5, D6, and D7.

A total of 45 off-gas tests in thirteen selected aeration tanks in Batteries A, B, C, and D at the NSWRP were conducted in 1999. Preliminary analyses of the field data indicate that the average standard OTEs (SOTEs), which are standardized to a standard condition at 20°C, 1 atmospheric pressure and maximum DO deficit, before and after the cleaning of the plates were 0.128 and 0.135 for the west bay, respectively, and 0.118 and 0.26 for the control bay. The lack of a significant difference between the values suggests that the cleaning of the diffuser plates in the west bay of the aeration tank B6 did not improve the OTE. The report for this project in under preparation.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 12

PLAN VIEW OF OFF-GAS TEST STATIONS AND HOOD POSITIONS IN AERATION TANKS D5, D6, and D7 AT THE NSWRP



Off-gas hood station at 1/4 tank distance from influent end

Off-gas hood station at 1/2 tank distance from influent end

Note: Not to scale.

CHEMICAL CHARACTERISTICS OF COMBINED SEWER OVERFLOWS AND TARP FLOWS IN 1995 THROUGH 1997

A report was prepared describing the results of studies conducted on the chemical characteristics of CSOs and TARP overflows. Two studies were conducted during 1995, 1996, and 1997 to characterize CSOs within the service area of the District. One study focused on the occurrence and levels of organic priority pollutants and volatile organic compounds (VOCs) in CSOs and TARP flows. The other study focused on conventional pollutants, particularly total suspended solids (TSS) and biochemical oxygen demand (BOD_5) in CSOs.

The CSOs from several locations within the service area of the District were sampled during various rainfall events from 1995 through 1997. These locations were:

1. The TARP Mainstream Pumping Station.
2. The TARP Calumet Pump Station.
3. The Kirie WRP influent sewage pump station.
4. The 125th Street drop shaft station (CDS-13).
5. The Racine Avenue drop shaft station (DS-M28).
6. The Riverside drop shaft station (DS-D45).
7. The Evanston drop shaft station (DS-M106).
8. The Lake Street overflow stations (CS-106A).
9. The Evanston overflow station (CS-106B).

In 1995, 28 samples were collected at 5 locations during 13 rainfall events. In 1996, 47 samples were collected at 9 locations during 22 rainfall events. In 1997, 28 samples were taken at 7 locations during 17 rainfall events. Each sample was a grab sample collected either from the pumpage of a TARP pump station or from the overflow at a TARP drop shaft or overflow station. The samples were analyzed for 160 organic pollutants including most of the organic priority pollutants and VOCs. These will be referred to as organic pollutants in this report.

During the same period, i.e., 1995 through 1997, four conventional pollutants, total solids (TS), TSS, NH_4-N, and BOD_5 in CSOs discharged into the TARP system, were analyzed to fulfill a contractual obligation with the ACOE. In this study, the CSOs discharged into the TARP systems at four TARP drop shaft stations and into receiving waterways at three overflow stations were sampled for the four conventional pollutants during various rainfall events from 1995 through 1997. These locations were:

1. The 125th Street drop shaft station.
2. The Racine Avenue drop shaft station.
3. The Riverside drop shaft station.
4. The Evanston drop shaft station.
5. The Riverside overflow station.

6. The Lake Street overflow station.

7. The Evanston overflow station.

Samples of CSOs from these stations were collected by automatic samplers at predetermined time intervals during rainfall events of more than 0.5 inch rainfall, for the determination of conventional parameter concentrations. Four hundred twenty-one (421) samples were collected at three TARP drop shaft stations during 13 rainfall events in 1995. Two hundred thirty-nine (239) samples were collected at six TARP drop shaft and overflow stations during 7 rainfall events in 1996. In 1997, 175 samples were collected at six TARP drop shaft and overflow stations during 8 rainfall events. All 1995 samples were analyzed for TS, BOD_5, and NH_4-N, and all 1996 and 1997 samples were analyzed for TSS and BOD_5.

Organic Priority Pollutants and VOCs in CSOs. The results of organics analysis of 103 samples collected at 9 locations during 52 rainfall sampling events from 1995 through 1997 were divided into two categories in terms of the type of TARP stations, namely, TARP pump stations and TARP drop shaft and overflow stations. The following conclusions were drawn from the study of these results:

1. The average number of organic pollutants found in the pumpback and pumpage of the three TARP pump stations was more than that in the six TARP

drop shaft and overflow stations. The average number of organic pollutants detected in at least one sample from the three TARP pump stations was 28, compared to 17 organic pollutants from the six TARP drop shaft and overflow stations.

2. At the three TARP pump stations, VOCs were the predominant pollutants. The most frequently detected organic pollutants were acetone with 97 percent, toluene with 82 percent, and chloroform with 82 percent occurrence.

3. At the three TARP pump stations, the concentrations of the organic pollutants detected in the pumpback and pumpage varied widely from sample to sample. The highest concentration found for VOCs was 1371 µg/L (acetone), and for semi-volatile compounds was 454.3 µg/L (4-methylphenol). The concentrations of pesticides and PCBs in the samples collected were generally low, less than 2.4 µg /L. No general correlation between the quantity of rainfall and concentrations of pollutants in the samples collected was observed.

4. The trend of occurrence of the predominant volatile and semi-volatile compounds in the CSOs from the six TARP drop shaft and overflow stations was similar to that in the pumpback and pumpage from the three TARP pump stations.

The concentrations of organic pollutants in the samples from the six TARP drop shaft and overflow stations varied widely. The highest concentration detected for VOCs was 173.0 µg/L (acetone), and for semi-volatile compounds was 1845 µg/L (4-methylphenol). The concentrations of pesticides and PCBs were normally low, less than 0.3 µg/L. No general correlation between the quantity of rainfall and concentrations of organic pollutants at the six TARP drop shaft and overflow stations was observed.

Conventional Pollutants. The following conclusions were drawn from the data originating from the following sources: (1) the routine monitoring data collected for TARP pumpbacks to the District's WRPs, and (2) the data from the study on conventional pollutants in CSOs conducted jointly by the District and the ACOE:

1. Based on the data from the District's routine monitoring, the concentrations of the conventional pollutants in the pumpback and pumpage varied widely during the period of 1995 through

1997 when the pumpback and pumpage were sampled for the analysis of organic pollutants. The concentration of TSS from TARP pumpback at the TARP Mainstream Pumping Station ranged from 14 to 356 mg/L, BOD_5 from 10 to 174 mg/L, and NH_4-N from 1.28 to 9.12 mg/L. The concentration of TSS from TARP pumpback at the TARP Calumet Pump Station ranged from 22 to 610 mg/L, BOD_5 from 10 to 174 mg/L, and NH_4-N from 1.60 to 13.7 mg/L. The concentration of TSS from TARP pumpage at the Kirie WRP Influent Pump Station ranged from 36 to 1504 mg/L, BOD_5 from 29 to 245 mg/L, and NH_4-N from 2.60 to 12.51 mg/L.

2. No pattern between rainfall and the time-weighted average concentrations of conventional pollutants in CSOs was observed based on 28 sets of data collected at the seven TARP drop shaft and overflow stations during various rainfall events from 1995 through 1997.

3. No correlation between the average concentrations of conventional pollutants and the number of organic pollutants detected was found from

the data obtained from either the TARP pump stations or the TARP drop shaft and overflow stations.

Land Reclamation and Soil Science Section

The Land Reclamation 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 lands, and landfill sites. The environmental monitoring component of the program includes the sampling and analyses of waters, soils, and plants at land application sites, landfills, and solids drying facilities receiving biosolids. The research component consists of an in-depth examination of the selected environmental and biosolids parameters related to the application of biosolids to agricultural fields, disturbed lands, and the utilization of biosolids in landfills and for landscaping.

FULTON COUNTY PRAIRIE PLAN ENVIRONMENTAL MONITORING

The Prairie Plan is a large tract of land, 6,156 hectares (15,348 acres), owned by the District in Fulton County, Illinois. The site is used to recycle biosolids for the purpose of reclaiming mine soil and the growing of 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 affect surface waters, groundwaters, soils, and crops. The Land Reclamation and Soil Science Section is responsible for preparing monthly reports that summarize the monitoring data for compliance with the IEPA, and USEPA Part 503 regulations for land application of biosolids.

In 1999, the monitoring activities at the Fulton County site remained similar in quantity and nature to those conducted in 1998. No supernatant or dewatered liquid fertilizer from Holding Basin 1 was applied to Fulton County fields during 1999. Air dried, anaerobically digested biosolids from the District's Calumet Water Reclamation Plant (WRP) were shipped to the Fulton County site in 1999 and land-applied.

The water monitoring included the quarterly sampling of 20 groundwater monitoring wells, quarterly sampling of 15 lysimeters in the supernatant application area, sampling of surface waters from 10 streams, 8 reservoirs, and 14 sites in the supernatant application area three times per year between April and November, and the sampling of 65 field runoff retention basins as needed. Water samples were collected monthly from 19 lysimeters and 3 drainage tiles at the St. David Coal Refuse Pile, 3 lysimeters at the Morgan Mine Coal Refuse Pile, and 10 lysimeters at the United Electric Coal Refuse Pile.

Samples were collected quarterly as available from 18 surface runoff collectors at the St. David Coal Refuse Pile, 2 at the Morgan Mine Coal Refuse Pile, and 4 at the United Electric Coal Refuse Pile. Water monitoring also included weekly, monthly, and quarterly sampling of the discharges from the neutralization facility treating acid water from an acidic lake receiving drainage from the United Electric Coal Refuse Pile. Soil samples were collected from 75 fields for chemical analysis, and plant samples were collected from 1 wheat field, 11 hay fields, 36 soybean fields, and 17 corn fields for chemical analysis in 1999. Climatological conditions were monitored at the project weather station.

Biosolids have been applied to fields at the Fulton County site since 1972. Table 14 shows the concentrations of total metals (0 - 15 cm) found in 1998 corn field soils from fields receiving different cumulative rates of biosolids. Zinc, chromium, nickel, cadmium, copper, and lead concentrations generally increased with increased loading rates, but the differences in concentration were not widespread or consistently increasing with cumulative loading rate.

Corn leaf samples are collected annually from fields leased to local farmers at the Fulton County site. Table 15 shows the concentrations of total metals found in corn leaves collected from fields with different cumulative loading rates

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 14

CONCENTRATIONS OF TOTAL METALS (0 TO 15 cm) IN 1998 CORN FIELDS AT THE FULTON COUNTY SITE

Field No.	Cumulative Biosolids Applied[1]		Zn	Cd	Cu	Cr	Ni	Pb
	------Dry Solids------		----------mg/kg----------					
	Mg/ha	(tons/acre)						
7	1,393.5	(622.1)	709	38	271	478	84	147
8	1,222.4	(545.7)	921	52	355	620	103	196
12	1,306.1	(583.1)	741	41	304	518	86	163
13	1,162.1	(518.8)	1,164	65	453	780	112	251
14	1,278.1	(570.6)	1,023	57	408	708	110	233
39	442.0	(197.3)	707	42	289	514	86	161
40	497.3	(222.0)	760	47	303	571	86	179
50	6.6[2]	(3.0)	54	2	16	21	21	5
52	9.1[2]	(4.1)	48	3	19	24	27	<1.2

[1]Amount applied through 1997.
[2]Solids applied only as supernatant.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 15

CONCENTRATIONS OF TOTAL METALS IN 1998 CORN LEAF SAMPLES
FROM THE FULTON COUNTY SITE

Field No.	Cumulative Biosolids Applied[1]		Zn	Cd	Cu	Cr	Ni	Pb
	------Dry Solids------		----------mg/kg----------					
	Mg/ha	(tons/acre)						
7	1,393.5	(622.1)	45.2	<1.0	6.5	<1.0	0	0
8	1,222.4	(545.7)	49.0	1.0	6.5	<1.0	0	0
12	1,306.1	(583.1)	57.5	1.5	6.5	<1.0	0.50	0
13	1,162.1	(518.8)	31.0	2.0	5.0	<1.0	0	0
14	1,278.1	(570.6)	50.5	1.5	5.5	<1.0	0	0
39	442.0	(197.3)	34.5	3.5	5.5	<1.0	0	0
40	497.3	(222.0)	43.0	2.0	5.5	<1.0	<0.035	0
50	6.6	(3.0)	12.0	<1.0	5.5	<1.0	<0.035	0.50
52	9.1	(4.1)	13.5	<1.0	6.0	<1.0	0	0

[1]Amount applied through 1997.

of biosolids. Cadmium, copper, chromium, nickel and lead were present in relatively low concentrations. Corn leaf zinc concentrations were similar for all fields at all dry biosolids loading rates, except for fields #50 and #52 with biosolids applied as supernatant. Although zinc levels were higher in plant tissues from biosolids-amended fields, there was no clear pattern of increase in plant tissue concentration with increase in cumulative biosolids loading rate.

CORN FERTILITY EXPERIMENT ON CALCAREOUS MINE SOIL

In 1973, a corn fertility experiment was established on calcareous mine soil at the Fulton County site in cooperation with Dr. T. D. Hinesly, Agronomy Department, University of Illinois. Dr. Hinesly's participation in the experiment ceased in 1980. 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 soil chemical composition. The experiment was designed to simulate biosolids applications to fields at the site, and to provide information that can be used for management of biosolids and crops.

Dewatered sewage sludge cake, brought by barge from Chicago in 1992, was applied to the plots in the spring of 1999 prior to the planting of corn. The total amount of biosolids

applied to the maximum-amended plots in 1999 was 67.2 dry Mg/ha (30.0 tons/acre). The one-fourth and one-half maximum treatments received the corresponding amounts, and the check treatment received commercial fertilizer (Table 16). From 1973 to 1999, the maximum treatment received a cumulative total of 1749.4 dry Mg/ha (781 tons/acre) of biosolids.

Mean corn grain and stover yields were the lowest in the plots receiving 16.8 Mg/ha (7.5 tons/acre) of biosolids. Although stover yields were highest in the control plots, grain yields were highest in the maximum-amended plots. Grain yields ranged from 1.29 Mg/ha (20.6 bu/acre) on a plot amended with 16.8 Mg/ha (7.5 tons/acre) of biosolids to 9.42 Mg/ha (137.6 bu/acre) on a plot receiving 67.2 Mg/ha (30 tons/acre) of biosolids.

CHEMICAL PARAMETERS OF SUBSURFACE AND SURFACE WATER AT THE ST. DAVID, ILLINOIS, COAL REFUSE PILE RECLAMATION SITE

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. The experiment was initiated with the approval of the IEPA.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 16

CORN GRAIN AND STOVER YIELDS ON BIOSOLIDS-AMENDED MINE SOIL AT THE FULTON COUNTY SITE IN 1999

Biosolids Application[1]				Corn Yields[2]			
Annual		Cumulative		Grain		Stover	
----------Dry Solids----------							
Mg/ha	(tons/acre)	Mg/ha	(tons/acre)	Mg/ha	(bu/acre)	Mg/ha	(tons/acre)
0.0	(0.0)	0.0	(0.0)	8.14	(129.9)	6.42	(2.87)
16.8	(7.5)	437.9	(195.5)	1.29	(20.6)	2.17	(0.97)
33.6	(15.0)	875.8	(391.0)	4.89	(78.0)	3.95	(1.76)
67.2	(30.0)	1,749.4	(781.0)	8.63	(137.6)	5.78	(2.58)

[1]Check plots receive 336-224-112 kg/ha of N-P-K annually, and biosolids-amended plots receive 112 kg/ha of K annually.
[2]Grain yields are reported at 15.5 percent moisture, and stover yields include total dry matter for cobs and stalks.

Ten treatments were established on the west lobe and side slopes of a coal refuse pile at St. David, Illinois (Table 17). Each of the ten treatment plots was approximately 0.405 ha (1 acre). In establishing the treatments, a specific sequence of operations was used, and these operations were conducted in four phases. The first phase consisted of preliminary grading to fill existing erosion gullies on the surface, and removing the old nonfunctioning terraces from the side slopes of the coal refuse pile. When this was completed, lysimeters were installed in each treatment.

The second phase of operations consisted of applying the amendments. Agricultural limestone was applied to those treatments requiring it, then anaerobically digested municipal biosolids were applied in 10.2 cm (4 inch) layers using a scraper. These biosolids were from the District's Stickney WRP. A chisel plow was used to incorporate the applied biosolids. After the last layer of biosolids was applied, 10.2 cm (4 inches) of clay was applied to those treatments requiring it, and then incorporated by chisel plow mixing.

The third phase of operations consisted of planting the vegetative cover. The amended surface of the coal refuse pile was disked with an agricultural disk transverse to the slopes. The planted vegetative cover consisted of broadcast seeding of

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 17

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.

cereal rye at a rate of 121 kg/ha (108 lb/acre), followed by broadcast seeding of alfalfa and alsike clover at a rate of 22.4 kg/ha (20 lb/acre). Next, bromegrass and tall fescue were drill seeded at a rate of 11.2 kg/ha (10 lb/acre).

The final phase of operations consisted of mulching each treatment after planting the vegetative cover. Those areas on each treatment, which were flatter, and had an average slope of ten percent or less, received a mulching of straw or old hay at the rate of 136 bales/ha (55 bales/acre). Portions of each treatment with slopes greater than ten percent were covered with a biodegradable paper fabric, and held in place with 10.2 cm (4 inch) staples.

Lysimeters were installed in the middle of the upper slope of each treatment to collect monthly samples, as specified in the site permit from the IEPA. The lysimeter for each treatment consisted of a 3.04 m x 5.1 cm (10 ft x 2 inch) diameter PVC pipe placed in a lateral trench at a depth of 1.22 m (4 ft) in the coal refuse material prior to application of any amendments. The PVC pipe, used as a lateral drain, had 0.32 cm diameter holes (0.125 inch) drilled in three rows on the top and down both sides to allow water to flow into the pipe. The lateral drain was placed on top of a polyethylene sheet underlain by sand. The drain pipe was placed in the center of a polyethylene sheet, which was laid upward at an

angle of about 30 degrees on each side of the pipe. Pea gravel was placed directly over the pipe, 0.304 m (1 ft). The remainder of the trench was back filled with coal refuse material. Water collected by the lateral drain moved to a 25.4 cm (10 inch) vertical PVC standpipe placed adjacent to the trench. The bottom of the standpipe was placed at a minimum of 1.82 m (6 ft) below grade. Monthly water samples were collected by placing a plastic bucket, 15.2 cm x 30.5 cm (6 inch x 12 inch), in the standpipe below the outlet of the lateral drain to collect percolating water. The vertical standpipe had a plastic cover placed over the top to prevent any rainfall or contamination from entering the collection container.

Surface runoff has been collected quarterly each year from each treatment, if available, as specified in a site permit from the IEPA. Due to less than average precipitation and continued development of the vegetative cover, only one surface runoff sample could be collected in 1996 and none were collected in 1997, 1998 or 1999. Due to success in petitioning the IEPA for permit changes, these samples will no longer be collected after 1999.

Lysimeters. Water was collected from lysimeters on a monthly basis. Yearly means of selected chemical parameters for 1996, 1997, 1998, and 1999 are presented in Table 18. Due

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 18

YEARLY MEANS OF CHEMICAL PARAMETERS IN WATER FROM LYSIMETERS AT THE ST. DAVID, ILLINOIS, COAL REFUSE PILE RECLAMATION SITE

Chemical Parameters	Year	Plot Number									
		1	2	3	4	5	6	7	8	9	10
pH	1996	NA	6.3	7.3	7.0	7.3	7.4	7.3	6.8	6.8	6.4
	1997	NA	6.6	7.1	7.2	7.2	7.1	7.5	7.1	6.9	6.5
	1998	2.4	6.7	7.1	7.1	7.0	7.2	7.1	7.1	6.9	6.9
	1999	2.2	7.2	7.4	7.3	7.5	7.5	7.6	7.2	7.1	6.7
		----------mg/L----------									
SO_4	1996	NA	2827	1722	2108	1801	1856	1845	1242	1620	1340
	1997	NA	2146	1574	1687	1506	1593	1434	1227	1668	2354
	1998	37417	1834	1265	1675	1446	2031	1425	1062	1790	1770
	1999	31250	1788	1284	1631	1495	1681	1557	1147	1639	1899
NH_3-N	1996	NA	0.32	0.20	0.22	0.19	0.20	0.26	0.41	0.38	1.58
	1997	NA	0.17	0.12	0.19	0.14	0.11	0.39	0.35	0.21	2.65
	1998	0.80	0.19	0.15	0.12	0.20	0.16	0.17	0.58	0.29	0.36
	1999	0.76	0.23	0.16	0.12	0.16	0.17	0.25	0.19	0.22	0.71
NO_3+NO_2-N	1996	NA	2.82	1.84	2.97	11.7	0.99	13.6	5.58	52.6	68.5
	1997	NA	1.50	1.80	2.65	9.23	0.56	11.5	3.44	52.7	42.2
	1998	5.99	1.44	0.82	2.19	8.61	0.67	16.3	5.27	60.7	42.3
	1999	1.48	1.62	1.17	2.54	7.97	0.60	18.0	3.60	57.4	49.1

NA = Samples are not available due to insufficient precipitation.

to lower than normal precipitation, and possible lysimeter malfunction, water samples could not be collected from the unamended plot number 1 in 1996, and 1997. The lysimeter in plot number 1 was replaced in 1997. The pH values for this plot in 1998 and 1999 were 2.4 and 2.2, respectively.

The pH values in the biosolids-amended plots ranged from 6.3 to 7.4 in 1996, from 6.5 to 7.5 in 1997, from 6.7 to 7.2 in 1998, and from 6.7 to 7.6 in 1999.

The highest mean sulfate concentration of 37,417 mg/L occurred in 1998 lysimeter water from plot number 1. Mean sulfate levels in all other plots varied from 1,062 to 2,827 mg/L from 1996 through 1999.

The highest mean NH_3-N level of 2.65 mg/L occurred in plot number 10 in 1997. Lysimeter samples from all other plots had lower levels of NH_3-N, ranging from 0.11 to 1.58 mg/L for 1996, 1997, 1998 and 1999 biosolids-amended plots.

High mean levels of NO_3+NO_2-N (11.5 to 68.5 mg/L) were found in plot numbers 7, 9 and 10 in 1996 through 1999.

CHEMICAL PARAMETERS OF SUBSURFACE AND SURFACE WATERS AT THE UNITED ELECTRIC COAL REFUSE PILE RECLAMATION SITE

In 1990, the Abandoned Mined Lands Reclamation Council (AMLRC) began reclamation of the United Electric Coal (UEC) coal refuse pile in cooperation with the District. The cooperative project was initiated with the approval of the IEPA.

The UEC site covers approximately 44.6 hectares (110 acres) in Fulton County, near Cuba, Illinois. Reclamation of the site was accomplished in five phases. The first phase consisted of preliminary grading to fill existing erosion gullies on the surface, and smooth the top, side slopes and lower level areas.

The second phase of operations consisted of applying a clay cover. In 1991, the AMLRC applied a 0.61 meter (two feet) thick clay cap over the entire surface of the coal refuse pile. The surface was graded and smoothed, and then the lysimeters were installed.

The third phase of operations consisted of applying biosolids. Anaerobically digested municipal biosolids were applied at a rate of 2,242 Mg/ha (1000 dry tons/acre) over the entire site. The biosolids were spread with self-loading scrapers and smoothed with bulldozers.

The fourth phase of operations consisted of planting the vegetative cover. The amended surface of the coal refuse pile was disked with an agricultural disk, transverse to the slopes, in preparation for planting. The planted vegetative cover consisted of broadcast seeding of cereal rye at a rate of 56 kg/ha (50 lb/acre), alsike clover broadcast at a rate of 11.2 kg/ha (10 lb/acre), tall fescue broadcast at a rate of 11.2 kg/ha (10 lb/acre), and orchard grass broadcast at a rate

of 11.2 kg/ha (10 lb/acre). Then, alfalfa and bromegrass were drill seeded at rates of 22.4 kg/ha (20 lb/acre) and 11.2 kg/ha (10 lb/acre) respectively.

The final phase of operations consisted of mulching the coal refuse pile after planting the vegetative cover. Flatter areas within the reclamation site, with an average slope of five percent or less, received a mulching of old hay at the rate of 136 bales/ha (55 bales/acre). Areas with slopes greater than five percent were covered with a biodegradable paper fabric, and held in place with 10.2 cm (4 inch) staples. After mulching the site, surface runoff collection devices were installed.

Ten lysimeters were installed in various locations on the upper slope to collect monthly samples, as specified in the site permit from the IEPA. At each location, the lysimeter was installed in the same manner as described for the St. David, Illinois, Coal Refuse Pile Reclamation Site. Monthly water samples were collected by placing a plastic bucket, 15.2 cm x 30.5 cm (6 inch x 12 inch), in the standpipe below the outlet of the lateral drain to collect percolating water. The vertical standpipe had a plastic cover placed over the top to prevent any rainfall or contamination from entering the collection container.

Surface runoff has been collected quarterly, each year from each treatment, if available, as specified in the site permit from the IEPA. Due to less than average precipitation and continued development of the vegetative cover, no surface runoff samples were collected in 1997, 1998, or 1999. Due to success in petitioning the IEPA for permit changes, these samples will no longer be collected.

Lysimeters. Water was collected from lysimeters on a monthly basis. Yearly means of selected chemical parameters for 1996, 1997, 1998, and 1999, are presented in Table 19. The pH of water collected from the lysimeters from 1996 through 1999 ranged from 6.0 to 7.4. Due to lower than average precipitation, no water samples were collected from lysimeter number 10 in 1996 through 1999, and from lysimeter 1 in 1996.

Between 1996 and 1999, sulfate concentrations in all lysimeters ranged between 95.0 mg/L and 2,874 mg/L.

Mean NH_3-N levels ranged from 0.20 mg/L to 23.5 mg/L between 1996 and 1999. Lysimeter 1 had the lowest mean NH_3-N level of the ten lysimeters during 1999 while plot 8 continued to exhibit the highest values for these four years.

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TABLE 19

YEARLY MEANS OF CHEMICAL PARAMETERS IN WATER FROM LYSIMETERS AT THE UNITED ELECTRIC COAL REFUSE PILE RECLAMATION SITE

Chemical Parameters	Year	Plot Number									
		1	2	3	4	5	6	7	8	9	10
pH	1996	NA	6.7	6.9	7.1	7.0	6.8	7.1	7.0	7.3	NA
	1997	6.0	6.8	7.0	7.0	7.0	6.1	7.1	6.9	7.4	NA
	1998	7.1	7.1	7.2	7.0	7.0	6.5	7.3	7.1	7.3	NA
	1999	7.2	7.2	7.3	7.1	7.1	7.1	7.4	7.0	7.4	NA
		----------mg/L----------									
SO_4	1996	NA	1180	2320	2234	2787	2578	2363	2797	2687	NA
	1997	178	1677	1937	2217	2443	2631	1891	2552	2391	NA
	1998	545	922	1824	2228	2302	1967	1939	2812	2853	NA
	1999	95	927	1859	2116	2158	1749	1915	2874	2762	NA
NH_3-N	1996	NA	0.62	4.01	0.81	0.48	0.74	0.71	16.1	0.87	NA
	1997	4.02	0.62	1.72	0.37	0.38	0.45	0.84	19.5	3.49	NA
	1998	1.13	0.66	0.75	0.43	0.40	0.51	0.38	23.5	0.40	NA
	1999	0.20	0.43	0.52	0.47	0.40	0.34	0.60	14.3	0.40	NA
NO_3+NO_2-N	1996	NA	63.7	341	49.1	18.0	61.3	34.9	3.8	23.8	NA
	1997	17.4	77.4	169	68.6	11.0	40.5	24.6	2.3	10.1	NA
	1998	111	35.4	73.4	39.2	9.5	22.8	13.7	2.6	3.6	NA
	1999	109	14.3	43.1	13.1	5.4	23.8	2.4	2.3	1.6	NA

NA = Samples are not available.

Mean NO_3+NO_2-N levels ranged from 1.6 mg/L to 341 mg/L during 1996, 1997, 1998, and 1999. The NO_3+NO_2-N levels of all lysimeters have dropped between 1996 and 1999 with the exception of lysimeter 1.

NU EARTH VEGETABLE GARDEN

The Nu Earth vegetable garden was established at the Stickney WRP in 1977 to study the accumulation of trace metals into edible portions of common garden vegetables that were fertilized with Nu Earth sludge, which was distributed throughout Chicagoland in the 1970s. The garden was fertilized with equal increments of Nu Earth (air-dried Imhoff sludge, no longer produced by the District) from 1977 through 1981. Garden plots received either commercial fertilizer or 9, 18, 36, or 45 tons of Nu Earth per acre per year.

After 1981, no Nu Earth was applied to any of the plots, and all plots annually received commercial fertilizer. Soil pH was maintained between 7.0 and 7.5 on all plots throughout the course of the experiment.

The concentrations of cadmium, copper, nickel, and zinc in tomatoes harvested from the garden plots in 1982 and every other year through 1998 are presented in Tables 20, 21, 22, and, 23, respectively. The last Nu Earth garden experiment was conducted in 1998.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 20

CADMIUM CONCENTRATION IN TOMATOES GROWN IN THE NU EARTH GARDEN RESEARCH PLOTS AT THE STICKNEY WATER RECLAMATION PLANT

Total Nu Earth Applied from 1977 through 1981[1]	Cadmium Concentration								
	1982	1984	1986	1988	1990	1992	1994	1996	1998
(Dry Tons/Acre)	mg/kg								
0[2]	1.39	1.13	1.80	1.60	2.08	0.85	0.99	1.05	0.78
45	2.56	1.21	1.82	2.84	1.97	1.23	1.83	1.21	1.35
90	2.92	1.50	2.58	2.26	2.54	1.36	1.84	2.03	1.55
180	3.46	2.02	2.77	2.60	3.47	2.01	1.90	1.96	1.63
225	3.44	2.20	2.92	3.96	2.98	1.70	1.87	1.50	2.11

[1]Nu Earth was applied from 1977 through 1981 in five equal applications annually. All experimental plots also received an additional 89 lbs K/acre each year.
[2]Check plots received inorganic fertilizer N (89 lbs/acre), and P (89 lbs/acre) from 1977 through 1981. After 1981 all plots received these inorganic fertilizer treatments every year.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 21

COPPER CONCENTRATION IN TOMATOES GROWN IN THE NU EARTH GARDEN RESEARCH PLOTS AT THE STICKNEY WATER RECLAMATION PLANT

Total Nu Earth Applied from 1977 through 1981[1]	Copper Concentration								
	1982	1984	1986	1988	1990	1992	1994	1996	1998
(Dry Tons/Acre)	mg/kg								
0[2]	9.74	8.02	12.0	13.5	15.0	9.1	8.2	11.1	8.7
45	11.8	9.19	12.5	13.5	13.5	8.1	9.8	12.3	10.1
90	11.1	11.2	12.5	10.4	13.4	8.5	9.0	13.1	10.1
180	10.7	10.5	15.3	12.7	13.3	10.4	8.8	13.3	9.4
225	10.4	10.9	12.6	14.6	12.8	9.9	7.5	12.0	11.1

[1]Nu Earth was applied from 1977 through 1981 in five equal applications annually. All experimental plots also received an additional 89 lbs K/acre each year.
[2]Check plots received inorganic fertilizer N (89 lbs/acre), and P (89 lbs/acre) from 1977 through 1981. After 1981 all plots received these inorganic fertilizer treatments every year.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 22

NICKEL CONCENTRATION IN TOMATOES GROWN IN THE NU EARTH GARDEN RESEARCH PLOTS AT THE STICKNEY WATER RECLAMATION PLANT

Total Nu Earth Applied from 1977 through 1981[1]	Nickel Concentration								
	1982	1984	1986	1988	1990	1992	1994	1996	1998
(Dry Tons/Acre)	mg/kg								
0[2]	1.60	3.53	0.15	0.42	0.31	0.13	0.20	0.96	2.30
45	2.86	3.42	0.30	0.37	0.50	0.33	0.35	0.73	2.16
90	1.54	4.29	0.41	0.98	0.37	0.17	0.40	0.87	1.53
180	2.21	3.46	0.62	0.82	0.69	0.40	0.40	0.62	2.21
225	1.85	4.48	0.86	2.01	0.67	0.27	0.35	0.81	3.59

[1]Nu Earth was applied from 1977 through 1981 in five equal applications annually. All experimental plots also received an additional 89 lbs K/acre each year.
[2]Check plots received inorganic fertilizer N (89 lbs/acre), and P (89 lbs/acre) from 1977 through 1981. After 1981 all plots received these inorganic fertilizer treatments every year.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 23

ZINC CONCENTRATION IN TOMATOES GROWN IN THE NU EARTH GARDEN RESEARCH PLOTS AT THE STICKNEY WATER RECLAMATION PLANT

Total Nu Earth Applied from 1977 through 1981[1]	Zinc Concentration								
	1982	1984	1986	1988	1990	1992	1994	1996	1998
(Dry Tons/Acre)	mg/kg								
0[2]	23.0	26.3	25.1	29.8	27.2	18.3	23.0	24.9	16.3
45	29.8	29.6	23.3	51.0	29.9	21.3	32.5	27.8	21.9
90	27.9	30.8	27.0	24.7	30.0	18.0	32.0	36.4	21.8
180	28.2	30.9	28.8	30.3	28.5	24.7	27.0	31.4	20.0
225	26.2	32.0	28.5	37.0	30.2	21.7	31.5	27.1	25.1

[1]Nu Earth was applied from 1977 through 1981 in five equal applications annually. All experimental plots also received an additional 89 lbs K/acre each year.
[2]Check plots received inorganic fertilizer N (89 lbs/acre), and P (89 lbs/acre) from 1977 through 1981. After 1981 all plots received these inorganic fertilizer treatments every year.

Nu Earth additions had no consistently significant effect on the concentrations of copper in tomatoes, and produced only small increases in the concentrations of zinc, nickel, and cadmium in tomatoes harvested from the garden (Tables 20, 21, 22, and 23. Concentrations of cadmium were lower in tomatoes harvested from the garden in 1992 through 1998 than they were in 1982, indicating that bioavailability of cadmium may have decreased over this 16 year span. None of the metals appears to have increased in bioavailability since Nu Earth applications ceased 18 years ago.

SCREENING PLANT SPECIES FOR SUITABILITY FOR GROWTH IN DISTRICT BIOSOLIDS

In early 1996, a research project was begun to assess the suitability of District biosolids for use as a substitute for topsoil. This is because District biosolids are being marketed as a soil substitute for use as a final cover material at municipal solid waste landfills. Since these landfill sites are used for a variety of purposes, such as golf courses, parks, and recreation areas after closure, as well as being planted in low maintenance vegetative cover, a wide variety of grass species were considered as potential candidates for utilization at these sites. The study was expanded in 1997 to include forage grasses, legumes, prairie grasses, and

wildflowers, and this work continued in 1999. The results of work conducted on this study in 1999 are reported below.

We continued our assessment of the suitability of turf grasses for use with District biosolids. Their ability to germinate in the material was determined under conditions simulating those likely to be encountered at unirrigated sites. The results obtained from this study in 1999 are presented in Table 24.

Also in 1999, we evaluated suitability of three forage species to germinate in District biosolids (Table 25). Common buckwheat was observed to have a significantly greater average germination rate in biosolids (89.1 percent) than in topsoil (69.1 percent). The germination rates of the three forages in biosolids were generally greater than that of the turfgrasses. In 1997, the District began acquiring seeds of prairie grasses and wildflowers for use in the screening program. To date, the seeds of over 60 species have been acquired and tested. Germination rates in biosolids and soil for species that were tested and screened in 1999 are presented in Table 26. Of the three wildflower species tested this year for germination in biosolids, all had significantly lower germination rates in the biosolids than in topsoil. The biosolids germination rates for lemon mint (Monarda citriodaia), purple cone-flower

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 24

GERMINATION OF TURFGRASS IN BIOSOLIDS UNDER CONDITIONS SIMULATING UNIRRIGATED MANAGEMENT PRACTICES

Species	Varieties	Germination %Control
Fescue - red	2	90.8
Fescue - chewings	1	50.0
Fescue - sheep	2	49.6
Fescue - tall	2	44.6
Fescue - hard	3	34.3
Fescue - creeping red	2	28.2
Rough Bluegrass	1	1.9

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 25

GERMINATION OF FORAGE CROPS IN BIOSOLIDS UNDER CONDITIONS SIMULATING UNIRRIGATED MANAGEMENT PRACTICES

Species	Germination Rate	
	Control	Biosolids
	----------%	----------
Buckwheat - common	69.1 ± 11.3	89.1 ± 7.4*
Clover-crimson	99.6 ± 1.21	96.0 ± 3.1
Wheat v. Patterson	99.3 ± 1.6	79.3 ± 8.2*

*Significantly different at the 0.05 level using t-test.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 26

GERMINATION OF WILDFLOWERS IN BIOSOLIDS UNDER CONDITIONS SIMULATING UNIRRIGATED MANAGEMENT PRACTICES

Species	Germination Rate	
	Control	Biosolids
	----------%	----------
Aster/Sunflower Family (Asteraceae/Compositae)		
Coneflower - purple	73 ± 6.5	4 ± 3.3*
Goldenrod - stiff	16 ± 3.3	0 ± 0.0*
Mint Family (Labiatae/Lamiaceae)		
Lemon mint	49.8 ± 8.1	30.6 ± 12.7*

*Significantly different at the 0.05 level using t-test.

(Echinacea purpurea), and stiff goldenrod (Solidagorigida) were 61.4, 5.5, and 0.0 percent of their germination rates in topsoil, respectively.

HANOVER PARK FISCHER FARM

The Hanover Park Fischer Farm is a 48 hectare (120 acres) tract of land which utilizes all of the biosolids produced by the Hanover Park WRP. The farm, located on the south side of the WRP grounds, has 18 gently sloping fields, each surrounded by a berm to control surface runoff. An underdrain tile system collects surface and subsurface drainage which is returned to the Hanover Park WRP for treatment.

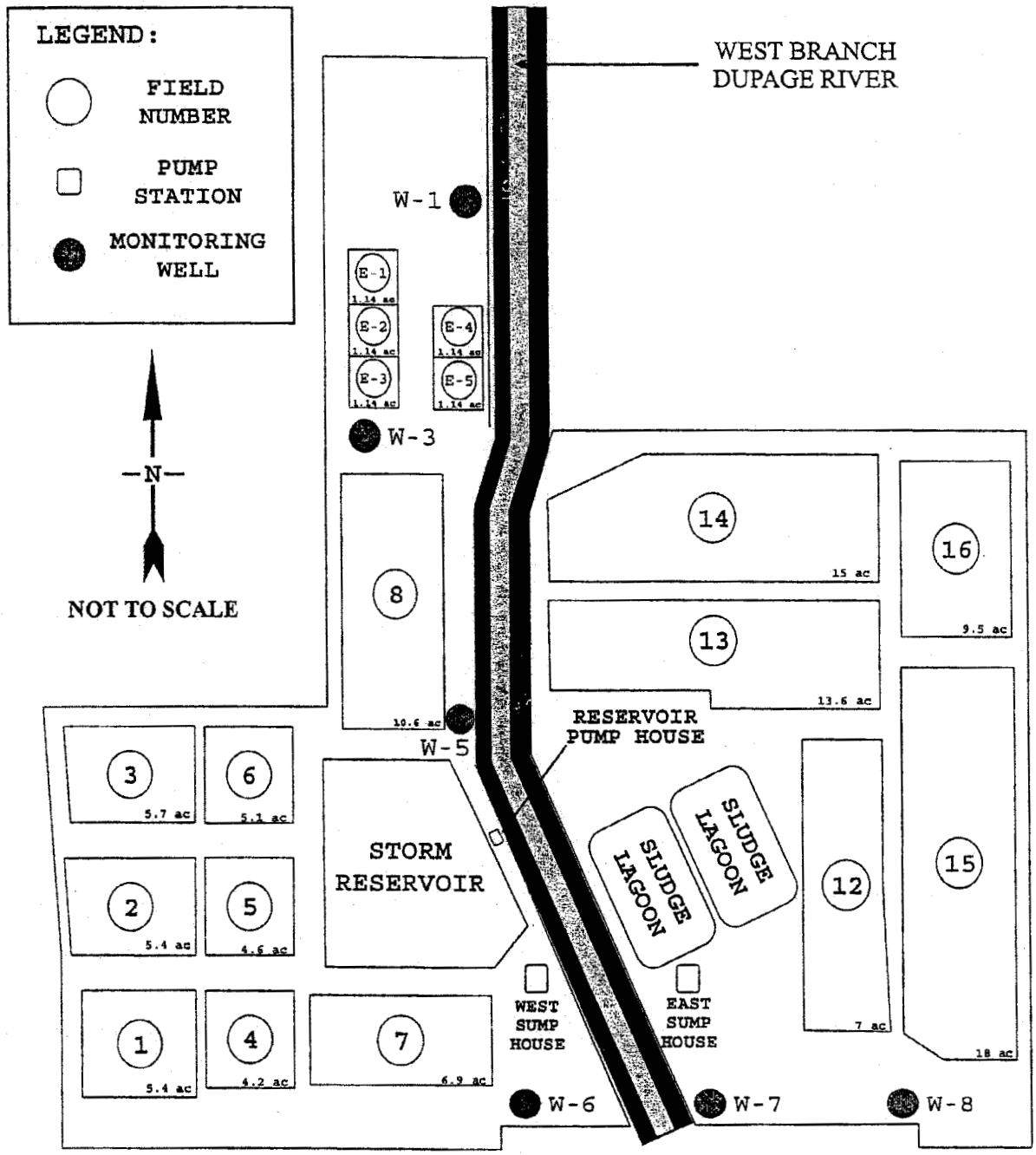
Anaerobically digested biosolids are applied by injection from tank trucks. The IEPA operating permit for the site limits the annual biosolids application rate to 56 dry Mg/ha (25 dry tons/acre). The crop plan for 1999 included 12 fields used for biosolids application of which 10 fields produced corn.

Groundwater monitoring is required by the IEPA operating permit. Fields and monitoring locations at the Fischer Farm are shown on Figure 13. 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 annual mean quality

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 13

LOCATION OF THE FISCHER FARM FIELDS AND WELLS
AT THE HANOVER PARK WATER RECLAMATION PLANT



of groundwater from these wells for 1979 and 1999 are compared in Table 27. This comparison is used to indicate any impact on groundwater quality due to continuous biosolids application since 1979. The groundwater quality in 1999 was better in some aspects than in 1979, as shown by the reduced levels of TKN, Zn, Fe, and electrical conductivity (EC). Twenty years of biosolids application has not adversely affected the groundwater quality at the Hanover Park Fischer Farm.

In June 1988, the six-acre area used for an experimental corn plot in the 1970s was divided into five fields.

Two shallow wells (W-1 and W-3) located next to these fields were sampled twice a month. Mean analysis of water from these wells in 1999 is shown in Table 28.

GROUNDWATER QUALITY AT THE JOHN E. EGAN AND CALUMET SOLIDS DRYING FACILITIES

In 1986, paved solids drying areas were constructed at the John E. Egan and Calumet WRPs. These areas were designed to handle biosolids production at the Egan and Calumet WRPs by air drying the biosolids to greater than 60 percent solids content. This substantially reduces the volume of biosolids produced, and results in a material which can be distributed locally for landscaping purposes.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 27

HANOVER PARK WRP FISCHER FARM AVERAGE ANNUAL WELL WATER ANALYSIS FOR 1979 AND 1999 BASED ON BIWEEKLY SAMPLING OF FOUR WELLS APRIL THROUGH OCTOBER 1979, AND FOUR WELLS JANUARY THROUGH DECEMBER 1999

Parameter	Units	1979	1999
pH		7.0	7.7
EC	mS/m	102	77
Total P	mg/L	0.2	0.11
Cl^-	"	61	24.8
$SO_4^=$	"	122	121
TKN	"	5.4	3.75
NH_3-N	"	0.1	2.24
NO_2+NO_3-N	"	0.3	0.034
Alkalinity as $CaCO_3$	"	386	371
Zn	"	0.2	0.030
Cd	"	<0.02	0.001
Cu	"	<0.02	0.029
Cr	"	<0.02	0.003
Ni	"	<0.1	0.011
Mn	"	0.80	0.071
Fe	"	122	7.2
Fecal Coliform[1]	per 100 mL	2.6	1.4

[1]Geometric mean.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 28

HANOVER PARK WRP FARM AVERAGE ANNUAL WELL WATER ANALYSIS FOR 1999 BASED ON BIWEEKLY SAMPLING OF TWO WELLS LOCATED NEAR THE PREVIOUS EXPERIMENTAL CORN PLOT AREA

Parameter	Units	Concentration
pH		7.5
EC	mS/m	179
Total P	mg/L	0.13
Cl^-	"	310
$SO_4^=$	"	208
TKN	"	0.77
NH_3-N	"	0.27
NO_2+NO_3-N	"	0.051
Alkalinity as $CaCO_3$	"	259
Zn	"	0.291
Cd	"	0.004
Cu	"	0.023
Cr	"	0.004
Ni	"	0.014
Mn	"	0.260
Fe	"	31
Fecal Coliform[1]	per 100 mL	1.1

[1]Geometric mean.

In November 1990, a second solids drying area was put into service at the Calumet WRP. This area is called the Calumet East Solids Drying Facility, the facility constructed in 1986 is called the Calumet West Solids Drying Facility.

The IEPA operating permits for these three drying facilities require groundwater monitoring. Lysimeters were installed for sampling groundwater immediately below the drying sites in October 1986 at the John E. Egan and Calumet West drying facilities, and in November 1990 at the Calumet East drying facility. Samples were taken once per month at both of the Calumet drying sites and twice per month at the Egan drying site in 1999.

Table 29 presents the analysis of water from the two lysimeters at the John E. Egan WRP. Table 30 presents the analysis of water from the three lysimeters at the Calumet West drying facility, and Table 31 presents the analysis of water from the six lysimeters at the Calumet East drying facility for samples taken in 1999. The data indicate that the shallow groundwater at all three sites is highly mineralized. The principal constituents are Ca, Mg, K, Na, SO_4, and alkalinity.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 29

MEAN[1] ANALYSIS OF WATER SAMPLES TAKEN IN 1999 FROM TWO LYSIMETERS AT THE JOHN E. EGAN SOLIDS DRYING FACILITY

Parameter	Units	Lysimeter Location[2] North	Lysimeter Location[2] South
pH		7.5	7.6
EC	mS/m	122	101
Total Dissolved Solids	mg/L	1,311	813
Total Dissolved Organic C	"	8	6
Cl^-	"	44	64
$SO_4^=$	"	304	211
Total Kjeldahl Nitrogen	"	0.40	0.38
NH_3-N	"	0.08	0.06
Total P	"	0.09	0.08
NO_2+NO_3-N	"	0.31	3.68
Alkalinity as $CaCO_3$	"	680	244
Al	"	<0.03	<0.03
As	"	0.03	0.02
B	"	0.21	0.22
Ca	"	210	128
Cd	"	0.001	0.001
Cr	"	<0.002	<0.002
Cu	"	0.014	0.014
Fe	"	0.094	0.017
Hg	µg/L	0.10	0.08
K	mg/L	2.1	7.0
Mg	"	100	40.8
Mn	"	0.038	0.132
Na	"	33.2	37.9
Ni	"	0.01	0.02
Pb	"	<0.002	<0.002
Se	"	0.006	0.004
Zn	"	0.028	0.029

[1]The method detection limit (MDL) was used in calculating the mean. If all values were less than the MDL, the mean is reported as <MDL.

[2]Lysimeter depths: North, 20 feet; South, 21 feet.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 30

MEAN[1] ANALYSIS OF WATER SAMPLES TAKEN IN 1999 FROM THREE LYSIMETERS AT THE CALUMET WEST SOLIDS DRYING FACILITY

Parameter	Units	Lysimeter[2] 1	2	3
pH		7.3	7.3	7.3
EC	mS/m	274	286	300
Total Dissolved Solids	mg/L	2,792	3,035	3,211
Total Dissolved Organic Carbon	"	5	3	3
Cl^-	"	97	33	24
$SO_4^=$	"	1,403	1,616	1,711
TKN-N	"	0.79	0.30	0.22
NH_3-N	"	0.20	0.06	0.04
Total P	"	0.17	0.10	0.10
NO_2+NO_3-N	"	0.29	0.29	0.46
Alkalinity as $CaCO_3$	"	163	177	156
Al	"	0.18	0.18	0.16
Ca	"	325	345	367
Cd	"	0.005	<0.004	<0.004
Cr	"	0.008	0.007	0.008
Cu	"	0.020	0.017	0.014
Fe	"	0.83	0.07	0.05
Hg	µg/L	0.10	0.07	0.07
K	mg/L	8.1	8.5	6.8
Mg	"	167	185	200
Mn	"	0.114	0.453	0.173
Na	"	204	217	209
Ni	"	0.02	0.02	0.02
Pb	"	0.05	<0.05	<0.05
Zn	"	0.05	0.03	0.02

[1]The method detection limit (MDL) was used in calculating the mean. If all values were less than the MDL, the mean is reported as <MDL.

[2]Lysimeter depths: No. 1, 20 feet; No. 2, 21 feet; No. 3, 21 feet.

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TABLE 31

MEAN[1] ANALYSIS OF WATER SAMPLES TAKEN IN 1999 FROM SIX LYSIMETERS AT THE CALUMET EAST SOLIDS DRYING FACILITY

Parameter	Units	Lysimeter[2] 1	2	3
pH		7.6	7.6	7.5
EC	mS/m	417	376	254
Total Dissolved Solids	mg/L	4,691	4,136	2,461
Total Dissolved Organic Carbon	"	5	16	11
Cl^-	"	173	172	101
$SO_4^=$	"	2,425	3,573	1,022
TKN-N	"	0.41	0.76	0.45
NH_3-N	"	0.04	0.13	0.05
Total P	"	0.10	0.21	0.15
NO_2+NO_3-N	"	0.37	0.17	0.09
Alkalinity as $CaCO_3$	"	559	490	543
Al	"	0.29	0.29	0.23
Ca	"	577	555	296
Cd	"	<0.004	<0.004	<0.004
Cr	"	0.011	0.011	0.008
Cu	"	0.205	0.054	0.016
Fe	"	0.09	0.14	0.26
Hg	µg/L	0.07	0.08	0.06
K	mg/L	11.3	7.2	3.8
Mg	"	351	291	194
Mn	"	0.097	0.040	0.015
Na	"	225	150	88.6
Ni	"	0.04	0.05	0.02
Pb	"	<0.05	0.06	<0.05
Zn	"	0.22	0.11	0.06

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 31 (Continued)

MEAN[1] ANALYSIS OF WATER SAMPLES TAKEN IN 1999 FROM SIX LYSIMETERS AT THE CALUMET EAST SOLIDS DRYING FACILITY

Parameter	Units	Lysimeter[2] 4	5	6
pH		7.2	7.4	7.5
EC	mS/m	347	187	162
Total Dissolved Solids	mg/L	3,722	1,529	1,381
Total Dissolved Organic Carbon	"	5	3	3
Cl^-	"	326	169	17
$SO_4^=$	"	1,449	499	608
TKN-N	"	0.89	0.66	0.38
NH_3-N	"	0.44	0.35	0.21
Total P	"	0.19	0.12	0.16
NO_2+NO_3-N	"	0.14	0.17	0.34
Alkalinity as $CaCO_3$	"	415	256	274
Al	"	0.17	0.18	0.18
Ca	"	422	197	172
Cd	"	<0.004	<0.004	<0.004
Cr	"	0.007	0.008	0.009
Cu	"	0.011	0.010	0.027
Fe	"	8.11	1.74	0.45
Hg	µg/L	0.06	0.06	<0.04
K	mg/L	6.8	5.7	4.1
Mg	"	274	102	89.3
Mn	"	0.078	0.086	0.038
Na	"	138	112	78.3
Ni	"	0.02	0.02	0.02
Pb	"	<0.05	<0.05	<0.05
Zn	"	0.03	0.02	0.03

[1]The method detection limit (MDL) was used in calculating the mean. If all values were less than the MDL, the mean is reported as <MDL.

[2]Lysimeter depths: Nos. 1, 2, and 3, 28 feet; Nos. 4, 5, and 6, 22 feet.

GROUNDWATER QUALITY AT THE LAWNDALE AVENUE SOLIDS MANAGEMENT AREA

In 1983, the District began biosolids drying operations at the Lawndale Avenue Solids Management Area (LASMA). This involves spreading either dewatered lagoon biosolids or centrifuged digested biosolids 45-60 cm (18-24 in) deep on specially designed flat areas, and turning the biosolids over daily to enhance drying until the solids content is greater than 60 percent. The 1983 biosolids drying operations were performed on clay surfaces. These drying surfaces were paved with asphalt in 1984, and biosolids drying operations resumed on August 31, 1984.

The IEPA operating permit for this site 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 frequency was instituted.

In July 1984, six lysimeters were installed for sampling groundwater (every two weeks) immediately above the limestone bedrock which is located 6-12 m (20-40 ft) below the surface in this area. However, only three of the six lysimeters were functional. In early 1985, six more lysimeters were installed at the site; three to replace the nonfunctional lysimeters and three new ones. By April 1985, nine functional lysimeters

were installed at LASMA as required by the IEPA operating permit.

Average well water analysis for samples taken in 1999 is presented in Table 32. The water quality is typical of limestone aquifers. Calcium, Mg, and Na are the major cations, and HCO_3 (alkalinity) and SO_4 are the major anions. There is no indication that biosolids constituents have entered the aquifer underlying the site.

Average lysimeter water analysis for 1999 is presented in Table 33. Lysimeter water is highly mineralized and is affected by the fill material in which the lysimeters are located. The lysimeters are located in a marshland covered with imported fill.

The renewed operating permit for LASMA required monthly groundwater monitoring in 1999.

GROUNDWATER QUALITY AT THE RIDGELAND AVENUE SOLIDS MANAGEMENT AREA

The solids drying area at 119th and Ridgeland was originally constructed with a clay base. The drying area was paved with asphalt in 1992 and 1993. Drying operations on asphalt began on June 29, 1993.

The IEPA operating permit for this site requires groundwater monitoring. Four lysimeters, approximately 20 feet

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 32

MEAN[1] ANALYSIS OF TWENTY WATER SAMPLES TAKEN IN 1999 FROM THE FIVE MONITORING WELLS AT THE LAWNDALE AVENUE SOLIDS MANAGEMENT AREA

Parameter	Units	Monitoring Well[2]				
		M-11	M-12	M-13	M-14	M-15
pH		7.2	7.4	7.3	7.2	7.1
EC	mS/m	91	105	141	88	138
Total Dissolved Solids	mg/L	699	879	1,366	565	1,716
Total Dissolved Organic C	"	6	3	4	3	9
Cl^-	"	6	15	9	8	9
$SO_4^=$	"	193	328	609	129	798
TKN	"	1.49	0.39	0.45	0.25	0.55
NH_3-N	"	1.14	0.27	0.31	0.17	0.43
NO_2+NO_3-N	"	0.31	0.04	0.17	0.14	0.09
Total P	"	0.05	0.06	0.14	0.05	0.06
Alkalinity as $CaCO_3$	"	358	308	338	332	368
Al	"	0.18	0.17	0.16	0.19	0.17
As	"	<0.2	<0.2	<0.2	<0.2	<0.2
B	"	1.38	1.83	1.52	1.32	1.19
Ca	"	98.8	83.5	179	76.5	245
Cd	"	<0.004	<0.004	<0.004	<0.004	<0.004
Cr	"	0.009	0.007	0.006	0.007	0.006
Cu	"	0.010	0.009	0.008	0.009	<0.008
Fe	"	0.18	0.05	0.05	0.04	0.70
Hg	µg/L	0.04	0.05	0.05	<0.04	0.04
K	mg/L	9.83	10.8	11.6	9.43	11.8
Mg	"	50.0	41.1	89.7	44.9	117
Mn	"	0.009	0.003	0.007	0.002	0.017
Na	"	63.0	149	97.0	46.7	67.9

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 32 (Continued)

MEAN[1] ANALYSIS OF TWENTY WATER SAMPLES TAKEN IN 1999 FROM THE FIVE MONITORING WELLS AT THE LAWNDALE AVENUE SOLIDS MANAGEMENT AREA

Parameter	Units	Monitoring Well[2] M-11	M-12	M-13	M-14	M-15
Ni	"	0.02	<0.02	<0.02	<0.02	<0.02
Pb	"	<0.05	<0.05	<0.05	<0.05	<0.05
Se	"	<0.4	<0.4	<0.4	<0.4	<0.4
Zn	"	2.37	0.86	1.28	0.77	2.12
Fecal Coliform	#/100mL	4	<1	<1	<1	<1
Static Water Elev.	feet	580.8	577.9	583.1	583.7	580.5

[1]The method detection limit (MDL) was used in calculating the mean. If all values were less than the MDL, the mean is reported as <MDL.

[2]Well depths: No. 11, 160 feet; No. 12, 100 feet; No. 13, 180 feet; No. 14, 100 feet; No. 15, 100 feet.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 33

MEAN[1] ANALYSIS OF WATER SAMPLES TAKEN IN 1999 FROM NINE LYSIMETERS AT THE LAWNDALE AVENUE SOLIDS MANAGEMENT AREA

Parameter	Units	Lysimeter[2] L-1	L-2	L-3	L-4	L-5
pH		7.2	6.9	7.4	7.1	7.3
EC	mS/m	188	273	142	386	140
Total Dissolved Solids	mg/L	1,466	2,016	891	4,401	1,200
Total Dissolved Organic C	"	14	14	12	23	5
Cl^-	"	50	372	170	59	21
$SO_4^=$	"	524	462	77	1,926	429
TKN		5.92	0.44	5.44	13.5	0.11
NH_3-N	"	4.77	0.36	4.67	9.37	0.04
NO_2+NO_3-N	"	0.05	<0.01	0.01	0.03	0.19
Total P		0.08	<0.04	2.23	0.97	0.10
Alkalinity as $CaCO_3$	"	500	424	390	848	269
Al	"	0.14	0.16	0.12	0.14	0.10
As	"	<0.2	<0.2	<0.2	<0.2	<0.2
B	"	0.51	0.22	0.24	0.25	0.78
Ca	"	251	253	122	633	155
Cd	"	0.004	<0.004	0.004	<0.004	<0.004
Cr	"	0.007	0.012	0.008	0.007	0.007
Cu	"	0.011	0.036	0.012	0.010	0.017
Fe	"	5.97	0.84	1.16	22.2	0.08
Hg	µg/L	0.49	0.24	0.16	0.20	<0.004
K	mg/L	7.5	4.8	4.2	9.0	5.4
Mg	"	107	141	5.57	349	108
Mn	"	0.097	0.014	0.079	0.978	0.033
Na	"	49.4	263	106	29.9	53.9
Ni	"	0.02	<0.02	0.02	<0.02	<0.02
Pb	"	<0.05	<0.05	<0.05	<0.05	<0.05
Se	"	<0.4	<0.4	<0.4	<0.4	<0.4
Zn	"	0.02	0.02	0.02	0.02	0.02

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 33 (Continued)

MEAN[1] ANALYSIS OF WATER SAMPLES TAKEN IN 1999 FROM NINE LYSIMETERS AT THE LAWNDALE AVENUE SOLIDS MANAGEMENT AREA

Parameter	Units	Lysimeter[2] L-6	L-7	L-8	L-9
pH		7.8	8.1	7.9	7.4
EC	mS/m	174	179	185	192
Total Dissolved Solids	mg/L	1,368	NA	NA	1,791
Total Dissolved Organic C	"	28	NA	NA	16
Cl^-	"	84	NA	NA	106
$SO_4^=$	"	531	NA	NA	523
TKN	"	0.24	NA	NA	0.66
NH_3-N		0.12	NA	NA	0.05
NH_2+NO_3-N	"	1.00	NA	NA	0.18
Total P	"	<0.04	NA	NA	0.08
Alkalinity as $CaCO_3$	"	416	NA	NA	543
Al	"	0.40	NA	NA	0.13
As	"	<0.2	NA	NA	<0.2
B	"	0.32	NA	NA	0.34
Ca	"	218	NA	NA	249
Cd	"	<0.004	NA	NA	<0.004
Cr	"	0.032	NA	NA	0.006
Cu	"	0.104	NA	NA	0.117
Fe	"	0.24	NA	NA	0.05
Hg	µg/L	0.28	NA	NA	7.13
K	mg/L	8.4	NA	NA	3.6
Mg	"	129	NA	NA	127
Mn	"	0.044	NA	NA	0.213
Na	"	70.0	NA	NA	58.1

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 33 (Continued)

MEAN[1] ANALYSIS OF WATER SAMPLES TAKEN IN 1999 FROM NINE LYSIMETERS AT THE LAWNDALE AVENUE SOLIDS MANAGEMENT AREA

Parameter	Units	Lysimeter[2] L-6	L-7	L-8	L-9
Ni	mg/L	<0.02	NA	NA	0.03
Pb	"	<0.05	NA	NA	0.06
Se	"	<0.4	NA	NA	<0.4
Zn	"	0.08	NA	NA	0.07

[1]The method detection limit (MDL) was used in calculating the mean. If all values were less than the MDL, the mean is reported as <MDL.
[2]Lysimeter depths: No. 1, 41 feet; No. 2, 29.5 feet; No. 3, 30 feet; No. 4, 26 feet; No. 5, 38 feet; No. 6, 31 feet; No. 7, 15 feet; No. 8, 25 feet; No. 9, 18 feet.
NA = No analysis.

deep, were installed for sampling groundwater every two weeks, which began in September 1993. Three of the four lysimeters rarely yielded water. The installation contractor inspected and tested the lysimeters in June 1994, and found no problems with the lysimeters themselves. The contractor determined that due to soil conditions, there was little free water available at the depths the three lysimeters were installed. This also held true for inspections of the lysimeters in 1999.

Table 34 presents the analysis of lysimeter water for 1999. The average values presented show that the shallow groundwater at this site is highly mineralized. The principal dissolved constituents are Ca, Mg, Na, SO_4, Cl, and HCO_3 (alkalinity). The current IEPA operating permit requires biweekly groundwater monitoring.

GROUNDWATER QUALITY AT THE HARLEM AVENUE SOLIDS MANAGEMENT AREA

In 1990, the District began biosolids drying operations at the Harlem Avenue Solids Management Area (HASMA). Dewatered lagoon biosolids or centrifuged digested biosolids are agitated on this paved area, to enhance evaporation until the solids content reaches 60 percent or greater.

The IEPA operating permit for this site requires biweekly groundwater monitoring. Three lysimeters were installed for

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 34

MEAN[1] ANALYSIS OF WATER SAMPLES TAKEN IN 1999 FROM FOUR LYSIMETERS AT THE 119TH AND RIDGELAND SOLIDS MANAGEMENT AREA

Parameter	Units	Lysimeter L-1	L-2	L-3	L-4
pH		7.7	7.7	7.6	7.3
EC	mS/m	308	264	252	186
Total Dissolved Solids	mg/L	3,788	1,440	NA	1,539
Total Dissolved Organic C	"	20	NA	NA	13
Cl^-	"	60	132	NA	144
$SO_4^=$	"	1,222	480	NA	477
TKN	"	1.40	1.27	0.33	0.82
NH_3-N	"	0.24	0.15	0.05	0.19
NO_2+NO_3-N	"	4.43	1.76	0.71	1.01
Total P	"	0.26	0.08	<0.04	0.11
Alkalinity as $CaCO_3$	"	715	381	NA	352
Al	"	0.32	NA	NA	0.13
Ca	"	515	NA	NA	256
Cd	"	<0.004	NA	NA	<0.004
Cr	"	0.008	NA	NA	0.006
Cu	"	0.022	NA	NA	0.012
Fe	"	0.26	NA	NA	0.08
Hg	µg/L	0.08	NA	NA	0.09
K	mg/L	4.1	NA	NA	3.6
Mg	"	240	NA	NA	87.0
Mn	"	0.106	NA	NA	0.224
Na	"	33.3	NA	NA	82.3
Ni	"	0.03	NA	NA	0.02
Pb	"	0.08	NA	NA	<0.05
Zn	"	0.06	NA	NA	0.05

[1]The method detection limit (MDL) was used in calculating the mean. If all values were less than the MDL, the mean is reported as <MDL.

NA = No analysis.

sampling the groundwater immediately below the drying site. Table 35 presents the analysis of water sampled from the three lysimeters in 1999. The data indicate that the shallow groundwater at this site is highly mineralized. The principal constituents are Ca, Mg, Na, SO_4, and Cl. Lysimeter 1 has had a high, naturally occurring NH_3-N content. In 1996 a new lysimeter, designated 1N, was installed, and it produced water of quality similar to the other HASMA lysimeters. Groundwater monitoring will continue in 2000.

GROUNDWATER QUALITY AT THE 122ND AND STONY ISLAND SOLIDS MANAGEMENT AREA

In 1991, the solids drying facility at 122nd and Stony Island was paved to facilitate biosolids drying. Prior to 1991, drying was done on a clay surface. This drying facility is used to process biosolids for final distribution. In 1999, the site was used to dewater centrifuged digested biosolids from the Stickney WRP. These biosolids were utilized in landfills as daily and final vegetative cover. The IEPA operating permit for this drying facility required groundwater monitoring. Four lysimeters were installed in September 1991 for sampling groundwater immediately below the drying site. Table 36 presents the average values for the analysis of water from

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 35

MEAN[1] ANALYSIS OF WATER SAMPLES TAKEN IN 1999 FROM THREE LYSIMETERS AT THE HARLEM AVENUE SOLIDS MANAGEMENT AREA

Parameter	Units	Lysimeter[2] L-1	L-1N	L-2	L-3
pH		7.3	7.7	7.4	7.3
EC	mS/m	428	181	219	243
Total Dissolved Solids	mg/L	3,616	1,279	2,137	2,046
Total Dissolved Organic C	"	71	48	9	12
Cl^-	"	98	48	138	105
$SO_4^=$	"	1,620	138	706	345
TKN	"	220	4.32	9.74	1.23
NH_3-N	"	173	2.74	8.06	0.52
NO_2+NO_3-N	"	9.14	0.96	4.52	0.36
Total P	"	0.82	0.51	0.14	0.15
Alkalinity as $CaCO_3$	"	1,091	949	447	1,073
Al	"	0.18	0.22	0.13	0.14
Ca	"	446	429	383	377
Cd	"	0.004	<0.004	<0.004	<0.004
Cr	"	0.010	0.007	0.008	0.007
Cu	"	0.033	0.123	0.056	0.014
Fe	"	0.13	0.08	0.04	0.04
Hg	µg/L	0.08	0.09	0.09	0.09
K	mg/L	19.6	16.5	2.0	1.8
Mg	"	271	276	107	160
Mn	"	0.366	0.372	0.042	0.620
Na	"	72.4	83.0	49.8	47.4
Ni	"	0.03	0.03	0.03	0.02
Pb	"	<0.05	0.07	<0.05	<0.05
Zn	"	0.04	0.80	0.05	0.09

[1]The method detection limit (MDL) was used in calculating the mean. If all values were less than the MDL, the mean is reported as <MDL.

[2]Lysimeter depths: No. 1, 14 feet; No. 2, 14 feet; No. 3, 16 feet.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 36

MEAN[1] ANALYSIS OF WATER SAMPLES TAKEN IN 1999 FROM FOUR LYSIMETERS AT THE 122ND AND STONY ISLAND SOLIDS MANAGEMENT AREA

Parameter	Units	Lysimeter L-1	L-2	L-3	L-4
pH		7.1	7.3	7.2	7.1
EC	mS/m	358	250	300	262
Total Dissolved Solids	mg/L	2,637	1,736	2,968	2,243
Total Dissolved Organic C	"	54	32	52	34
Cl^-	"	362	441	89	317
$SO_4^=$	"	440	287	942	332
TKN	"	50.6	10.1	7.69	8.17
NH_3-N	"	44.3	8.02	3.78	5.81
NO_2+NO_3-N	"	0.15	0.04	0.05	0.19
Total P	"	0.12	1.28	0.24	0.10
Alkalinity as $CaCO_3$	"	1,333	428	1,161	792
Al	"	0.24	0.18	0.22	0.20
Ca	"	323	178	557	344
Cd	"	<0.004	<0.004	<0.004	<0.004
Cr	"	0.009	0.007	0.009	0.008
Cu	"	0.011	0.010	0.011	0.011
Fe	"	19.7	5.6	19.1	8.6
Hg	µg/L	0.06	0.05	0.10	0.09
K	mg/L	26.4	50.3	6.5	8.5
Mg	"	174	92.9	175	144
Mn	"	0.494	0.471	0.639	0.428
Na	"	298	271	59.9	136
Ni	"	0.02	<0.02	<0.02	0.02
Pb	"	<0.05	<0.05	0.06	<0.05
Zn	"	0.03	0.02	0.02	0.02

[1]The method detection limit (MDL) was used in calculating the mean. If all values were less than the MDL, the mean is reported as <MDL.

the four lysimeters at the 122nd and Stony Island drying facility for samples taken at monthly intervals in 1999. The lysimeter water was highly mineralized.

Groundwater monitoring will continue at the site in 2000.

Biology Section

The Biology Section of the Environmental Monitoring and Research Division is composed of five professional and eighteen technical personnel. The section is organized into four groups which perform specific monitoring or research activities. The four groups are:

I. Analytical Microbiology and Parasitology

II. Virology, Toxicology and Biomonitoring

III. Fisheries Biology

IV. Water and Sediment Quality

Biology Section personnel are often involved in studies of wastewater treatment, biosolids assessment, and environmental monitoring which require the application of specific biological disciplines and expertise such as microbiology, virology, toxicology, biomonitoring, fisheries biology, invertebrate zoology, entomology, and parasitology. The areas of study in which Biology Section personnel can be involved during the course of a given year include, but are not limited

to: environmental and population biology, public health risk assessment and ecological risk assessment, water and sediment quality monitoring, dissolved oxygen (DO) monitoring in the Chicago Waterway System, combined sewer overflow (CSO) characterization, ecotoxicology and biomonitoring, bioassay methodology, microbial processes, enumeration of viral, microbial, and parasitic indicators and specific pathogens, mutagen and toxicology studies, and the microbiology and/or biology of specific wastewater or biosolids treatment options.

In 1999, the personnel of the Biology Section participated in a variety of monitoring and research activities. Listed below are the most important of these activities and the Biology group which had the most direct participation.

I. ANALYTICAL MICROBIOLOGY AND PARASITOLOGY GROUP ACTIVITIES

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

b. Operation Lake Watch. Monitoring the Lake Michigan shoreline for the presence and density of fecal

coliforms and heterotrophic bacteria to detect pollution.

c. Bypasses to Lake Michigan. Monitoring the Lake Michigan shoreline, and Chicago area beaches for the presence and density of fecal coliforms, and concentrations of conventional pollutants following diversion of storm water and combined sewage to the lake.

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

e. Monitoring Wells. Monitoring fecal coliform presence and density in groundwater for TARP, as required by Illinois Environmental Protection Agency (IEPA) operational permits.

f. Land Reclamation. Monitoring the presence and density of fecal coliforms in groundwater and wells

around sludge handling sites in Cook County.

g. Process Certification for Class A Biosolids. Analysis of biosolids from the District's process trains for fecal coliforms, Salmonella species, and parasitic ova (helminths, etc.) to determine if Class A biosolids can consistently be produced as specified under the USEPA Part 503 Regulations.

h. Biological characteristics of activated sludge mixed liquor as an index for WRP process control.

i. Ecosystematic Study. Second year of a two year study of bacterial populations in Salt Creek.

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

k. Review research reports and draft legislation to determine the impact on District operations.

II. VIROLOGY, TOXICOLOGY AND BIOMONTORING GROUP ACTIVITIES

a. Toxicity testing for NPDES Permits. Use of fathead minnows and daphnids to assess acute and chronic toxicity of effluents from District WRPs.

b. Discretionary Toxicity Testing for NPDES Permits. Use of Ames Mutagen Assay and Microtox™ tests as surrogates for acute toxicity tests with fish, invertebrates, or algae.

c. Research study on the effect of fish age on biomonitoring results.

d. WET test interlaboratory variability study.

e. Process Certification for Class A Biosolids. Analysis of biosolids for enteric viruses to determine if Class A biosolids can be consistently produced under the USEPA Part 503 Regulations.

f. Review research reports and draft legislation for any impact on District operations.

III. FISHERIES BIOLOGY GROUP ACTIVITIES

a. Fish survey of the metropolitan Chicago Waterway System as part of the R&D Department's ongoing water quality study.

b. Fish survey of the North Branch of the Chicago River, and the deep draft canals of the Chicago Waterway System.

c. Fish kill investigations.

d. Illinois fish flesh contaminant advisory program.

e. Review research reports and draft legislation for the impact on District operations.

IV. WATER AND SEDIMENT QUALITY

a. Water and sediment quality study of the Illinois Waterway.

b. CSO characterization.

c. Dissolved oxygen survey in the North Shore Channel, North Branch of the Chicago River, South Branch of the Chicago River, and the Chicago Sanitary and Ship Canal.

d. CSO characterization for the U. S. Army Corps of Engineers.

e. Review of research reports and draft legislation for the impact on District operations.

ANALYTICAL MICROBIOLOGY AND PARASITOLOGY GROUP ACTIVITIES

The Analytical Microbiology Group is responsible for all bacterial population density analyses used for the WRP effluent monitoring required by NPDES permits. Monitoring the densities of fecal coliform bacteria in effluents of the District's WRP was begun in 1972, when first required by NPDES permits, and continues to the present. Fecal coliform data are available to the Hanover Park, Kirie, and John E. Egan WRPs within 24 hours of sample collections. These data are used as a guide in maintaining proper chlorination at these District WRPs, and for reporting compliance with NPDES permit regulations. All District WRPs with NPDES disinfection requirements have a seasonal exemption from November 1st through April 30th of each year, and are not subject to effluent disinfection requirements during those periods. In 1993, the determination of fecal coliform and Ascaris ova densities in sludge became a condition of the District's NPDES permits. In compliance with the NPDES permits, the Analytical Microbiology

Group performed most probable number analyses for fecal coliform bacteria on 18 samples from the Hanover Park WRP lagoons and 114 samples from the District's other biosolids management areas during 1999. Analyses for Ascaris ova were performed on 67 samples of biosolids from various District biosolids management areas. Current NPDES permits also require the monitoring of fecal coliform levels in retention ponds at the Hanover Park WRP; as a result, 97 samples from the Hanover Park WRP retention ponds and related plant processing streams were analyzed. Results were reported to the plant as soon as data were available.

The Analytical Microbiology Group supported a variety of Research and Industrial Waste programs in 1999. These included Operation Lake Watch, TARP, Sludge Pathogen Densities, Land Reclamation, District Waterway surveys, and the Illinois Waterway Survey. Table 37 is a summary of the major programs receiving support from 1997 through 1999, and the number of analyses performed for each program.

The Analytical Microbiology Group at the Stickney R&D Laboratory is certified by the Illinois Department of Public Health (IDPH), Registry #17508, for heterotrophic plate count (HPC), total coliform (TC), and fecal coliform (FC) examination of samples of water from public water supplies and their

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 37

INDICATOR BACTERIA ANALYSES PERFORMED BY THE ANALYTICAL MICROBIOLOGY GROUP FOR VARIOUS DISTRICT PROGRAMS 1997 THROUGH 1999

Program	Total Coliform			Fecal Coliform			Fecal Streptococci		
	1997	1998	1999	1997	1998	1999	1997	1998	1999
Effluent Analysis	12	10	8	695	892	818	9	-	-
Land Reclamation	-	-	-	255	440	169	-	-	-
Sludge	-	-	-	72	148	114	-	-	-
District Waterway Surveys	21	10	10	542	541	521	21	10	10
Industrial Waste Surveys	-	-	30	87	40	39	-	-	14
Research Support	40	14	-	82	14	94	35	14	-
Operation Lake Watch[1]	-	-	-	277	55	82	-	-	-
Major Treatment Facility Monitoring	-	-	-	61	35	-	-	-	-
Illinois Waterway	-	-	-	98	-	195	-	-	-
TARP	-	-	-	481	464	633	-	-	-
Emergency Response	-	-	-	-	-		-	-	-
Combined Sewer Overflow	-	-	-	-	-	-	-	-	-
Other[2]	217	266	193	-	-	-	-	-	-
Total	290	300	241	2,650	2,629	2,665	65	24	24

[1]Includes festivals and District bypasses to Lake Michigan.
[2]Includes drinking water.

sources by the membrane filtration (MF), presence/absence (P/A), and most probable number (MPN) techniques. The Group's facilities, equipment, and procedures were the subject of the biennial on-site evaluation for certification by the IDPH on November 19, 1998, and were found to be in general compliance with the provisions of Standard Methods for the Examination of Water and Wastewater (18^{th} Edition) and the Illinois Rules for certification and Operation of Environmental Laboratories (July 15, 1998). The Analytical Microbiology Group is scheduled for certification review again in November 2000.

Table 38 and Figure 14 summarize the number and type of analyses performed by the Group from 1997 through 1999. Bacterial analyses for TC, FC, and fecal streptococci (FS) 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. Analyses for Pseudomonas aeruginosa (PA), Salmonella spp. (SAL), and Enterococci (ENT) are performed as a part of the Ecosystematic Study. Pseudomonas aeruginosa is a common inhabitant of soil and water and has a worldwide distribution. It is responsible for a number of infections in humans, particularly in debilitated or immunocompromised hosts. Salmonella spp. are enteric pathogens, but some species occur naturally in the environment.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 38

ANALYTICAL MICROBIOLOGY GROUP SAMPLES AND ANALYSES
1997 THROUGH 1999

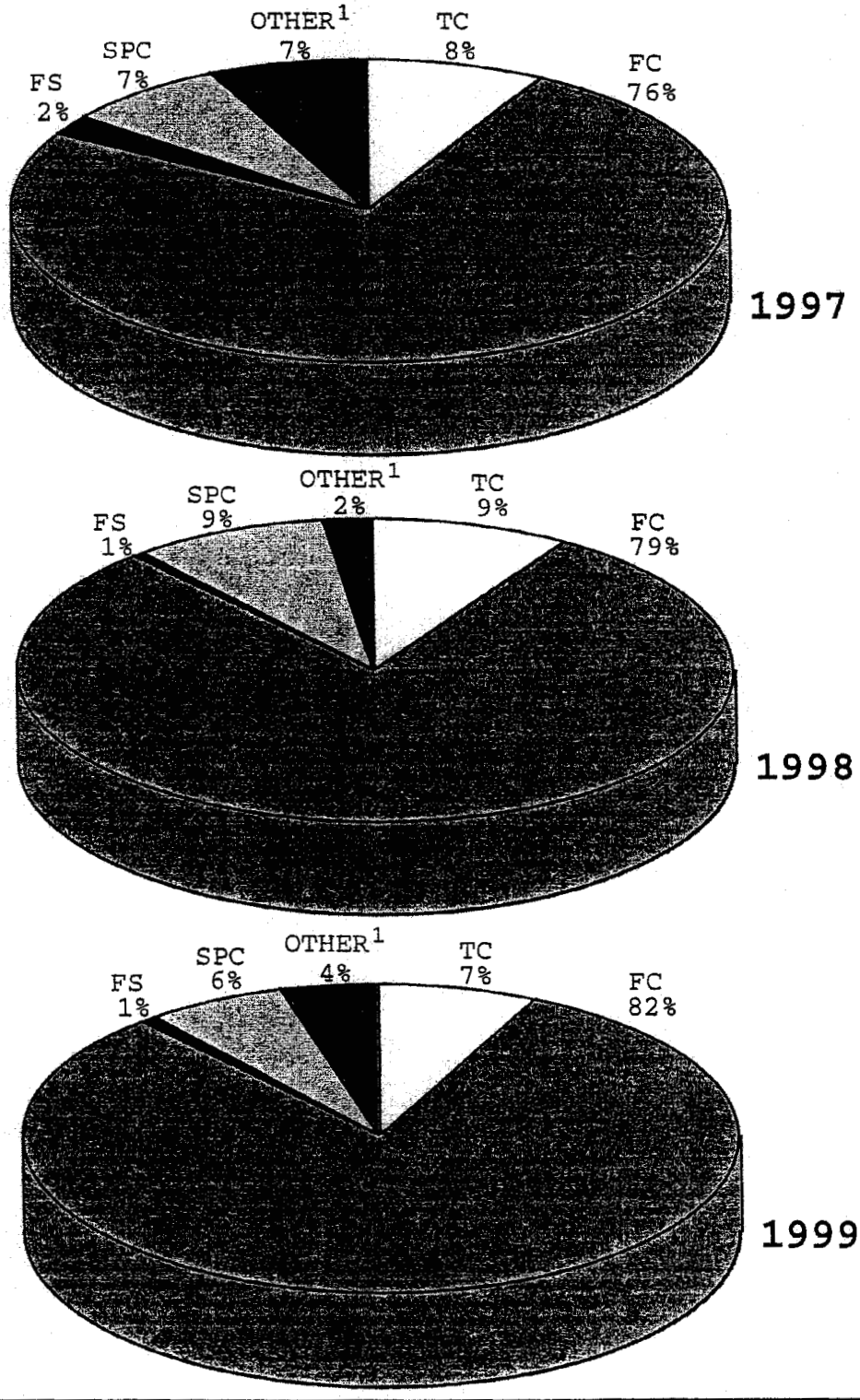
Year	Samples	TC	Analysis or Tests Performed[1]										
			FC	FS	PA	SAL	HPC	EC	ENT	IQC	BIO-E	ID-CONF	Total
1997	3,187	290	2,650	65	56	141	261	35	21	5,971	277	1,490	11,257
1998	3,034	300	2,629	24	24	24	287	14	10	5,646	427	1,342	10,727
1999	2,905	241	2,665	24	10	89	213	31	10	5,284	146	702[2]	9,419

[1]TC = Total Coliform; FC = 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);BIO-E = Microscopic evaluation of protozoan and filamentous organisms; ID-CONF = Organism Identification using specific biochemical metabolic characteristics.
[2]The lower number in 1999 reflects a reduction in the number of colony confirmations required by the IDPH for QC purposes.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 14

ANALYTICAL MICROBIOLOGY GROUP BACTERIAL ANALYSES
1997 THROUGH 1999



[1] Includes analyses for Pseudomonas aeruginosa, Salmonella spp., Escherichia coli, and Enterococcus.

Ecosystematic Study. The Ecosystematic Study was designed to document and assess the water quality in the Chicago area waterways. In 1999, the District completed a two year project monitoring the water quality along the Salt Creek. The study area is shown in Figure 15. Samples for bacterial analysis were collected on two occasions during 1999. These analyses are part of a study designed to document and assess the water quality in this waterway. The results are summarized in Tables 39 and 40 and Figures 16 and 17.

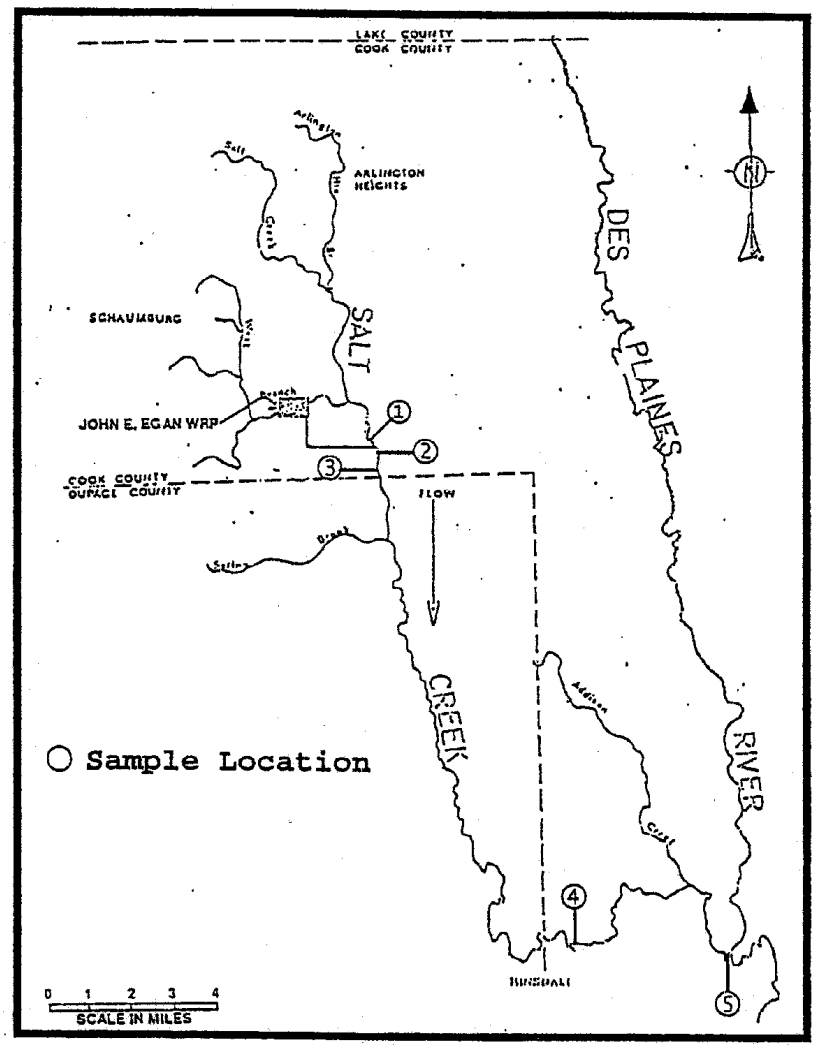
Compliance with Part 503 Sludge Disposal Regulation. In 1996 the District began monitoring fecal coliform. Salmonella spp. and viable Ascaris ova levels in its final air-dried sludge product for compliance with the Class A biosolids criteria in the 40 CFR part 503 sludge disposal regulations. Since that time, all District biosolids samples analyzed were in compliance with these criteria for shipment and use under the District's Controlled solids Distribution Program.

In 1999, 67 air-dried sludge samples were analyzed for viable Ascaris ova in compliance with the Part 503 regulations. No viable Ascaris ova or larvae were isolated from any of the samples analyzed, and all of the samples analyzed were in compliance with the Class A biosolids criteria. Parenthetically, these data also lend support to the District's petition to the USEPA to have its sludge process trains (SPTs)

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 15

FISH MONITORING STATIONS IN SALT CREEK



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 39

BACTERIAL DENSITY IN SALT CREEK WITHIN COOK COUNTY[1]
(GEOMETRIC MEAN OF ALL SAMPLES 1999)

Station Locations	TC[2]	FC[2]	FS[2]	ENT[2]	HPC[2]	PA[2]	Salmonella spp.
Salt Creek, @ Busse Lake Dam	6,600	580	290	300	4,600	80	<0.17
Salt Creek, @ Arlington Heights Road	18,000	1,600	390	420	46,000	200	<0.23
Salt Creek, @ Devon Avenue	20,000	1,400	460	560	39,000	480	<0.26
Salt Creek, @ Wolf Road Forest (pedestrian bridge)	1,400	120	90	220	3,400	30	0.23
Salt Creek, @ First Avenue	7,900	1,700	290	300	5,600	30	0.17

[1]All counts per 100 mL except HPC which is in counts per mL. Values shown are the results of analyses of samples collected on August 23, and November 1, 1999.
[2]TC =Total Coliform; FC = Fecal Coliform; FS = Fecal Streptococcus; ENT = Enterococcus; HPC = Heterotrophic Plate Count; PA = Pseudomonas aeruginosa.
Note: John E. Egan WRP is located between the Busse Lake Dam and Arlington Heights Road sampling locations.

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TABLE 40

RESULTS OF COLONY CONFIRMATION TESTS[1] FOR THE 1999 ECOSYSTEMATIC STUDY

Analysis	Primary Isolation Medium	Number of Colonies Picked	Number of Colonies Confirmed	Percent Confirmed
Total Coliforms	m-Endo	50	42	84
Fecal Coliforms	MFC	50	50	100
Fecal Streptococci	KF Streptococcus	50	45	90
Enterococci	mE	50	47	94
Pseudomonas aeruginosa	mPA	54	39	72

[1]Total coliform: lauryl tryptose broth and brilliant green bile 2% at 35°C. Fecal coliform: gas production in lauryl tryptose broth at 35°C and EC medium at 44.5°C. Fecal Streptococcus: Catalase production; growth at 45°C; growth in 40% bile at 35°C; Enterococci: Growth on, and blackening of bile esculin agar at 35°C; growth at 45°C; growth in 6.5% NaCl at 35°C. Pseudomonas aeruginosa: Casein hydrolysis and yellow to green diffusible pigments on milk agar at 35°C.

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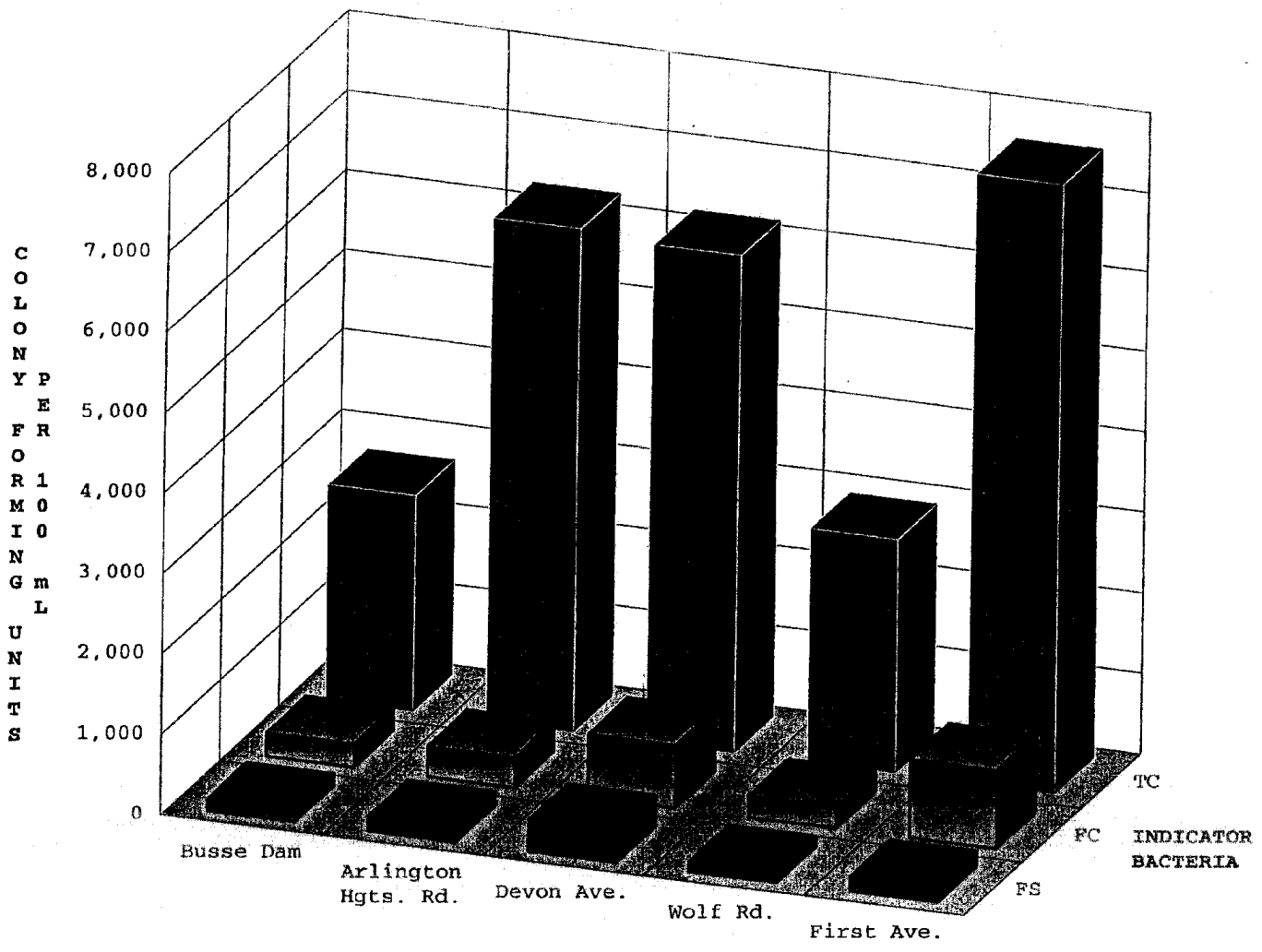
FIGURE 16

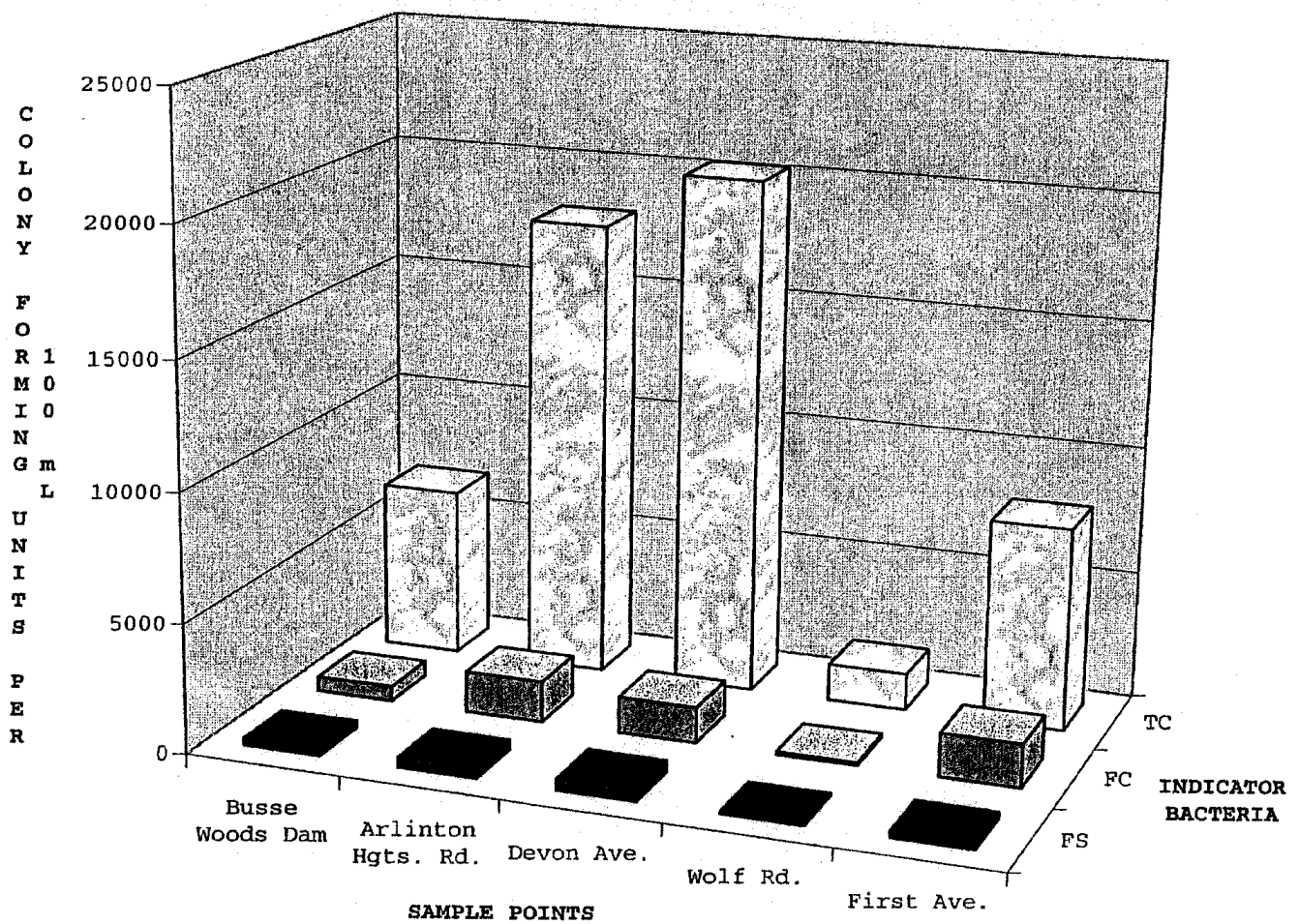
GEOMETRIC MEAN OF INDICATOR BACTERIA DENSITY
IN SALT CREEK (FOUR SAMPLES, 1998 AND 1999)



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 17

GEOMETRIC MEAN OF INDICATOR BACTERIA IN SALT CREEK
(TWO SAMPLES COLLECTED IN 1999)



certified as Processes to Further Reduce Pathogens (PFRPs). The analytical method for helminth ova used in the District was developed by Dr. M. Dale Little of Tulane University's Department of Tropical Medicine. This method employs a combination of sieving, flotation, and centrifugation to extract and enumerate helminth ova (Ascaris, Toxocara, and Trichuris). District personnel were trained in the use of this method by Dr. Little.

Laboratory Seeding Study. The Group also conducted a seeding study in the laboratory to determine the efficiency of helminth recovery from sludge. Recoveries of seeded Ascaris ova from small (4.5 gram) and large (45 gram) samples of digester feed and final air-dried product were determined twice. The first time this was done, concentrated ova were incubated for 30 days. The second time this was done no incubation period was used. The results are shown in Tables 41 and 42. Recoveries of seeded Ascaris ova from digester feed ranged from 63.1 to 102.9 percent. Recoveries of seeded Ascaris ova from final air-dried product ranged from 22.0 to 97.6 percent.

Research Support to Other Sections. The Group conducted analyses in support of a Wastewater Treatment Research Section project. The project was undertaken to biologically characterize centrifuge centrate and digester supernatant at the

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TABLE 41

VIABILITY AND MEAN PERCENT RECOVERIES OF "SPIKED" *ASCARIS SUUM* OVA FROM STICKNEY WRP DIGESTER FEED AND FINAL AIR-DRIED PRODUCT ACHIEVED IN THE DISTRICT'S R&D LABORATORY USING THE YANKO PROCEDURE[1] - EXPERIMENT INCLUDED A 30-DAY INCUBATION PERIOD[2]

Sample	g Dry Weight	Total Ova Added[3]	Percent Recovery[4,5]	Percent Viability[6]
Digester Feed	4.53	453	63.1 ± 4.0	89.7 ± 1.8
Digester Feed	45.27	4,527	80.2 ± 1.3	88.7 ± 0.8
Final Air-Dried Product	5.26	592	22.0 ±16.4	89.8 ± 4.6
Final Air-Dried Product	46.02	5,088	97.6 ± 2.6	91.1 ± 0.4

[1]Yanko, W.A., "Occurrence of Pathogens in Distribution and Marketing Municipal Sludges," EPA/600/1-87-014, National Technical Information Services, 5285 Port Royal Road, Springfield, VA 22161 (PB 88-154273/AS), 1987

[2]Concentrated ova were incubated in 0.5 percent formalin at 28°C in the dark for 30 days and examined for viability.

[3]91 percent viability demonstrated with an embryonation test.

[4]Total recovery (included viable and non-viable ova).

[5]Mean percent recovery from three "spiking" experiments ± one standard deviation.

[6]Mean percent viability of the ova recovered ± one standard deviation.

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TABLE 42

MEAN PERCENT RECOVERIES OF "SPIKED" *ASCARIS SUUM* OVA FROM STICKNEY WRP DIGESTER FEED AND CALUMET WRP FINAL AIR-DRIED PRODUCT ACHIEVED IN THE DISTRICT'S R&D LABORATORY USING THE YANKO PROCEDURE[1] - EXPERIMENT CONDUCTED WITHOUT A 30-DAY INCUBATION PERIOD[2]

Sample	g Dry Weight	Total Ova Added[3]	Percent Recovery[4,5]
Stickney Digester Feed	4.56	461	102.9 ± 6.2
Stickney Digester Feed	45.63	4,614	91.5 ± 6.4
Calumet Final Air-Dried Product	5.16	613	49.5 ± 24.4
Calumet Final Air-Dried Product	45.12	4,594	85.2 ± 6.2

[1]Yanko, W.A., "Occurrence of Pathogens in Distribution and Marketing Municipal Sludges," EPA/600/1-87-014, National Technical Information Services, 5285 Port Royal Road, Springfield, VA 22161 (PB 88-154273/AS), 1987

[2]Ova were simply concentrated and counted. The incubation step and subsequent check for viability were omitted.

[3]91 percent viability demonstrated with an embryonation test.

[4]Total recovery (included viable and non-viable ova).

[5]Mean percent recovery from three "spiking" experiments ± one standard deviation.

Calumet, Egan, and Stickney WRPs. Fecal coliform, Salmonella spp., and helminth ova densities were determined for this project.

VIROLOGY, TOXICOLOGY AND BIOMONITORING GROUP ACTIVITIES

The Virology, Toxicology and Biomonitoring Group conducts research and monitoring studies related to the District's interests and activities. The group has conducted studies designed to develop and improve the methods for the detection, enumeration, and identification of viruses in water, sewage, sludge, and aerosols. The District's WRP influents, effluents, and intermediate process waters, as well as the receiving waters have been examined for viruses as part of broader health effects studies.

The group conducts toxicity tests with fish and water fleas on effluent and environmental samples as part of a biomonitoring program designed to protect aquatic life and human health. The group also investigates the feasibility of new more rapid and economical methods of assessing toxicity in environmental samples. This includes conducting surrogate bioassays such as the Microtox™ toxicity analysis.

The major activities of the Virology, Toxicology and Biomonitoring Group during 1999 included the following:

Virus Levels in Biosolids. In 1996, the District began monitoring virus levels in its final air-dried sludge product for compliance with the Class A biosolids criteria in the 40 CFR Part 503 sludge disposal regulations. Since that time, all District biosolids samples analyzed were in compliance with these criteria for shipment and use under the District's Controlled Solids Distribution Program.

In 1999, the Virology Group analyzed 67 air-dried sludge samples for viruses for compliance with these regulations. The results are shown in Table 43. No viruses were isolated from any of the samples analyzed, and all of the samples analyzed were in compliance with the Class A biosolids criteria. Parenthetically, these data also lend support to the District's petition to have its SPTs certified as PFRP.

Laboratory Virus Seeding Study. The Group also conducted a seeding study in the laboratory to determine the efficiency of virus recovery from sludge. Recoveries of seeded viruses from 5 and 50 gram samples of digester feed were 3.3 and 1.0 percent, respectively. However, recoveries of seeded viruses from 5 and 50 gram samples of final air-dried sludge product were 66.9 and 49.1 percent, respectively. Results of this study are shown in Table 44.

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TABLE 43

VIROLOGICAL ANALYSIS OF BIOSOLIDS FOR DISPOSAL IN 1999[1]

Drying Area	Number Samples Positive/Number Samples Collected	Range of Test Detection Limits PFU/g[2,3]
Calumet	0/38	<0.0279 - <0.2325
RASMA[4]	0/11	<0.0325 - <0.2236
LASMA[5]	0/6	<0.0498 - <0.2189
Vulcan	0/2	<0.2178 - <0.2409
HASMA[6]	0/5	<0.0377 - <0.2091
Marathon	0/5	<0.1292 - <0.2379

[1]Results of analyses performed in the District's Virology Laboratory.
[2]Confirmed plaque forming units/gram.
[3]Failure to detect viruses in sludge eluates is recorded as less than (<) the limit of test sensitivity (1/mass of solids used in the analysis).
[4]Ridgeland Avenue Sludge Management Area.
[5]Lawndale Avenue Sludge Management Area.
[6]Harlem Avenue Sludge Management Area.

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TABLE 44

MEAN PERCENT RECOVERIES OF "SPIKED" POLIOVIRUS 1 SABIN STRAIN FROM STICKNEY WRP DIGESTER FEED AND FINAL AIR-DRIED PRODUCT ACHIEVED IN THE DISTRICT'S R&D LABORATORY USING ASTM METHOD D 4994-89

Sample	g Dry Weight	Average Total PFUs[1] Added	Percent Recovery[2]
Digester Feed	5.03	1,820	3.3 ± 3.1
Digester Feed	50.3	19,000	1.0 ± 0.2
Final Air-Dried Product	6.57	1,500	66.9 ± 12.5
Final Air-Dried Product	65.7	13,933	49.1 ± 13.9

[1]Plaque forming units.
[2]Mean recovery from three "spiking" experiments ± one standard deviation.

Support for the Wastewater Treatment Research Section. The Virology Group conducted analyses in support of one Wastewater Treatment Research Section project. The project was undertaken to biologically characterize centrifuge centrate and digester supernatant at the Calumet, Egan, and Stickney WRPs.

Biomonitoring of WRP Effluent. WET tests were conducted on effluent samples from the Hanover Park and Kirie WRPs in compliance with the respective NPDES permits for these WRPs. The results of these tests are shown in Table 45. Biomonitoring reports for these WRPs were submitted to the IEPA.

Effect of Fish Age on Biomonitoring. The Group also conducted an in-house research project to investigate the effects of the age of fish used in acute WET tests on fish survival after exposure to toxicants. The raw data collected for this project are shown in Tables 46, 47, and 48. These data will be analyzed, and the results will be discussed in a District report.

Whole Effluent Toxicity (WET) Test Interlaboratory Variability. Upon completion of a prequalification process, the District's Biomonitoring Group was selected to participate in the USEPA WET Test Interlaboratory Variability Study. The Group conducted acute and chronic WET tests with fish

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 45

RESULTS[1] OF WET TESTS[2] FOR WATER RECLAMATION PLANTS DURING 1999

Effluent Tested	Date(s) Collected	WET Test	Result
James C. Kirie WRP	6/14/99	Microtox™	NTE
		Acute Minnow (Survival)	NTE
		Acute Water Flea (Survival)	NTE
Hanover Park WRP	6/20-25/99	Microtox	NTE[3]
		Chronic Minnow (Survival)	NTE
		(Growth)	NTE
		Chronic Water Flea (Survival)	NOEC = 25%
		(Reproduction)	NOEC = 25%
Hanover Park WRP	12/5-10/99	Microtox	EC10 = <45%; NTE[4]
		Chronic Water Flea (Survival)	NOEC = 50%
		(Reproduction)	NOEC = 50%

[1]Results: NTE = no toxic effect; EC10 = the effective concentration (%) of sample causing a 10% decrease in the Microtox™ reagent light output after 15 minutes. This is interpreted to indicate the toxicity threshold of the analysis; NOEC (No Observed Effect Concentration) = percent effluent at which no effect on test organisms is observed.

[2]WET Tests: Microtox™ = Microtox™ basic toxicity test with the luminescent bacterium, V. fischeri, formerly referred to as P. phosphoreum; Acute Minnow = 96-hour Fathead Minnow, P. promelas, Acute Toxicity Test; Acute Water Flea = Daphnid, (C. dubia), Acute Toxicity Test; Chronic Minnow = Fathead Minnow, P. promelas, Larval Survival and Growth Test; Chronic Water Flea = Cladoceran, C. dubia, Survival and Reproduction Test.

[3]Three samples.

[4]Three samples. No toxic effect was observed for two of these samples. An EC10 = <45% was calculated for one of the samples.

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TABLE 46

RESULTS OF 48-HOUR ACUTE TOXICITY TESTS WITH PIMEPHALES PROMELAS USING THE TOXICANT KCl[1]

Age of Fish (days)	LC50[2]	Method	Date Set up
1-2	1,595.2	P	3/8/99
	1,189.6	P	3/17/99
	1,239.4	P	3/17/99
	1,347.5	P	4/12/99
3-4	1,131.0	P	3/24/99
	1,008.4	P	4/19/99
	1,136.8	S	4/21/99
	1,350.9	S	4/28/99
7-8	1,148.5	P	3/24/99
	1,176.2	S	4/14/99
	1,088.1	P	4/19/99
	1,130.6	P	4/21/99
11-12	1,195.5	P	3/15/99
	1,041.5	P	3/22/99
	1,285.1	S	4/12/99
	1,255.5	P	4/14/99
13-14	1,332.4	P	3/10/99
	1,209.3	S	3/15/99
	1,076.0	S	5/3/99
	1,275.2	S	5/3/99

[1]KCl = Potassium chloride.
[2]LC50 = Concentration of toxicant in mg/L lethal to 50 percent of test organisms.
[3]LC50 values were calculated by the Probit Method (P). When acute toxicity test data did not meet the requirements for use of the Probit Method, LC50 values were calculated by the Trimmed Spearman-Karber Method(s).

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TABLE 47

RESULTS OF 48-HOUR ACUTE TOXICITY TESTS WITH PIMEPHALES PROMELAS USING THE TOXICANT SDS[1]

Age of Fish (days)	LC50[2]	Method[3]	Date Set up
1-2	29.0	S	3/3/99
	25.2	P	3/17/99
	29.0	S	3/17/99
	29.2	S	6/2/99
3-4	17.1	S	3/24/99
	25.9	P	5/13/99
	24.9	P	5/24/99
	23.8	S	5/26/99
7-8	25.5	P	3/24/99
	26.6	P	5/19/99
	24.8	S	5/19/99
	21.5	S	6/2/99
11-12	24.2	S	3/15/99
	28.6	S	3/22/99
	24.8	S	3/29/99
	24.5	S	3/29/99
13-14	24.8	S	3/15/99
	24.8	S	5/24/99
	25.5	P	6/1/99
	23.3	P	6/1/99

[1]SDS = Sodium dodecyl sulfate.
[2]LC50 = Concentration of toxicant in mg/L lethal to 50 percent of test organisms.
[3]LC50 values were calculated by the Probit Method (P). When acute toxicity test data did not meet the requirements for use of the Probit Method, LC50 values were calculated by the Trimmed Spearman-Karber Method(s).

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 48

RESULTS OF 48-HOUR ACUTE TOXICITY TESTS WITH PIMEPHALES PROMELAS USING A MIXTURE OF THE TOXICANTS KCl[1] AND SDS[2]

Age of Fish (days)	LC50[3]	Method[4]	Date Set up
1-2	72.1	P	3/1/99
	65.0	S	3/3/99
	61.3	S	3/8/99
	42.5	S	5/6/99
3-4	56.2	P	3/1/99
	43.7	S	3/8/99
	51.7	S	5/10/99
	62.8	S	5/12/99
7-8	52.9	S	3/1/99
	49.4	S	3/3/99
	45.5	S	5/5/99
	53.4	S	5/12/99
11-12	54.1	S	3/1/99
	56.6	S	3/3/99
	52.9	S	5/10/99
	55.3	S	5/13/99
13-14	47.1	S	3/10/99
	51.5	P	3/8/99
	53.3	S	5/5/99
	63.6	S	5/6/99

[1]KCl = Potassium chloride.
[2]Sodium dodecyl sulfate.
[3]LC50 Percentage of a solution of both KCl (1,500 mg/L) and SDS (35 mg/L) lethal to 50 percent of test organisms.
[4]LC50 values were calculated by the Probit Method (P). When acute toxicity test data did not meet the requirements for use of the Probit Method, LC50 values were calculated by the Trimmed Spearman-Karber Method(s).

(Pimephales promelas) and daphnids (Ceriodaphnia dubia) for this study. Data collected were sent to the coordinator of the study in four reports.

FISHERIES BIOLOGY GROUP ACTIVITIES

The Fisheries Biology Group monitors the distribution and abundance of fish populations in Chicago area waterways, and investigates fish kills.

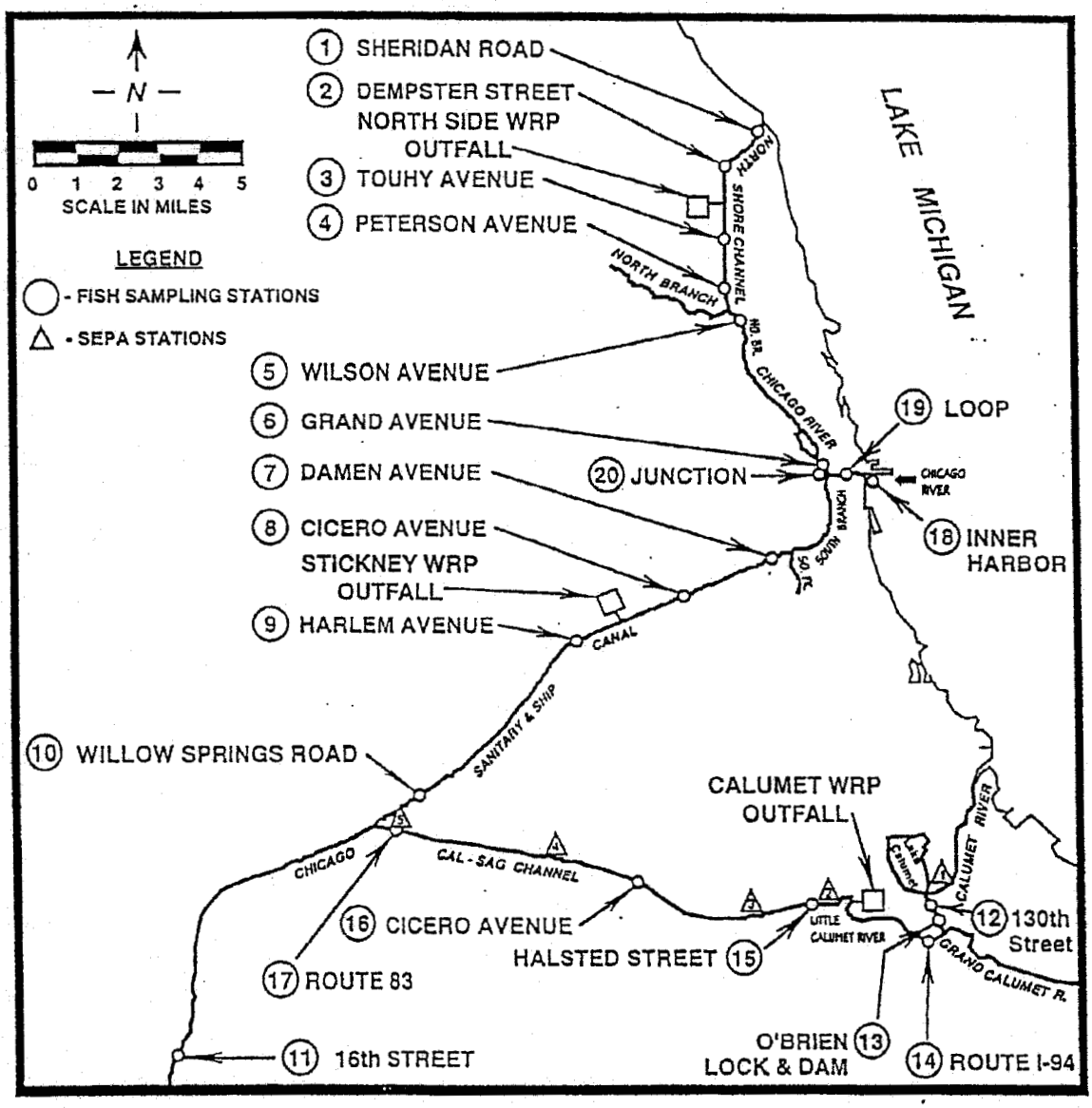
Fish Surveys. In 1985, 17 stations were selected to monitor fish populations in the Chicago and Calumet Waterway Systems (Figure 18). The Chicago Waterway System includes the North Shore Channel, the North Branch of the Chicago River, the Chicago River, the South Branch of the Chicago River and the Chicago Sanitary and Ship Canal. The Calumet Waterway System includes the Calumet River, the Little Calumet River, and the Cal-Sag Channel. Three additional stations in the Chicago River were added to the study during 1987.

In 1999, fish were collected once at the 20 locations. During a second collection, 10 of the 20 stations were sampled. Also monitored during 1999 were 5 locations above and below the five Sidestream Elevated Pool Aeration (SEPA) Stations (Figure 18) and five locations on Salt Creek (Figure 15).

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 18

LOCATION OF FISH MONITORING STATIONS IN THE CHICAGO AND CALUMET WATERWAY SYSTEMS



Chicago and Calumet Waterway Systems. During 1999, a total of 3,863 fish, including 29 species and two hybrids, were collected from 20 locations on the deep draft waterways.

Results from the fish collection are shown in Table 49 and are summarized as follows:

1. Fourteen fish species (957 fish) were collected from the North Shore Channel.
2. Nine fish species (292 fish) were collected from the deep draft portion of the North Branch of the Chicago River.
3. Eleven fish species (118 fish) were collected from the Chicago River.
4. Eight fish species (74 fish) were collected from the South Branch of the Chicago River.
5. Thirteen fish species (703 fish) were collected from the Chicago Sanitary and Ship Canal.
6. Nineteen fish species (1,103 fish) were collected from the Calumet River.
7. Sixteen fish species (372 fish) were collected from the Little Calumet River.
8. Eleven fish species (244 fish) were collected from the Cal-Sag Channel.

Gizzard shad (1,671 fish, 43 percent of the total catch), bluntnose minnows (616 fish, 16 percent), carp (399 fish, 10

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 49

NUMBER OF FISH COLLECTED BY ELECTROFISHING FROM THE CHICAGO AND CALUMET WATERWAY SYSTEMS DURING 1999

Fish Species	Chicago Waterway System[a]					Calumet Waterway System[b]			Total	Percent of Total
	NSC	NBCR	CR	SBCR	CSSC	CAL	LCAL	C-S		
Herrings										
Alewife	0	0	0	0	0	1	0	0	1	0.03
Gizzard shad	638	146	8	2	299	341	151	86	1,671	43.26
Salmon and Trouts										
Brown trout	0	0	0	0	0	1	0	0	1	0.03
Minnows and Carps										
Goldfish	9	4	4	19	0	1	8	3	48	1.24
Carp	21	27	33	35	139	35	47	62	399	10.33
Carp x goldfish	9	3	0	0	0	1	1	0	14	0.36
Golden shiner	2	0	0	1	0	0	1	0	4	0.10
Emerald shiner	0	0	0	0	2	171	64	2	239	6.19
Spotfin shiner	0	0	0	0	2	0	0	0	2	0.05
Bluntnose minnow	2	0	4	3	201	352	17	37	616	15.95
Fathead minnow	0	0	0	0	2	0	0	0	2	0.05
Suckers										
Quillback	0	0	0	0	0	1	0	0	1	0.03
White sucker	0	0	0	0	3	6	2	0	11	0.28

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 49 (Continued)

NUMBER OF FISH COLLECTED BY ELECTROFISHING FROM THE CHICAGO AND CALUMET WATERWAY SYSTEMS DURING 1999

Fish Species	Chicago Waterway System[a]					Calumet Waterway System[b]			Total	Percent of Total
	NSC	NBCR	CR	SBCR	CSSC	CAL	LCAL	C-S		
Freshwater catfishes										
Black bullhead	11	0	0	0	0	0	0	0	11	0.28
Yellow bullhead	0	1	0	0	6	1	3	1	12	0.31
Channel catfish	1	0	0	0	0	0	1	0	2	0.05
Sticklebacks										
Threespine stickleback	0	0	0	0	0	2	0	0	2	0.05
Ninespine stickleback	1	0	0	0	0	0	0	0	1	0.03
Temperates basses										
White bass	0	0	0	0	1	0	0	0	1	0.03
White perch	0	0	0	0	0	2	9	18	29	0.75
Yellow bass	0	0	0	0	0	0	3	2	5	0.13
Sunfishes										
Rock bass	0	0	23	0	0	17	0	0	40	1.04
Green sunfish	7	21	6	4	4	3	2	17	64	1.66
Pumpkinseed	20	2	1	2	23	12	16	0	76	1.97
Orangespotted sunfish	0	3	0	0	0	0	0	0	3	0.08
Bluegill	114	54	15	0	3	56	8	3	253	6.55

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 49 (Continued)

NUMBER OF FISH COLLECTED BY ELECTROFISHING FROM THE CHICAGO AND CALUMET WATERWAY SYSTEMS DURING 1999

Fish Species	Chicago Waterway System[a]					Calumet Waterway System[b]			Total	Percent of Total
	NSC	NBCR	CR	SBCR	CSSC	CAL	LCAL	C-S		
Sunfishes (Continued)										
Smallmouth bass	0	0	1	0	0	14	3	0	18	0.47
Largemouth bass	101	31	20	8	18	83	35	12	308	7.97
Black crappie	16	0	3	0	0	2	0	0	21	0.54
Bluegill x green sunfish hybrid	0	0	0	0	0	1	1	1	3	0.08
Cichlids										
Nile tilapia	5	0	0	0	0	0	0	0	5	0.13
Total Fish	957	292	118	74	703	1,103	372	244	3,863	100.00
Total Species	14	9	11	8	13	19	16	11	29	

[a]Chicago Waterway System includes the North Shore Channel (NSC), North Branch of the Chicago River (NBCR), Chicago River (CR), South Branch of the Chicago River (SBCR), and Chicago Sanitary and Ship Canal (CSSC).
[b]Calumet Waterway System includes the Calumet River (CAL), Little Calumet River (LCAL), and Cal-Sag Channel (C-S).

percent), largemouth bass (308 fish, 8 percent), bluegill sunfish (253 fish, 7 percent), and emerald shiners (239 fish, 6 percent) were collected in the greatest numbers from the Chicago and Calumet deep draft waterway systems. The carp was the most widely distributed fish species in the Chicago and Calumet Waterway Systems. During the 1999 surveys, carp were collected at all 20 locations.

Sidestream Elevated Pool Aeration (SEPA). A total of 328 fish, including 18 fish species and one hybrid, were collected upstream and downstream from the five SEPA stations on the Calumet River, Little Calumet River, and the Cal-Sag Channel (Table 50). Gizzard shad (56 fish, 24 percent of the total), emerald shiners (43 fish, 19 percent), carp (41 fish, 18 percent), and largemouth bass (29 fish, 13 percent) were the most abundant fish species in the SEPA study. Game fish, including largemouth bass and channel catfish, were collected below the SEPA stations. These fish may have been attracted to the elevated dissolved oxygen (DO) concentrations downstream from SEPA #3 (DO = 7.4 mg/L), SEPA #4 (DO = 6.6 mg/L), and SEPA #5 (DO = 6.8 mg/L on the Chicago Sanitary and Ship Canal and 8.1 mg/L on the Cal-Sag Channel).

Salt Creek. A total of 769 fish, including 20 species and three hybrids, were collected from five locations on Salt Creek (Table 51). The bluegill sunfish (203 fish, 26

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 50

NUMBER OF FISH COLLECTED BY ELECTROFISHING ABOVE AND BELOW THE SIDESTREAM ELEVATED POOL AERATION STATIONS DURING 1999[a]

Fish Species	Calumet River SEPA 1	Little Calumet River SEPA 2	Cal-Sag Channel SEPA 3	Cal-Sag Channel SEPA 4	Cal-Sag Channel SEPA 5	Total Number of Fish	Percent of Total
Herrings							
Gizzard shad	26	27	1	1	1	56	24.45
Minnows and Carps							
Goldfish	0	2	0	0	0	2	0.87
Carp	7	1	9	15	9	41	17.90
Carp x goldfish	0	0	2	0	0	2	0.87
Golden shiner	0	1	0	0	0	1	0.44
Emerald shiner	27	1	2	13	0	43	18.78
Spottail shiner	0	1	0	0	0	1	0.44
Bluntnose minnow	3	0	2	0	3	8	3.49
Suckers							
White sucker	1	2	2	1	0	6	2.62
Freshwater catfishes							
Black bullhead	0	1	1	0	0	2	0.87
Channel catfish	0	0	1	5	3	9	3.93

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 50 (Continued)

NUMBER OF FISH COLLECTED BY ELECTROFISHING ABOVE AND BELOW THE SIDESTREAM ELEVATED POOL AERATION STATIONS DURING 1999[a]

Fish Species	Calumet River SEPA 1	Little Calumet River SEPA 2	Cal-Sag Channel SEPA 3	Cal-Sag Channel SEPA 4	Cal-Sag Channel SEPA 5	Total Number of Fish	Percent of Total
Temperate basses							
White perch	1	1	0	0	0	2	0.87
Yellow bass	0	0	5	3	0	8	3.49
Sunfishes							
Rock bass	0	0	0	1	0	1	0.44
Green sunfish	3	1	0	0	0	4	1.75
Pumpkinseed	1	0	0	0	0	1	0.44
Bluegill	0	0	1	4	0	5	2.18
Smallmouth bass	6	0	0	0	0	6	2.62
Largemouth bass	15	0	5	6	3	29	12.66
Gobies							
Round goby	2	0	0	0	0	2	0.87
Total Fish	92	38	31	49	19	229	100.00
Total Species	13	10	10	9	5	21	

[a]Fish were collected 200 meters above and below the SEPA stations.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 51

NUMBER OF FISH COLLECTED FROM SALT CREEK DURING 1999[a]

Fish Species	Above Egan WRP Outfall (Sta. 1)	Arlington Heights Road (Sta. 2)	Devon Avenue (Sta. 3)	Wolf Road (Sta. 4)	First Avenue (Sta. 5)	Total Number of Fish	Percent of Total
Minnows and Carps							
Goldfish	0	0	0	3	3	6	0.78
Carp	0	1	0	0	0	1	0.13
Carp x goldfish	0	0	0	0	1	1	0.13
Golden shiner	6	0	0	0	0	6	0.78
Spotfin shiner	12	9	1	14	66	102	13.26
Sand shiner	0	0	0	8	15	23	2.99
Bluntnose minnow	4	0	1	21	77	103	13.39
Fathead minnow	0	0	0	0	4	4	0.52
Creek chub	0	0	0	5	3	8	1.04
Suckers							
White sucker	1	0	0	2	7	10	1.30
Freshwater catfishes							
Yellow bullhead	2	10	1	6	2	21	2.73
Killifishes							
Blackstripe topminnow	61	3	8	0	0	72	9.36

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 51 (Continued)

NUMBER OF FISH COLLECTED FROM SALT CREEK DURING 1999*

Fish Species	Above Egan WRP Outfall (Sta. 1)	Arlington Heights Road (Sta. 2)	Devon Avenue (Sta. 3)	Wolf Road (Sta. 4)	First Avenue (Sta. 5)	Total Number of Fish	Percent of Total
Silversides							
Brook silverside	9	0	0	0	0	9	1.17
Sunfishes							
Green sunfish	5	12	19	23	11	70	9.10
Pumpkinseed	40	3	1	2	0	46	5.98
Orangespotted sunfish	14	2	9	3	0	28	3.64
Bluegill	123	44	8	23	5	203	26.40
Largemouth bass	23	9	3	4	7	46	5.98
Black crappie	1	0	0	0	0	1	0.13
Green sunfish x bluegill hybrid	5	0	0	0	0	5	0.65
Pumpkinseed x bluegill hybrid	0	1	1	0	0	2	0.26
Perches							
Johnny darter	0	0	0	0	1	1	0.13
Blackside darter	0	0	0	0	1	1	0.13

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 51 (Continued)

NUMBER OF FISH COLLECTED FROM SALT CREEK DURING 1999[a]

Fish Species	Above Egan WRP Outfall (Sta. 1)	Arlington Heights Road (Sta. 2)	Devon Avenue (Sta. 3)	Wolf Road (Sta. 4)	First Avenue (Sta. 5)	Total Number of Fish	Percent of Total
Total Number of Fish	306	94	52	114	203	769	100.00
Total Fish Species	13	9	9	12	13	20	

[a]Fish were collected twice during 1999 (July 22 - August 5 and September 1 - September 22) from each station using a 24-volt Smith-Root Model 12-B backpack electrofisher and a 25-foot 3/16-inch square-mesh bag seine.

percent), bluntnose minnow (103 fish, 13 percent of the total catch), spotfin shiner (102 fish, 13 percent), blackstripe topminnow (72 fish, 9 percent), and the green sunfish (70 fish, 9 percent) were collected in the greatest numbers in Salt Creek.

Illinois Fish Flesh Contaminant Advisory Program. During 1999, the Fisheries Biology Group assisted the Illinois Department of Natural Resources (IDNR) and the IEPA by participating in a statewide effort to provide consumption advisories for sport statewide effort to provide consumption advisories for sport fish. The District provided the IEPA with 56 composite samples of fish fillets (three to six fillets per composite sample). The fish were collected from the Chicago and Calumet Waterway Systems. The fillets were analyzed by the IEPA for aldrin, total chlordane, total DDT and analogs, dieldrin, total PCBs, heptachlor, heptachlor epoxide, toxaphene, methoxychlor, hexachlorobenzene, gamma-BHC (lindane), alpha-BHC, mirex, endrin, and total mercury. Results of these analyses will be used by IDNR to provide the public with information as to the safety of eating fish collected from the Chicago and Calumet Waterway Systems.

Water and Sediment Quality Group Activities. The Water and Sediment Quality Group monitors water and sediment quality in Chicago area inland waterways and along the Illinois

Waterways from the Lockport lock to the Peoria lock. In addition, the group developed and supervised a combined sewer monitoring program under contract with the United States Army Corps of Engineers.

Major activities of the Water and Sediment Quality Group during 1999 included the following three studies.

Continuous Monitoring of Dissolved Oxygen in the Chicago Waterway System. In order to gain a better understanding of the oxygen dynamics in the Chicago Waterway System (North Shore Channel, North Branch Chicago River, Chicago River, South Branch Chicago River, Bubbly Creek, and Chicago Sanitary and Ship Canal), the General Superintendent requested that the Research and Development Department develop a comprehensive field monitoring program to determine the dissolved oxygen (DO) levels in the subject inland waterways. A field monitoring program was initiated in August 1998.

DO is measured hourly using remote (in situ) water quality monitors (monitors) deployed in protective stainless steel housing units. The monitors are located at 20 stations in the waterways from the Wilmette Pumping Station on the North Shore Channel to the Lockport Lock and Dam on the Chicago Sanitary and Ship Canal. Following a week of continuous monitoring, the monitors are retrieved from the field and brought back to the laboratory for data downloading, servicing, and

calibration. During the field retrieval process, additional monitors that have been calibrated and serviced are deployed in the protective housing units. The DO data is downloaded electronically from the monitors to a specially designed database from which summary tables and line drawings are prepared. The DO monitoring program was continued in 1999.

The number and percent of values below the Illinois Pollution Control Board's DO water quality standards measured during the period January through July 1999 in the study area are presented in Table 52.

During January through July 1999, the highest percentage of DO values that were below the 4.0 mg DO/L standard for Secondary Contact Waters in the Chicago Waterway System were measured at I-55 in Bubbly Creek (39%), and at Romeoville (25%), Lockport (23%), and Cicero (19%) in the Chicago Sanitary and Ship Canal (Table 52). In the General Use Waters of the North Shore Channel (upstream of the North Side WRP outfall), 55 percent of the field measurements were below the 5.0 mg DO/L standard (Table 52).

Overall during the seven-month monitoring period, 7,423 of 76,701 measurements (10%) and 6,775 of 17,458 measurements (39%) were below the 4.0 and 5.0 mg DO/L water quality standards for Secondary Contact and General Use Waters, respectively.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 52

NUMBER AND PERCENT OF DISSOLVED OXYGEN VALUES
BELOW THE ILLINOIS POLLUTION CONTROL BOARD'S WATER QUALITY STANDARD IN THE
NORTH SHORE CHANNEL, NORTH BRANCH OF THE CHICAGO RIVER, CHICAGO RIVER,
SOUTH BRANCH OF THE CHICAGO RIVER, BUBBLY CREEK, CHICAGO SANITARY AND SHIP CANAL,
AND THE CAL-SAG CHANNEL DURING JANUARY THROUGH JULY 1999[1]

Sampling Location	DO Standard (mg/L)	Number of DO Values	Number of DO Values Below IPCB Standard	Percent of DO Values Below IPCB Standard
		North Shore Channel		
Linden	5.0	3,861	2,357	61
Simpson	5.0	4,033	2,713	67
Main	5.0	4,700	1,683	36
Devon	4.0	4,862	5	<1
		North Branch of the Chicago River		
Lawrence	4.0	5,015	43	1
Addison	4.0	5,190	11	<1
Fullerton	4.0	4,522	246	5
Division	4.0	4,669	216	5
Kinzie	4.0	5,025	337	7

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 52 (Continued)

NUMBER AND PERCENT OF DISSOLVED OXYGEN VALUES
BELOW THE ILLINOIS POLLUTION CONTROL BOARD'S WATER QUALITY STANDARD IN THE
NORTH SHORE CHANNEL, NORTH BRANCH OF THE CHICAGO RIVER, CHICAGO RIVER,
SOUTH BRANCH OF THE CHICAGO RIVER, BUBBLY CREEK, CHICAGO SANITARY AND SHIP CANAL,
AND THE CAL-SAG CHANNEL DURING JANUARY THROUGH JULY 1999[1]

Sampling Location	DO Standard (mg/L)	Number of DO Values	Number of DO Values Below IPCB Standard	Percent of DO Values Below IPCB Standard
		Chicago River		
Clark	5.0	4,864	22	<1
		South Branch of the Chicago River		
Jackson	4.0	5,188	50	1
Loomis	4.0	4,748	61	1
		Bubbly Creek		
I-55	4.0	4,381	1,726	39

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 52 (Continued)

NUMBER AND PERCENT OF DISSOLVED OXYGEN VALUES
BELOW THE ILLINOIS POLLUTION CONTROL BOARD'S WATER QUALITY STANDARD IN THE
NORTH SHORE CHANNEL, NORTH BRANCH OF THE CHICAGO RIVER, CHICAGO RIVER,
SOUTH BRANCH OF THE CHICAGO RIVER, BUBBLY CREEK, CHICAGO SANITARY AND SHIP CANAL,
AND THE CAL-SAG CHANNEL DURING JANUARY THROUGH JULY 1999[1]

Sampling Location	DO Standard (mg/L)	Number of DO Values	Number of DO Values Below IPCB Standard	Percent of DO Values Below IPCB Standard
		Chicago Sanitary and Ship Canal		
Cicero	4.0	4,830	922	19
B&O RR	4.0	4,697	159	3
Rt. 83	4.0	3,753	639	17
Mile 302.6	4.0	4,528	488	11
Romeoville	4.0	5,198	1,287	25
Lockport	4.0	5,102	1,168	23
		Cal-Sag Channel		
Rt. 83	3.0	5,083	65	1

[1]Dissolved oxygen was measured hourly using a continuous water quality monitor.

Illinois Waterways Water/Sediment Quality Survey. In 1984, the Research and Development Department established a long-term water and sediment monitoring program along the Illinois Waterways from the Lockport lock to the Peoria lock, a distance of approximately 133 miles. The purpose of the monitoring program was to assess the chemical and microbiological quality of the water and to characterize the chemical quality of sediments.

Water samples were collected twice during May, August, and October from each of the 49 sampling stations. Sediment samples were collected at 14 stations during October. Similar studies were conducted annually through 1998. During 1999, water samples were collected twice in August and October from each of the 49 sampling stations. Sediment samples were collected in October at 14 stations.

The mean dissolved oxygen (DO) and ammonium-nitrogen levels measured during August and October 1999 at 11 selected stations in the six navigational pools (Lockport, Brandon Road, Dresden Island, Marseilles, Starved Rock, and Peoria) is presented in Table 53.

During 1999, the mean DO concentration increased substantially along the waterways from the Lockport pool (mean = 4.9 mg/L) to the Peoria pool (mean = 8.0 mg/L). The increase in

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 53

MEAN CONCENTRATION OF DISSOLVED OXYGEN AND AMMONIUM-NITROGEN AT SELECTED SAMPLING STATIONS IN THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES, STARVED ROCK, AND PEORIA NAVIGATIONAL POOLS OF THE ILLINOIS WATERWAY DURING 1999[1]

Station Number	Navigational Pool	Dissolved Oxygen (mg/L)	Ammonium-Nitrogen (mg/L)
1	Lockport	4.9	0.48
3	Brandon Road	5.4	0.30
8	Dresden Island	7.1	0.18
15	Marseilles	7.7	0.09
20	Marseilles	8.6	0.02
24	Starved Rock	8.6	<0.01
29	Peoria	9.3	<0.01
35	Peoria	9.0	<0.01
40	Peoria	8.0	0.01
45	Peoria	7.2	0.05
49	Peoria	6.6	0.05

[1]Water samples were collected twice from each sampling station during August and October (n=4).

DO may be attributable to reaeration at the Brandon Road, Dresden Island, and Marseilles navigational dams and to photosynthesis.

The mean ammonium-nitrogen concentration decreased considerably during the 1999 surveys from the Lockport pool (mean = 0.48 mg/L) to the Peoria pool (mean = 0.03 mg/L). Instream nitrification and nutrient uptake by algae, periphyton, and aquatic vegetation resulting in primary production may account for the decrease in ammonium-nitrogen along the waterways.

Combined Sewer Overflow Characterization. In 1995, the United States Army Corps of Engineers (Corps) initiated an intergovernmental agency cooperative agreement with the Research and Development Department. The agreement included the collection and analysis of water quality samples during storm events from selected combined sewer overflow (CSO) tributary areas in Cook County. These data will be used by the corps for modeling the maximum oxygen requirements in order to design a cost-effective aeration system for the proposed McCook Reservoir. The CSO program continued during 1999.

Water quality samples were collected during 1999 from three combined sewers that overflow to TARP drop shafts (Calumet, Evanston, and Racine) and three combined sewers that discharge directly to Chicago area waterways (Evanston and Riverside). Individual discrete water quality samples were

collected periodically from combined sewers with automatic samplers. Total suspended solids (TSS) and five-day biochemical oxygen (BOD_5) were measured in individual overflow samples.

Characteristics of overflow events for storms monitored during April through December 1999 are presented in Table 54. The average BOD_5 values ranged from 10 mg/L at Riverside to 129 mg/L at Racine Avenue. The maximum concentrations of TSS and BOD_5 measured during 1999 for all storm events were 3,180 and 515 mg/L, respectively.

Toxic Substances Section

The Toxic Substances Section has established the analytical capability for all the USEPA organic priority pollutants. These include more than 100 organic parameters listed by the USEPA. The NPDES permits for District WRPs also require the Section to analyze for non-listed organic compounds when the detected peaks are ten times higher than the background, and some projects require the analysis of numerous non-listed organics. The Toxic Substances Section currently analyzes for more than 120 non-listed organic compounds.

There are a variety of projects conducted by this Section which are interdisciplinary in nature. Frequently, the Section is called upon to carry out specialized analyses in

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 54

CHARACTERISTICS OF COMBINED SEWER OVERFLOWS
IN THE CHICAGO METROPOLITAN AREA
FOR STORMS MONITORED DURING APRIL THROUGH DECEMBER 1999

CSO Location	Number of Storms Monitored	Average Total Rainfall (inches)	Average TSS[1] (mg/L)	Average BOD_5[2] (mg/L)
Calumet	4	1.3	130	34
Evanston	2	1.4	108	31
Racine	2	1.4	671	129
Riverside	2	1.3	39	10

[1]Total suspended solids.
[2]Five-day, biochemical oxygen demand.

support of litigation, administrative hearings, and various technical assistance projects. The Section provides assistance to the Industrial Waste Division in emergency situations and performs specialized analyses in connection with hazardous and toxic industrial waste spills, as well as pollution control of waterways and Lake Michigan.

An Internal Quality Control Program was conducted to guarantee the high quality of the laboratory analyses and results, and to evaluate the analytical performance for the numerous parameters analyzed.

MONITORING OF ORGANIC PRIORITY POLLUTANTS IN DISTRICT WATER RECLAMATION PLANTS

In order to comply with the requirements of the NPDES permits, the District analyzes the raw sewage, final effluent, and biosolids from its seven WRPs for determination of the 111 organic priority pollutants following USEPA 600 Series Methods.

Tables 55, 56 and 57 present the average concentrations of the compounds found in District raw sewage, final effluent, and biosolids samples, respectively, for two sets of samples which were taken in January and July 1999.

The highest values of purgeables or volatile organic compounds (VOCs) observed in the raw sewage was 29 µg/L of toluene and 19 µg/L of benzene at the Calumet WRP.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 55

ANALYSIS OF ORGANIC PRIORITY POLLUTANTS IN DISTRICT RAW SEWAGE IN 1999

Compounds	Detection Limit µg/L	Values in µg/L (ppb)[1]							
		Calumet	Egan	Hanover Park	Kirie	Lemont	North Side	Stickney[2] Southwest	Stickney[2] West Side
PURGEABLES									
Benzene	1	19	ND	ND	ND	ND	ND	ND	ND
Chloroform	1	2	4	4	4	6	4	4	5
Methylene chloride	2	4	2	5	4	ND	5	5	5
Tetrachloroethylene	2	ND	ND	8	ND	2	4	5	ND
Toluene	2	29	4	9	2	8	7	7	6
Trichloroethylene	2	ND	ND	2	ND	ND	8	ND	ND
BASE/NEUTRAL/ACID EXTRACTABLES									
2,4-Dimethylphenol	4	4	ND	ND	ND	ND	ND	ND	ND
Phenol	1	47	ND	12	2	4	ND	ND	ND
Butyl benzyl phthalate	5	ND	6	ND	ND	ND	10	ND	ND
Diethyl phthalate	3	5	8	6	3	ND	6	4	7
Di-n-octyl phthalate	3	12	ND	ND	ND	ND	ND	ND	ND
Naphthalene	2	2	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	1	2	ND	ND	ND	1	ND	1	ND
PESTICIDES and PCBs									
None Found									

[1]Average results of two samples.

[2]Stickney WRP receives two influent raws.

ND = Not Detected.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 56

ANALYSIS OF ORGANIC PRIORITY POLLUTANTS IN DISTRICT FINAL EFFLUENT IN 1999

Compounds	Detection Limit µg/L	Values in µg/L (ppb)[1]						
		Calumet	Egan	Hanover Park	Kirie	Lemont	North Side	Stickney
PURGEABLES								
Chlorodibromomethane	2	ND	2	ND	ND	ND	ND	ND
Chloroform	1	ND	4	8	1	3	2	2
Dichlorobromomethane	1	ND	2	2	ND	ND	ND	ND
BASE/NEUTRAL/ACID EXTRACTABLES								
Di-n-octyl phthalate	3	ND	ND	ND	ND	ND	ND	98
PESTICIDES and PCBs								
None Found								

[1]Average results of two samples.
ND = Not Detected.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 57

ANALYSIS OF ORGANIC PRIORITY POLLUTANTS IN DISTRICT BIOSOLIDS IN 1999

Compounds	Values in mg/Kg (ppm)[1]						
	Calumet	Egan	Hanover Park	Kirie	Lemont	North Side	Stickney
(Average Solids)	(1.52%)	(2.61%)	(2.49%)	(0.52%)	(1.40%)	(0.68%)	(4.18%)
PURGEABLES							
Benzene	0.40	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	0.29	ND
Methyl chloride	ND	ND	ND	ND	ND	ND	0.19
Methylene chloride	ND	ND	0.20	0.38	ND	0.29	ND
Toluene	1.18	0.27	29.3	1.35	ND	0.74	2.30
BASE/NEUTRAL/ACID EXTRACTABLES							
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	1.27
3,4-Benzofluoranthene	ND	ND	ND	ND	ND	ND	1.72
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	1.99
Bis(2-ethylhexyl)phthalate	149	28.5	ND	ND	27.6	58.7	35.3
Chrysene	ND	ND	ND	ND	ND	ND	1.94
Fluoranthene	2.76	3.68	ND	ND	ND	ND	4.54
Phenanthrene	4.47	2.07	ND	ND	ND	ND	3.44
Pyrene	7.83	2.68	ND	ND	ND	ND	5.60
PESTICIDES and PCBs							
None Found							

[1]Average results of two samples based on solids content.
ND = Not Detected.

The highest values of purgeables found in the final effluent was for chloroform in concentrations of 4 µg/L and 8 µg/L at the Egan and Hanover Park WRPs, respectively.

The highest values of purgeables in the biosolids samples were for toluene in concentrations of 29.3 mg/Kg and 2.30 mg/Kg dry weight (based on the solids content), at the Hanover Park and Stickney WRPs, respectively.

The highest values of base/neutral/acid extractable (BNA) compounds in the raw sewage were phenol in concentrations of 47 µg/L and 12 µg/L at the Calumet and Hanover Park WRPs, respectively, and di-n-octyl phthalate in a concentration of 12 µg/L at the Calumet WRP. Butyl benzyl phthalate was found in a concentration of 10 µg/L at the North Side WRP.

The highest value of BNA compounds for the final effluents was di-n-octyl phthalate in a concentration of 98 µg/L at the Stickney WRP.

The highest values of BNA compounds detected in the biosolids were bis(2-ethylhexyl)phthalate in concentrations of 149 mg/Kg and 58.7 mg/Kg dry weight (based on solids content) at the Calumet and North Side WRPs, respectively.

No pesticides or polychlorinated biphenyls (PCBs) were found in any final effluent, raw sewage, or biosolids samples.

The frequency of occurrence of the compounds detected in all WRP samples (raw sewage, final effluent, and biosolids) are summarized as follows:

1. Only 4 of the 111 listed organic priority pollutants were detected in the final effluent samples 3 of the 30 purgeables (chlorodibromomethane, chloroform, and dichlorobromomethane), 1 of the 57 BNAs (di-n-octyl phthalate), and none of the 24 pesticides and PCBs).
2. Most of the organic priority pollutant compounds found in the raw sewage samples were completely removed by the treatment process, and were not detected in the effluents. They include benzene, methylene chloride, tetrachloroethylene, toluene, trichloroethylene, 2,4-dimethylphenol, phenol, butyl benzyl phthalate, diethyl phthalate, naphthalene, and phenanthrene.
3. Other compounds (dichlorobromomethane and di-n-octyl phthalate) showed partial removals; i.e., lower frequency of occurrence in effluent than in raw sewage samples. An example is chloroform which was present in the raw sewage

of all the WRPs, occurred in the final effluent of 6 WRPs.

MONITORING OF NON-LISTED ORGANIC COMPOUNDS IN DISTRICT WATER RECLAMATION PLANTS

In addition to the listed organic compounds (priority pollutants), the concentrations of non-listed organic compounds were determined in the raw sewage, final effluent, and biosolids at District WRPs, sampled in January and July 1999.

The non-listed purgeable compounds found were solvents, hydrocarbons, and products from anaerobic biological degradation. Only 2 purgeable compounds occurred 3 times in District WRP effluents, whereas 23 compounds occurred 105 times in raw sewage samples. This indicates excellent removal efficiencies for these compounds during the treatment process.

Fifty-two non-listed BNA compounds were found in District WRP samples during 1999. The majority of these compounds come from human and animal wastes, industrial waste, and gasoline and/or oil derivatives. Six compounds occurred 21 times in the effluents, whereas 51 compounds occurred 581 times in the raw sewage, indicating good removal efficiencies of many of these compounds during the wastewater treatment process.

Table 58 shows the frequency of occurrence of non-listed organic compounds in District WRP samples during 1999.

Toxicity Characteristic Leaching Procedure (TCLP). The TCLP test is required under the Resource Conservation Recovery Act to characterize waste material, such as biosolids and scum, to ensure that it is safe for disposal. The original sample undergoes a series of tests, of which total PCBs are analyzed within the Toxic Substances Section. A TCLP extract is also made from the sample for subsequent analyses. Following USEPA Method 1311, the sample is shaken with an acetate buffer solution for 18 hours and filtered using specialized equipment to yield a TCLP extract, which is the filtrate. Separate extracts are generated for VOCs and non-VOCs. The respective extract is analyzed for a subset of the priority pollutant compounds, both inorganic and organic. The Section analyzes for 30 organics (10 VOCs, 12 BNAs, 6 pesticides, and 2 herbicides), using USEPA Methods 624, 625, 608, and Standard Methods 6640B, respectively. The TCLP samples analyzed in 1999 were from Stony Island, Calumet East, Ridgeland Avenue Solids Management Area (RASMA), Harlem Avenue Solids Management Area (HASMA), Lawndale Avenue Solids Management Area (LASMA), U.S. Steel Works site and two Worth sites. None of the samples were found to be hazardous.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 58

FREQUENCY OF NON-LISTED ORGANIC COMPOUNDS FOUND IN DISTRICT WRP SAMPLES DURING 1999

Compound	Raw Sewage 16 Samples[1] Times Found(%)	Effluent 14 Samples[1] Times Found(%)	Biosolids 14 Samples[1] Times Found(%)
PURGEABLES			
Labile sulfide group	2(12)	0	7(50)
Acetone	16(100)	0	6(43)
Dimethyl sulfide	7(44)	1(7)	6(43)
Carbon disulfide	1(6)	0	2(14)
Methyl acetate	4(25)	0	8(57)
Tetrahydrofuran	6(38)	2(14)	0
Diethyl ether	2(12)	0	0
Acetaldehyde	1(6)	0	0
Propionaldehyde	2(12)	0	0
2-Butanone (MEK)	8(50)	0	0
Methy t-butyl ether	1(6)	0	0
4-Methyl-2-pentanone	1(6)	0	0
Isopropylbenzene (Cumene)	2(12)	0	2(14)
Xylenes	9(56)	0	3(21)
Styrene	1(6)	0	0
n-Propylbenzene	1(6)	0	0
2-Ethyltoluene	4(25)	0	2(14)
3-and/or 4-Ethyltoluene	9(56)	0	3(21)
α- Methylstyrene	1(6)	0	0
Nonane	0	0	2(14)
Isobutylbenzene	1(6)	0	1(7)
Limonene	15(94)	0	7(50)
4-Isopropyltoluene	11(69)	0	6(43)

TABLE 58 (Continued)

FREQUENCY OF NON-LISTED ORGANIC COMPOUNDS FOUND IN DISTRICT WRP SAMPLES DURING 1999

Compound	Raw Sewage 16 Samples[1] Times Found(%)	Effluent 14 Samples[1] Times Found(%)	Biosolids 14 Samples[1] Times Found(%)
BASE/NEUTRAL/ACID EXTRACTABLES			
2-Methyl propanoic acid	8(50)	0	2(14)
Butanoic acid	15(94)	0	3(21)
3-Methyl butanoic acid	16(100)	0	5(36)
2-Methyl butanoic acid	13(81)	0	3(21)
Pentanoic acid	16(100)	0	3(21)
Ethylene glycol butyl ether	16(100)	0	0
Decane	1(6)	0	1(7)
Benzyl alcohol	15(94)	0	0
o-Cresol	2(12)	0	0
m-and/or p-Cresol	15(94)	0	8(57)
Hexanoic acid	15(94)	0	3(21)
Undecane	8(50)	0	6(43)
Heptanoic acid	2(12)	0	1(7)
Benzoic acid	16(100)	0	0
Octanoic acid	15(94)	0	4(29)
Dodecane	9(56)	0	5(36)
Diethylene glycol butyl ether	16(100)	0	0
α-Terpineol	16(100)	0	0
Phenyl acetic acid	16(100)	0	11(79)
Nonanoic acid	10(63)	2(14)	2(14)
Tridecane	10(63)	0	6(43)
2-Methylnaphthalene	1(6)	0	0
Tripropylene glycol methyl ether	0	1(7)	0

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 58 (Continued)

FREQUENCY OF NON-LISTED ORGANIC COMPOUNDS FOUND IN DISTRICT WRP SAMPLES DURING 1999

Compound	Raw Sewage 16 Samples[1] Times Found (%)	Effluent 14 Samples[1] Times Found (%)	Biosolids 14 Samples[1] Times Found (%)
BASE/NEUTRAL/ACID EXTRACTABLES (Cont)			
1-H-Indole	11 (69)	0	4 (29)
Decanoic acid	12 (75)	0	1 (7)
Tetradecane	11 (69)	0	6 (43)
Acetophenone	2 (12)	0	0
N,N-Dimethyl-1-dodecanamine	14 (88)	0	7 (50)
Pentadecane	14 (88)	0	10 (71)
1,1'-Biphenyl	1 (6)	0	0
Dimethylnaphthalene isomers	1 (6)	0	2 (14)
Dodecanol	16 (100)	0	8 (57)
Trimethylnaphthalene isomers	5 (31)	0	3 (21)
Dodecanoic acid	16 (100)	0	10 (71)
Hexadecane	11 (69)	0	8 (57)
Tridecanoic acid	13 (81)	0	3 (21)
Heptadecane	14 (88)	0	12 (86)
1-Tetradecanol	16 (100)	0	10 (71)
Tetradecanoic acid	16 (100)	0	11 (79)
Nonyl phenol isomers	14 (88)	0	11 (79)
Octadecane	9 (56)	0	6 (43)
Caffeine	14 (88)	0	0
Pentadecanoic acid	16 (100)	0	9 (64)
N,N-Dimethyl-1-hexadecanamine	2 (12)	0	0
Carbazole	1 (6)	0	1 (7)
Nonadecane	6 (38)	0	4 (29)
1-Hexadecanol	16 (100)	0	3 (21)

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 58 (Continued)

FREQUENCY OF NON-LISTED ORGANIC COMPOUNDS FOUND IN DISTRICT WRP SAMPLES DURING 1999

Compound	Raw Sewage 16 Samples[1] Times Found(%)	Effluent 14 Samples[1] Times Found(%)	Biosolids 14 Samples[1] Times Found(%)
BASE/NEUTRAL/ACID EXTRACTABLES (Cont)			
cis-9-Hexadecenoic acid	16(100)	2(14)	8(57)
Hexadecanoic acid	15(94)	11(79)	14(100)
Heptadecanoic acid	16(100)	0	6(43)
z-9-Octadecenoic acid	16(100)	1(7)	10(71)
Octadecanoic acid	16(100)	4(29)	13(93)

[1]Two sampling cycles for each of the seven WRPs, with the Stickney WRP having two influents (raw sewage).

SPECIAL STUDIES OF CLEAN AIR ACT COMPOUNDS

The Toxic Substances Section provides analytical support to the Wastewater Treatment Research Section by analyzing organic hazardous air pollutants found in District raw sewage samples.

Raw sewage samples were collected once per month at each of the District's seven WRPs during 1999, and analyzed for 87 compounds. The data were used as the input values for various mathematical models which predict VOC air emissions. Results from the raw sewage sampling are presented in Table 59.

The District is also interested in directly measuring VOC emissions from its WRPs by collecting air samples. The Toxic Substances Section purchased a preconcentrator/gas chromatograph/mass spectrometer system in late 1998. This system will be used to determine the actual VOC emissions by direct measurement from the various WRPs. During 1999, standards of the target analytes were purchased and diluted, calibration files were made for these analytes, and contamination problems were resolved. A limited number of grab samples of air were collected at Egan WRP to test the instrumentation. In the year 2000, air samples will be taken at other District's WRPs from various unit processes or at various strategic places within the WRPs to obtain a better

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 59

CLEAN AIR ACT ORGANIC COMPOUNDS IN DISTRICT RAW SEWAGE[1]

Compounds	Detection Limit µg/L	Values in µg/L (ppb)							
		Calumet	Egan	Hanover Park	Kirie	Lemont	North Side	Stickney South-West	Stickney West Side
Acetaldehyde	58	ND	ND	ND	ND	ND	ND	ND	ND-3,545[2]
Acetophenone	3	9-32	ND	ND-7[2]	ND	ND	ND	ND	ND
Benzene	1	4-27	ND	ND-12[2]	ND	ND	ND	ND-5[2]	ND
Biphenyl	2	ND-3[2]	ND	ND	ND	ND	ND	ND-17[2]	ND
Carbon disulfide	4	ND	ND	ND	4-7	ND	ND	ND	ND
Chloroform	1	2-6	2-6	3-7	2-6	2-70	2-5	2-8	3-6
o-Cresol	3	7-33	ND	ND-10[2]	ND	ND	ND	ND	ND
m- and/or p-Cresol	3	16-102	5-29	2-77	5-35	17-105	9-21	4-12	10-22
Total Cresols/ Cresylic Acid	3	16-120	5-29	2-87	5-35	17-105	9-21	4-12	10-22
Cumene	2	2-25	ND	ND	ND-9[2]	ND	ND	ND	ND
2,4-D, salts and esters	0.8	ND-1[2]	ND	2-4	ND-3[2]	ND-2	ND	ND	ND-2[2]
DDE	0.05	ND	ND	ND	0.08-0.09	ND	ND	ND	ND
Ethyl benzene	2	2-4	ND	ND-9[2]	ND	ND	ND-2[2]	ND-2	ND
Ethylene dichloride	2	ND-4[2]	ND	ND	ND	ND	ND	ND	ND
Heptachlor	0.07	ND	ND	ND	ND	ND-0.11[2]	ND	ND	ND-0.08[2]
Isophorone	2	ND	ND	ND	ND-2	ND	ND	ND	ND
α-BHC	0.04	ND	ND	ND-0.07[2]	ND	ND	ND	ND	ND
γ-BHC (Lindane)	0.03	ND-0.07[2]	ND	0.04-0.05	ND	ND	ND-0.06[2]	ND	ND

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 59 (Continued)

CLEAN AIR ACT ORGANIC COMPOUNDS IN DISTRICT RAW SEWAGE[1]

Compounds	Detection Limit µg/L	Values in µg/L (ppb)							
		Calumet	Egan	Hanover Park	Kirie	Lemont	North Side	Stickney South-West	Stickney West Side
Methyl chloride	3	ND	3-4	3-4	ND-6[2]	ND-2[2]	ND	ND	ND
Methyl ethyl ketone	6	10-24	6-10	6-13	6-32	ND-6[2]	9-11	8-22	8-19
Methyl isobutyl ketone	3	ND	ND	ND	ND	ND	ND	ND-6[2]	ND
Methylene chloride	2	3-16	2-3	2-20	3-9	6-177	4-30	2-11	2-10
Naphthalene	2	2-3	ND	ND	ND	ND	ND	ND	ND-3[2]
Propionaldehyde	21	ND-73[2]	ND	ND	ND	ND	ND	ND-89[2]	ND-286[2]
Styrene	2	2-8	ND	3-6	ND	ND	2-4	ND	ND
Tetrachloroethene	2	2-14	2-11	2-61	ND-2[2]	2-7	2-9	2-10	2-6
Toluene	2	3-39	2-8	4-41	2-3	5-48	5-13	3-10	4-11
Trichloroethene	2	ND	ND	2-113	ND	ND-2	2-17	ND-2[2]	2-4
Vinylidene chloride	1	ND	ND-1[2]	ND	ND	ND	ND	ND	ND
o-Xylenes	2	2-6	ND	ND-14[2]	2-11	ND	2-3	2-4	ND-2[2]
m-and/or p-Xylenes	3	3-14	ND	ND-30[2]	ND-6[2]	ND	3-9	2-10	3-4
Total Xylenes	2	7-20	ND	ND-44[2]	8-11	ND	3-12	4-14	3-6

[1]Based on a 12 month study from January through December 1999.
ND = Not Detected.
[2]Detected only once.

overall picture of the VOC emissions from these locations by direct measurements.

INDUSTRIAL WASTE MONITORING

This is the continuation of a project started in July 1992, for the in-house analysis and monitoring of total toxic organics (TTOs) in industrial waste discharges, as part of the District's pretreatment program. Samples from different industries were analyzed for specific target analytes from the USEPA organic priority pollutant list.

Each of the USEPA listed industrial category and other Significant Industrial Users (SIUs) have a different set of target analytes. Because of the diverse range of organic analytes, these industrial waste samples must also be analyzed like the WRP samples, for three separate groups; namely, VOCs by purge and trap gas chromatograph/mass spectrometer (GC/MS), BNAs by GC/MS, and organochlorine pesticides and/or PCBs (PP) by gas chromatograph/electron capture detector (GC/ECD). In addition to the samples collected from the USEPA listed categories and other SIUs, other samples were also collected for Surveillance and Special Analyses purposes. A list of all the categories of analyses, number of analytes in each category, and number of samples received are shown in Table 60.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 60

INDUSTRIAL WASTE CATEGORIES AND SAMPLES RUN IN 1999

Categories of Analyses		Analysis Type[1]	Analytes	Samples	Analyses
413	Electroplating	VOC, BNA, PP	113	20	2260
414	Organic Chemicals and Plastics	VOC, BNA	42	13	546
420	Iron and Steel	VOC, BNA	2	2	4
433	Metal Finishing	VOC, BNA, PP	113	48	5424
464-15C	Metal Molding and Casting	VOC, BNA	25	2	50
	PCBs Only	PP	6	21	126
	Significant Industrial Users	VOC	33	9	297
	Surveillance	VOC, BNA, PP	125	29	3625
	Special Analyses	FID, HPLC	Non specific	5	5
	Trip Blanks	VOC	33	38	1254
	Totals			187	13,591

[1]VOC = volatile organic compounds, BNA = base/neutral/acid extractable compounds, PP = pesticides and/or PCBs, FID = flame ionization detector for flammables, HPLC = high pressure liquid chromatograph with UV detector.

REVIEW OF ANALYTICAL REPORTS FOR THE PRETREATMENT PROGRAM

A number of industries are required to participate in the District's pretreatment self-monitoring program. This involves the analysis of industrial discharges, that enter the District's sewerage system, for specific organic priority pollutants determined by the categorical designation of the industry. The industries usually contract with private laboratories to perform the required analytical functions. Analytical results are reported to the District using special forms which delineate the analytical and quality control protocols used by the industries and/or the contract laboratories. Methodologies and quantitation limits of the USEPA Contract Laboratory Program (CLP) are required. Frequently, the evaluation of these reports is difficult, especially regarding the proper use of dilution factors used for preparing the extracts and acceptable quantitation limits. The industrial analytical reports which present technical problems to Industrial Waste personnel are sent to the Toxic Substances Section for review. A thorough examination of these reports is made to evaluate their acceptability, and to ensure that they meet District requirements. Reports that are deemed unacceptable are returned to the industries of origin for remedial action, and resubmittal of acceptable analytical reports. In 1999, eight reports were reviewed by the Toxic Substances Section.

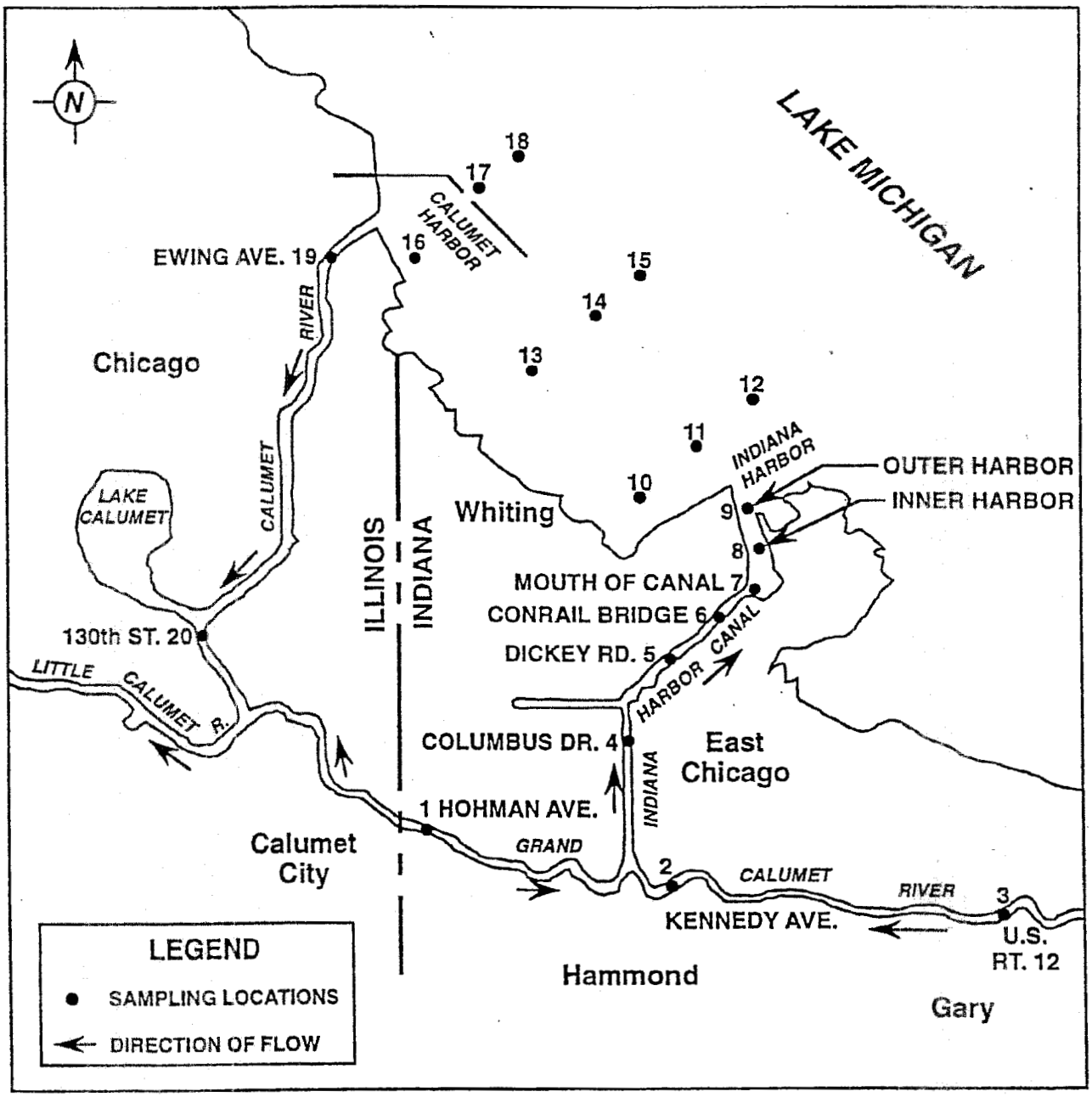
ENVIRONMENTAL MONITORING

The projects covered under the general classification of Environmental Monitoring include samples taken from Lake Michigan, the north area (Evanston, Winnetka, and Waukegan drinking water inlets), storm related events; e.g., diversion to Lake Michigan and discharge to the O'Hare CUP reservoir, sludge and soil analyses, spills and events not directly tied to Industrial Waste monitoring. The analyses are generally for the analytes listed in USEPA Methods 608, 624, and 625, or in the corresponding CLP methods using GC/MS and GC/ECD. Other analytes of concern in certain samples (submitted for troubleshooting) may require alternate methods using GC with flame ionization detector (GC/FID), UV/visible, or infrared spectroscopy.

Lake Michigan Monitoring. Routine sampling and monitoring of Lake Michigan was severely cut back in 1999 from previous years. Sampling and analysis of three north areas (Evanston, Wilmette, and Waukegan) was completely eliminated, and Calumet Harbor was sampled only once, in July, taking both water and sediment samples at all nine Stations shown in Figure 19. No target analytes were detected in any of the nine water samples, except for di-n-octyl phthalate, that was detected at Station 16 in a concentration of 34 µg/L. In the

FIGURE 19

MAP SHOWING LOCATION OF LAKE MICHIGAN AND CALUMET AREA SAMPLING STATIONS



sediment samples, eight polynuclear aromatic hydrocarbons were found at Station 16 in a concentration range of 0.35 to 1.14 mg/Kg. Five stations, including Station 16, had di-n-octyl phthalate in a concentration range of 1.04 to 2.60 mg/Kg. No other target analytes were detected.

Diversion of Water to Lake Michigan. Diversion of water to Lake Michigan occurred only twice in 1999, June 2, at Calumet Harbor, and June 13, at Wilmette. The Calumet Harbor water sample showed only chloroform in a concentration of 2 µg/L. Acetone was detected at Wilmette in a concentration of 9 µg/L.

Special Analyses. There were thirteen samples in 1999 that were classified as Special analyses, that is, requiring analytical methods other than the usual GC/MS or GC/ECD analyses. Eight of these were either WRP raw sewage samples, suspected of containing fuel oil (kerosene or Diesel), or samples from storage tanks suspected of causing potential problems. The other sample groups included two samples of brake fluid from a District vehicle, suspected of being mixed with anti-freeze. These ten samples were tested using GC/FID. Three samples from grease traps were also tested with gel permeation chromatography (GPC) comparison.

TOXIC SUBSTANCES QUALITY CONTROL/QUALITY ASSURANCE PROGRAM

An extensive quality assurance program was conducted in 1999 for organic analyses, as required by the laboratory accreditation requirement. It consisted of the analysis of more than 700 GC/MS purgeable runs, 500 GC/MS BNA runs, and 350 GC/ECD pesticides/PCBs, and herbicides runs. Protocols included instrument checks and development of calibration curves for the determination of listed BNAs, VOCs, pesticides, PCBs, and herbicides. Protocols also included analysis of water blanks, field blanks, equipment blanks, check standards, recovery of pollutant standards, and surrogates from samples as well as from reagent water.

The 600 series analytical methods used in the analysis of the target compounds; Methods 608, 624, and 625 and the Standard Methods 6640B; comply with the standardized quality assurance and quality control as specified in these methods. The analytical instruments and analytical processes are calibrated with reference materials that are traceable to the National Institute for Standards and Technology (NIST). More than three calibration points are used with the lowest of these points near the method detection limit and the highest point near the upper linear range of the analytical system. The linearity of calibration curves is within the limits of the specified methods. For verification of calibration, the

specifications outlined for each compound are followed as stated in the methods. Blanks are analyzed on a routine basis with each batch of samples prepared, and adhere to the general guidelines pertaining to common laboratory contaminants. Matrix spikes are performed at least once for every 20 samples for VOC, BNA, and herbicide analysis and every 10 samples for pesticide/PCB analysis. The recovery is compared to the percent recovery (%R) limits as specified in the methods to ensure that the analyses are yielding acceptable results.

Evaluation of the QC/QA program showed that the Toxic Substances Laboratory performance meets the requirements of the USEPA.

Interlaboratory Studies. The USEPA has stopped supplying Water Pollution Performance Evaluation Study samples, requiring, instead, that participating laboratories purchase these samples from approved commercial sources. We have been obtaining performance evaluation samples from Environmental Resource Associates; two sets of seven samples for water analysis and two sets for soils analysis. These studies are run semiannually each for water and soil. Each of these sets potentially contains all the 111 analytes of EPA Methods 608, 624, and 625, requiring identification as well as quantitation, as contrasted to the limited subset of identified analytes that the USEPA previously supplied.

LABORATORY CERTIFICATION

The Toxic Substances Laboratory has prepared for the application for certification under the Illinois Environmental Protection Agency's Environmental Laboratory Accreditation Program (IL ELAP) for organic compounds in wastewater and solid waste. The application was completed and submitted during 1999 for certification. The Section has written an extensive Quality Assurance Plan (QAP), eleven Standard Operating Procedures (SOPs) for analytical methods, and established an elaborate record keeping system which includes daily monitoring of cold room temperatures, monthly checks of analytical balances, etc.

The IL IEPA has approved our application, and we are waiting for the on-site laboratory inspection required for final certification.

Radiochemistry Section

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

The radiological monitoring of the area's waterways under the jurisdiction of the District includes the Calumet, Chicago, and Des Plaines River systems.

The radiological monitoring of raw and treated wastewaters, from the District's seven WRPs, was initiated in 1967 as the State of Illinois Sanitary Water Board had effluent criteria (Technical Release 20-22, April 1, 1967). The radioactive substances limits for the effluents discharged to the waters of the State for gross beta activity in the known absence of more than 3 pCi/L alpha emitters and more than 10 pCi/L strontium-90 is not to exceed 1,000 pCi/L at any time. Although the present NPDES permits from the IEPA do not include limits for radioactivity in the District's effluents, monitoring continued into 1999 since there are radioactivity water quality standards for the general use waters.

Since 1978, the Section has conducted radiological monitoring of sludges from the Lawndale Avenue Solids Management Area (LASMA), and from the Harlem Avenue Solids Management Area (HASMA). Beginning in 1993, sludge sampling was greatly increased to include digested sludges from District WRPs and air-dried biosolids ready for final disposal.

The Section also maintains the radioactive material license issued to the District by the Illinois Department of Nuclear Safety (IDNS), assuring that the activities are conducted according to the license conditions and regulations.

The radiation safety program consists of radiological monitoring of personnel and work areas in the Radiochemistry

Section, leak testing of sealed sources used as detectors in gas chromatographs at the R&D laboratories, leak testing of gauges used by the Engineering Department, and an x-ray fluorescent (XRF) paint analyzer used by the M&O Department.

The Section continued to participate in the U.S. Department of Energy, Environmental Laboratory's Quality Assessment Program. Water samples were analyzed for gross alpha, gross beta, tritium, cobalt-60, and cesium-137 activity, and soil samples were analyzed for potassium-40, cesium-137, bismuth-212, lead-212, bismuth-214 and lead-214 activity.

RADIATION SAFETY

The Radiochemistry Section continues to maintain a radiation safety program for the District. The program includes keeping the radioactive material license issued to the District by the IDNS up-to-date, and reporting information regarding low-level radioactive waste to IDNS. It also includes radiological monitoring of personnel and work areas in the Radiochemistry Laboratory, leak testing of nickel-63 detectors, nuclear gauges, and XRF analyzer, and monitoring users of these devices for radiation exposure.

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 IDNS. In 1999, the relevant forms were received from the IDNS, completed, and returned to the IDNS.

The radiological monitoring of District employees and work areas was carried out using dosimeter badges and finger ring dosimeters. The dosimeters are worn by laboratory personnel, users of moisture/density gauges, and the XRF paint analyzer. A total of 226 dosimeters were analyzed in 1999. No employee of the District was exposed to an overdose of radiation.

The Radiochemistry Laboratory is regularly surveyed for radiation contamination. A total of 120 wipe tests were performed in 1999. No contamination was found in any work area.

As per IDNS regulations, radioactive sealed sources are tested for leakage or contamination at intervals not to exceed six months. All the radioactive sealed sources possessed by the District were tested for leakage twice in 1999.

Nickel-63 sources constitute a part of the electron capture detectors of gas chromatographs used by the R&D Department. Leak tests were performed on the following detectors in March and September 1999:

Hewlett-Packard S-11225	Two leak tests
Carlo Erba S/N 963912*	Two leak tests
Carlo Erba S/N 963978*	Two leak tests
Finnigan 5678	Two leak tests

Finnigan 5680	Two leak tests
Hewlett-Packard U-1440	One leak test
Hewlett-Packard U-1451	One leak test

(* = Not in use)

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

Leak tests were also performed on the concentric moisture/density gauge stored in the Fulton County R&D Laboratory, four surface moisture/density gauges used by the Construction Division of the Engineering Department, and an XRF paint analyzer used by the M&O Department. A total of 22 leak tests were performed in 1999. No leaks were detected in any of these gauges.

PARTICIPATION IN THE USDOE ENVIRONMENTAL LABORATORY QUALITY ASSESSMENT PROGRAM

Laboratory Quality Assessment Program. The Radiochemistry Section continues to participate in the USDOE Environmental Laboratory Quality Assessment Program, along with 141 other laboratories (regional, state, national, nuclear, commercial, and international).

The purpose of this participation is to maintain a good quality control program, and document the precision and accuracy of the methods used.

The participating laboratories receive, for analysis, water and soil samples from the USDOE Environmental Laboratory, New York, New York. The known radioactivity concentrations, and the participants' experimental results are published in a USDOE report.

During 1999, the Radiochemistry Section analyzed two Quality Assessment water samples for tritium, gross alpha, gross beta, cobalt-60, and cesium-137. The Section also analyzed two soil samples for potassium-40, cesium-137, bismuth-212, lead-212, bismuth-214 and lead-214 activity. The analyses of all samples were reported to the USDOE, and the results were published in an USDOE report.

LEVELS OF RADIOACTIVITY IN RAW AND TREATED WASTEWATERS

Radiological monitoring of raw wastewaters and final effluents from the District's seven WRPs continued in 1999, since data from the monitoring serves as a measure of present-day radioactivity levels in comparison to levels in past years. The IPCB has established General Use water quality standards for radioactivity in the waters of the state. According to IPCB regulations (Title 35, Chapter 1, Section 302.207) gross beta concentration shall not exceed 100 pCi/L, and the concentration of radium-226 and strontium-90 shall not

exceed 1 and 2 pCi/L of water, respectively. There are no IPCB radioactivity standards for effluents.

The radioactivity analysis was conducted on 24-hour composite samples of raw sewage and final effluent. The samples were processed using Standard Methods for the Examination of Water and Wastewater (Standard Methods), 20th Edition procedures, 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 americium-241, and for beta efficiency using cesium-137 standards obtained from the USEPA Environmental Monitoring System Laboratory in Las Vegas, Nevada.

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

In a set of data points with a combination of real numbers and LLD values, the highest real number was considered as

the maximum value. The lowest real number was considered as the minimum value if the number was lower than the lowest LLD value of the data set, otherwise LLD value was reported as the minimum value.

Table 61 presents 1999 yearly averages of gross alpha activity for the raw sewage, and final effluent from the District's seven WRPs. With the exception of the Lemont WRP, average raw sewage gross alpha activity ranged from less than the LLD (4.0 pCi/L) for the North Side and Egan WRPs to 5.7 pCi/L for the Southwest raw sewage of the Stickney WRP. The gross alpha activity at the Lemont WRP was 35.4 pCi/L. The gross alpha activity in the final effluent at all the WRPs was less than the detection limit (3.5 to 6.8 pCi/L). This level of activity in Lemont raw sewage has been observed since the Village of Lemont began water-treatment process for removal of radium from their water supply in 1989 as the backwash water from the system is discharged into the Lemont WRP. However, this backwash from the Lemont drinking water system does not pose a threat to the District's compliance status.

Table 62 presents 1999 yearly averages for gross beta activity in raw sewage and final effluent from the District's seven WRPs. The Lemont WRP has the highest average raw sewage and final effluent gross beta activity levels, 59.1 and 21.8

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 61

1999 YEARLY AVERAGE GROSS ALPHA RADIOACTIVITY IN RAW AND TREATED WASTEWATER FROM DISTRICT WRPs

WRP Type of Sample	Gross Alpha Radioactivity (pCi/L)
Stickney	
Raw (West Side)	<4.2
Raw (Southwest)	5.7
Secondary - Final Effluent	<3.6
Calumet	
Raw	<4.6
Secondary - Final Effluent	<3.8
North Side	
Raw	<4.0
Secondary - Final Effluent	<3.5
Hanover Park	
Raw	<4.2
Tertiary - Final Effluent	<3.5
John E. Egan	
Raw	<4.0
Tertiary - Final Effluent	<3.5
Lemont	
Raw	35.4
Secondary - Final Effluent	<6.8
James C. Kirie	
Raw	<4.2
Tertiary - Final Effluent	<3.7

< = Less than lower limit of detection.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 62

1999 YEARLY AVERAGE GROSS BETA RADIOACTIVITY IN RAW AND TREATED WASTEWATER FROM DISTRICT WRPs

WRP Type of Sample	Gross Beta Radioactivity (pCi/L)
Stickney	
Raw (West Side)	24.7
Raw (Southwest)	33.1
Secondary - Final Effluent	11.1
Calumet	
Raw	24.9
Secondary - Final Effluent	14.1
North Side	
Raw	19.1
Secondary - Final Effluent	10.9
Hanover Park	
Raw	18.4
Tertiary - Final Effluent	10.8
John E. Egan	
Raw	22.5
Tertiary - Final Effluent	12.3
Lemont	
Raw	59.1
Secondary - Final Effluent	21.8
James C. Kirie	
Raw	21.4
Tertiary - Final Effluent	15.5

pCi/L, respectively. At the remaining six WRPs, the average raw sewage gross beta activity ranged from 18.4 to 33.1 pCi/L, and the average final effluent total beta activity ranged from 10.8 to 15.5 pCi/L.

There are no USEPA radioactivity standards for raw sewage or final effluent from District WRPs.

LEVELS OF RADIOACTIVITY IN SLUDGES

In 1993, the Radiochemistry Section revised and expanded its monitoring program of District sludges in response to the increased emphasis on sludge characteristics 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.

During 1999, sludge samples were collected monthly at all WRPs. Some sludge samples were also collected from the Hanover Park Lagoons and from eight sludge drying sites.

Sludge samples were processed according to the Standard Methods procedures, and counted for alpha and beta activity using a Tennelec LB5100 alpha/beta counting system. The instrument was calibrated with americium-241 standard for gross alpha and cesium-137 standards for gross beta activity

determinations. The results, in pCi/g of dry weight, were averaged and are tabulated in Tables 63 and 64.

In Table 63, the average gross alpha activity of WRP sludges ranged from a low of 3.7 pCi/g dry wt. at the North Side WRP to a high of 76.6 pCi/g dry wt. at the Lemont WRP.

Table 63 shows that average gross beta activity of WRP sludges ranged from a low of 13.0 pCi/g dry wt. at the Hanover Park WRP to a high of 101.4 pCi/g dry wt. at the Lemont WRP.

Table 64 presents gross alpha and gross beta data for lagooned, and air-dried sludges from the District sludge drying areas. Average total alpha activity ranged from a low of 6.0 pCi/g dry wt. for the Vulcan drying site to a high of 7.9 pCi/g dry wt. for the Stony Island drying site. Average total beta activity ranged from a low of 15.2 pCi/g dry wt. for the Hanover Park East Lagoon to a high of 28.6 pCi/g dry wt. for the HASMA drying site.

Sludge samples were also processed for the determination of specific radionuclides. The samples were dried on hot plates. The dried samples were ground and passed through a 30 mesh sieve. The samples were packed in 3 oz. cannisters and analyzed by a gamma spectroscopy system equipped with a high-purity germanium detector and Gamma Trac software analysis package from Oxford Instruments, Inc.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 63

GROSS ALPHA/BETA RADIOACTIVITY OF WATER RECLAMATION PLANT SLUDGES DURING 1999

WRP Type of Sample	No. of Samples	Gross Alpha (pCi/g dry wt)			Gross Beta (pCi/g dry wt)		
		Average	Minimum	Maximum	Average	Minumum	Maximum
Calumet Digester Draw	12	6.5	4.8	10.4	22.6	17.4	27.7
John E. Egan Disgester Draw	12	5.2	3.5	7.1	19.7	16.8	22.8
Lemont[1] Return Sludge	11	76.6	35.9	126.9	101.4	60.7	134.3
Hanover Park Digester Draw	12	4.3	3.5	5.4	13.0	11.4	15.9
James C. Kirie[1] Return Sludge	12	4.1	2.6	5.4	13.5	9.3	19.8
North Side[1] Return Sludge	12	3.7	2.8	5.3	13.6	10.1	16.8
Stickney Digester Draw	11	6.1	4.4	7.5	25.9	23.7	29.9

[1] No digesters at this WRP.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 64

GROSS ALPHA AND GROSS BETA RADIOACTIVITY OF
LAGOONED AND AIR-DRIED SLUDGES DURING 1999

Lagoon/Drying Site Location	No. of Samples	Gross Alpha (pCi/g dry wt)			Gross Beta (pCi/g dry wt)		
		Average	Minimum	Maximum	Average	Minimum	Maximum
Hanover Park East	2	6.5	6.4	6.7	15.2	14.5	15.9
Hanover Park West	2	6.5	6.3	6.6	18.1	16.3	19.9
LASMA	5	6.8	5.3	7.8	21.5	14.3	24.1
Calumet East	5	6.9	6.4	7.8	23.7	22.4	25.3
Calumet West	5	7.4	6.2	9.5	24.4	20.9	30.2
HASMA	5	7.4	6.4	10.0	28.6	22.8	45.0
Marathon	5	6.8	6.2	7.2	25.4	21.7	31.0
Stony Island	5	7.9	6.2	9.8	25.0	20.6	28.8
Vulcan	5	6.0	5.2	7.8	22.8	21.9	24.0
Ridgeland	5	6.7	5.8	7.9	24.6	22.3	27.6

Eleven specific radionuclides, with a potential for re-concentration in sludge were analyzed. Only three of them were detected at measurable levels. Two of these three radionuclides, potassium-40 and radium-226, are of natural origin. The third radionuclide, cesium-137, is man-made and may have arisen from fallout of nuclear weapon testing.

Table 65 presents potassium-40, cesium-137, and radium-226 concentrations in the District's sewage sludge. The average potassium-40 activity ranged from 5.5 pCi/g dw at Hanover Park WRP to 11.0 pCi/g dw at Stickney WRP. The average cesium-137 activity ranged from non-detectable levels at Hanover Park and Lemont WRP to 0.1 pCi/g dw at Stickney and Calumet WRP. The average radium-226 activity ranged from 2.2 pCi/g dw at Stickney WRP to 72.4 pCi/g dw at Lemont WRP.

Table 66 presents potassium-40, cesium-137, and radium-226 concentrations in the District's biosolids from the drying sites. The average potassium-40 activity in the biosolids ranged from 9.2 pCi/g dw at Calumet West to 12.3 pCi/g dw at Vulcan drying site. The average cesium-137 activity was 0.10 pCi/g dw at all drying sites. The average radium-226 activity ranged from 2.8 pCi/g dw at Vulcan to 4.1 pCi/g dw at Calumet West drying site.

METROPOLITAN WATER RECLAMATION DISTRICTOF GREATER CHICAGO

TABLE 65

POTASSIUM-40, CESIUM-137, AND RADIUM-226 RADIOACTIVITY OF WATER RECLAMATION PLANT SLUDGES DURING 1999

WRP Type of Sample	No. of Samples	Potassium-40			Cesium-137			Radium-226		
		Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.
		pCi/g								
Calumet Digester Draw	3	8.7	6.8	9.8	0.1	0.1	0.1	4.0	3.2	5.4
Egan Digester Draw	3	9.2	7.8	10.9	0.02	nd	0.04	3.6	2.8	4.9
Hanover Park Digester Draw	3	5.5	4.9	6.5	nd	nd	nd	3.5	2.7	4.8
Stickney Digester Draw	3	11.0	10.6	11.4	0.1	0.1	0.1	2.2	nd	2.3
Lemont Return Sludge[1]	3	8.6	7.0	10.6	nd	nd	nd	72.4	58.7	86.6

[1] No digester at this WRP
nd = not detected

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 66

POTASSIUM-40, CESIUM-137, AND RADIUM-226 RADIOACTIVITY IN DISTRICT BIOSOLIDS DURING 1999

Sludge Drying Site	No. of Samples	Potassium-40			Cesium-137			Radium-226		
		Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.
		pCi/g dw								
Calumet East	4	11.6	10.5	13.5	0.1	0.1	0.1	3.8	3.4	4.3
Calumet West	4	9.2	6.5	14.6	0.1	0.1	0.1	4.1	3.1	5.9
HASMA	4	10.5	8.9	12.6	0.1	0.1	0.1	3.4	2.6	4.6
LASMA	4	10.7	8.6	12.6	0.1	0.1	0.1	3.6	2.8	4.4
Marathon	4	10.4	8.7	11.7	0.1	0.1	0.1	3.4	2.6	4.0
RASMA	4	11.0	9.7	12.4	0.1	0.1	0.1	3.4	2.8	4.6
Stony Island	4	9.8	8.4	12.4	0.1	0.1	0.1	3.4	2.7	4.3
Vulcan	4	12.3	9.6	16.9	0.1	0.1	0.1	2.8	2.2	3.4

Table 67 presents potassium-40, cesium-137, and radium-226 radioactivity concentrations in Hanover Park lagooned sludge. The average potassium-40 activity in Hanover Park East and Hanover Park West lagooned sludge was 5.0 pCi/g dw and 4.6 pCi/g dw, respectively. The average cesium-137 activity was 0.01 pCi/g dw in both lagooned sludges. The radium-226 activity at Hanover Park East lagooned sludge was 4.4 pCi/g dw and at Hanover Park West lagooned sludge was 4.2 pCi/g dw.

Currently, there are no USEPA standards for radioactivity levels in sludge.

RADIOLOGICAL MONITORING OF THE CHICAGO WATERWAYS

The radiological monitoring of waterways, under the jurisdiction of the District, is a part of the overall monitoring program of the water quality within District waterways. The radiological monitoring involves the determination of gross alpha and gross beta activities of the waterways samples. The program includes the Calumet, Chicago, and Des Plaines River systems comprising 170 miles (273.6 km) of waterways. There were six sampling locations on the Chicago River, three on the Calumet River, and six on the Des Plaines River. Each location was sampled once per month.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 67

POTASSIUM-40, CESIUM-137, AND RADIUM-226 RADIOACTIVITY OF HANOVER PARK LAGOONED SLUDGES DURING 1999

Lagoon Location	No. of Samples	Potassium-40			Cesium-137			Radium-226		
		Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.
		pCi/g dw								
Hanover Park East	2	5.0	3.1	7.0	0.01	nd	0.02	4.4	3.4	5.3
Hanover Park West	2	4.6	2.9	6.3	0.01	nd	0.01	4.2	3.4	4.9

nd = not determinted

The waterways samples were processed using Standard Methods procedures, and the gross alpha and beta activities were counted using a Tennelec LB5100 gas proportional counter.

Table 68 presents the 1999 average values for gross alpha and gross beta activity for the Chicago waterways at each of the 15 sampling locations. The average gross alpha activity in the water samples ranged from less than 3.4 pCi/L to less than 4.9 pCi/L. The average gross beta activity ranged from less than 6.0 pCi/L to 16.8 pCi/L.

The concentrations of radioactivity in all samples analyzed were well within the USEPA Drinking Water Standards of 15 pCi/L for gross alpha, and 50 pCi/L for gross beta.

Experimental Design and Statistical Evaluation Section

The Experimental Design and Statistical Evaluation Section is responsible for providing assistance in the design of laboratory and full-scale experiments, development of guidelines for data collection methods, collection of appropriate data, and statistical analyses. For the optimum performance of the statistical analyses and to reduce cost, the personnel of this Section successfully transferred the computing media from the VAX to PCs in 1999. Computer programs suitable for various research projects or generating reports are developed

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 68

1999 YEARLY AVERAGES OF RADIOACTIVITY
FOR THE CHICAGO WATERWAYS

Location	Gross Alpha (pCi/L)	Gross Beta (pCi/L)
Central Avenue, North Shore Channel	<3.4	<6.0
Touhy Avenue, North Shore Channel	<3.5	8.5
Cicero Avenue, Chicago Sanitary and Ship Canal	<4.0	7.4
Harlem Avenue, Chicago Sanitary and Ship Canal	<4.9	9.2
Route 83, Chicago Sanitary and Ship Canal	<4.3	9.3
Stephens Street, Chicago Sanitary and Ship Canal	<4.2	10.3
Indiana Avenue and 135th Street, Little Calumet River	<3.5	7.1
Halsted Street, Little Calumet River	<3.7	9.2
Route 83 Bridge, Cal-Sag Channel	<3.6	9.0
Longmeadow Lane, Upstream of Hanover Park WRP, DuPage River	4.1	8.5
Walnut Lane, Downstream of Hanover Park WRP, West Branch DuPage River	<3.6	10.6
Elmhurst Road, Upstream of Kirie WRP, Higgins Creek	<3.8	7.2
Willie Road, Downstream of Kirie WRP, Higgins Creek	<3.7	16.8
Higgins Road, Upstream of Egan WRP, Salt Creek	<3.6	<6.1
Arlington Heights Road, Downstream of Egan WRP, Salt Creek	<3.5	12.0

< = Less than lower limit of detection.

in Visual Basic and SAS by the personnel of the statistical section. Programs were also developed to create tables/reports in Visual Basic interlinking the SAS and Excel software programs. Most of the statistical processing and analysis of the data are accomplished by using SAS software.

STATISTICAL AND COMPUTING SUPPORT

During 1999, an associate statistician and a statistical consultant in the section provided statistical and computing support to various projects undertaken within the Environmental Monitoring and Research (EM&R) Division. The following is a description of some activities:

1. Statistical support was provided in the analyses of Monitoring Frequency for Mainstream Tunnel and Reservoir Plan (TARP) Water Level and Quality Monitoring Wells. As a result of the study, the District developed guidelines for safely reducing the frequency of monitoring TARP wells.
2. Statistical support was provided to the Biology Section on the toxicity studies with Pimephelas Promelas. Studies are being conducted to determine whether age of fish used for testing whole effluent toxicity (WET) effects the survival response of the organism exposed to WRP influent

in the 48-hour acute toxicity test, and to develop a mathematical model of the mortality rate due to age and the dose level for a known toxicant. The studies began in the middle of 1999, and they are expected to be finished by March 2000.

3. Statistical support was provided to the Wastewater Treatment Research Section on the study of Oxygen Transfer Efficiency of Diffuser Plates in aeration tanks. The project was started in July 1999, and is expected to be finished by March 2000.

4. Statistical support was provided to the Land Reclamation and Soil Science Section to evaluate the effect of time after cessation of biosolids applications on the concentration of cadmium, copper, nickel, and zinc in soil, leaves, and grain of corn from fields at the District's Fulton County site.

5. In 1999, this section provided support on numerous requests, short projects, and reports by personnel from other departments, and on requests received from outside the District.

WATER QUALITY DATA

Each year, the section prepares an annual report describing the water quality of the streams and channels within the District's jurisdiction for the preceding year. Surface water quality data for 1996, 1997, and 1998 were evaluated regarding compliance with water quality standards set by the Illinois Pollution Control Board (IPCB), and annual reports of 1996, 1997, and 1998 were produced.

Compliance of General Use Waters. In 1998, 27 water quality parameters (phenols, zinc, cadmium, copper, chromium, nickel, lead, boron, arsenic, selenium, barium, un-ionized ammonia, manganese, WAD cyanide, DO, temperature, pH, ammonium nitrogen, total dissolved solids, sulfate, iron, mercury, silver, fecal coliform, soluble iron, chloride and fluoride) were assayed. The first 14 parameters listed were in total compliance in General Use Waters of all river systems. Of the remaining 13 parameters, 12 parameters had compliance rates greater than 92.9 percent in all river systems. Fecal coliform had the lowest compliance rate, varying from 37.5 to 59.7 in the Chicago, Calumet, and Des Plaines river systems.

Compliance of Secondary Contact Waters. Twenty-four water quality parameters (silver, arsenic, barium, cadmium, cyanide, chromium, lead, fluoride, nickel, phenols, selenium, temperature, zinc, mercury, manganese, FOG, total dissolved

solids, dissolved oxygen, pH, ammonium nitrogen, un-ionized ammonia, soluble iron, iron, and copper) were covered by IPCB Water Quality Standards for samples taken in Secondary Contact Waters. Seventeen water quality parameters (silver, arsenic, barium, cadmium, cyanide, chromium, lead, fluoride, nickel, phenols, selenium, temperature, zinc, mercury, manganese, FOG, and total dissolved solids) were in complete compliance. The compliance rates of remaining 7 parameters varied from 86 to 100 percent.

STUDY OF SEWAGE AND WASTE CONTROL ORDINANCE LIMITS

The Statistical Section is also responsible for preparing annual summary reports on the Sewage and Waste Control Ordinance Limits Relative to Pretreatment Program. Draft pretreatment reports for 1995, 1996, and 1997 were prepared. It is expected that these reports will be ready for publication in the first half of 2000.

MEETINGS AND SEMINARS

1. United States Department of Agriculture W-170 Regional Technical Committee Meeting, Charlotte, North Carolina, January 1999.

2. Water Environment Federation/American Water Works Association Joint Specialty Conference on Water and Wastewater Treatment Residuals, Charlotte, North Carolina, January 1999.

3. Illinois Water Environment Association Government Affairs in Water Pollution Control Seminar, Lisle, Illinois, January 1999.

4. 1999 Midyear Water Environment Federation Meeting, Program Committee Meeting, New Orleans, Louisiana, January 1999.

5. "Forecasting Techniques Using SAS/ETS Software," Chicago, Illinois, February 1999.

6. Association of Metropolitan Sewerage Agencies 1999 Winter Conference, Air Quality Committee Meeting and General Session III, Phoenix, Arizona, February 1999.

7. "Optimizing Productivity and Data Compliance in the Analytical Laboratory," Seminar, Hewlett Packard, Elk Grove Village, Illinois, February 1999.

8. Lake Michigan Water Analysts Winter Meeting, Kenosha, Wisconsin, February 1999.

9. Chicago Public Schools Science Fair, Chicago, Illinois, March 1999.

10. United States Environmental Protection Agency, Region 5, Workshop on Biological Effects/Indicators of Nutrient Enrichment, Chicago, Illinois, March 1999.

11. 1999 Pittsburgh Conference and Short Courses, Orlando, Florida, March 1999.

12. Illinois Water Environment Association Annual Conference and Exhibition, Peoria, Illinois, March 1999.

13. "Analytical Solutions for the Environmentally Responsible," Seminar, Hewlett Packard, Elk Grove Village, Illinois, March 1999.

14. Association of Metropolitan Sewerage Agencies Whole Effluent Toxicity Training Course, Arlington, Virginia, March 1999.

15. "GC Open Forum Workshop," Hewlett Packard, Elk Grove Village, Illinois, April 1999.

16. Lake Michigan Water Analysts Second Quarter Meeting, Waukegan, Illinois, April 1999.

17. Association of Metropolitan Sewerage Agencies National Environmental Policy Forum and 29th Annual Meeting, Washington, DC, May 1999.

18. United States Environmental Protection Agency, Stakeholders Meeting on National Strategy to Develop Regional Nutrient Criteria, Arlington, Virginia, June 1999.

19. Annual Meeting of the North American Benthological Society, Duluth, Minnesota, June 1999.

20. General Meeting of the American Society for Microbiology, Chicago, Illinois, June 1999.

21. 47th American Society for Mass Spectrometry and Allied Topics (ASMS) Conference, Dallas, Texas, June 1999.

22. 15th Annual Waste Testing and Quality Assurance Symposium, Arlington, Virginia, July 1999.

23. Association of Metropolitan Sewerage Agencies Summer Conference Meeting, Unifying Urban Wet Weather Programs and Air Quality Committee Meetings, Philadelphia, Pennsylvania, July 1999.

24. Illinois Environmental Protection Agency, Bureau of Water, Public Hearing, Springfield, Illinois, August 1999.

25. Dionex Corporation New Developments in Ion Chromatography Seminar, Chicago, Illinois, September 1999.

26. Illinois Department of Public Health Environmental Laboratory Seminar, Springfield, Illinois, September 1999.

27. United States Environmental Protection Agency, Stakeholders Meeting on Total Maximum Daily Load Rulemaking, Atlanta, Georgia, September 1999.

28. Industrial Water, Waste and Sewage Group Meeting, Chicago, Illinois, September 1999.

29. Association of Metropolitan Sewerage Agencies Fall Leadership Retreat and Strategy Session, Washington, DC, September 1999.

30. Electric Power Research Institute Municipal Water and Wastewater program Meeting, Nashville, Tennessee, October 1999.

31. Water Environment Research Foundation, Biocriteria Workshop, New Orleans, Louisiana, October 1999.

32. Water Environment Federation 72nd Annual Conference and Exposition, New Orleans, Louisiana, October 1999.

33. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Philadelphia, Pennsylvania, November 1999.

34. Illinois Water Environment Association Industrial Pretreatment and Hazardous Waste Committee Annual Meeting, Lombard, Illinois, November 1999.

35. Illinois Water Environment Association Industrial Pretreatment and Hazardous Waste Committee Meeting, Yorktown, Illinois, November 1999.

36. Wet in the City, Teachers Education for Household Hazardous Waste at the Field Museum, Chicago, Illinois, December 1999.

PAPERS PRESENTED

1. "Assessing the Phytotoxic Threshold for Zn in the Part 503 Biosolids Regulation Risk Assessment." Presented at Annual Meeting of United States Department of Agriculture W-170 Regional Technical Committee, Charlotte, North Carolina, January 1999, by Thomas Granato.

2. "A National Sewage Sludge Survey: Quality Status Relative to Part 503 Rule." Presented at Illinois Water Environment Association Twentieth Annual Conference and Exhibition, Peoria, Illinois, March 1999, by R.I. Pietz, R. Johnson, R. Sustich, T.C. Granato, P. Tata, and C. Lue-Hing.

3. "The Chicago River Fishery." Presented at the Annual Spring Fishing Extravaganza, Henry's Sport and Bait Shop, Chicago, Illinois, March 1999, by Sam Dennison.

4. "Growing Grasses and Wildflowers in Biosolids." Presented at Research and Development Department Annual Seminar Series, Stickney, Illinois, August 1999, by Thomas Granato.

5. "Environmental Chemistry as it Relates to Wastewater Treatment." Presented at Associated Colleges of the Chicagoland Area Fall 1999 Seminar Series, Lemont, Illinois, September 1999, by Bernard Sawyer.

6. "Management of Odor Monitoring Programs and Odor Complaints at the Metropolitan Water Reclamation District of Greater Chicago." Presented at the Water Environment Federation Annual Conference, New Orleans, Louisiana, October 1999, by Thomas K. O'Connor, Prakasam Tata, David T. Lordi, and Cecil Lue-Hing.

7. "A National Sewage Sludge Survey: Quality Status Relative to Part 503 Rule." Presented at Residuals and Biosolids Management Symposium: Biosolids Regulations and Privatization, Water Environment Federation Annual Conference, New Orleans, Louisiana, October 1999, by C. Lue-Hing, R.I. Pietz, P. Tata, R. Johnson, R. Sustich, and T.C. Granato.

PAPERS PUBLISHED

1. Lue-Hing, C., R.I. Pietz, P. Tata, R. Johnson, R. Sustich, and T.C. Granato. "A 1996 National Sewage Sludge Survey: Quality Status Relative to the Part 503 Rule," in Residuals and Biosolids Management Symposium: Biosolids Regulations and Privatization, Water Environment Federation Annual Conference, New Orleans, Louisiana, 1999.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
RESEARCH AND DEVELOPMENT DEPARTMENT
1999 SEMINAR SERIES

Date	Subject
Friday March 26, 1999	***Use of Pure Oxygen vs. Air in the Management of Dissolved Oxygen in Receiving Waters*** Dr. Richard Speece, Professor Vanderbilt University, Nashville, Tennessee
Friday April 30, 1999	***Activated Sludge Aeration: State of the Art and Future Direction*** Dr. Jong Lee, Associate Mr. Joseph Grogan, Associate Greeley and Hansen, Chicago, Illinois
Friday May 28, 1999	***Potential for the Use of On-line Respirometry for the Control of Aeration*** Mr. Kamlesh Patel, Research Scientist Mr. Stanley Soszynski, Research Scientist Research and Development Department Metropolitan Water Reclamation District of Greater Chicago (District), Cicero, Illinois
Friday June 25, 1999	***State of the District and New Millennium Initiatives*** Mr. Hugh H. McMillan, General Superintendent District, Chicago, Illinois
Friday July 23, 1999	***Reflections of a Samurai*** Dr. Cecil Lue-Hing, Director Research and Development Department District, Chicago, Illinois
Friday August 27, 1999	***Utilization of Biosolids for Growing Grasses*** Dr. Thomas Granato, Soil Scientist Research and Development Department District, Cicero, Illinois
Friday September 24, 1999	***Electronic Nose and its Potential*** Dr. Peter Lykos, Professor Mr. Chris Morong, Student Illinois Institute of Technology, Chicago, Illinois
Friday October 29, 1999	***Waterways Management, Lake Water Diversion Control, and Water Quality*** Mr. Gregory Cargill, Assistant Chief Engineer Mr. Ram Koduri, Principal Civil Engineer Maintenance and Operations Department District, Chicago, Illinois
Friday November 19, 1999	***IT Makes Things Happen: Historical Perspectives and Future Direction*** Mr. Laurence B. Nybo, Director Information Technology Department District, Chicago, Illinois

LOCATION:
Stickney Water Reclamation Plant, R&D Laboratory Auditorium
6001 West Pershing Road, Cicero, Illinois 60804-4112

TIME: 10:00 AM

FOR INFORMATION CONTACT:
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Environmental Monitoring and Research Division

Section 121 – Administration

Tata, Prakasam, Research and Technical Services Manager

Messina, Deborah, Principal Clerk Stenographer

Sawyer, Bernard, Research Scientist 4

Vallos, Karen, Principal Clerk Stenographer

Pietz, Richard, Research Scientist 4

Zanders, Mary, Principal Clerk Stenographer

Martinez, Adela, Principal Clerk Typist

Section 122 - Wastewater Treatment

Jain, Jain, Research Scientist 3
Lordi, David, Research Scientist 3
Franklin, Laura, Principal Clerk Typist
Patel, Kamlesh, Research Scientist 2
Zhang, Heng, Research Scientist 2
Kaschak, John, Research Scientist 1
MacDonald, Dale, Research Scientist 1
Vacant, Research Scientist 1
Soszynski, Stanley, Research Scientist 1
Kawalko, Sheila, Laboratory Tech 2
Michiels, Paula, Laboratory Tech 2
Farooqui, Saeed, Laboratory Tech 1
Szafoni, John, Laboratory Tech 1
Tate, Tiffany, Laboratory Tech 1
Young, Robert, Laboratory Tech 1
Pierson, Rodney, Laboratory Tech 1

Section 124 – Biology

Zmuda, James, Microbiologist 4
Mackey, Olga, Principal Clerk Typist
Polls, Irwin, Biologist 3
Vacant, Virologist 2
Dennison, Sam, Biologist 2
Gore, Richard, Microbiologist 2
Yamanaka, Jon, Biologist 1
Billett, George, Laboratory Tech 2
Hartford, Mary Lynn, Laboratory Tech 2
Kamenjarin, Sheril, Laboratory Tech 2
Kaplan, Maria, Laboratory Tech 2
Maka, Andrea, Laboratory Tech 2
Patel, Minaxi, Laboratory Tech 2
Sopcak, Michael, Laboratory Tech 2
Jackowski, Kathleen, Laboratory Tech 1
Mangkorn, Damrong, Laboratory Tech 1
Roberts, David, Laboratory Tech 1
Schackart, Richard, Laboratory Tech 1
Shukla, Hemangini, Laboratory Tech 1
Robinson, Harold, Laboratory Tech 1
Credit, Eben, Laboratory Assistant
Yates, Marguerite, Laboratory Assistant

Section 127- Toxic Substances (Egan)

Khalil, Mary, Instrument Chemist 4
Bailey, Bonnie, Principal Clerk Typist
Vacant, Instrument Chemist 3
Sher, David, Instrument Chemist 3
Clayton, Frederick, Instrument Chemist 2
Olchowka, Victor, Instrument Chemist 2
Wu, Dongmei, Instrument Chemist 1
Xiao, Jun, Instrument Chemist 1
Gandhi, Bharat, Laboratory Tech 2
Shah, Pragna, Laboratory Tech 2
Shin, Joan, Laboratory Tech 2
Vermillion, John, Laboratory Tech 2

Section 128 – Radiology

Khalique, Abdul, Radiation Chemist
Vacant, Sanitary Chemist 1
Mysliwiec, Laurence, Laboratory Tech 1

Section 123 – Land Reclamation & Soil

Granato, Thomas, Soil Scientist 3
Pump, Gary, Sanitary Chemist 2
Dennison, Odona, Sanitary Chemist 1
Zumpano, Sarah, Sanitary Chemist 1
Hermann, Robert, Laboratory Tech 2
Stefanich, Tricia, Laboratory Tech 2
Rose, Rebecca, Laboratory Tech 1
Denton, Kina, Laboratory Assistant
Saric, Ronald, Laboratory Assistant

Section 125 - Land Reclamation & Soil (Fulton Cty)

Nelson, Scott, Soil Scientist 2
Carlson, Jr., Carl, Sanitary Chemist I
Boucek, Jr., Emil, Field and Lab Tech
DeWees, Josh, Field and Lab Tech
Swango, Rosalie, Field and Lab Tech

Section 129 – Experimental Design & Statistical Eval

Vacant, Biostatistician
Abedin, Zainul, Assoc. Statistician

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