Metropolitan Water Reclamation District of Greater Chicago

MONITORING AND RESEARCH DEPARTMENT

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ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

2014

ANNUAL REPORT

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Metropolitan Water Reclamation District of Greater Chicago
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ENVIRONMENTAL MONITORING AND RESEARCH DIVISION
2014 ANNUAL REPORT

Monitoring and Research Department
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LIST OF ABBREVIATIONS

ABL	Analytical Bacteriology Laboratory
AEWQ	Aquatic Ecology and Water Quality
AMB	Analytical Microbiology and Biomonitoring
ANL	Argonne National Laboratory
AOB	ammonia-oxidizing bacteria
AWQM	Ambient Water Quality Monitoring
BASTE	Bay Area Sewage Toxics Emission
BMPs	best management practices
BNR	biological nutrient removal
BOD_5	five-day biochemical oxygen demand
BU&SS	Biosolids Utilization and Soil Science
CAWS	Chicago Area Waterways System
CDC	Centers for Disease Control and Prevention
CIP	Capital Improvement Program
CO_2	carbon dioxide
COD	chemical oxygen demand
Combined Plan	dynamic long-term capital plan and Capital Improvement Program
CSD	Controlled Solids Distribution
CSM	Colorado School of Mines
CSO	combined sewer overflow
District	Metropolitan Water Reclamation District of Greater Chicago
DNA	deoxyribonucleic acid
DO	Dissolved Oxygen
EBPR	enhanced biological phosphorus removal
EC	*Escherichia coli*
ED_{50}	fiftieth percentile
EDSEG	Experimental Design and Statistical Evaluation Group
EIML	Environmental, Inc. Midwest Laboratory, Northbrook, Illinois
EM&R	Environmental Monitoring and Research
EQ	exceptional quality
EV	enteric viruses
F:M	food-to-mass
FC	fecal coliform
FOG	fats, oils, and grease
GCTs	gravity concentration tanks
H_2O_2	hydrogen peroxide
H_2S	hydrogen sulfide
HAPs	hazardous air pollutants
HO	helminth ova
HRTs	hydraulic residence times
IAS	In-Stream Aeration Station
IDPH	Illinois Department of Public Health
IEPA	Illinois Environmental Protection Agency

LIST OF ABBREVIATIONS (Continued)

IIT	Illinois Institute of Technology
IPCB	Illinois Pollution Control Board
Kirie	James C. Kirie
LC_{50}	lethal dose at the fiftieth percentile
LIFT	Leaders Innovation Forum for Technology
M&O	Maintenance and Operations
M&R	Monitoring and Research
MELT	mobile exposure laboratory trailer
MF	membrane filtration
Mg	magnesium
$Mg(OH)_2$	magnesium hydroxide
MGD	million gallons per day
MML	Molecular Microbiology Laboratory
MMO-MUG	orthonitro-phenyl-β-D-galactopyranoside-4-methylumbelliferyl-β-D-glucuronide
MTF	multiple tube fermentation
N	nitrogen
NH_3	ammonia
Nitri-VIT	vermicon® Identification Technology gene probe method
NOB	nitrite-oxidizing bacteria
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbulence units
O'Brien	Terrence J. O'Brien
OCBs	off-channel bays
ORP	oxidation-reduction potential
ortho-P	orthophosphate
P	phosphorus
PAOs	phosphate-accumulating organisms
Part 503	40 Code of Federal Regulations Part 503 Rule
pCi	picocuries
PFCP	Process Facilities Capital Planning
PFCs	perfluorinated compounds
PFRP	process to further reduce pathogens
PHB	poly-β-hydroxybutyrate
PL	Parasitology Laboratory
Plan	dynamic long-term capital plan
POTW	publicly owned treatment works
ppmv	parts per million by volume
PS	primary sludge
QAPPs	quality assurance project plans
RAS	return activated sludge
RTTs	reference toxicant tests
SBCR	South Branch Chicago River

LIST OF ABBREVIATIONS (Continued)

SBR	sequencing batch reactor
SCBNR	shortcut biological nitrogen removal
SMAs	solids management areas
SOPs	standard operating procedures
SS	total suspended solids
SVI	sludge volume index
SW	Southwest
TARP	Tunnel and Reservoir Plan
TC	total coliform
TKN	total Kjeldahl nitrogen
TP	total phosphorus
UAA	Use Attainability Analysis
UDP	Upper Des Plaines
USEPA	United States Environmental Protection Agency
VFAs	volatile fatty acids
VL	Virology Laboratory
VSS	volatile suspended solids
WAS	waste activated sludge
WASSTRIP®	Waste Activated Sludge Stripping to Remove Internal Phosphorus®
WEF	Water Environment Federation
WERF	Water Environment Research Foundation
WET	whole effluent toxicity
WML	Wastewater Microbiology Laboratory
WRP	water reclamation plant
WTPR	Wastewater Treatment Process Research

ACKNOWLEDGMENTS

This 2014 Annual Report is the result of the efforts of not only the scientists, microbiologist and biologists, who perform the monitoring and research initiatives of the Department, but also the impressive efforts of support staff and other personnel who contribute their valuable time, energy, and know-how to the production of the report. These individuals deserve special recognition and thanks. Special thanks are due to Ms. Laura Franklin for her immaculate typing, zealous adherence to the Monitoring and Research Department formatting guidelines, responsiveness to turnaround times, and dedication to moving the report forward.

DISCLAIMER

Mention of proprietary equipment and chemicals in this report does not constitute endorsement by the Metropolitan Water Reclamation District of Greater Chicago.

STRUCTURE AND RESPONSIBILITIES OF THE ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

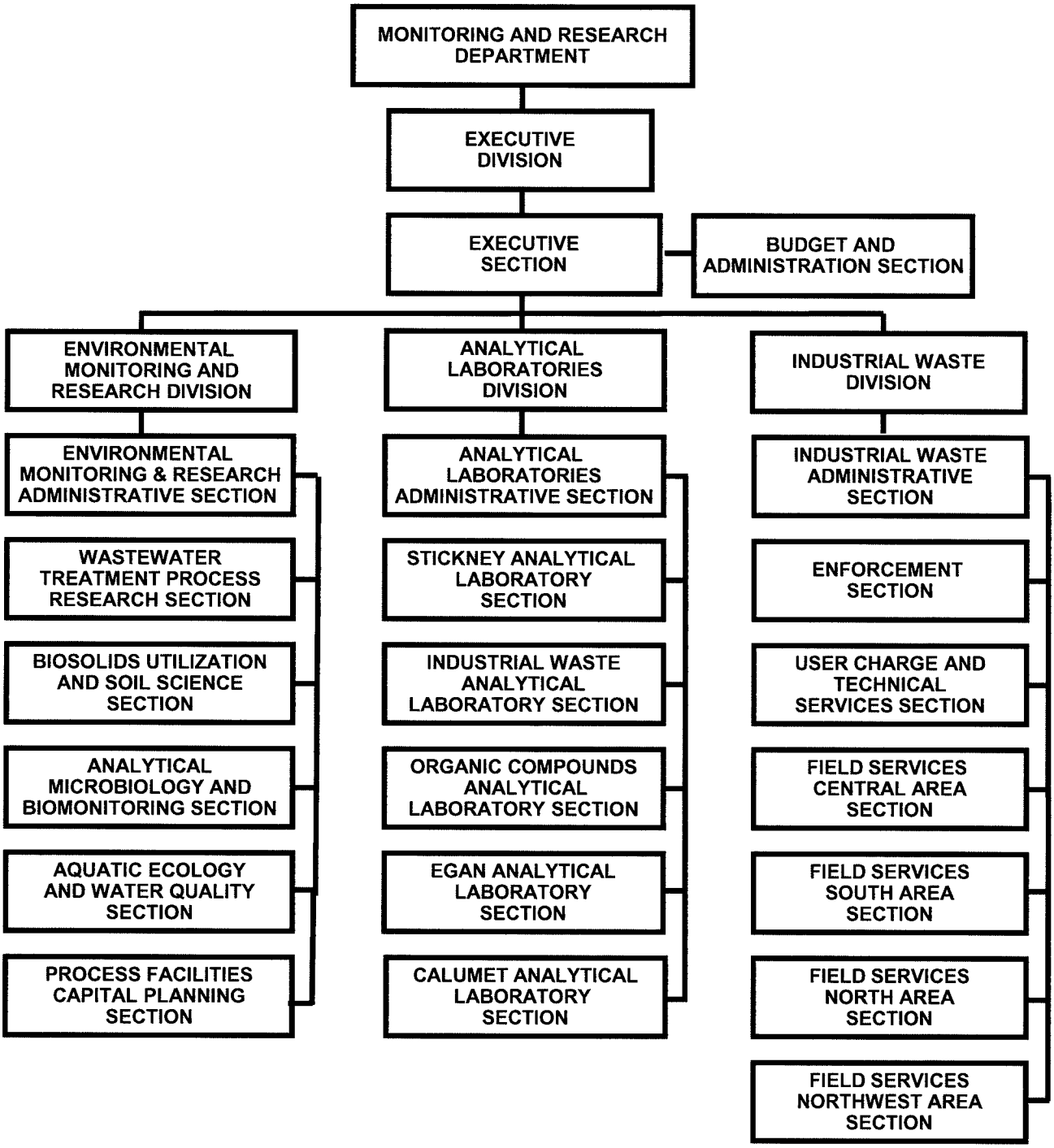
The Environmental Monitoring and Research (EM&R) Division has 80 employees, and comprises six Sections. These are illustrated in Figure 1 and Appendix I. The six Sections are:

1. Administrative.
2. Wastewater Treatment Process Research (WTPR).
3. Biosolids Utilization and Soil Science (BU&SS).
4. Analytical Microbiology and Biomonitoring (AMB).
5. Aquatic Ecology and Water Quality (AEWQ).
6. Process Facilities Capital Planning (PFCP).

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

- Monitoring the environmental quality of Lake Michigan and area rivers and canals to document the effectiveness of the Metropolitan Water Reclamation District of Greater Chicago's (District's) wastewater treatment operations.
- Assisting in the resolution of sewage treatment and solids management operation problems.
- Providing technical assistance to other departments and agencies on issues related to wastewater treatment; combined sewer overflow (CSO) management; waterways management; and solids processing, utilization, and marketing.
- Conducting operations and applied research to achieve improvement and cost reductions in District wastewater treatment, waterways management, and solids processing and biosolids utilization activities.
- Assessing the impacts of new or proposed regulations on District activities.
- Preparing environmental monitoring reports to regulatory agencies to ensure compliance with requirements of the Tunnel and Reservoir Plan (TARP), water reclamation plant (WRP) National Pollutant Discharge Elimination System (NPDES) permits, biosolids processing and utilization permits, and other operation permits.
- Identifying the District's capital infrastructure needs, ensuring their alignment with the District's Strategic Plan, and developing a long-term process facilities capital plan.

FIGURE 1: MONITORING AND RESEARCH DEPARTMENT
ORGANIZATION CHART FOR 2014



During 2014, the EM&R Division participated in numerous meetings and seminars (Appendix II), presented several papers, PowerPoint presentations, and poster presentations (Appendix III), and also published several papers (Appendix IV).

OVERVIEW OF SECTIONS OF THE ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

Administrative Section

The Administrative Section provides technical guidance, scientific review, and administrative support for the work done by EM&R Division staff. The Section also organizes a monthly seminar series, open to all District employees and the interested public through prior registration, which presents information on areas of interest to the District operations. In 2014, a total of 2,045 people attended these seminars. A list of the seminar topics is shown in Appendix V.

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

Experimental Design and Statistical Evaluation Group. The EDSEG is responsible for providing assistance in the design of laboratory and full-scale experiments, collection of appropriate data, development of guidelines for data collection methodology, and statistical analyses. Personnel in this Group also develop multistage automation programs to interconnect different software programs such as LATEX, Visual Basic, SAS, Access, Excel, Outlook, and PowerPoint. This computer automation has enabled the Group to produce reports, tables, and texts in suitable format more efficiently.

During 2014, the EDSEG provided statistical and computing support to various projects. The following is a description of some of the activities.

- Summarized results of the District's Ambient Water Quality Monitoring (AWQM) Program for the Chicago Area Waterways System (CAWS).

- Provided support to the AEWQ Section on the production of the annual Continuous Dissolved Oxygen (DO) Monitoring Reports (Deep-Draft and Wadeable).

- Provided data management support to the BU&SS Section to produce quarterly reports on the District's solids management areas (SMAs) and the Hanover Park Fischer Farm in accordance with Illinois Environmental Protection Agency (IEPA) permit requirements.

- Provided support to the AEWQ Section on regulatory issues such as the CAWS Use Attainability Analysis (UAA).

- Provided database program and maintenance for AWPM Program, BETEX Compound databases, and WRP databases on effluent, influent, TARP, centrifuge, mixed liquor (ML), and sludge.

- Provided statistical analysis support to the WTPR Section on many research projects.

- Provided support to meet requirements under the Freedom of Information Act.

- Prepared numerous statistical analyses and data summaries to respond to IEPA regulatory issues.

Wastewater Treatment Process Research Section

The WTPR Section's mission is to provide technical support to the Maintenance and Operations (M&O) and Engineering Departments and also to the Process Facilities Capital Planning Section, to conduct applied research on both current treatment processes and new technologies, to conduct regulatory required monitoring, and to review and develop technical information for imminent regulations. Technical assistance is provided to the M&O Department for solving WRP operating problems. The investigation of current operations may be done to address WRP problems or to generate new information on wastewater treatment processes. Plans and specifications are also reviewed at the request of Engineering to optimize process design criteria. The Section is responsible for conducting research aimed to solve problems and evaluate wastewater and sludge treatment processes currently utilized by the District. This Section also investigates innovative treatment processes for potential future use. Studies of new technologies address maximizing the operation and cost efficiencies of existing processes or the development of new processes. Investigations are performed through surveys, literature reviews, laboratory bench-scale testing, pilot-plant studies, full-scale testing, or special analyses.

Biosolids Utilization and Soil Science Section

The role of the BU&SS Section is the application of science for continuous improvement in the cost effectiveness of the District's biosolids management, TARP groundwater monitoring, and environmental stewardship through:

- Research, technical assistance, and public outreach.

- Contribution to formulation of and compliance with relevant regulations.

- National leadership in biosolids management.

- Assistance on the District's green initiatives.

- Technical assistance on the District's initiative to produce a value-added product by co-composting woodchips with biosolids.

The long-range goals of the BU&SS Section are to:

- Conduct environmental monitoring and reporting to comply with permits and regulations governing the District's biosolids management program and the TARP.

- Conduct applied research aimed at evaluating the benefits and environmental impacts of land application of biosolids and composted biosolids.

- Promote the beneficial, local use of biosolids and composted biosolids by showcasing benefits and performance of using biosolids and composted biosolids and through dissemination of information, demonstrations, public relations, and technical support to users.

- Monitor and review regulations and relevant issues to evaluate the impacts on the District's operations and assist with the development of technically sound regulations.

- Provide technical support on green initiatives relevant to the District's operations.

Analytical Microbiology and Biomonitoring Section

The AMB Section's mission is to provide on-time, high-quality, cost-effective microbiological monitoring and research services to support the Monitoring and Research (M&R) Department's five program goals. The AMB Section's role is to:

- Conduct microbiological monitoring of liquid and solids for operational control and regulatory reporting requirements and to assess the environmental impacts of District operations.

- Address and provide monitoring support to the District's sustainable operation improvements (disinfection, nutrient removal, biosolids and stormwater management) to fulfill the emerging regulatory developments, in meeting the CAWS recreational use attainment, and other environment improvements.

- Promote employee self-development, education, public awareness, and participation in the District's outreach activities.

The AMB Section has been certified by the Illinois Department of Public Health (IDPH) for the bacterial analysis of water since 1979 and is equipped with the latest technologies and highly knowledgeable professionals and technical staff. The Section is organized into the following five separate laboratories:

1. Analytical Bacteriology Laboratory (ABL).

2. Wastewater Microbiology Laboratory (WML).

3. Parasitology Laboratory (PL).

4. Virology Laboratory (VL).

5. Molecular Microbiology Laboratory (MML).

During 2014, the AMB Section performed the following activities to improve its operations and achieve its goals:

- Maintained its IDPH certification of the ABL, Registry No. 17508, for the examinations of:

    1. Heterotrophic bacteria, heterotrophic plate count.

    2. Total coliform (TC) with *Escherichia coli* (EC) broth verification examination of water from public water supplies and their sources (membrane filtration [MF] and multiple tube fermentation [MTF]).

    3. Fecal coliform (FC) examination of water from public water sources (MF and MTF).

    4. TC and EC examination of samples of water from public water supplies and their sources (minimal medium, orthonitro-phenyl-β-D-galactopyranoside-4-methylumbelliferyl-β-D-glucuronide [MMO-MUG]).

- Ensured laboratory personnel training by completing the demonstration of capability, which enables them to perform analyses according to the laboratory standard operating procedures (SOPs) and quality assurance project plans (QAPPs).

- Monitored the routine operational performance of the laboratory through participation in appropriate performance evaluation and/or inter-laboratory testing programs and provided for corrective actions as necessary.

- Updated SOPs and QAPPs, and implemented Quality Assurance policies and essential applicable Quality Control procedures to assure test validity.

- Increased the number of analyses that can be performed to more efficiently support the District's core monitoring and research programs.

- Fostered a "zero defects" commitment or course of action for all staff. This commitment seeks to produce analytical data and services of the highest quality.

During 2014, the AMB Section laboratories provided microbiological, analytical and technical support to various projects under all EM&R Division program goals. Table 1 shows a summary of the number of analyses provided under each program.

Aquatic Ecology and Water Quality Section

The mission of the AEWQ Section is to provide scientific and technical support to assess the waterways impacted by the District's wastewater treatment operations. The goals of the section are to:

TABLE 1: TOTAL NUMBER OF SAMPLES ANALYZED BY THE ANALYTICAL MICROBIOLOGY LABORATORY IN 2014

Program	Number of Samples		
	Total Coliform, Fecal Coliform, *E. coli,* HPC[1]	Pathogen[2]	Other[3]
4652 Liquid Monitoring	691	—[4]	—
4653 Solids Monitoring	83	65	115
4666 Sewage & Waste Control	12	—	—
4671 Lake Michigan (Bypass)	15	—	—
4672 Waterways	381	—	6
4674 Groundwater	400	—	—
4681 Assistance to M&O	—	—	259
4682 Assistance to Others	93	7	216
4690 Operations & Research	885	—	398
Total	2,560	72	994

[1]HPC = Heterotrophic plate count.
[2]Includes *Salmonella* spp., culturable enteric viruses, and *Ascaris* ova (helminth ova).
[3]Includes filamentous bacteria, zooglea, shelled protozoa, ammonia-oxidizing bacteria (AOB), nitrite-oxidizing bacteria (NOB), phosphorus-accumulating organisms (PAO), and adenosine triphosphate (ATP).
[4]No analyses.

- Assess the water and sediment quality in waterways in the District's service area and in other waterways impacted by flow from this service area in order to inform policy, guide and assess regulatory developments, and support and improve operations.

- Conduct biological and physical habitat monitoring in order to evaluate the health of waterways and assess changes in waterway conditions over time, especially those associated with District operations.

- Conduct whole effluent toxicity (WET) tests on District effluents in accordance with NPDES permits to monitor and evaluate the final effluents for any adverse effects to aquatic life.

- Perform laboratory chlorophyll analysis on the samples collected at AWQM stations.

- Design and conduct research projects to address potential changes in District operations, such as effluent disinfection and phosphorus (P) removal.

- Design and conduct research projects to explore emerging issues in water quality and treatment.

- Participate in regulatory review of water-quality related standards and documents, including attendance at regulatory hearings and stakeholder meetings relevant to District operations.

- Collaborate with other governmental and non-governmental agencies and academic institutions to develop water quality and aquatic ecology research projects.

- Review plans for stormwater improvement construction projects on small streams and recommend biologically sound implementations.

Process Facilities Capital Planning Section

The mission of the PFCP Section is to facilitate the long-term capital planning process to ensure alignment with the District's Strategic Plan by addressing anticipated regulations, District business initiatives and community service level expectations. The goals of the section are to:

- Identify and prioritize areas for research to obtain data for evaluating infrastructure needs and capital projects.

- Utilize data to define and justify capital projects and programs.

- Create and manage the District Odor Master Plan, which defines conceptual projects addressing areas of need.

- Create and manage the District Biosolids Master Plan, which defines conceptual projects addressing areas of need.

- Assist the M&O Department in addressing technical issues to achieve excellence.

SUMMARY OF ENVIRONMENTAL MONITORING AND RESEARCH DIVISION ACTIVITIES DURING 2014

During 2014, the EM&R Division performed activities under the following five program goals:

Goal 1: Operations Monitoring (4650) – Monitor liquid and solids process trains for operational control and regulatory reporting requirements and compliance.

Goal 2: Waste Monitoring (4660) – Monitor and control waste discharged into District's sewage collection system.

Goal 3: Environmental Monitoring (4670) – Monitor the environmental impacts of District operations to assess compliance with all regulations and properly assess the impacts of District operations in a cost-efficient manner.

Goal 4: Technical Assistance (4680) – Evaluate process control and monitoring information to improve process efficiency, inform design, and support effective regulatory developments.

Goal 5: Operations and Applied Research (4690) – Conduct applied and operations research to achieve improvement and cost reductions in District wastewater treatment, waterways management, and solids processing activities.

Goal 1: Operations Monitoring

Levels of Radioactivity in Raw and Treated Wastewaters. Radiological monitoring of raw wastewater and final effluent samples from the District's seven WRPs continued in 2014. The Illinois Pollution Control Board (IPCB) has established General Use Water Quality Standards for radioactivity in the waters of Illinois. According to IPCB regulations, (Title 35, Chapter 1, Section 302.207) gross beta concentration shall not exceed 100 picocuries (pCi)/L, and the strontium-90 concentration must not exceed 2 pCi/L. The annual average radium-226 and 228 combined concentration must not exceed 3.75 pCi/L in General Use waters.

The analysis of gross alpha and beta concentrations was conducted on 24-hour composite samples of raw sewage and final effluent collected monthly at all WRPs. The samples were analyzed by Environmental, Inc. Midwest Laboratory, Northbrook, Illinois (EIML). The data will be presented in the 2014 Radiological Annual Report.

Biosolids and Plant Odor Monitoring Program. The WTPR Section conducts an Odor Monitoring Program characterizing odors at its facilities. During 2014, WTPR, in collaboration with the M&O Department, monitored unit processes at the District's wastewater treatment facilities as well as biosolids drying areas for odors. Odor conditions were reported to the respective plant managers. Table 2 summarizes the results of the 2014 odor monitoring program

TABLE 2: 2014 ROUTINE ODOR MONITORING RESULTS OF DISTRICT BIOSOLIDS MANAGEMENT AREAS

Solids Management Area[1]	Departments Participating[2]	Total Number of Observations	Number of Observations Odors were Detected			Number Non-Detects[3]	Percent Non-Detects
			Very Strong	Strong	Easily Noticeable		
Calumet SDS	M&R	530	0	17	108	405	76
	M&O	328	0	3	13	312	95
HASMA and LASMA	M&R	1,236	0	18	301	917	74
RASMA[4]	M&R	152	0	0	2	150	99
Stony Island SDA	M&R	207	0	2	4	201	97

[1]HASMA = Harlem Avenue SMA; LASMA = Lawndale Avenue SMA (includes Vulcan and Marathon areas; RASMA = Ridgeland Avenue SMA.
[2]M&R = Monitoring and Research and M&O = Maintenance and Operations Departments, respectively.
[3]Non-detects are all observations of faint, very faint, or no odor.
[4]RASMA was not used as a biosolids drying site during 2013.

for the biosolids areas. The results of monitoring for 2014 are included in M&R Department Report No. 15-19, "Odor Monitoring Program at the Metropolitan Water Reclamation District of Greater Chicago's Solids Drying and Solids Processing Facilities During 2014."

Estimation of Emission of Hazardous Air Pollutants. Part a, Title I, of the Clean Air Act, states that a publicly owned treatment works (POTW) is considered a major source of hazardous air pollutants (HAPs) if it emits or has the potential to emit 10 tons per year or more of any single HAP or 25 tons per year or more of any combination of HAPs. Samples of the influent sewage to each of the District's WRPs are collected twice per year and analyzed for 65 of the HAP compounds of concern to POTWs. Emissions of these HAPs from the wastewater treatment process units (grit chamber, primary settling tanks, aeration tanks, and secondary settling tanks) are estimated using the Bay Area Sewage Toxics Emission (BASTE) computer model developed by CH2M. The average concentration of each HAP detected in the influent sewage and the annual running average operating conditions were used as input to the model. The physical properties, such as vapor pressure and molecular weight of the individual compounds, were taken from the United States Environmental Protection Agency (USEPA) database for use in the model as well. During 2014, influent samples were collected in January and August. The average influent concentrations and estimated emissions of the HAPs are presented in Table 3 for the three largest District WRPs (Calumet, Terrence J. O'Brien [O'Brien], and Stickney).

According to the BASTE model, all the individual HAP emissions were less than the ten tons/year criterion. Toluene was the predominant compound emitted from the wastewater treatment processes at the Stickney and Calumet WRPs. Methyl ethyl ketone was the predominant compound emitted from the wastewater treatment processes at the O'Brien WRP. The total measured HAP emissions were substantially less than the 25 tons/year threshold at each of the three WRPs. Therefore, the wastewater treatment process units at the District's WRPs are not considered major sources of HAPs. Additionally, the annual HAPs report was filed as part of the IEPA's Environmental Emissions Reduction Market System.

John E. Egan Water Reclamation Plant Air Quality Permit. As part of the Egan WRP's Federally Enforceable State Operating Permit, monthly hydrogen sulfide (H_2S) monitoring was performed at the facility's compressor room. The monthly permit limit for the digester H_2S is 1,000 parts per million by volume (ppmv). In 2014, there was no permit violation with respect to H_2S concentration in the Egan WRP digester gas.

Monitoring and Reporting for the Biosolids Management Program. The Division conducted the following activities under the District's biosolids management program:

- Biosolids Monitoring Under Process to Further Reduce Pathogens Certification – The District maintains certification of a site-specific process to further reduce pathogens (PFRP) for biosolids processing trains at the Stickney and Calumet WRPs, as awarded by the USEPA. In this certification, the District's air-dried biosolids generated according to a codified operation are designated as Class A according to pathogen standards under the USEPA 40 Code of Federal Regulations Part 503 Rule (Part 503). The monitoring program for this certification includes pathogen analysis of biosolids and

TABLE 3: INFLUENT CONCENTRATIONS AND ESTIMATED EMISSIONS OF HAZARDOUS AIR POLLUTANT CONCENTRATIONS AT THE CALUMET, STICKNEY, AND TERRENCE J. O'BRIEN WATER RECLAMATION PLANTS IN 2014

Hazardous Air Pollutant Organic Compound	Concentrations (µg/L)[1]			Emissions (tons/year)[2]		
	Stickney	Calumet	O'Brien	Stickney	Calumet	O'Brien
Acetophenone	0.00	0.00	23.65	0.00	0.02	0.00
Acetaldehyde	79.63	0.00	0.00	1.80	0.00	0.00
Carbon disulfide	0.00	3.25	1.00	0.41	0.15	0.28
Chloroform	0.46	0.64	2.97	0.73	0.08	0.85
Cresol	0.00	11.63	22.17	0.00	0.00	0.01
Cumene	0.00	7.93	0.00	0.00	0.18	0.00
Dichloromethane	0.00	0.00	8.29	0.00	0.05	0.00
Ethylbenzene	0.79	0.00	0.00	0.08	0.00	0.00
Methyl ethyl ketone	3.94	0.00	0.73	0.19	0.00	1.36
Propionaldehyde	84.58	0.00	0.00	0.80	0.00	0.00
Styrene	0.69	2.77	4.05	0.08	0.17	0.61
Toluene	7.57	4.05	1.32	2.10	0.33	0.26
Xylene	5.14	0.00	1.20	0.74	0.00	0.09

[1]Average results of two influent samples collected in January and August 2014.
[2]Emissions estimated using the Bay Area Sewage Toxics Emmissions (BASTE) Model.

annual reporting to the USEPA. The PFRP certification was renewed in 2012, and the certification period increased from two years to five years.

- Pathogen monitoring – The District utilizes its exceptional quality (EQ) lagoon-aged, air-dried biosolids in the Chicago metro area under a Controlled Solids Distribution (CSD) Program under a permit issued by the IEPA. The AMB Section laboratories conducted analyses of biosolids for FC bacteria, viable *Ascaris* ova (helminth ova [HO]), and culturable enteric viruses (EV) as required to demonstrate compliance with the Part 503 regulations for Class A pathogen criteria of the EQ standard. During 2014, biosolids analysis under the program included 61 samples for FC and 14 samples for HO and culturable EV analyses.

In 2014, the EM&R Division prepared the following regulatory reports under the biosolids management program:

- The 2013 Biosolids Management Report to the USEPA – This report (Report No. 14-01) was prepared to satisfy the reporting requirements of the Part 503 regulation. Based on the five-year PFRP certification issued in 2012, pathogen analysis data is reported in the Annual Biosolids Management Report to the USEPA.

- Four quarterly reports for the CSD permit were submitted to the IEPA (M&R Department Reports 14-02, 14-18, 14-23, and 14-57). The reports document the biosolids users, project descriptions and locations, and biosolids analyses.

National Pollutant Discharge Elimination System Effluent Biomonitoring. The AEWQ and AMB Sections conducted the following monitoring to satisfy the requirements of the NPDES permits issued to the District WRPs.

- Biomonitoring – Under the special conditions of the District WRPs' NPDES permits, the following acute tests were conducted: (1) fish (Fathead minnows) – 96 hour static lethal dose at the fiftieth percentile (LC_{50}) bioassay, and (2) invertebrate (*Ceriodaphnia dubia*) – 48-hour static LC_{50} bioassay, known as the WET test, to monitor and evaluate the District WRPs' effluents for toxicity to aquatic life. One acute WET test on the Egan WRP effluent and one acute WET test on the Lemont WRP effluent were conducted for NPDES permit compliance. No acute toxicity was observed. The acute WET test method and procedures were in accordance with the USEPA's established protocol following an approved SOP and QAPP (EPA, 2002)[1]. For each test performed, ongoing laboratory quality performance was evaluated by performing reference toxicant tests (RTTs) using sodium chloride. All RTTs were performed using the laboratory control water under test conditions identical to NPDES permit required tests. Laboratory staff maintains quality control charts using RTT data from the most recent twenty tests. All twenty RTTs conducted

[1]Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, EPA 821-R-02-012, Fifth Edition, October 2002.

were valid. The Aquatic Ecology Laboratory participated in the Discharge Monitoring Report Quality Assurance Program, established by the USEPA, by conducting toxicity tests of unknown samples. The results were within the acceptable ranges.

- FC monitoring – Membrane filtration analyses of FC bacteria was conducted to monitor the District's WRP effluents as required by their respective NPDES permits and to guide treatment operations. This included FC bacteria monitoring (one day/week/WRP) of the final treated effluent samples from each of the District's seven WRPs. The ABL performed FC analyses on a total of 691 samples from the District's seven WRPs (Table 1). The FC analysis results were reported to the M&O Department. As required in the NPDES permits, additional monitoring is done when rain storm events cause excess flow above the treatment capacities of the WRPs which result in discharge of untreated effluent to the receiving streams.

- Addressing the USEPA Changes to the Recreational Water Quality Bacteria Criteria Methods – In response to 2012 USEPA changes to the recreational water quality standards to modified mTEC method for EC bacteria, the AMB Section analyzed CAWS and final effluents samples by MF onto two different media, mFC agar for FC determination and modified mTEC agar for EC growth. The comparison of FC and EC membrane filtration methods were performed on samples collected from thirteen CAWS sites and from the O'Brien and Calumet WRPs. A total of 173 samples were collected for the EC and FC comparison. If the IEPA adopts the new USEPA recommendations for EC to replace FC, the District has two years of data comparing these methods at five locations along the Calumet River and eight locations along the Chicago River. The FC and EC results collected in 2013 and 2014 are being statistically analyzed to determine a relationship between the two methods.

Goal 2: Waste Monitoring

The AMB Section analyzed 12 industrial waste survey samples for FC bacteria to track the pollution sources and investigate the compliance of discharge quality of industrial users with the Industrial Waste Control Ordinance.

Goal 3: Environmental Monitoring

Fulton County Environmental Monitoring. The Fulton County Land Reclamation Site consists of 5,568 hectares (13,758 acres) of land the District owns in Fulton County, Illinois. The site was used to recycle biosolids for the purpose of reclaiming mine soil and fertilizing agricultural crops. To satisfy the IEPA permit requirements 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 water, groundwater, soils, and crops. The last application of biosolids at the site was done in 2004. As of 2007, all monitoring and reporting for soil, crop, and surface and groundwater at the site was terminated as approved by the IEPA until biosolids application resumes.

On a discretionary basis, samples of soil, plant tissue, groundwater, and surface water from a few locations at the site are collected every two years to add soil and plant tissue samples to the repository and add data to the historical database for the site. The M&O Department staff located at the Fulton County site assists EM&R Division staff with the sampling. The water samples are analyzed, but soil and plant tissue samples are stored without analysis.

Hanover Park Fischer Farm. The Hanover Park Fischer Farm is a 48-hectare (120 acre) site located on the south side of the Hanover Park WRP, which utilizes all biosolids generated at the WRP. The farm has seven gently sloping fields, each surrounded by a berm to control surface runoff. Anaerobically digested biosolids are applied by subsurface injection. The IEPA operating permit (No. 2012-SC-2255) for the site limits the annual biosolids application rate to 56 dry Mg/ha (25 dry tons/acre). An underground tile drain system collects surface and subsurface drainage, which is returned to the Hanover Park WRP for treatment. Groundwater monitoring is required by the IEPA operating permit. Monitoring wells on the farm are sampled quarterly, except Well No. 7, which is monitored monthly. The 2014 groundwater monitoring data were submitted to the IEPA in the quarterly monitoring reports (M&R Department Report Nos. 14-12, 14-29, 14-53 and 15-08).

Groundwater Quality Monitoring at Solids Management Areas. Groundwater quality is monitored at the SMAs where paved cells are used for air-drying of lagoon-aged or centrifuge cake biosolids to a solids content of 60 percent or greater. The monitoring frequency for groundwater quality at the SMAs is quarterly for all lysimeters, except three, which are monitored monthly. The SMAs include the following six sites:

- John E. Egan WRP Solids Management Area – This SMA is no longer used. The IEPA operating permit (No. 2015-AO-2196) does not require groundwater monitoring or reporting unless drying resumes at the site.

- Calumet WRP Solids Management Area – This SMA consists of the Calumet West and Calumet East SMAs. The IEPA operating permit (No. 2010-AO-0265) requires sampling of lysimeters for groundwater monitoring. The 2014 groundwater monitoring data were submitted to the IEPA in the quarterly reports for the Calumet West SMA (Report Nos. 14-11, 14-27 14-50 and 15-07) and the Calumet East SMA (Report Nos. 14-16, 14-28, 14-49, and 15-06).

- Lawndale Avenue Solids Management Area – The IEPA operating permit for this site (No. 2010-AO-0267) requires sampling of groundwater monitoring wells and lysimeters. The 2014 groundwater monitoring data were submitted to the IEPA in quarterly reports (Report Nos. 14-13, 14-24, 14-52 and 15-03).

- Ridgeland Avenue Solids Management Area – Currently, biosolids drying is not done on this site. Under the IEPA operating permit for this site (No. 2010-AO-0267) sampling of groundwater monitoring lysimeters has been terminated since January 27, 2014.

- Harlem Avenue Solids Management Area – The IEPA operating permit for this site (No. 2014-AO-58836) requires sampling of monitoring lysimeters. The

2014 groundwater monitoring data were submitted in quarterly reports to the IEPA (Report Nos. 14-14, 14-26, 14-51 and15-05).

- 122nd and Stony Island Solids Management Area – Currently, biosolids drying is not done on this site. Under the IEPA operating permit for this site (No. 2010-AO-0267) sampling of groundwater monitoring lysimeters has been terminated, except for lysimeter L-1. The 2014 groundwater monitoring data were submitted to the IEPA in quarterly reports (Report Nos. 14-15, 14-25, 14-48 and 15-04).

Tunnel and Reservoir Plan Groundwater Monitoring. The IEPA requires groundwater monitoring for the District's six TARP systems, which includes the Mainstream, Calumet, Des Plaines, and Upper Des Plaines (UDP) Tunnel Systems, the Gloria Alitto Majewski Reservoir, and the Thornton Transitional Flood Control Reservoir (Report Nos. 14-31, 14-32, 14-33, 14-34, 14-35, and 14-36, respectively). After each reservoir fill event resulting from storm events, the reservoirs are sampled and weekly thereafter, during the period that the stormwater remains in the reservoir. The groundwater monitoring program includes over 150 groundwater wells adjacent to the tunnel and reservoirs to monitor potential for groundwater contamination through extrusion of combined sewage. The wells are monitored three to six times per year, and all samples for general chemistry are analyzed by the Analytical Laboratories Division, and FC by the AML. A total of 400 samples were analyzed for FC bacteria.

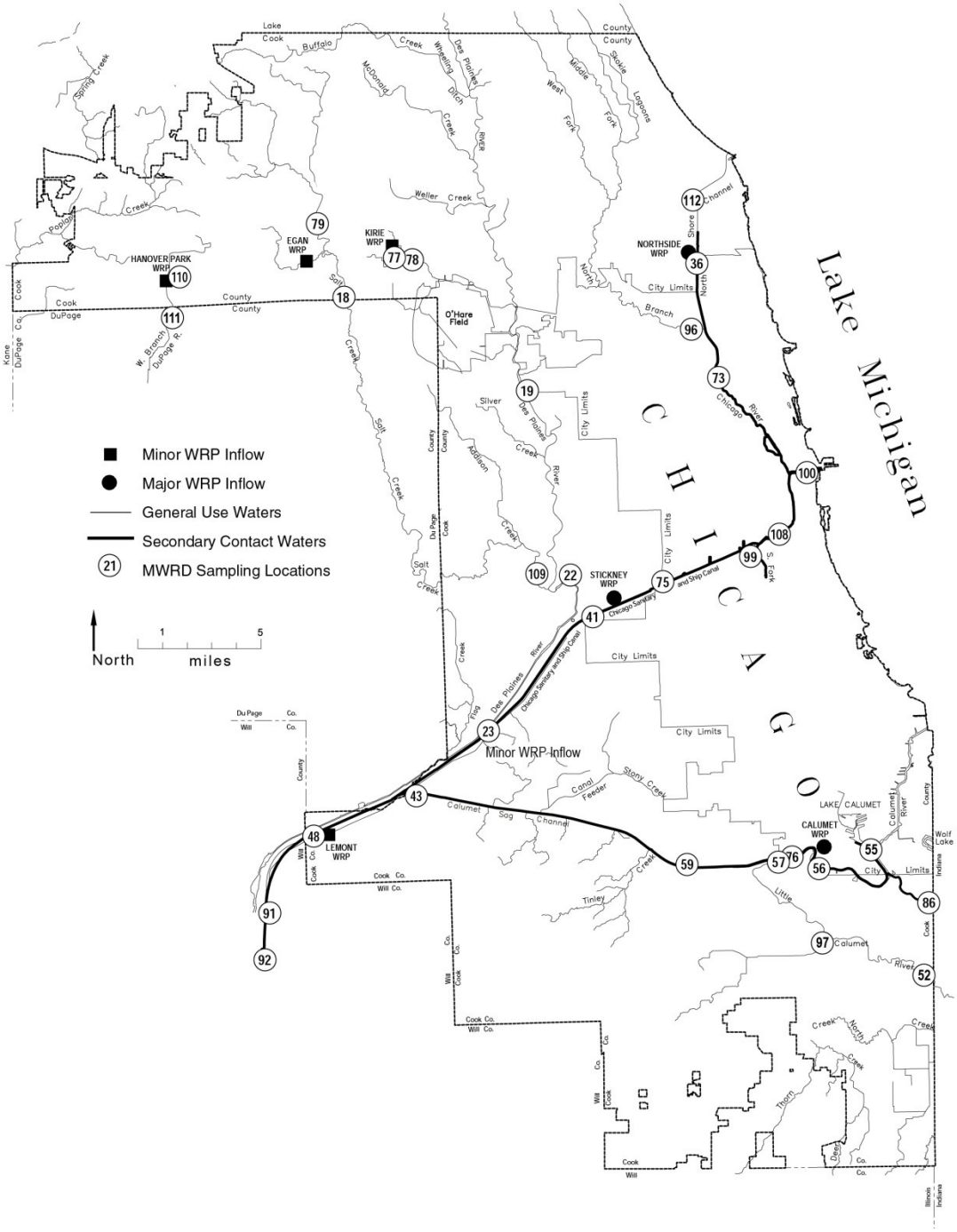
Lake Michigan Monitoring. Monitoring of the Chicago harbors is conducted when river backflow to Lake Michigan occurs due to heavy rainfall in the Chicagoland area. During the river backflow events, water quality monitoring is conducted to assess the impact of the release of CAWS water to Lake Michigan. In 2014, there was one backflow event to Lake Michigan. During the river backflow, 10 water samples collected by the Industrial Waste Division were analyzed for EC and FC.

Drinking Water Monitoring. The Division analyzes drinking water at District facilities on an as-needed basis. During 2014, a total of 35 samples were analyzed for bacteria in response to requests from other departments to assess water quality following new pipe construction at the Stickney and O'Brien WRPs and the Lockport Powerhouse facility, and mold contamination in drinking water pipe at the O'Brien WRP. All samples were examined for the presence of TC and EC, which are indicators of fecal contamination. The Heterotrophic Plate Count was also conducted, which is an indicator of the general bacteriological content of the water. The results were reported together with safety instructions and recommendations where applicable.

Ambient Water Quality Monitoring Program. The AWQM Program includes monthly sampling for water quality analysis, including FC and chlorophyll *a* analyses, at 28 stations on 13 waterways within the District's service area (Figure 2). Analytical results are reported on the District website (mwrd.org). The AWQM Program fulfills NPDES permit waterway monitoring requirements and generates data to be used by the District and provided to the IEPA to assess the waterways in the District service area for attainment of Clean Water Act goals.

The biological monitoring program, which runs in conjunction with the AWQM program, currently consists of fish monitoring. The primary purpose of biological monitoring is to assess the overall health of waterways in the District service area. Between August and October 2014,

FIGURE 2: AMBIENT WATER QUALITY MONITORING SAMPLE STATIONS



the AEWQ Section collected fish by electrofishing, mini fyke netting, and seining at six biological monitoring stations in the Calumet River System. In 2014, a total of 956 fishes comprised of 31 species and one hybrid species were identified, weighed, and measured. The fishes were also examined for parasites and disease. Data from these collections are shown in Table 4.

Continuous Dissolved Oxygen Monitoring. The AEWQ Section developed a comprehensive continuous DO monitoring program beginning in August 1998 in the Chicago River System and July 2001 in the Calumet River System to evaluate the DO dynamics in deep-draft sections of the CAWS. The DO monitoring in wadeable Chicago area waterways, particularly in the Des Plaines River System, began in July 2005. Figure 3 shows current continuous DO monitoring locations.

The DO results for 2014 are included in M&R Department Report No. 15-36, "Continuous Dissolved Oxygen Monitoring Chicago Area Waterways System During 2014."

Pre-Completion of Thornton Reservoir Wet Weather Monitoring of Calumet River System. Enhanced water quality monitoring was implemented at nine sampling locations in the Calumet River System to document baseline conditions for two years preceding the completion of the Calumet TARP System's Thornton Composite Reservoir. Water samples were analyzed for DO, ammonia (NH_3), total suspended solids (SS), total dissolved solids, FC, and five-day biochemical oxygen demand (BOD_5). Samples were collected on the fourth Monday of each month, as well as during or after separate dry- and wet-weather events. To evaluate receiving water impacts of TARP under a range of weather conditions the following criteria were used to categorize sampling events:

- Dry weather (<0.1 inch precipitation). Dry weather will be defined by antecedent dry conditions for two days following a 0.25–0.49 inch event, four days following a 0.50–0.99 inch event, and six days following a >1.0 inch event.

- Wet weather (>0.5 inch precipitation) without CSOs.

- Wet weather with CSOs, including the 125th Street Pump Station.

Besides the monthly samples, the sampling events completed during 2014 were one dry weather, two wet weather without CSOs, and three wet weather with CSOs. All wet-weather sampling events occurred within 12 hours from the end of each storm event. The goal is to complete five sampling events for each criterion by August 15, 2015.

Goal 4: Technical Assistance

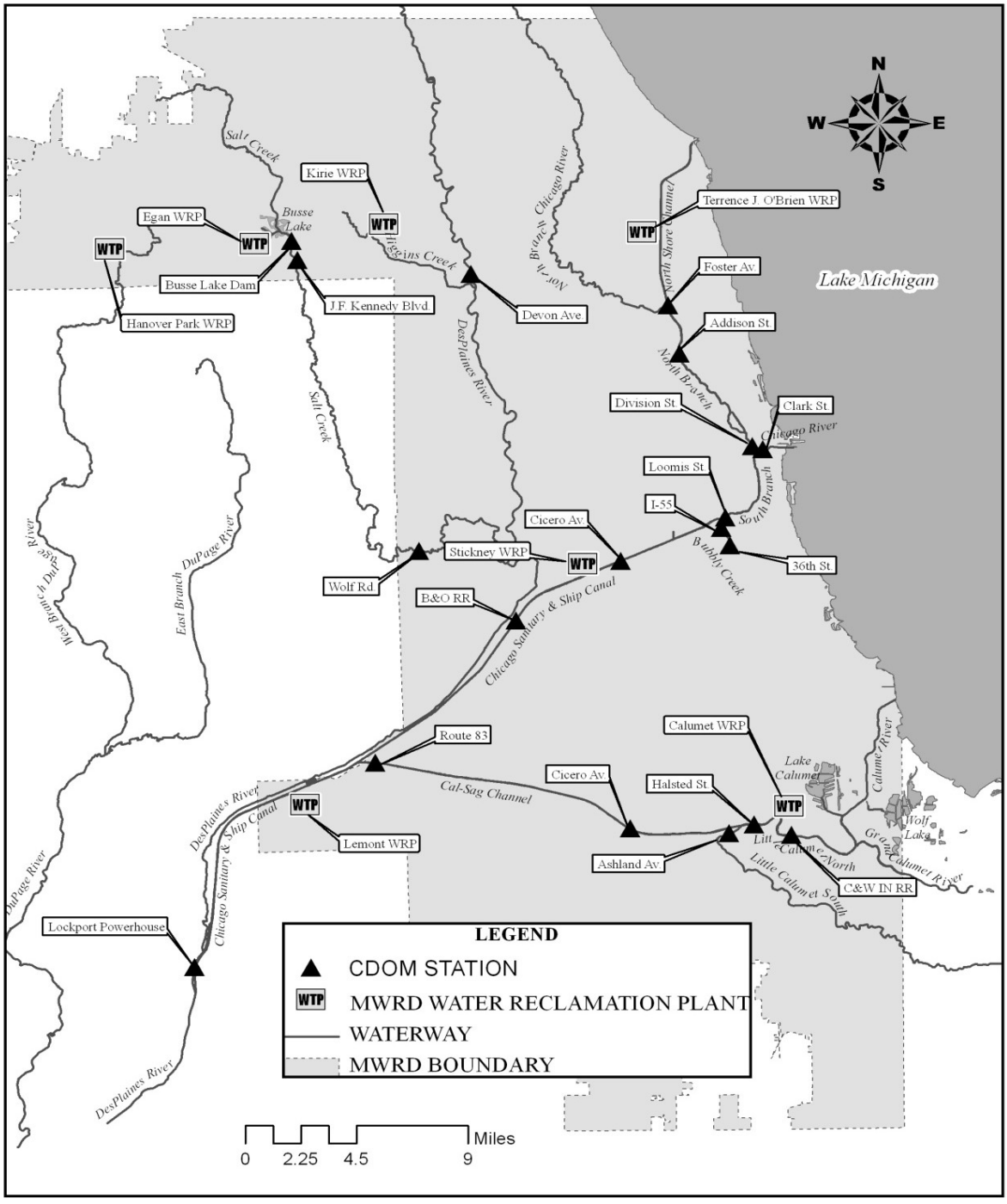
John E. Egan Water Reclamation Plant Profile Sampling. A DO and NH_3-N profile evaluation was performed on a quarterly basis in the North and South Aeration Batteries at the Egan WRP as part of an ongoing support to M&O Department plant operations. Based on the results of this monitoring for 2014, it was determined that NH_3-N was completely removed by mid-tank length for both the North and South Batteries, and the plant was operated adequately.

TABLE 4: SUMMARY OF FISH COLLECTION FROM THE CALUMET RIVER SYSTEM DURING 2014

Waterway	Number of Fish Collected	Weight of Total Catch (kg)	Number of Fish Species	Number of Game Fish Species	Most Abundant Fish Species
Grand Calumet River	59	0.2	11	5	Fathead minnow
Little Calumet River	878	391.5	30	13	Largemouth bass
Cal-Sag Channel	19	24.7	6	4	Common carp
Total	956	416.4	31[1]	17[1]	

[1]Some fish species were collected from more than one waterway.

FIGURE 3: CONTINUOUS DISSOLVED OXYGEN MONITORING SAMPLE STATIONS



John E. Egan Water Reclamation Plant Chlorine Disinfection Process Control Evaluation. In 2013, an investigation was completed of the mainstream disinfection process at the Egan WRP during dry- and wet-weather conditions. The study was undertaken to prevent violations of the Egan WRP NPDES permit for FC. A full-scale study and process evaluation was completed in order to determine the impact of turbidity, SS, and transient conditions on the effectiveness of the disinfection process. The M&R Department provided recommendations for process control improvements. The recommendations included increasing the clear well total residual chlorine from 1 mg/L to above 2 mg/L for the periods that have secondary effluent turbidity at 10 nephelometric turbulence units (NTU) or greater. The details and results of the study are in M&R Department Report No. 14-37, "Chlorine Disinfection Process Control Evaluation at the John E. Egan Water Reclamation Plant."

Additional monitoring was initiated in November 2013 and ended October 2014 to examine correlations between turbidity and SS in the effluent as a characterization of particle size as well as to determine if higher turbidity or SS led to higher FC concentrations. Data analysis and reporting on this subsequent monitoring will be completed in summer 2015.

Stickney Water Reclamation Plant Post-Centrifuge Building Polymer Bid Evaluation. Full-scale tests were conducted at the Stickney WRP post-centrifuge dewatering complex during January and February 2014 for the selection and purchase of winter polymer used in the post-digestion centrifuge dewatering process. During 2014, a total of four polymers from two manufacturers were submitted and tested at full scale followed by bench-scale tests. All four polymers met the District's criteria of a minimum of 95 percent solids capture during full-scale testing to be eligible for bidding on the Stickney dewatering polymer contract. The sludge cake solids and dosages determined from the testing of these polymers are shown in Table 5. The selection of polymer is based on the test performance criteria as described in the bid documents and the cost for conditioning per unit mass of sludge. The test results were transmitted to the M&O Department via memorandum.

Studies on Enhanced Biological Phosphorus Removal. During 2012, the WTPR Section, in conjunction with the Engineering and M&O Departments, formed a Phosphorus Task Force to assess and implement biological P removal and P recovery at the Calumet, Stickney, O'Brien, and James C. Kirie (Kirie) WRPs. As an initial step, the WTPR Section performed a demonstration of enhanced biological P removal (EBPR) in one battery at the Stickney WRP and one battery at the Calumet WRP using current plant infrastructure. The process was implemented by creating anoxic, anaerobic, and aerobic zones in the test batteries to facilitate the growth and luxury P uptake of phosphate-accumulating organisms (PAOs). In the EBPR operations, poly-β-hydroxybutyrates (PHBs) in the anaerobic zone were visualized using the Sudan Black staining procedure, and PAOs in the aerobic zone were visualized using the Neisser staining procedure (Figure 4).

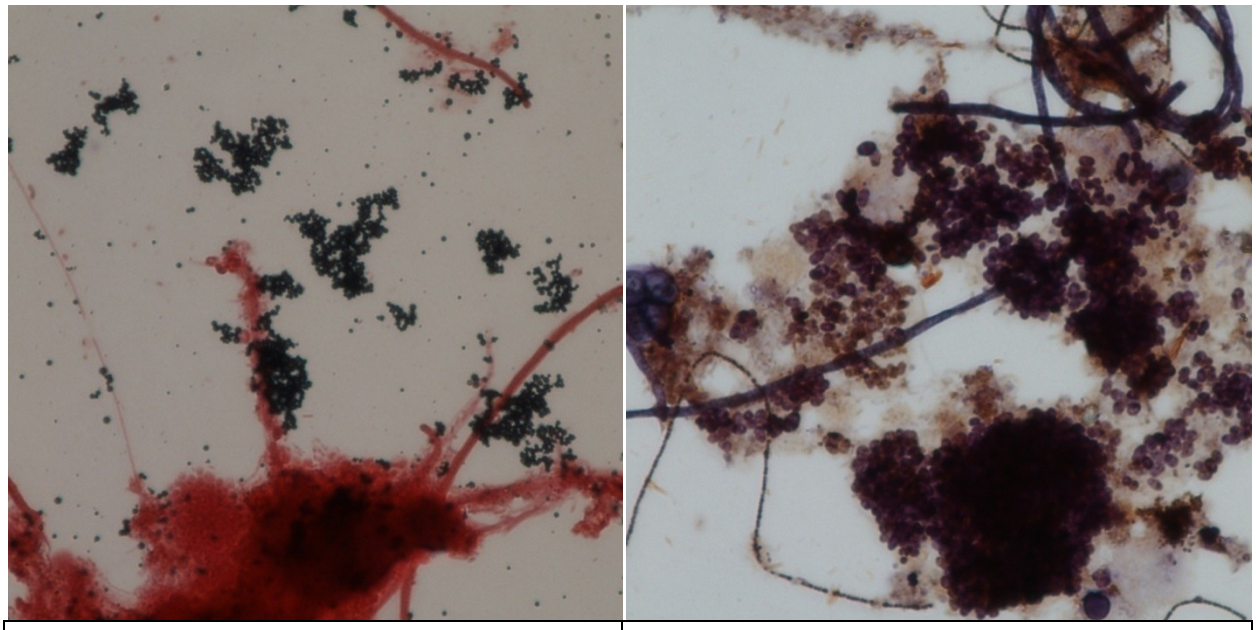
In 2013, all four batteries were converted to the EBPR process at the Stickney WRP and optimization practices continued. An annual average total P (TP) concentration of 0.87 mg/L in the final effluent was achieved in 2014 as shown in Figure 5. However, four out of twelve months the Stickney WRP TP monthly averages were above the 1 mg/L target. Because the site-specific EBPR process configuration uses the existing infrastructure to minimize the capital investment, the plant has to comply with stringent DO, NH_3, and SS NPDES limits, and achieving sustainable EBPR performance is difficult. In addition, inconsistent influent organics

TABLE 5: RESULTS OF POLYMER TESTING AT THE STICKNEY WATER RECLAMATION PLANT CENTRIFUGE COMPLEX IN JANUARY 2014

Polymer Manufacturer	Polymer Identification	Sludge Cake Solids (%)	Polymer Dose (lbs/Dry Ton)
Polydyne	CE 1520	20.0	307.6
Polydyne	CE 1640	21.7	352.6
Ashland Specialty Chemical Company[1]	K260FL	20.6	80.4
Ashland Specialty Chemical Company[1]	K136L	21.2	99.9

[1]These are emulsion polymer products.

FIGURE 4: MICROSCOPIC OBSERVATIONS OF PHOSPHORUS-ACCUMULATING MICROORGANISMS FROM THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S CALUMET WATER RECLAMATION PLANT – BATTERY A

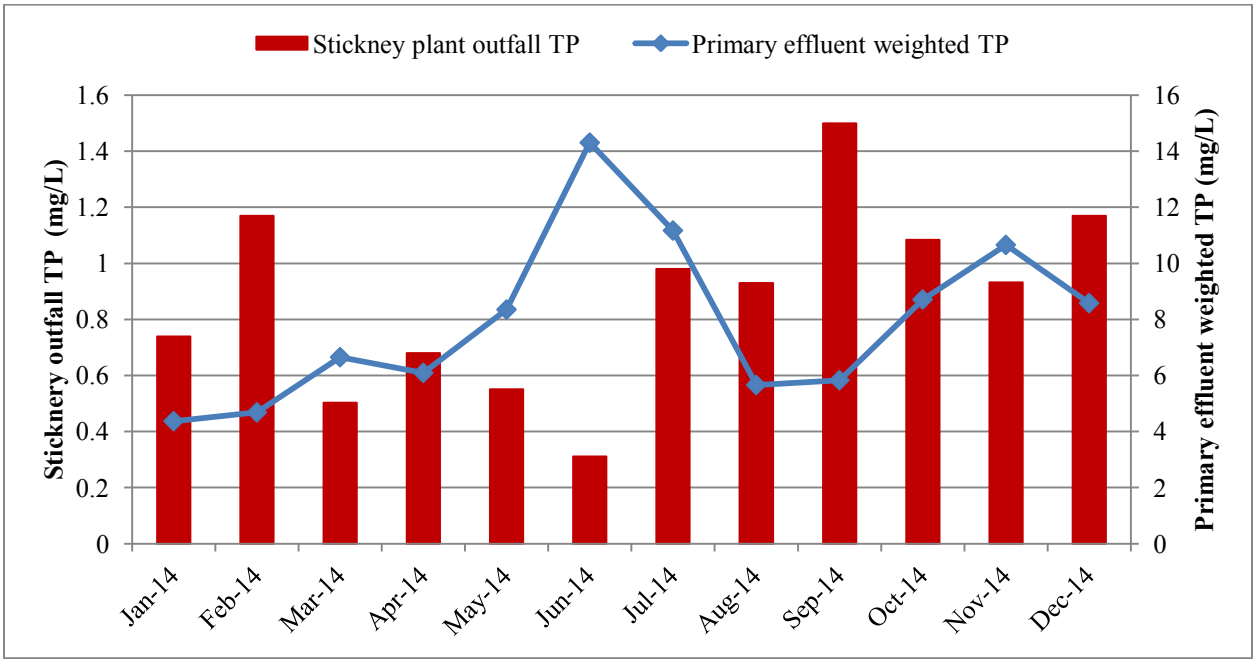


A	B

A. Sudan Black staining results, 100x Bright field – positive for PAOs (dark blue poly-hydroxybutyrate [PHB] granules).

B. Neisser staining results, 100x Brightfield – positive for PAOs (dark blue to purple in color polyphosphate [PolyP] granules, group in clusters within the floc).

FIGURE 5: STICKNEY WATER RECLAMATION PLANT PRIMARY EFFLUENT AND OUTFALL MONTHLY AVERAGE TOTAL PHOSPHORUS CONCENTRATIONS FOR 2014



is often observed. Major infrastructure changes such as adjustments to actuated air valves in the aeration tanks, baffles in anaerobic zone of the aeration tanks, and conversion of gravity concentration tanks (GCTs) to primary sludge (PS) fermentors will be studied in 2015 to help make the EBPR process more stable.

At the Calumet WRP, EBPR in the initial demonstration battery was not successful, due to a lack of carbon in the plant influent needed to drive the EBPR process. Therefore, a small sequencing batch reactor (SBR) test mimicking the EBPR process and using MicroC 2000™, a glycerin-based byproduct derived from renewable resources, was evaluated. This test showed significant P removal and associated increase in PAOs (Figure 6). Subsequently, a full-scale carbon supplement study was conducted from October 13, 2014, to December 24, 2014, in Calumet WRP Battery A to determine effectiveness and process sensitivity of carbon for the EBPR process. The results showed that the addition of MicroC 2000™ significantly improved EBPR performance and a viable carbon source for EBPR at the Calumet WRP using existing infrastructure. Figure 7 shows that the effluent orthophosphate (ortho-P) concentrations in the test Battery A with the carbon addition were much lower than those in the control battery without carbon addition throughout the study period. These results also correlated with higher PAO in the test battery than in the control battery (Figure 8; Table 6). The ortho-P removal efficiency averaged 63 percent with an average final effluent ortho-P of 1.32 mg/L during the study period in Battery A. Based on the success of this study, the WTPR Section and the task force will continue to work with industries to find a high-strength carbon waste and work on development of sludge fermentation options in an effort to meet the carbon needs for sustainable EBPR at Calumet WRP in 2015.

The WTPR Section and the P task force also initiated a Phase I (baseline) EBPR pilot study of the AAnO process at the Kirie WRP in 2014 by turning down the air in the return activated sludge (RAS) and feed channels and at the beginning of two selected aeration tanks. As expected, no EBPR or associated increase in PAO were observed, because the biomass from the EBPR and non-EBPR tanks could not be easily separated. In 2015, we will begin a pilot study in which the biomass to the tanks will be separated and the effectiveness of air mixing on EBPR performance will be evaluated. The result of the this phase of the pilot study will be used to evaluate if the Kirie WRP should move into Phase II and III of the pilot study, i.e. using mixers instead of air and adding baffle walls to generate a fermentation zone, quasi anaerobic/anoxic zone, and swing zone for EBPR optimization.

The P task force is also evaluating the following three P removal/recovery strategies to achieve lower effluent TP at the O'Brien WRP: (1) to reduce P loading to the plant through source control, (2) to use algae for P removal and recovery from the liquid stream, and (3) to implement EBPR for P removal from the liquid stream by modifying to the existing infrastructure.

Before EBPR can be adopted at the O'Brien WRP, optimization of the solids removal in the secondary clarifiers is needed to reduce TP load in the effluent solids. Therefore, the WTPR Section completed stress testing evaluating two retrofit options to improve the secondary clarifier performance and capacity for future EBPR in Batteries A, B, and C. These options would allow running the aeration tanks in Battery A, B, and C at higher MLSS concentration, which will benefit future EBPR. Final Tank 6 in Battery B (FT-B6) was chosen for the first retrofit option – installation of a pump on the underflow line to achieve higher underflow rates. Final Tank 1 in

FIGURE 6: MONITORING FOR PHOSPHORUS-ACCUMULATING MICROORGANISMS DURING THE CALUMET WATER RECLAMATION PLANT SEQUENCING BATCH REACTOR PILOT ENHANCED BIOLOGICAL PHOSPHORUS REMOVAL PROJECT

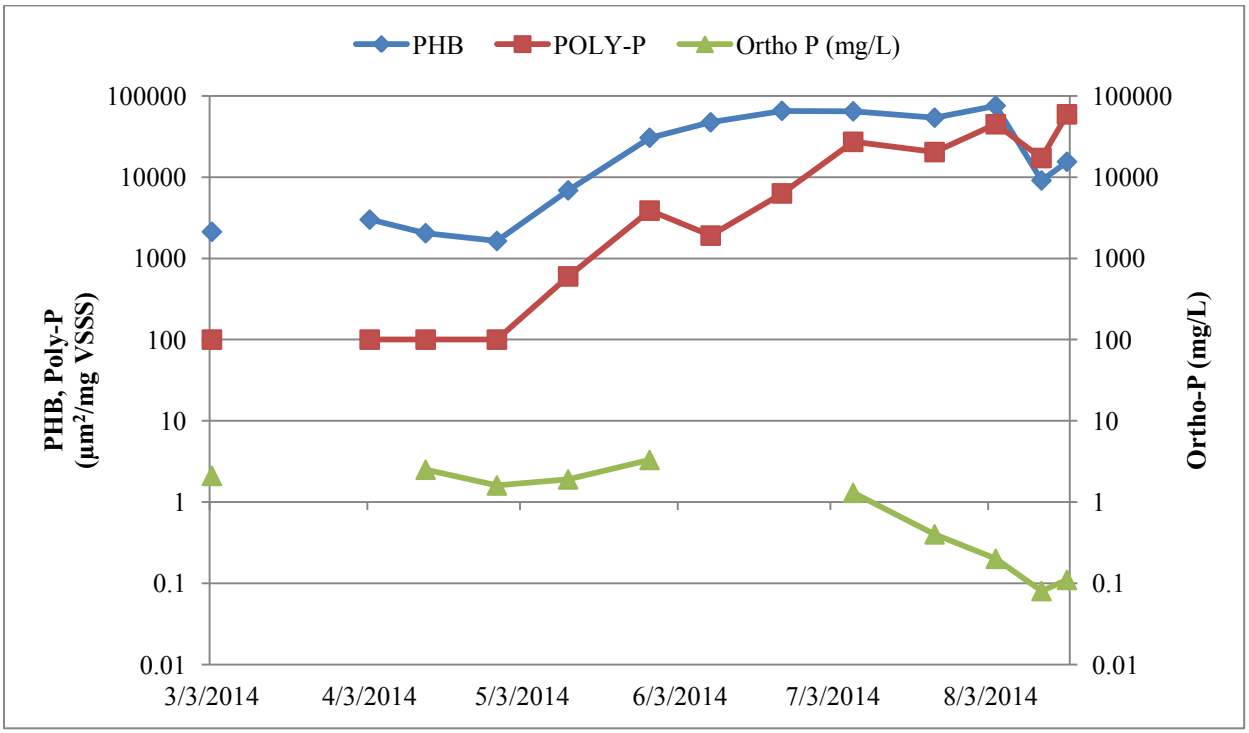


FIGURE 7: CALUMET WATER RECLAMATION PLANT TEST BATTERY A AND CONTROL BATTERY B INFLUENT AND EFFLUENT ORTHOPHOSPHATE CONCENTRATIONS DURING MICROC™ ADDITION STUDY

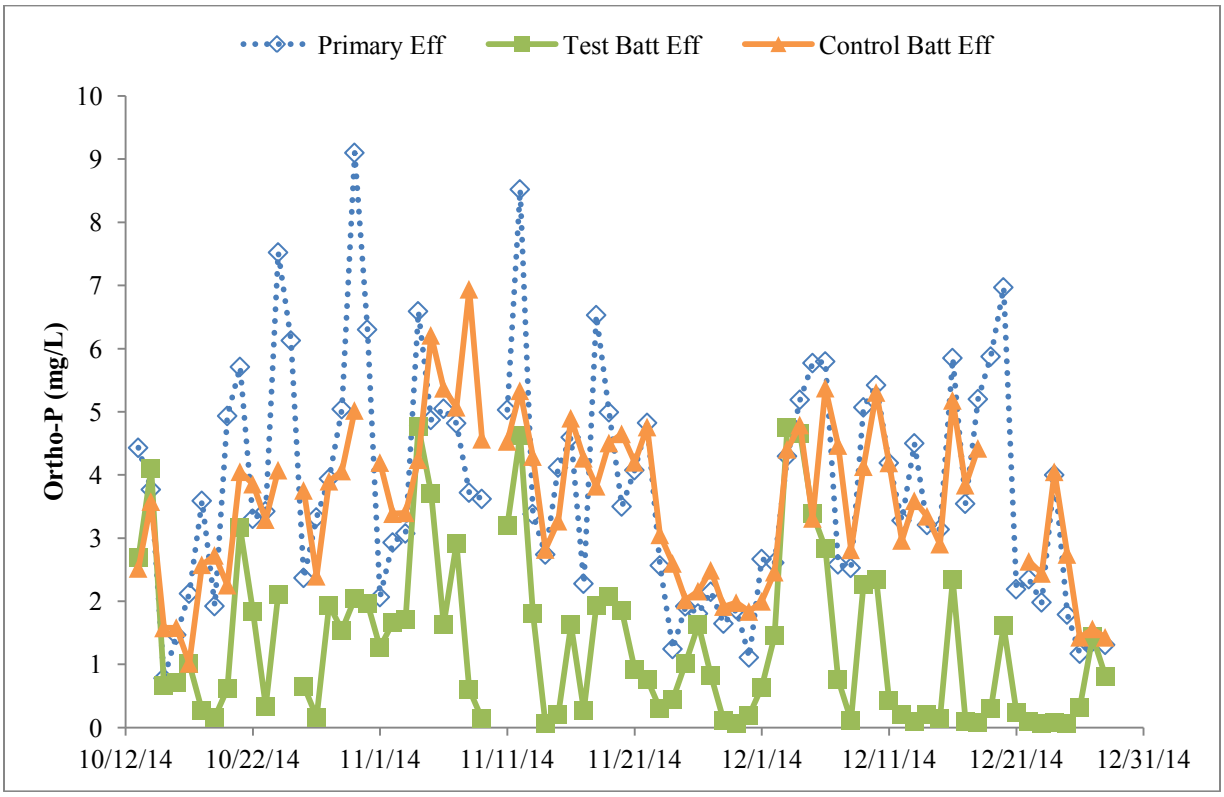


FIGURE 8: INCREASE IN POLYPHOSPHATE UPTAKE IN THE TEST BATTERY AFTER CARBON ADDITION DURING FULL-SCALE ENHANCED BIOLOGICAL PHOSPHORUS REMOVAL PROJECT AT THE CALUMET WATER RECLAMATION PLANT

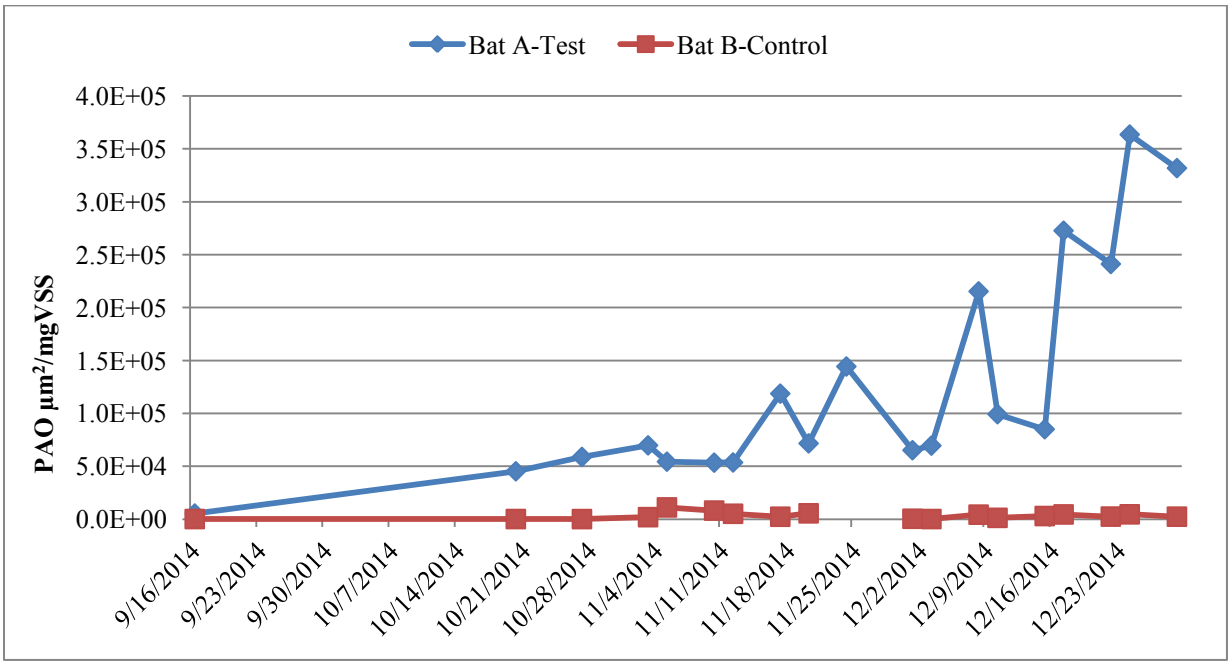


TABLE 6: PHOSPHORUS-ACCUMULATING MICROORGANISM ASSESSMENT IN CALUMET WATER RECLAMATION PLANT ACTIVATED SLUDGE DURING THE FULL-SCALE ENHANCED BIOLOGICAL PHOSPHORUS REMOVAL PROJECT PERIOD[1]

	PHB[2]		POLY-P[3]	
Sample Date	Test Battery[4] µm²/mg VSS[5]	Control Battery[4] µm²/mg VSS	Test Battery µm²/mg VSS	Control Battery µm²/mg VSS
9/16/2014	168,110	NS	5,334	100
Carbon addition began 10/13/14				
10/20/2014	83,779	71,677	45,245	100
10/27/2014	64,126	64,698	58,841	77
11/3/2014	385,090	71,597	69,783	1,907
11/5/2014	68,307	71,344	54,345	11,088
11/10/2014	53,913	241,201	53,413	8,103
11/12/2014	151,750	124,187	53,597	5,104
11/17/2014	150,131	116,578	118,645	2,305
11/20/2014	351,117	82,676	71,621	5,541
11/24/2014	177,077	NS	144,291	NS
12/1/2014	146,520	90,526	65,159	398
12/3/2014	113,867	123,785	69,488	100
12/8/2014	86,796	99,190	215,296	4,276
12/10/2014	119,317	110,766	99,202	1,245
12/15/2014	27,990	58,399	85,004	2,949
12/17/2014	39,193	32,038	272,654	4,478
12/22/2014	47,352	72,396	241,183	2,426
12/24/2014	93,283	171,754	363,532	4,567
Carbon addition ended 12/24/14				
12/29/2014	67,226	77,893	331,792	2,356
1/8/2015	245,679	75,925	173,726	13,658
1/12/2015	138,832	26,055	343,602	2,082
Average	128,861	90,570	139,798	3,221

[1]The project period was from September 2014 – January 2015.
[2]PHB – Poly-β-hydroxybutyrate – Sudan Black staining procedure.
[3]Poly-P – Polyphosphate granules – stained using the Neisser staining procedure.
[4]The test battery for Calumet WRP is Battery A and the control battery is Battery B.
[5]µm²/mg VSS - The abundance of phosphorus accumulating microorganisms (PAO) expressed as total area per milligram of volatile suspended solids.

Battery B (FT-B1) was chosen for the second retrofit option – installation of a plate to be attached under the center feed location of the clarifier to act as a baffle to alleviate non-ideal velocity currents affecting settling.

A total of 42 stress tests were conducted under different solids loading rates for four final tank scenarios: (1) Scenario FT-B1 with the plate; (2) FT-B2 as control without a plate; (3) FT-B6 with the underflow pump (FT-B6-a); (4) FT-B6 without an underflow pump but using the existing gravity underflow system (FT-B6-B) as the control. As shown in Table 7, FT-B1 retrofitted with the plate consistently produced good quality effluent during all tests, and it offers better performance than all other three testing scenarios. However, since all stress tests were conducted from April through July 2014, when wastewater temperatures were generally 55°F or above, to further verify and compare the clarifier performance, the WTPR Section and the M&O Department will continue monitoring the SS concentration in the effluent of the testing clarifiers throughout the winter of 2014–2015.

Additionally, an initial evaluation for implementing the EBPR process at the O'Brien WRP was performed through an analysis of historical plant influent data. The following summarizes the findings from the analysis:

- As shown in Figure 9, 99.63 percent of time, the BOD_5:TP ratio in the O'Brien WRP influent, and 100 percent of the time, the BOD_5:TP ratio in the O'Brien WRP primary effluent, were greater than 20, the recommended minimum value for the EBPR process. Influent and primary effluent characteristic monitoring will be conducted starting in the summer of 2015 to determine if the influent has sufficient volatile fatty acids (VFAs) and other readily biodegradable organics for sustainable EBPR.

- DO and nitrate and nitrite (NO_x) in the RAS recycled back to the head of aeration tank may negatively impact the EBPR process if there is not sufficient readily biodegradable carbon in the influent for PAOs, heterotrophs to use to consume oxygen, and for denitrifiers to use to remove the NO_x. RAS sampling to determine the DO and NO_x levels will be evaluated starting in summer 2015.

- The plant is currently operating at a relatively high NH_3-N in the final effluent compared to the other District WRPs and may be at its nitrification capacity. NH_3-N profile sampling conducted by the M&R Department also indicates that Batteries A, B, and C are not always able to fully nitrify by the end of aeration tanks compared to Battery D, even though hydraulic residence times (HRTs) were higher than in Battery D. The higher NH_3 in Battery A, B, and C effluent could be due to the current single pass two-bay configuration and unbalanced air supply in these batteries. Nitrification rates in Batteries A, B, C, and D will be evaluated and compared starting in summer 2015. The option for improving aeration tank volume efficiency in Batteries A, B, and C will also be evaluated.

- An HRT analysis compared O'Brien Batteries A, B, C, and D to Kirie WRP and Stickney WRP batteries. While Battery D has a lower HRT than Batteries

TABLE 7: RESULTS OF FINAL CLARIFIER STRESS TEST EFFLUENT FOR THE TERRENCE J. O'BRIEN WATER RECLAMATION PLANT

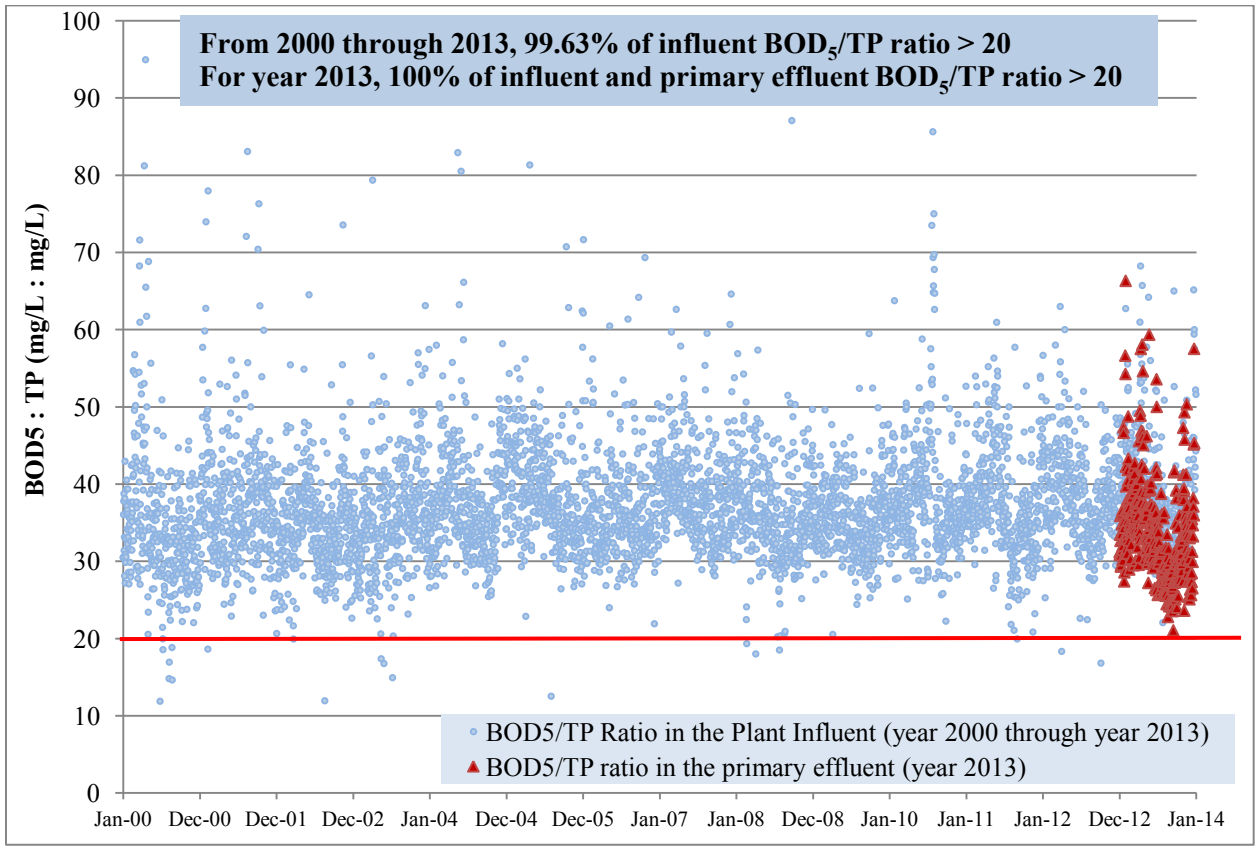
Date	Tank and Condition[1]	ESS,[2] mg/L	Blanket ave, ft	SLR,[3] lbs/day/sf
7/14/2014	FT-B1	5.0	4	47
5/13/2014	FT-B1	5.2	6	38
7/17/2014	FT-B1	3.8	4	34
5/21/2014	FT-B1	2.8	3	33
5/14/2014	FT-B1	3.4	3	32
7/18/2014	FT-B1	3.2	2	28
5/23/2014	FT-B1	2.4	3	26
5/30/2014	FT-B1	2.5	2	20
6/13/2014	FT-B1	2.2	2	16
6/6/2014	FT-B1	2.8	2	16
Mean		3.3	3.1	29.1
8/1/2014	FT-B2	6.6	8	37
7/3/2014	FT-B2	3.8	5	36
7/10/2014	FT-B2	4.8	3	34
7/9/2014	FT-B2	6.4	3	32
7/11/2014	FT-B2	4.2	2	30
7/31/2014	FT-B2	7.2	6	29
7/24/2014	FT-B2	3.2	3	25
7/23/2014	FT-B2	3.2	3	24
7/30/2014	FT-B2	4.4	2	16
7/25/2014	FT-B2	3.0	3	16
Mean		4.7	3.8	28.0

TABLE 7 (Continued): RESULTS OF FINAL CLARIFIER STRESS TEST EFFLUENT FOR THE TERRENCE J. O'BRIEN WATER RECLAMATION PLANT

Date	Tank and Condition[1]	ESS,[2] mg/L	Blanket ave, ft	SLR,[3] lbs/day/sf
6/23/2014	FT-B6-A	4.4	10	30
7/2/2014	FT-B6-A	3.0	5	29
5/9/2014	FT-B6-A	6.6	9	28
4/15/2014	FT-B6-A	3.6	5	27
5/2/2014	FT-B6-A	3.0	4	27
4/11/2014	FT-B6-A	4.2	5	26
4/9/2014	FT-B6-A	5.2	4	26
6/18/2014	FT-B6-A	3.0	2	18
4/26/2013	FT-B6-A	6.0	0	18
5/6/2014	FT-B6-A	2.0	3	16
4/3/2013	FT-B6-A	4.2	3	11
Mean		4.1	4.6	23.3
4/18/2014	FT-B6-B	4.2	7	35
4/25/2014	FT-B6-B	6.6	7	34
4/16/2014	FT-B6-B	4.4	6	33
6/26/2014	FT-B6-B	4.0	10	32
6/20/2014	FT-B6-B		15	29
6/27/2014	FT-B6-B	4.2	9	29
4/29/2014	FT-B6-B	3.4	4	24
4/23/2014	FT-B6-B	4.0	4	23
4/22/2014	FT-B6-B	2.3	4	22
6/19/2014	FT-B6-B	2.4	5	18
4/30/2014	FT-B6-B	2.7	3	12
Mean		3.8	6.8	26.4

[1]FT-B1 and FT-B2 are Battery B with and without plate, respectively; FT-B6-A and FT-B6-B are with and without underflow pump, respectively.
[2]ESS = Effluent suspended solids.
[3]SLR = Solids loading rate.

FIGURE 9: TERRENCE J. O'BRIEN WATER RECLAMATION PLANT HISTORIC INFLUENT AND PRIMARY EFFLUENT FIVE-DAY BIOCHEMICAL OXYGEN DEMAND:TOTAL PHOSPHORUS RATIO



A, B, and C, the overall average, fiftieth percentile, and first through tenth percentile HRTs in all four aeration batteries (especially A, B, and C) in the O'Brien WRP are in a similar range as that in the Stickney WRP, which has demonstrated successful EBPR using the existing infrastructure. In addition, the wastewater strength in terms of BOD_5, total Kjeldahl nitrogen (TKN), and TP concentration feeding into the aeration tanks at the O'Brien WRP is much lower than that at Stickney. As such, it appears that the O'Brien WRP may have sufficient aeration tank volume for EBPR. However, the BOD_5:TKN ratio in the O'Brien primary effluent is lower than at both the Kirie and Stickney WRPs, which could cause more severe carbon competition between PAOs and denitrifiers under EBPR operation.

The results from the above testing and evaluation will be used to select and conduct pilot studies to evaluate the process improvement alternatives to enhance O'Brien nitrification and EBPR capacity.

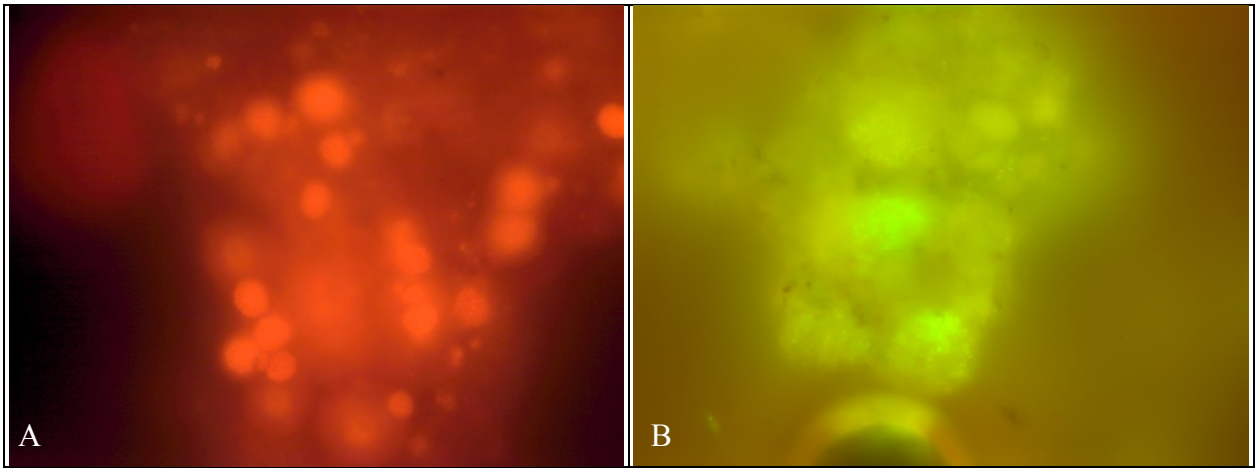
The population of NH_3-oxidizing bacteria (AOB) and nitrite-oxidizing bacteria (NOB) were also monitored to evaluate the EBPR processes. The vermicon® Identification Technology gene probe method (Nitri-VIT) was evaluated for use as a rapid molecular method for identifying AOBs and NOBs and for the development of a bacterial baseline index. The baseline index is developed by viewing 20 fields using a fluorescent microscope and ranking the fluorescence from one to five (slight to excessive) (Figure 10). The VIT indexes for AOB and NOB were combined to obtain a Total Nitrifying Bacteria (TNB) index. This method is linked directly to the viability of the nitrifying bacteria and therefore detects living active cells. The AOB and NOB abundance was measured in a total of 16 samples to support the full-scale Calumet EBPR project. The results were compared to a baseline index developed in 2013 for the specific nitrifying bacteria population. The data are summarized in Table 8.

Odor Study at the John E. Egan Water Reclamation Plant Pretreatment and Thickening Buildings. A series of studies was initiated to evaluate the indoor air quality in the Pretreatment and Thickening Buildings at the Egan WRP. The field monitoring and sampling were completed in 2013, and the data was analyzed and reported in 2014. Air quality parameters such as H_2S, carbon dioxide (CO_2), NH_3, and effective dosage at the fiftieth percentile (ED_{50}) were measured at select locations in the two buildings. The study was performed to confirm the results obtained and the Odor Control recommendations of an Illinois Institute of Technology (IIT) study completed in 2010 and provide recommendations in how to improve air quality if necessary. The average concentration of select air quality parameters observed in both the WTPR Section and IIT study are shown in Table 9.

The following conclusions from the study were made:

- The NH_3 and H_2S results of the study generated by the District (WTPR Section) and IIT for all areas tested were dissimilar in the Pretreatment Building. The instantaneous results measured by the WTPR for H_2S and NH_3 were up to ninefold, and up to twenty-four-fold higher than the analysis by IIT, respectively, for the Pretreatment Building. The monitoring of the Thickening Building indicated that the WTPR results for NH_3 were about two times higher than IIT's results, but the WTPR's H_2S results were similar to

FIGURE 10: FLUORESCENT MICROSCOPIC IMAGES OF AMMONIA-OXIDIZING BACTERIA AND NITRITE-OXIDIZING BACTERIA



Images of the nitrifying bacteria observed at the Calumet WRP.
A. Red clusters of AOB.
B. Light green clusters of NOB.

TABLE 8: A SUMMARY OF THE VERMICON® IDENTIFICATION TECHNOLOGY INDEX VALUES FOR TOTAL NITRIFYING BACTERIA[1] IN THE CALUMET WATER RECLAMATION PLANT ACTIVATED SLUDGE DURING THE FULL-SCALE BIOLOGICAL PHOSPHORUS REMOVAL PROJECT

	Test Battery A		Control Battery B	
	Aerobic Zone	Anaerobic Zone	Aerobic Zone	Anaerobic Zone
09/16/14	5.2	4.8	4.2	4.1
10/27/14	7.1	4.9	7.4	6.7
11/20/14	4.6	5.3	5.9	6.2
12/17/14	3.9	4.8	5.9	5.6

[1]Total nitrifying bacteria = ammonia-oxidizing bacteria (AOB) + nitrite-oxiziding bacteria (NOB).
[2]Baseline index for Battery A developed in 2013 = 3.2.
[3]Baseline index for Battery B developed in 2013 = 3.3.

TABLE 9: COMPARISON BETWEEN THE RESULTS OF ODOR ANALYSIS (AVERAGE VALUES) FOR EFFECTIVE DOSE AT THE FIFTIETH PERCENTILE, AMMONIA, AND HYDROGEN SULFIDE BY THE MONITORING AND RESEARCH DEPARTMENT AND THE ILLINOIS INSTITUTE OF TECHNOLOGY

	ED_{50} (D/T)		NH_3 (ppmv)		H_2S (ppmv)[1]	
	M&R[2]	IIT	M&R[3]	IIT	M&R[3]	IIT
Pretreatment Building						
Coarse Screen Area	92	70	32	3	2.61	0.49
Fine Screen Area	96	72	41	5	4.39	0.49
Above Wet Well	92	76	33	4	3.10	0.42
Screening Conveyors	92	79	33	4	3.10	0.47
South of Coarse Screen	154	63	36	2	2.93	0.80
North of Fine Screen	80	63	48	2	5.14	0.65
Thickening Building						
Middle of Two Gravity Belt Thickeners in Service	68	32	6	4	0.07	0.06
Near Plastic Curtain Wall	19	20	8	3	0.07	0.03
Middle of the Thickening Building	14	15	9	3	0.03	0.02

[1]Jerome instantaneous measurements (two measurements per day).
[2]Average of one or two days of measurements.
[3]Average of two measurements per sampling day for eleven days.

IIT's results. Both IIT and WTPR studies indicated that the Pretreatment Building is more odorous than the Thickening Building.

- The monitoring results for H_2S measured by the WTPR Section using continuous measuring OdaLogs and instantaneous measuring Jerome meters were much higher than those measured by IIT.

- The CO_2 concentrations in all areas are concerning, especially in the Pretreatment Building. The ventilation in this building should be improved.

- In the Pretreatment Building, the ED_{50} results based on the WTPR Section and IIT identified strong odor conditions in all areas, although the WTPR's study suggested stronger odors. In the Thickening Building, the ED_{50} by WTPR identified relatively strong odor conditions; the ED_{50} by IIT identified easily noticeable odor conditions.

Evaluation of Hydrogen Sulfide Emission in the ANITA™MOX Equalization Tank at the John E. Egan Water Reclamation Plant. The WTPR Section conducted a study to test the centrate from the Egan WRP post-digestion dewatering facility in order to evaluate the potential for emissions of H_2S inside the newly modified equalization tank located ahead of the future ANITA™ MOX system. The results of this study were used by Engineering for design to protect the interior of the equalization tank from corrosion due to H_2S. In order to evaluate the emission of H_2S potential from each event, raw and manufactured centrate samples were individually added to a 2.5-gallon carboy container and mixed with a stir bar to mimic the mechanical mixing in the equalization tank without breaking the liquid surface. Here the manufactured sample was the supernatant of a dewatered sludge conditioned with only polymer, i.e. no ferric chloride as is used at Egan currently; this represents potential future conditions. The headspace H_2S levels of the containers were measured with a Jerome H_2S analyzer at two to three hours. The results of analysis for the headspace H_2S showed that the short-term residence time (two to three hours) as well as longer residence time, up to 12 hours, could not trigger concentrations that could potentially cause corrosion in the concrete based on a limit of 1 ppmv suggested by the Water Environment Federation (WEF) (Water Environment Research Foundation [WERF] Report No. 04-CTS-1).

Calumet Water Reclamation Plant Background Odor Evaluation. As part of the Odor Master Plan that is being developed for District facilities and service area, three major sources of odors at the Calumet WRP were identified based on past studies in this plant. These sources were the Fine Screen Building, Grit Building, and Concentration Building. Wastewater and odor monitoring were performed by WTPR Section personnel from each of these locations in the Calumet WRP as well as contributing interceptors in 2014 to quantify the extent of the odor from these sources. The conclusions of the study were:

1. Among the unit processes investigated, the sludge screen room and concentration tank room had the highest odor levels.

2. The South Park and Blue Island interceptors had relatively high odors and potential for corrosion.

3. The major odorous compounds that were detected were H_2S and NH_3. The indoor air concentrations of other odorous compounds were below their respective detection limits.

4. Ambient H_2S concentrations tended to increase at higher wastewater temperatures.

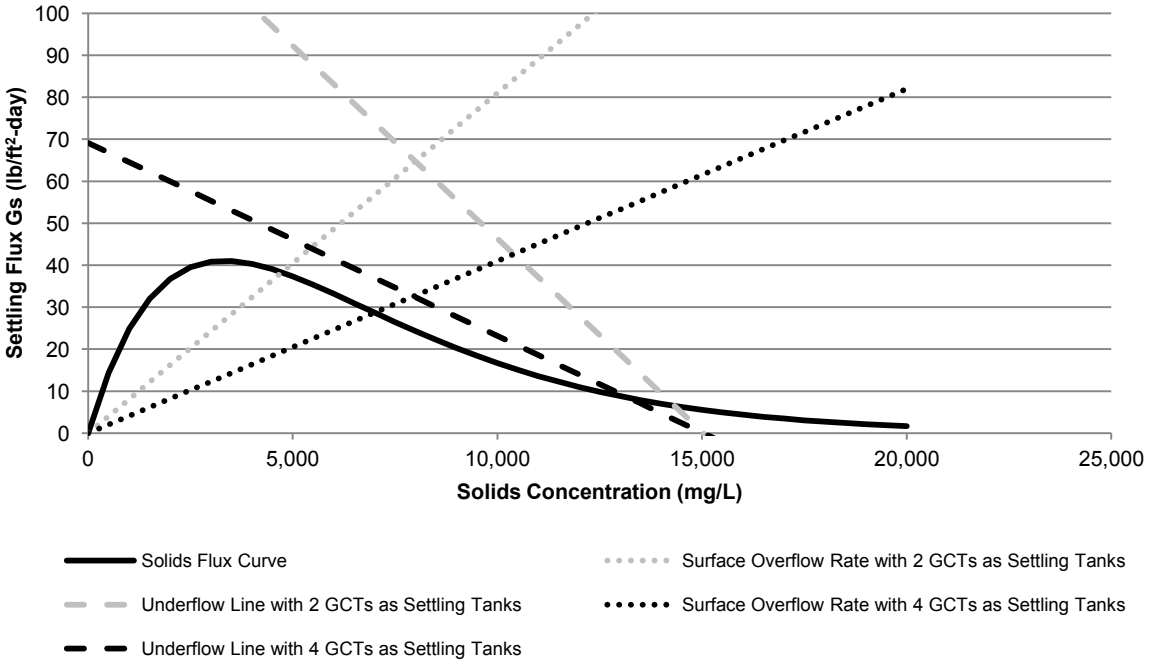
Stickney Water Reclamation Plant Waste Activated Sludge Stripping to Remove Internal Phosphorus. With the implementation of the EBPR process in all batteries at the Stickney WRP, there could be increased concentrations of TP and magnesium (Mg) in the waste activated sludge (WAS) stream. As part of the plan to install Ostara® reactors at the plant for P recovery, a WAS Stripping to Remove Internal Phosphorus (WASSTRIP®) process is being planned that can strip off the P and Mg in the WAS which can subsequently be recovered through struvite precipitation in the Ostara® reactors. This WASSTRIP® process is based on holding WAS quiescently under anaerobic conditions with available, readily-degradable carbon to promote ortho-P release from the PAO biomass. Mg cations carry the ortho-P across the PAO cell walls. An advantage with WASSTRIP® is that the extraction from the WAS stream will reduce ortho-P and Mg concentrations in the digester feed sludge, reduce the potential for struvite formation in the digesters, and reduce the amount of Mg addition needed for the Ostara reactor. Therefore, the WASSTRIP® process is an integral part of the Ostara P recovery system.

Ten former GCTs will be used for the WASSTRIP® process. The tanks will be dedicated for the following: WAS thickening to reduce the volume of sludge that needs to be treated; sludge fermentation to provide the carbon needed to drive the phosphate release in the WASSTRIP® process; and for the actual WASSTRIP® process. Therefore, in 2014 a number of laboratory tests were performed to examine WAS thickening and sludge fermentation for process design information. Laboratory WASSTRIP® testing using the information from these two preliminary studies will be performed in 2015.

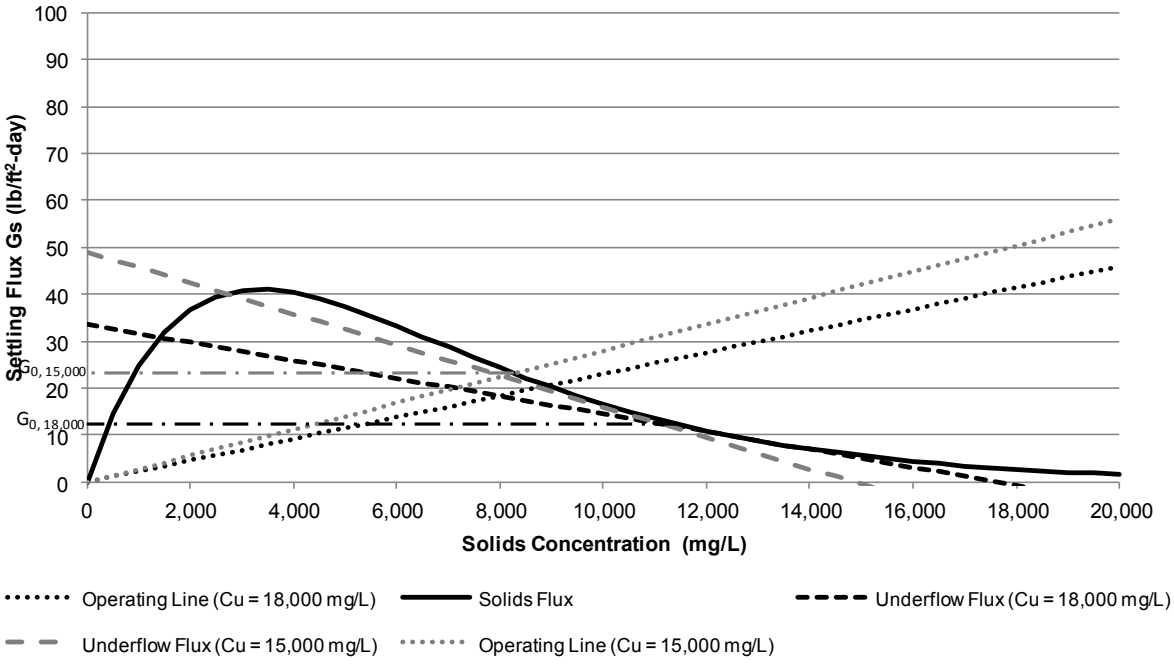
It is recommended to thicken the WAS to 15,000–20,000 mg/L TSS prior to delivery of the thickened WAS to a WASSTRIP® reactor tank. During 2014, a column settling test was done to determine the time necessary for satisfactory thickening of the WAS. Based on the concentrations at the bottom of the settling column from multiple trials, underflow solids concentrations of 15,000 mg/L TSS after 60 minutes or 20,000 mg/L TSS after 120 minutes could be achieved. However, the flux curve derived based on laboratory settling tests (Figure 11) shows that the GCTs would be overloaded when treating the full average WAS flow of 13.4 million gallons per day (MGD) using either two or four GCTs, i.e. the number of tanks currently allocated for thickening, ultimately limiting their ability to settle. Operating the WASSTRIP® thickeners in an overloaded state is not recommended as this will cause significant solids overflow and could potentially have detrimental effects on the EBPR process once these solids are returned to the head of the plant. Therefore, it is recommended that the influent to the tanks is limited to 4.75 MGD if using two GCTs and 9.5 MGD if using four GCTs or the number of tanks allocated for thickening should be increased. There are advantages and disadvantages to each alternative that would need further evaluation in order to optimize the process.

The type and amount of carbon added to the WASSTRIP® reactor is a key process control parameter as well. This carbon is typically generated within the treatment stream of the plant. A number of different internal sources (i.e. sludges from different plant processes) were

FIGURE 11: FLUX CURVE FROM SETTLING DATA WITH UNDERFLOW AND OPERATING LINES FROM LABORATORY WASTE ACTIVATED SLUDGE SETTLING FOR WASTE ACTIVATED SLUDGE STRIPPING TO RECOVER INTERNAL PHOSPHORUS® DESIGN AT THE STICKNEY WATER RECLAMATION PLANT



Underflow and overflow lines developed based on average WAS SS concentration and flow.



Underflow and overflow lines developed by limiting the influent WAS flow to force lines under the flux curve.

fermented in laboratory batch tests. At the Stickney WRP, PS had higher total carbon concentrations and carbon production per total solids mass than other sources. In addition, mixing, seeding, and continuous feeding of PS were tested as ways to stimulate carbon production beyond amounts produced through endogenous decay of PS over time alone. Mixing had no significant impact on the rate or amount of carbon produced. However, seeding with PS stimulated carbon production (Figure 12). Increased carbon concentrations were also correlated to increasing initial solids concentrations of the sludge. Based on average maximum carbon concentrations seen through the fermentation trials, an estimated 1–2 MGD of PS fermentate is necessary for implementation of WASSTRIP®.

Technical Support to Biosolids Management Program. Technical support is provided to projects under the CSD Program, in which EQ, air-dried biosolids and composted biosolids are used in the Chicago metropolitan area, and to the Class B Biosolids Farmland Application Program. The technical support is provided to help biosolids users maximize the benefits they receive from the program and to ensure that the District and the users comply with applicable regulations and permits. The Division also conducts extensive marketing activities to promote the use of biosolids and composted biosolids under the CSD Program.

- CSD Program – The activities conducted in 2014 to promote and support the CSD Program include:

    1. Marketing activities and technical support on projects where 8,844 dry tons of EQ air-dried biosolids were used as a soil conditioner or topdressing fertilizer by four schools, 62 parks and suburban villages, five golf courses, one landscaping company, and two District properties. The 2014 biosolids distribution season was very short due to relatively wet summer and fall seasons, which resulted in a shortage of dried biosolids to fulfill demand of the CSD customers.

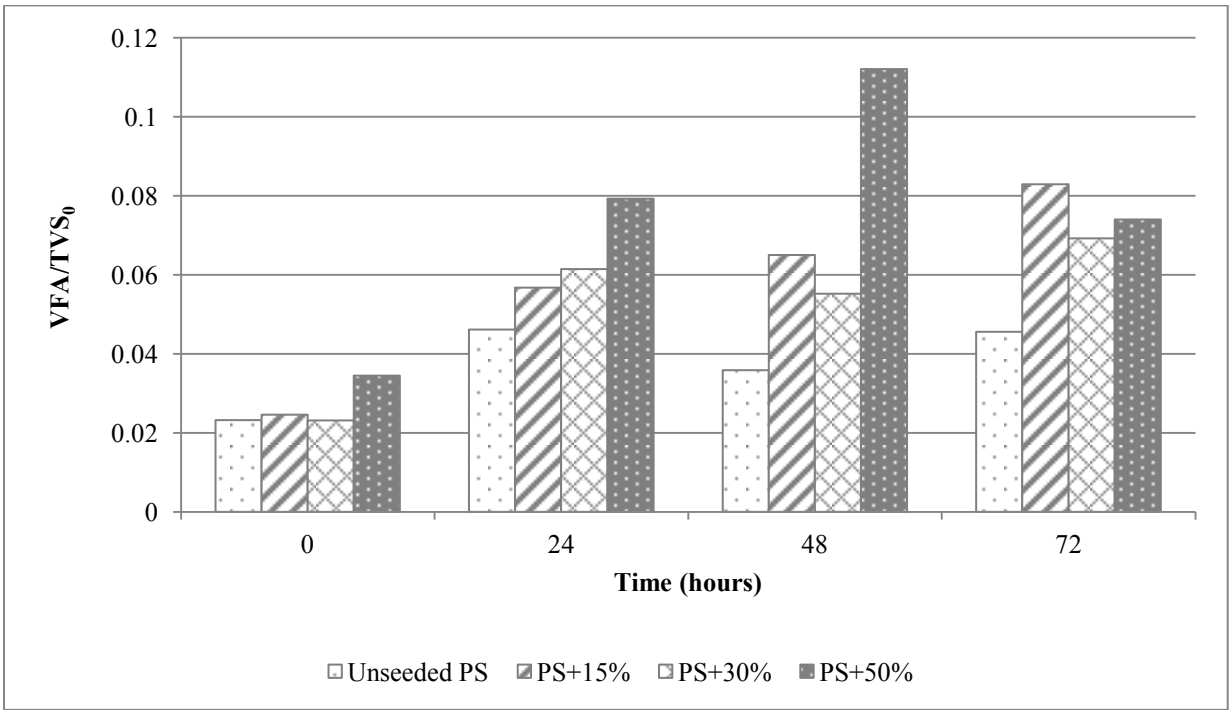
    2. Collaboration with the City of Chicago, especially the Chicago Park District, to promote the use of biosolids for development of parks and recreational areas in Chicago.

    3. Revision of biosolids information pamphlets.

    4. Collaboration with the Public Affairs Section to organize and conduct a Sustainability Summit in Chicago jointly hosted by the District and the United States Department of Agriculture W2170 Workgroup. Attendees learned about the District's green initiatives, sustainable practices, regulations pertaining to land application of biosolids, benefits of using biosolids for topdressing turf, and interacted with biosolids users.

    5. Performed a strengths, weaknesses, opportunities and threats analysis of the CSD program to identify strengths of the CSD Program that the District could build upon to further grow the program.

FIGURE 12: EFFECT OF FERMENTED PRIMARY SEEDED AND UNSEEDED PRIMARY SLUDGE AS MEASURED BY TOTAL CARBON PRODUCTION OVER INITIAL VOLATILE SOLIDS AND TIME



Note: % represents seed fraction.

6. Conducted 42 site visits to meet the biosolids users to answer their questions and to ensure biosolids were applied properly.

- Class B Biosolids Farmland Application Program – The activities the BU&SS Section conducted in 2014 to support the program include:

    1. Reviewed 177 field information packets for potential application fields under the Class B Biosolids Farmland Application Program. This includes reviewing the field location, buffers established for surface water, roads and dwellings, contacts made with neighbors and public officials, and soil pH and liming requirement, if any. Approval or disqualification notice for the proposed fields is submitted to the M&O Department.

    2. Conducted 33 field inspections and meetings with individuals, community groups, and public officials to answer questions and address concerns regarding the use of biosolids.

Biosolids Master Plan. The Biosolids Master Plan aims to identify the past and present and define the future path of the District's biosolids management program. In 2014, the first phase of the Biosolids Master Plan which documented the past and present status of the program was completed. This first phase addressed the following:

- Facilities and Processes.
- Social Considerations.
- Regulatory Considerations.
- Economic Considerations.

A significant result of completing the first phase of the plan was an in-depth financial analysis of existing processes coupled with recommendations to improve the financial accounting of our program. The second phase of the Biosolids Master Plan focuses on the future of the District's Biosolids program and will identify facility and process modifications to align with the District's strategic goals. The Biosolids Master Plan will be completed by the end of 2016. The PFCP section will maintain the Biosolids Master Plan and update it as necessary.

Calumet Water Reclamation Plant Final Biosolids Processing Technologies Evaluation. Recommendations for District facilities and processes are part of the Biosolids Master Plan. A task force was formed to evaluate technologies to improve the final biosolids processing at the Calumet Water Reclamation Plant. The task force included members from the M&O, Engineering, Procurement and Materials Management, Finance, and M&R Departments. The results of this evaluation will be used in the second phase of the overall Biosolids Master Plan. The major items that are being studied include:

- Reduce/eliminate odors due to current biosolids drying and handling procedures.

- Create readily available end-use products that are not dependent on weather conditions.

- Optimize operational land requirement.

- Increase utilization within Cook County.

- Ensure financial/environmental sustainability of the program.

The evaluation will provide feasible alternative strategies for biosolids management at the Calumet WRP, including production of new marketable products. The evaluation will be completed in summer 2015.

Evaluation of Permeable Pavement at the Stickney Water Reclamation Plant. In this project, the District is evaluating porous pavement technology for stormwater management in the Chicago metropolitan area. Three different permeable pavements (paver stone, concrete, and asphalt) were established on driving areas and parking slots on the general parking lot at the Stickney WRP. The permeability of the pavements measured in 2014 is shown in Table 10. Permeability of different surfaces varied and was in the order of asphalt > concrete > paver stone and was generally lower in the driving area than in the parking area. Vacuum cleaning of permeable pavements was conducted in May 2014, which helped in improving the permeability of all surfaces as compared to the values measured in 2013. Periodic site visits during periods of rainfall indicated no visible standing water or runoff on any of the permeable lots during all monitoring seasons. Standing water and runoff were observed in the impermeable control lot.

Streetscape and Sustainable Design Program. The District is conducting a collaborative project with the Chicago Department of Transportation and the United States Geological Survey for evaluating various green infrastructure best management practices (BMPs) to reduce stormwater and pollutant loads to the collection systems. Construction of the BMPs was completed in fall 2012, which consisted of permeable pavers, planter boxes, and bioswales. Immediately after construction of BMPs, the permeability of pavers and soil in the planter boxes and bioswales was measured. Permeability of permeable pavers at different sites measured during 2014 is shown in Table 11. Permeability declined with time; however, when pavers were cleaned, the permeability of pavers increased significantly. Permeability of bioswales is presented in Table 12. Permeability in the center of bioswales was higher as compared to near curb cut, probably due to higher sediment deposition close to the curb cut. Permeability of bioswales at both locations declined with time.

Native Prairie Landscaping. During 2014, the Division provided technical support for maintenance of the conventional and native prairie landscaping at the District's facilities.

Wastewater Microbiology Monitoring. Under this program, the WML conducts microscopic examination of ML samples from the District's seven WRPs to determine the relative abundance of protozoan and metazoan species, identify and quantify filamentous bacteria; and to characterize the health of the biological floc. The results are used to guide

TABLE 10: PERMEABILITY OF PERMEABLE SURFACES AT THE STICKNEY WATER RECLAMATION PLANT PARKING LOT IN 2014, SIX YEARS AFTER INSTALLATION

Area	Paver Stone	Concrete	Asphalt
	Permeability (inch/sec)		
Driving Area	0.15 ± 0.01	0.24 ± 0.01	0.32 ± 0.01
Parking Slot	0.30 ± 0.02	0.33 ± 0.03	0.55 ± 0.02

TABLE 11: CHANGES IN PERMEABILITY OF PERMEABLE PAVERS AT DIFFERENT LOCATIONS OF THE STREETSCAPE SITE

Date	Juarez Academy	Blue Island – North	Blue Island – South
	Permeability (inch/sec)		
10/31/12	0.15 ± 0.02	0.30 ± 0.06	0.34 ± 0.04
06/11/13	0.07 ± 0.02	0.07 ± 0.03	0.14 ± 0.03
07/26/13	No Cleaning	Pavers Cleaned	Pavers Cleaned
08/05/13	0.05 ± 0.01	0.75 ± 0.12	2.83 ± 0.37
May 2014	0.04 ± 0.01	0.35 ± 0.10	1.05 ± 0.24
July 2014	No Cleaning	Pavers Cleaned	Pavers Cleaned
August 2014	0.04 ± 0.01	0.72 ± 0.18	2.34 ± 0.37

TABLE 12: CHANGES IN PERMEABILITY OF BIOSWALE WITH TIME AT THE STREETSCAPE SITE

Date	Near Curb Cut	Center
	Permeability (inch/sec)	
10/31/12	0.19 ± 0.06	1.02 ± 0.31
06/11/13	0.15 ± 0.05	0.92 ± 0.26
08/05/13	0.13 ± 0.06	0.84 ± 0.20
05/12/14	0.09 ± 0.04	0.73 ± 0.15
10/10/14	0.08 ± 0.04	0.65 ± 0.19

research projects and to provide technical guidance to the M&O Department to optimize plant operations and to address treatment system upsets.

In 2014, detailed microscopic examinations were performed on 259 ML samples from the District's seven WRPs. Samples were collected on a rotating biweekly and/or monthly schedule. The data, recorded as counts per milligram of volatile SS (VSS) (counts/mg VSS), were compared to the WRP process control test parameters sludge volume index (SVI) and food-to-mass (F:M) ratio. Three key microbiological parameters, zoogleal mass index, shelled metazoa-protozoa count, and total filamentous bacteria count, were compared to plant performance. The microscopic assessment results were summarized and transmitted to the M&O Department and posted on the District's intranet.

Annual average microbiological data for 2014 were generated for each of the District's WRPs (Table 13). The average filamentous bacteria count ranged from 201–19,491/mg VSS in the Egan WRP to 254–2,359/mg VSS in the Stickney WRP. Excessive amounts of filamentous bacteria such as *Microthix parvicella* can interfere with sludge settling and may cause operational problems.

The average number of zoogleal masses ranged from 75–342/mg VSS in Stickney WRP to 12–146/mg VSS at the Kirie WRP (Table 13). The number of zoogleal masses is an indication of stressful conditions for the bacteria responsible for removing organic material from the wastewater. Microorganisms stress can be caused by adverse conditions such as changes in pH, low levels of toxicity after a heavy rain or other acute changes to the treatment system environment.

Evaluation of the Devon in-Stream Aeration Station Location. Dr. Charles Melching was hired to perform a water quality modeling study that would satisfy Special Condition 10 of the Terrence J. O'Brien WRP NPDES Permit, which states that the District "shall perform a waterway study to determine the option which will provide the greatest overall net benefit to the waterway considering: (1) identification of optimal relocation point of a potential new aeration station, (2) investing in rehabilitation of the existing Devon Aeration Station, or (3) utilizing other alternatives."

The main recommendations of Dr. Melching's modeling assessment and report were as follows:

- It would be most cost effective and beneficial to water quality to refurbish the existing Devon Avenue in-Stream Aeration Station (Devon IAS), rather than to relocate it.

- The Devon IAS should be operated based on real-time DO concentrations at Fullerton Avenue on the North Branch Chicago River, rather than the North Branch Pumping Station.

- The practice of operating the Devon IAS to supplement the performance of the Webster Avenue IAS is ineffective and should be discontinued.

TABLE 13: ANNUAL AVERAGE VALUES FOR KEY MICROBIOLOGICAL PARAMETERS AT THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S WATER RECLAMATION PLANTS IN 2014

WRP	Total Shelled – Metazoa-Protozoa Count/mg VSS	Zoogleal Mass Index Count/mg VSS	Filament Bacteria Count/mg VSS
Kirie	387	53	1,092[1]
Egan, Mean (2 Batteries)	553	102	2,753[2]
North	726	112	1,271
South	379	92	4,235
Stickney, Mean (4 Batteries)	308	215	669[3]
A	297	232	921
B	385	212	530
C	295	251	590
D	253	164	636
O'Brien, Mean (4 Batteries)	513	94	1,897[2]
A	836	123	1,553
B	481	103	2,175
C	449	89	1,925
D	285	59	1,935
Hanover Park, Mean (4 Batteries)	356	68	2,398[3]
A	223	57	2,587
B	446	70	2,268
C	356	64	2,489
D	397	79	2,247

TABLE 13 (Continued): ANNUAL AVERAGE VALUES FOR KEY MICROBIOLOGICAL PARAMETERS AT THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S WATER RECLAMATION PLANTS IN 2014

WRP	Total Shelled – Metazoa-Protozoa Count/mg VSS	Zoogleal Mass Index Count/mg VSS	Filament Bacteria Count/mg VSS
Lemont, Mean (3 Batteries)			—[4]
Composite	271	72	1,604
Calumet, Mean (5 Batteries)	283	108	1,112[2]
A	466	203	2,176
B	338	133	1,219
C	211	72	996
E1	224	82	727
E2	174	48	441

[1]Filament bacteria (Type 0041, Type 0675 and Type 1851).
[2]Filament bacteria (*Microthrix,* Type 0041, and Type 0675).
[3]Filament bacteria (*Microthrix,* Type 021N, Type 0041, Type 0675, and fungi).
[4]Filament bacteria (Type 021N).

Biological Monitoring of Tinley Creek. Contract 10-882-AF is a plan designed to stabilize eroding banks in Tinley Creek. Four sites were selected to conduct biomonitoring pre- and post-project completion to evaluate the ecological effects of this work. The data collected in 2014 was pre-stream bank stabilization and will serve as baseline data. Fish were collected three times from the four stations between July and September 2014. A total of 865 fishes, comprising 14 species and one hybrid species, was collected. Five of these were game species. The most abundant species collected was green sunfish. In August 2014, benthic organisms were collected and preserved once at each of the four stations using the IEPA method to collect aquatic macroinvertebrates from wadeable streams for biotic integrity assessments.

Scum Treatment Process Evaluation. In June, 2014 the PFCP Section began the task of investigating the costs and benefits of increasing the local fats, oils, and grease (FOG) limits for the District's industrial clients. An increase in the permitted limit of FOG discharge would benefit a client's pretreatment, and the Industrial Waste Division would decrease its workload associated with enforcing compliance. The PFCP Section reviewed different scum handling and utilization alternatives and conducted an assessment of scum treatment practices at all seven plants. The District's current practice is collecting scum from preliminary and final settling tanks, dewatering and sending the scum to dumpsters for landfill disposal. The District's average annual scum disposal costs are approximately $60,000 based on 2012–2013 actual scum removal costs. This evaluation showed that the low quantities of scum and low associated disposal costs do not provide strong economic basis for implementing alternative scum handling processes that would require significant capital costs.

Stickney Water Reclamation Plant Southwest Scum Process Evaluation. During the District-wide scum treatment process assessment, the PFCP Section identified several process inefficiencies with the scum removal practices at the Stickney WRP. The deficient condition of the scum removal mechanisms and a decreasing trend in scum removal quantities prompted an evaluation to improve the scum treatment process at the Stickney WRP. The West Side scum collection and removal process will be completely replaced by a recently awarded Engineering Contract, Contract 04-128-3P, that will install new Aerated Grit Facility and Primary Settling Tanks with a dedicated scum removal system. Therefore, the PFCP Section focused its efforts to evaluate the scum removal process at the Southwest (SW) part of the Stickney WRP. Towards the end of 2014, the PFCP Section began data collection and analysis to determine recommended improvements and vet a SW scum improvement project.

Odor Master Plan. In 2014, the PFCP Section started the development of a District-wide Odor Master Plan for the District. Significant odors will be prioritized and addressed at the WRPs, collection systems, pump stations and the solids processing facilities.

The goals of the Odor Master Plan include:

- Reviewing existing odor control technologies and procedures employed at the District for effectiveness and cost efficiency.

- Providing guidelines to supplement the current monitoring program to identify and prioritize odorous "hot spots" and to identify any technologies available for collecting and testing samples.

- Providing a menu of mitigation options to address different odorous compounds and treated air flows.

- Providing recommendations on dispersion modeling that will be used to assist with the identification and prioritization of odors as well as provide support for the design of odor mitigation projects.

- Identifying potential improvements the District's current community relations program with respect to odor.

Calumet Water Reclamation Plant Odor Evaluation. This evaluation was initiated in 2014 as an early deliverable of the Odor Master Plan. The EM&R Division, in conjunction with the Engineering and M&O Departments, formed an evaluation team to identify options to effectively treat the odorous areas at the Calumet WRP headworks, aerated grit facility, and sludge concentration building. These locations were identified as the most odorous areas of the plant by reviewing data collected under the existing Odor Monitoring Program. The sludge concentration building was excluded from this evaluation due to anticipated process changes in the building, and will be evaluated under a separate project.

Baseline data was collected from both the liquid and air streams in the junction chamber, screen building, and aerated grit facility to determine the existing odor compounds and their concentrations. This information, along with a comparison air flow of 12 air changes per hour, was used to compare different odor control technologies. A long list of options was identified for these areas which were narrowed down to a short list by the evaluation team. Utilizing a bio-trickling filter with the existing carbon adsorption system, increase the dosing at the existing sodium hypochlorite dosing station, and installing a high speed exhaust fan at the junction chamber are the short list of options identified for the headworks of the plant. Modifying existing ductwork and covering and treating the effluent channel and weirs with a carbon adsorption system were identified as the short list options for the aerated grit facility. The short list options for each area will be evaluated using a modified triple bottom line analysis that compares economic, technological, environmental, and social criteria. An evaluation matrix using subcategories of these criteria with percentages agreed upon by the evaluation team will be used to determine the best odor control option for each area. Results from this evaluation are anticipated to be completed in summer 2015.

The PFCP Section initiated the process of acquiring a "real time" odor monitoring system to improve odor monitoring at the Calumet WRP. The system will use "electronic noses," calibrated to plant-specific odor compounds coupled with a calibrated dispersion model and a weather station to produce "real time" odor plumes originating from the plant. These odor plumes can be used by plant personnel to: (1) identify odorous areas in the plant, (2) initiate corrective actions to prevent odors from reaching the surrounding communities, and (3) utilize the system's historian to determine if received odor complaints were in fact caused by the plant. This system is scheduled to be operational by early fall 2015.

Long Term Capital Planning. In 2014, the PFCP Section along with a number of interdepartmental workgroups began the process of developing a dynamic long-term capital plan (Plan) for the District focusing on the 5 to 20 year timeframe. To develop and gather the information needed to generate a Plan, a number of interdepartmental workgroups were formed

which included the following: Regulatory, District Initiative, Community, Budget/Finance, and Supporting Information. The information generated by these groups was used to develop a conceptual Plan. Once approved, this conceptual Plan was combined with the list of Capital Improvement Program (CIP) projects maintained by the Engineering Department. As the Plan and CIP were combined, projects serving as placeholders were removed as needed and conceptual level cost estimates were developed for projects listed in the Plan. The combination of the Plan and CIP (Combined Plan) were approved in early 2015. The next steps for the Long Term Capital Planning project include annual updates of the Combined Plan, so that the Combined Plan remains dynamic in response to changing conditions. In addition, a list of project evaluations with start dates was identified from the Plan. These evaluations are required to further develop the scope of the conceptual level projects. All information regarding the Long Term Capital Planning projects such as meeting minutes and deliverables are available to District staff on the District's intranet.

Stickney Water Reclamation Plant Racine Avenue Pumping Station Switchgear Evaluation. In 2014, the PFCP Section coordinated the review of Contract 09-183-3E, Transformer and Switchgear Replacement, with the Engineering and M&O Departments. The project was created in response to electrical supply issues encountered in 2008 and was planned to address: (1) short-circuit capacity, (2) source alignment between main sewage pumps and exciters/controls, and (3) bus capacity. The review of the contract goals in parallel with other work being conducted at the pump station determined that there was no longer a need for the contract. The PFCP Section recommended that the project be removed from the District's capital plan. While the evaluation recommended eliminating the contract, a structural inspection of the wet well was recommended.

Regulatory Review. The Division conducts reviews and provides technical support in response to imminent regulations that can potentially affect District operations. Some of these reviews are requested by professional affiliations or organizations. Some of the technical support is provided to the Law Department regarding various legal challenges and lawsuits. The following reviews were conducted in 2014:

- Provided data and review of the national water quality criteria for bacteria and NH_3-N.

- Reviewed documents and provided data in support of the IPCB Rulemaking concerning the CAWS UAA.

- Reviewed and commented on documents related to District and third–party NPDES permit appeals for the O'Brien, Calumet, and Stickney WRPs.

- Provided technical review of testimony and provided answers to Illinois Department of Natural Resources and third-party intervener questions concerning District's petition for modification of Lake Michigan discretionary diversion allocation.

- Provided technical review of expert witness reports, supplied data and information to District's expert witness, and helped the Law Department

provide the technical basis for legal arguments in the citizen's suit against the District.

- Attended workgroup meetings and reviewed/commented on draft revision of "Offensive Conditions" water quality standard, regarding algae.

Goal 5: Operations and Applied Research

Mainstream Shortcut Biological Nitrogen Removal. In 2014, a technology review was completed on mainstream shortcut biological nitrogen (N) removal (SCBNR) to reduce aeration energy in the mainstream and achieve total N removal. The details for the literature review have been summarized in M&R Department Report No. 14-30, "Shortcut Biological Nitrogen Removal Methodologies: Mainstream Partial Nitritation/Deammonification and Nitration/ Denitritation: A Literature Review." This literature review identified four process options to be further researched and evaluated for potential energy savings, N removal, and application at District facilities, as follows:

Option 1: Anaerobic + Nitritation/Denitritation through Modulating Aeration + Integrated Fixed-Film Activated Sludge + Reaeration

Option 2: Step-Feed SCBNR Activated Sludge Process

Option 3: Two Stage Process with 1st Stage for EBPR and High Rate Activated Sludge to Remove Carbon and Phosphorus and 2nd Stage for Deammonification for Ammonia and TN Removal

Option 4: Reducing Energy Consumption through Ammonia Based Aeration Control.

Options 1 and 3 have process uncertainties and would require significant infrastructure modification. The District will be collaborating with a university to conduct bench-scale studies for these two options to evaluate the process concept and establish design and operating parameters for potential full-scale application. Options 2 and 4 have been proven to work at full scale by other utilities and require minimum modification to the existing infrastructure. A District task force with members from the Engineering, M&R, and M&O Departments has been formed to conduct full-scale pilot tests for these two options. Option 4 is planned for evaluation at the Stickney WRP. Option 2 will be evaluated by converting one of the two aeration tanks in the North Battery at the Egan WRP. The pilot test results will be used to evaluate the next steps for full-scale implementation.

Routine Nitrification Monitoring. Nitrification performance is critical to all seven District WRPs in order to meet the NH_3-N limit in their respective NPDES permits. Once nitrification is inhibited or upset, it can take up to several weeks to recover. The WTPR Section plans to perform routine monitoring of the nitrification rates at the District's WRPs in the next several years to develop a seasonal nitrification rate baseline. This would be very beneficial to detect any nitrification problems and to provide guidance to the M&O Department for operational control to improve plant nitrification capacity. To perform this monitoring, a number of laboratory or in the field test methods for nitrification were evaluated. The preliminary results

suggest a modification of a specific oxygen uptake rate test can be used. This method modification will be developed further in 2015.

Evaluation of the Efficiency of Magnesium Hydroxide Solution (Thioguard®) for Mitigating Hydrogen Sulfide in Wastewater. A bench-scale test was initiated to evaluate the efficacy of THIOGUARD® (magnesium hydroxide [$Mg(OH)_2$] solution) in mitigating H_2S in the headspace of sewers. This study was conducted to determine the potential application of this product for future pilot testing in the Calumet service areas.

Seven sampling and bench tests were conducted during the study period of September 9 through 25, 2014. During each sampling event, two five-gallon grab samples of raw sewage were collected by staff of the Industrial Waste Division and the WTPR Section. The samples were collected from the Laramie Avenue interceptor or the West Side fine screens at the Stickney WRP. The wastewater samples were dosed at three different concentrations of the $Mg(OH)_2$ solution (42, 63, and 84 mg/L). The samples were mixed for two hours, then headspace H_2S was measured.

The results of the study showed the following:

1. At the dose levels of $Mg(OH)_2$, the highest solution pH achieved was 7.33 (Table 14), which is lower than the pH of 8.5, at which most of the sulfides in the wastewater would remain in solution.

2. The data collected were insufficient to evaluate the ability of $Mg(OH)_2$ to decrease the dissolved sulfide concentration.

3. For the tests when the initial headspace concentration was less than 2 ppmv H_2S (Group A), $Mg(OH)_2$ was able to decrease on average the headspace H_2S concentration by about four times at the dosage of 84 mg/L. For the tests when the initial headspace concentration was above 2 ppmv H_2S (Group B), $Mg(OH)_2$ was able to decrease on average the headspace H_2S concentration by about 15 times at the dosage of 84 $Mg(OH)_2$ mg/L but was not effective in reducing the H_2S to less than 1 ppmv during the tests.

4. Statistical analyses showed a significant difference in headspace H_2S between the control and 42, 63, and 84 $Mg(OH)_2$ mg/L doses for both Group A and Group B, although headspace H_2S in the control reactors decreased over time.

Evaluation of an Odor Control Technology for Wastewater. In order to address odor and corrosion problems in the District's interceptors and indoor facilities due to H_2S generation, one traditional and one advanced odor mitigation treatment were evaluated in 2013. Hydrogen peroxide (H_2O_2) alone (traditional) and H_2O_2 with a proprietary Fenton type catalyst (advanced) were evaluated in a laboratory bench-scale study on a mixture of Stickney raw wastewater and preliminary sludge. In 2014, the data evaluation was completed and a report was prepared.

Findings suggested that:

TABLE 14: pH VALUES BEFORE AND AFTER MIXING WITH DIFFERENT DOSAGES OF MAGNESIUM HYDROXIDE (THIOGUARD®)

Date	pH	Original[1]	Control with Mix	Dose 1[2]	Dose 2	Dose 3
9/9/2014	Before Mix	6.81				
	After Mix and H_2S Measurement[3]	—	6.79	6.95	7.05	6.83
9/11/2014	Before Mix	6.94				
	After Mix and H_2S Measurement	—	6.95	7.32	7.31	7.33
9/16/2014	Before Mix	7.07				
	After Mix and H_2S Measurement	—	6.91	7.14	7.22	7.22
9/18/2014	Before Mix	6.56				
	After Mix and H_2S Measurement	—	6.73	6.99	7.07	6.88
9/19/2014	Before Mix	6.65				
	After Mix and H_2S Measurement	—	6.78	7.02	7.04	7.16
9/22/2014	Before Mix	6.68				
	After Mix and H_2S Measurement	—	6.68	6.82	6.91	6.96
9/25/2014	Before Mix	6.63				
	After Mix and H_2S Measurement	—	6.67	6.75	6.9	6.91
Average	Before Mix	6.76				
	After Mix and H_2S Measurement	—	6.79	7.00	7.07	7.04

[1]"Original" is the raw sample without mixing or $Mg(OH)_2$ addition.
[2]Doses 1, 2, and 3 are 50, 75, and 100 gallons of THIOGUARD® per million gallons of wastewater, which are equivalent to 42, 63, and 84 mg $Mg(OH)_2$/L, respectively.
[3]"After Mix and H_2S Measurement" = after 2 hrs mix and 1 hr H_2S measurement.

1. The effectiveness for oxidation-reduction potential (ORP) increases and H_2S and dissolved sulfide decreases up to one hour of reaction time was similar for the H_2O_2 and the Fenton catalyst/H_2O_2 treatments after a single dose. However, because of the high variability of the response of the dissolved sulfide concentration and subsequently H_2S results in both treatments and the control, the effectiveness of H_2O_2 versus Fenton catalyst/H_2O_2 could not be determined. However, the consistency of the ORP results suggests that both treatments are effective in producing an aerobic environment where H_2S production would be suppressed.

2. The effective dose of H_2O_2 in the combined Fenton catalyst/H_2O_2 treatment was 18 percent of the H_2O_2 required for H_2O_2 alone, based on similar performance during the first hour after treatment.

3. The wastewater characteristics of the treated samples were variable and had a greater chemical oxygen demand (COD) concentration than what is expected in interceptor wastewater. The organic compounds that contribute to the COD concentration may be reactive with the H_2O_2 and Fenton catalyst/H_2O_2 treatments, reducing the effectiveness for H_2S suppression.

4. The initial reaction rate for the H_2O_2 and Fenton catalyst/H_2O_2 treatments was very fast for both treatments.

Corn Fertility Experiment at the Fulton County Site. Since 1973, the District has been conducting a corn fertility experiment on calcareous mine spoil at the Fulton County site. The purpose of this experiment is to evaluate the effect of long-term applications of anaerobically digested biosolids on crop yields, crop chemical composition, and mine spoil chemical composition. The experiment was designed to simulate biosolids application to fields at the site at agronomic and reclamation rates and to provide information that can be used for managing land application of biosolids for crop production. In 2010, these plots were abandoned and new plots were established in 2011.

The new long-term biosolids experimental plots were established in Field 83, which is on unmined land. The experiment was designed to obtain more information compared to the information received from the abandoned plots. The experiment will evaluate the effect of unaged biosolids to support the Farmland Application Program and the effect of aged, air-dried biosolids to support the CSD Program. The experiment is also aimed at collecting data to evaluate biosolids P management practices to address future state regulations that may stipulate P-based agronomic rates of biosolids. The experiment includes a chemical fertilizer treatment, annual application of two types of biosolids (Class B centrifuge-dewatered biosolids and Class A air-dried biosolids) at agronomic rate, one time application of biosolids at three high (reclamation) rates, and annual applications of vegetative compost at agronomic and reclamation rates. Therefore, there are eight treatments (one chemical fertilizer control, two compost references, two types of biosolids for annual agronomic rates, and three treatments of biosolids for land reclamation application) in this experiment. The corn yield and stover dry matter for 2014 are shown in Table 15.

TABLE 15: CORN GRAIN YIELD AND STOVER DRY MATTER AT THE BIOSOLIDS LONG-TERM EXPERIMENT AT THE FULTON COUNTY SITE[1] IN 2014

Treatment	Grain Yield	Stover Dry Matter
	Mg/ha	
Chem. fert. 225-50-85 (N-P-K) kg/ha/yr (Control 1)	10.0	7.7
Compost 33 Mg/ha/yr (Control 2)	9.9	7.8
Aged biosolids 33 Mg/ha/yr	10.4	7.5
Unaged biosolids 25 Mg/ha/yr	10.8	9.5
Aged biosolids 165 Mg/ha + 3/4 chem. fert. rate[1]	11.1	8.9
Aged biosolids 330 Mg/ha + 1/2 chem. fert. rate	10.7	7.9
Aged biosolids 495 Mg/ha + 1/4 chem. fert. rate	12.0	8.4
Compost 165 Mg/ha + 3/4 chem. fert. rate	11.1	8.1

[1]For the biosolids and compost plus chemical fertilizer treatments, the fertilizer was applied annually.

Biosolids Composting. The District started the biosolids composting initiative in 2011. The main goal of this initiative is to produce a value-added and odor-free biosolids product for distribution in the Chicago metro area. Biosolids are composted in windrows with wood chips obtained from the city of Chicago. In 2014, the EM&R staff monitored temperature in the windrows and advised M&O Department staff to manage the windrows as needed to comply with the time and temperature requirement to produce a Class A product. Samples of the final product were collected and analyzed for FC, volatile solids, nutrient content, and degree of odor to evaluate product quality (Table 16).

Plant Uptake of Perfluorinated Compounds in Biosolids-Amended Soil. The occurrence of perfluorinated compounds (PFCs) in biosolids and the potential risk of transport of these compounds through the food chain are emerging concerns that have to be addressed to ensure public acceptance and long-term sustainability of biosolids application to farmlands. The District collaborated with the USEPA Region 5 and the Colorado School of Mines (CSM) to generate data on the uptake of PFCs by plants grown in biosolids-amended soils for an evaluation of exposure risks to humans. As a part of this collaboration, the District conducted a three-year field study that consisted of plots amended with four rates of biosolids application each year, including control plots that received only the recommended rate of commercial fertilizers. All plots were planted with corn and four vegetable crops, i.e., tomatoes, zucchini, carrots, and lettuce. The soil and plant tissue samples were collected at the time of crop maturity and shipped to CSM for analysis of PFCs. Due to, shortage of funds, only a small number of samples were analyzed. The District established a contract with CSM to analyze more plant tissue samples from the field study to generate a dataset to adequately evaluate the uptake of PFCs by the vegetable crops grown in biosolids-amended soils. A final report summarizing the results will be prepared in 2015.

Nutrient Loss Reduction Research at Fulton County Site. Nutrient loss from agricultural fields is the primary source of N and P enrichment in lakes, rivers, and coastal waters of the United States. Reduction in N and P loss from agricultural fields can lead to significant reduction in Illinois N and P load to the Mississippi River. To contribute to Illinois statewide Nutrient Loss Reduction Strategy, the District initiated a multi-year nutrient loss reduction research project at the Fulton County site. In 2014, the five-year work plan for the research project was prepared. The work plan includes the development and demonstration of the effectiveness of several BMPs such as cover cropping, riparian vegetation buffer restoration, runoff irrigation, and bioreactor for nutrient loss reduction from agricultural fields.

Phosphorus Removal Using Phycoremediation. In 2013, the EM&R Division, in collaboration with the Engineering Department, evaluated many technologies for phycoremediation using algae for nutrient removal from wastewater treatment streams. In 2014, activities included review of a moving flat panel bioreactor developed at Iowa State University. A collaborative research project between the District and Iowa State University was developed to design and construct a greenhouse for testing a pilot-scale algae-based system for nutrient removal and recovery at the O'Brien WRP.

Microbial Source Tracking Study of the Chicago Area Waterway System. A collaborative research project with Argonne National Laboratory (ANL) was initiated to track the microbial sources in the CAWS as the District begins disinfecting to comply with the new primary contact use designated effluent bacteria limitations. The goal of the study is to

TABLE 16: BIOLOGICAL STABILITY, NUTRIENT CONCENTRATION, ODOR EVALUATION, AND PATHOGEN TEST OF COMPOSTED BIOSOLIDS PRODUCED BY CO-COMPOSTING WITH WOODCHIPS IN 2014

Constituent	Unit	Composted Biosolids	Target Level[2]
pH		6.2	NA
Total Solids	%	46.0	NA
Total Volatile Solids	%	54.0	NA
CO_2 Production	mg CO_2-C/g/d	0.24	<2
Total Kjeldahl Nitrogen	%	1.64	1.5–2.0
NH_3-N	mg/kg	25.1	NA
Total P	%	1.24	1.5–2.0
NO_3-N + NO_2-N	mg/kg	143	NA
Total K	%	0.55	0.1–0.3
Volatile Acids	mg/kg	217	NA
Odor Scoring[1]	0–10	2.1	<5
Fecal Coliform	MPN/g	43	<1,000

[1]Based on sniffing by an odor panel.

[2]The target level was established to meet the biosolids Environmental Management System requirement. The ranges for nutrients are values commonly seen in air-dried biosolids. The odor score for the air-dried biosolids was set at 5. The carbon dioxide production target level was the standard for stable composed (United States Composting Council). The fecal coliform target level was that used for Exceptional quality biosolids.

NA = Not applicable. Target not established.

understand the microbial community and their sources in the CAWS in response to the changes in FC levels in the final effluents due to WRP disinfection and frequency of CSO discharges due to TARP reservoir completion during the study period. The seven-year (2013–2019) research project is defined by three phases of facility improvements in the Calumet and Chicago River Systems. Disinfection facility construction at the Calumet and O'Brien WRPs (Chicago River System) are scheduled for completion in 2015. At both WRPs, disinfection will begin in the 2016 disinfection season, which is March through November. In the Calumet River System, the Thornton Composite Reservoir portion of the TARP, serving the south side of Chicago and south suburbs of Cook County, is scheduled for completion in 2015. In the Chicago River system, the McCook Reservoir is being constructed in two stages and Stage 1 is scheduled for completion in 2017. Therefore, the three phases of the project are defined as:

1. Phase I – Pre-disinfection and pre-TARP reservoir completion, in both Calumet and Chicago River Systems (2013–2015).

2. Phase II – Post-disinfection and pre-TARP reservoir completion, in the Chicago River Systems (2016–2017).

3. Phase III – Post-disinfection and post-TARP reservoir completion, in the Calumet River System (2016–2019) and in the Chicago River Systems (2018–2019).

During 2014, the study continued as scheduled. During March through November 2014, approximately 567 samples (water, sediment, effluent) were collected from 12 CAWS locations and two final effluent waters from the O'Brien and Calumet WRPs. Water and sediment samples were collected monthly (May-November). Water and sediment samples were analyzed for general chemistry and EC and/or FC. The genomic deoxyribonucleic acid (DNA) of samples was isolated and analyzed by ANL using two approaches:

1. Amplicon sequencing: The 16S rRNA genes of the environmental samples were amplified and sequenced through next-generation sequencing that gives information about the microorganism taxa present.

2. Shotgun metagenomics: The sequencing of the pool of genome fragments of the environmental sample that give information about the potential functions of the community.

The 2013 and 2014 samples and the genomic DNA collected have been isolated for amplicon sequencing. The genomic data mining of samples will be completed in 2015. The CAWS chemistry and microbial community data are fed into the DuFlow model with a series of environmental factors linking to land use and urban planning structure. The CAWS-Microbiome framework characterizes the good and bad members of the microbial community, thus providing a more complete picture of the sources of microbes in the CAWS.

South Branch Chicago River Slip Study. This study will determine which slips in the South Branch Chicago River (SBCR) have the most abundant aquatic life and why, and then determine if and how less productive slips could be modified to be more favorable to fish. The slips are off-channel bays (OCBs) that provide needed refuge for fish in the SBCR. The CAWS

has a limited number of OCBs and the SBCR slips are some of the largest OCBs in the system. The SBCR slips of interest are Mason's Slip, Stetson's Slip, and Arnold's Slip.

During 2014, each slip was assessed individually for sediment quality, quantity and quality of benthic invertebrates, fish abundance and health, and water quality. Hester-Dendy samplers were deployed and retrieved in Mason's, Stetson's, and Arnold's Slips. The slips were also sampled for fish twice, using a boat mounted pulse direct current electrofisher during 2014. A summary of the fish data is presented in Table 17. Sediment samples were collected at select locations in each of the slips in May. Overall, sediment from Arnold's Slip had the highest concentrations of most of the chemical constituents that were analyzed (Table 18). Fifteen organic priority pollutants were also detected in the slips, most of which were polycyclic aromatic hydrocarbons. Cross-sectional DO measurements were conducted in the slips at select transects in May, June, August, and October. During 2015, the SBCR slips will be sampled for fish and water quality. Cross-sectional data and the analysis of all data that were collected for this study will be included in a District report in 2016.

Effect of Treatment Plant Upgrades on Endocrine-Active Compounds Biological Recovery in an Effluent-Dominated Aquatic Ecosystem. In collaboration with St. Cloud State University, University of St. Thomas, and the College of Wooster, as part of a National Science Foundation grant, the AEWQ Section is committed to provide data, sample collection, and mobile laboratory experiment support for a four-year period from 2014 through 2017. The goal of this research is to assess how the effluent disinfection being implemented at the O'Brien and Calumet WRPs will reduce the overall load of endocrine-active compounds in the effluent and if there will be a biological effect to the native fish populations.

In 2014, the AEWQ section collected monthly water samples from eight sampling sites, collected wild sunfish from four sites in the spring, exposed caged bluegill sunfish to ambient water for 14 days at six locations in the spring and conducted on-site mobile laboratory exposure experiments at the Calumet and O'Brien WRPs in the spring and fall. The monthly water samples were analyzed for select compounds with known endocrine activity and used for bioassay based estimation of estrogenic and androgenic activity. The wild and caged sunfish were assessed for their health and reproductive potential.

The mobile laboratory experiments involved the use of a mobile exposure laboratory trailer (MELT) that was set up with a flow-through design to expose male fathead minnows to various concentrations of the final effluent. The MELT is used to evaluate the relationship between a water source and observed endocrine disruption and the compounds that may be responsible. After seven days of continuous exposure, the male fathead minnows were analyzed for various biological endpoints to identify any biological effects from exposure to WRP effluents. The 2014 results from the two years pre-disinfection (2014 and 2015) and the two years post-disinfection (2016–2017) will be combined.

Research Collaboration. The Division staff participated in the following collaborative research activities:

- WERF Research Projects – The Division staff served on project sub-committees and provided technical review of the research projects and

TABLE 17: SAMPLING TIME, NUMBER, WEIGHT, AND NUMBER OF SPECIES FOR FISH COLLECTED FROM SLIPS IN THE SOUTH BRANCH CHICAGO RIVER DURING 2014

	Sampling Time (seconds)	Number of Fish	Weight (kg)	Number of Species		Most Abundant Species
				Total	Game	
Mason's Slip	2,826	316	14	12	5	Gizzard shad, largemouth bass, bluntnose minnow
Stetson's Slip	7,525	944	48	19	8	Gizzard shad, pumpkinseed, largemouth bass
Arnold's Slip	3,723	457	26	16	8	Gizzard shad, pumpkinseed, largemouth bass
Total	14,074	1,717	89	22	10	Gizzard shad, Pumpkinseed, largemouth bass

TABLE 18: MEAN CONCENTRATIONS OF CONSTITUENTS IN SEDIMENTS COLLECTED FROM SOUTH BRANCH CHICAGO RIVER SLIPS DURING 2014

Constituents	Units	Mason's Slip	Stetson's Slip	Arnold's Slip
Total Solids	%	29	26	19
Total Volatile Solids	%	19	14	18
Ammonia Nitrogen	mg/kg	136	194	455
Nitrate Nitrogen	mg/kg	9	7	11
Total Kjeldahl Nitrogen	mg/kg	4,252	4,483	7,868
Total Phosphorus	mg/kg	3,466	3,683	6,702
Phenols	mg/kg	0.458	0.495	1.538
Cyanide	mg/kg	1.054	0.917	2.296
Arsenic	mg/kg	<5	<5	6
Cadmium	mg/kg	9	6	7
Chromium	mg/kg	104	86	91
Copper	mg/kg	251	236	277
Iron	mg/kg	22,467	23,870	22,919
Lead	mg/kg	238	192	241
Manganese	mg/kg	342.3	363.7	329.7
Mercury	mg/kg	0.744	0.708	0.786
Nickel	mg/kg	32	32	33
Silver	mg/kg	6	5	5
Zinc	mg/kg	625	653	845

regulatory documents. This included attendance at meetings, evaluation of project proposals, and a final report.

- WEF and WERF Leaders Innovation Forum for Technology (LIFT) – Division staff served on working groups for different technical areas. This included attendance at meetings and sharing information and collaborating with other utilities.

- National Association of Clean Water Agencies – Division staff participated as an advisory member of the National Association of Clean Water Agencies' Recreational Criteria Workgroup that conducted review of the USEPA's efforts to develop new recreational water quality criteria.

- Lake Michigan Total Maximum Daily Load for Illinois Beaches, USEPA Region 5, and the IEPA.

- Testing and Refinement of the Trace Organics Screening Tool – The AEWQ section collaborated on a WERF project (CEC6R12) that is examining trace organic compounds and tools that can be used to support assessments of risk from these compounds to the aquatic community. The District's Egan WRP and its receiving water (Salt Creek) were one of three sites chosen to apply these screening tools. AEWQ provided WRP and waterway data, and assisted with a weeklong field sampling and data WERF report is expected in 2015.

Outreach Activities

The EM&R Division staff continued outreach support activities to promote public awareness and acceptance of District operations. The staff attended and presented at the local and national meetings and provided support to the following activities.

- Science Fair Participation. Staff participated and judged middle school and high school science fairs. Staff offered encouragement to students and provided insight on research, report writing, and the scientific process.

- In response to Midwest medical centers regarding the Centers for Disease Control and Prevention (CDC) guidance on Ebola to wastewater workers, a factsheet addressing concerns and questions was developed as an advance planning for public health emergencies. The factsheet includes the World Health Organization, CDC reports and webcast sponsored by WEF and WERF on the spread and safety of Ebola virus to wastewater workers.

- The AMB Section participated in the District's internship program by providing a learning opportunity to a student in her essential career skills development in environmental microbiology.

- Wastewater Microbiology Hands-On Workshop. As a member of the WEF program, staff presented at the WEF Technical Exhibition and Conference, sharing knowledge on wastewater microbes in an interactive on-site workshop

session. The workshop presented real-life examples covering several different aspects of wastewater process control.

- Laboratory Tours. Laboratory tours are conducted as part of the District's tours and are also conducted, upon request, for any person or group interested in learning about the EM&R Division's laboratory operations. Individual and group tours were provided in 2014.

- Waterway Tours In 2014, the AEWQ Section provided eight tours of the Chicago Area Waterway System on the M&R Department research and monitoring vessel to various groups, including area legislators.

- AEWQ Section staff participated in 11 local parades with the District float.

APPENDIX AI
ENVIRONMENTAL MONITORING AND RESEARCH DIVISION EMPLOYEES 2014

Environmental Monitoring and Research Division

Heng Zhang, Assistant Director of M&R (121 [8])

Vacant, Secretary

Albert E Cox, Environmental Monitoring and Research Manager; Zainul Abedin, Biostatistician; Edward Podczerwinski, Managing Civil Engineer; Paramasivam Srinivasan, Senior Environmental Research Scientist; Kathleen A Quinlan, Senior Administrative Specialist; Cynthia Colvin, Administrative Specialist

Wastewater Treatment Process Research (122 [16])

Joseph Kozak
Supervising Environmental Research Scientist
Laura Franklin
Administrative Specialist

Senior Env. Research Scientist

Ali Oskouie
Kamlesh Patel
Fenghua Yang

Associate Env. Research Scientist

Weizhe An
Doris Bernstein
Dale MacDonald
Dongqi Qin

Laboratory Technician II

Thota Reddy
Vacant

Laboratory Technician I

Marc Byrnes
Robert Bodnar
Shawn Kowalski
Harold Robinson
Edgar Rojas Herbas
Luke Toonen

Biosolids Utilization & Soil Science (123 [12])

Lakhwinder Hundal
Supervising Environmental Soil Scientist
Coleen Maurovich
Administrative Specialist

Senior Env. Soil Scientist

Kuldip Kumar
Guanglong Tian

Associate Env. Soil Scientist

Dominic Brose
Pauline Lindo
Olawale Oladeji

Assistant Env. Chemist

Minaxi Patel

Laboratory Technician II

Upendra Patel
Tiffiany Tate

Laboratory Technician I

Maricela Sabido

Field and Laboratory Technician

Jacob Baylor
Jeffrey Simpson

Laboratory Assistant
Andrew Scott

Analytical Microbiology & Biomonitoring (124 [15])

Geeta Rijal
Supervising Environmental Microbiologist
Marie Biron
Administrative Specialist

Senior Env. Microbiologist

Auralene Glymph-Martin

Associate Env. Microbiologist

Kaylyn Patterson
Vacant

Assistant Env. Microbiologist

Hemangini Shukla

Laboratory Technician II

Kathleen Jackowski
James Kaehn
Andrea Maka
Shafiq Rahman

Laboratory Technician I

Meera Advani
Jeffrey Kowar
Brandon Reynolds
James Southworth IV
Laboratory Assistant
Petronela Paul
Reginald Rembert

Aquatic Ecology & Water Quality (126 [22])

Jennifer Wasik
Supervising Aquatic Biologist

Senior Aquatic Biologist

Thomas Minarik

Associate Aquatic Biologist

Dustin Gallagher
Justin Vick

Assistant Aquatic Biologist

Nicholas Kollias

Laboratory Technician II

Angel Whitington
Vacant
Vacant
Vacant

Laboratory Technician I

Matthew Bryan
Rolinda Dominguez

Patrol Boat Operator

Kazimier Iwasyk
John Jacob
Vacant

Pollution Control Technician II

Ryan Kirkland
James Rivera

Pollution Control Technician I

Janis Dickerson
Kara Gavin
Patricia Sandrik
David Zintak

Process Facility Capital Planning (129 [11])

Principal Civil Engineer

Jonathan Grabowy

Senior Civil Engineer

Matthew McGregor
Daniel Salabaj

Senior Env. Research Scientist

Judith Moran-Andrews

Senior Electrical Engineer

Mohammed Nator

Senior Mechanical Engineer

Brent Bedell

Associate Civil Engineer

Peter O'Brien

Associate Electrical Engineer

Predrag Ungureanu

Associate Env. Research Scientist

Avanti Kavathekar

Associate Civil Engineer

Ghanshyam Patel

Associate Mechanical Engineer

Jonathan Villegas

APPENDIX AII
MEETINGS AND SEMINARS 2014, ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

MEETINGS AND SEMINARS 2014, ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

January 2014

Illinois Association of Wastewater Agencies, Technical Committee Meeting (and follow-up meetings throughout the year), Utica, Illinois.

Illinois Water Environment Association and the Illinois Section of the Central States Water Environment Association, 2014 Government Affairs, Burr Ridge, Illinois.

Industrial Water, Waste, and Sewage Group Meeting (and follow-up meetings throughout the year), Chicago, Illinois.

Midwest Water Analyst Association, Winter Expo 2014 (and follow-up meetings throughout the year), Kenosha, Wisconsin.

United States Composing Council's 22nd Annual Conference, Oakland, California.

Water Environment Research Foundation, 9th Annual Research Forum, New Orleans, Louisiana.

February 2014

DuPage River Salt Creek Workgroup, Annual Meeting (and follow-up meetings throughout the year), Lombard, Illinois.

Gasvoda and Associates, Latest Evolution in Flow Monitoring and Technologies Seminar, Calumet City, Illinois.

Illinois Fisheries Society Geographic Information System for Fisheries Science Workshop, Macomb, Illinois.

Midwest Stream 5th Annual Restoration Symposium, La Crosse, Wisconsin.

Partnership for River Restoration and Science in the Upper Midwest, Annual Stream Restoration Symposium, La Crosse, Wisconsin.

Teledyne ISCO, Infiltration & Inflow Monitoring and Profiling Seminar, Lombard, Illinois.

Water Environment Research Foundation, Research Council Meeting, Alexandria, Virginia.

March 2014

Illinois Chapter of the American Fisheries Society, 52nd Annual Meeting, Bloomington, Illinois.

Illinois Section of the American Water Works Association and Illinois Water Environment Association, WaterCon 2014, Joint Conference and Exposition, Springfield, Illinois.

MEETINGS AND SEMINARS 2014, ENVIRONMENTAL MONITORING AND RESEARCH DIVISION (Continued)

Michigan Water Environment Association Annual Conference, Biosolids Optimization, Big Rapids, Michigan.

Midwest Chapter Society of Environmental Toxicology and Chemistry Annual Meeting, Chicago, Illinois.

Occupational Safety and Health Administration Safety Day Seminar 2014, Waubonsee, Illinois.

Pittsburg Conference on Analytical Chemistry and Applied Spectroscopy, 2014, Conference and Expo, Chicago, Illinois.

SET Environmental Inc, Annual Department of Transportation Hazardous Waste and Materials Management Seminar, Lombard, Illinois.

United States Environmental Protection Agency, Advanced Environmental Crimes Investigation Training Program (and follow-up meetings throughout the year), Gynco, Georgia.

University of Chicago Booth School of Business, Chicago Management Conference, Chicago, Illinois.

April 2014

American Dental Association Spill Prevention and Mitigation Spring Seminar, Lisle, Illinois.

Chicago Wilderness Congress, Track Greening Infrastructure, Chicago, Illinois.

Earth Awareness Day and 4th Annual Exposition, South Suburban College, South Holland, Illinois.

National Fish and Wildlife Foundation Chicago Calumet Rivers Fund Meeting (and follow-up meetings throughout the year), Chicago, Illinois.

Water Environment Federation: Algae Bioreactors as a Cost-Effective Approach for Enhanced Nutrient Removal-Approaching it from all sides, Webinar, Stickney Water Reclamation Plant, Cicero, Illinois.

May 2014

American Society for Microbiology, 2014 Meeting, Boston, Massachusetts.

Illinois Association of Wastewater Agencies, Technical Committee Meeting (and follow-up meetings throughout the year), Utica, Illinois.

Illinois Environmental Protection Agency, Flexibility for Using Composed Biosolids Under Controlled Solids Program Meeting, Springfield, Illinois.

MEETINGS AND SEMINARS 2014, ENVIRONMENTAL MONITORING AND RESEARCH DIVISION (Continued)

National Association of Clean Water Agency, Annual Pretreatment and Pollution Prevention Workshop, Minneapolis, Minnesota.

Water Environment Federation, Odors and Air Pollutants Conference, Miami, Florida.

Water Environment Federation Residuals and Biosolids Conference, Sustainability Made Simple: Facilitating Resource Recovery, Austin, Texas.

June 2014

CareerTrack, Project Management: Beyond the Basics Seminar, Chicago, Illinois.

Restek, Gas Chromatography-Mass Spectrometry Fundamental Seminar, Chicago, Illinois.

W2170 Research Group, Soil in the City Decennial Conference 2014, Chicago, Illinois.

Water Environment Federation: What Does the Proposed "Waters of the United.States" Rule Mean for Water Utilities, Webinar, Stickney Water Reclamation Plant, Cicero, Illinois.

July 2014

National Association of Clean Water Agencies, Summer Conference, Portland, Oregon.

Soil and Water Conservation Society, 69th Annual Conference, Lombard, Illinois.

Water Environment Federation, Chicago Water Summit 2014: Global Lessons from Great Water Cities, Chicago, Illinois.

August 2014

Chicago Metropolitan Agency for Planning, Green Infrastructure Workshop, Chicago, Illinois.

Fox River Study Group Meeting (and follow-up meetings throughout the year), Elgin, Illinois.

National Environmental Monitoring, The Future of Environmental Measuring and Monitoring Conference, Washington, D.C.

Thermo Scientific, Liquid Chromatography/Gas Chromatography/Inductively Coupled/Mass Spectrometry and Atomic Spectroscopy Seminar, Schaumburg, Illinois.

September 2014

Illinois Association of Wastewater Agencies, Annual Meeting, Lisle, Illinois.

Illinois Water Environment Association, the Illinois Association of Wastewater Agencies, and the Illinois Association of Water Pollution Control Operators Joint 2014 Nutrient Removal and Recovery Workshop, Addison, Illinois.

Water Environment Federation, Technical Exhibition and Conference 2014, New Orleans, Louisiana.

October 2014

American Chemical Society: Planet of Viruses, Webinar, Stickney Water Reclamation Plant, Cicero, Illinois.

Friends of the Chicago River, Annual Chicago River Summit, Chicago, Illinois.

Illinois Environmental Protection Agency Nutrient Standard Workgroup Meeting, Springfield, Illinois.

Illinois Department of Public Health Title 77: Public Health, Part 465, Certification and Operation of Environmental Laboratories Rule Changes, Glencoe, Illinois.

Illinois Water Conference 2014, Champaign-Urbana, Illinois.

Illinois Water Environment Association, Plant Operations and Maintenance Seminar, Loves Park, Illinois.

International Water Association Specialist Conference on Global Challenges: Sustainable Water Treatment and Resource Recovery, Kathmandu, Nepal.

iPACS (internet POTW Administrative and Compliance System), Annual User Group Conference, Brunswick, New Jersey.

Marquette University, Emerging Contaminants in Water and Wastewater Short Course, Milwaukee, Wisconsin.

University of Wisconsin-Madison, Essentials of Hydraulics for Civil and Environmental Professionals Course, Madison, Wisconsin.

November 2014

AGree Transforming Food & Ag Policy Event, Washington, D.C.

American Society of Agronomy, Crop Science Society of America and Soil Science Society of America International Annual Meeting, Long Beach, California.

MEETINGS AND SEMINARS 2014, ENVIRONMENTAL MONITORING AND RESEARCH DIVISION (Continued)

American Water Works Association Webinars: Preparing for Ebola in the Water Sector, Webinar, Stickney Water Reclamation Plant, Cicero, Illinois.

Central States Water Environment Association 2014 Biosolids Mini-Seminar, Chicago, Illinois.

Technical and Policy Advisory Workgroup for the Asian Carp Regional Coordinating Committee, Chicago, Illinois.

Water Environment Federation: How We "See" Pathogens: Using Better Indicators to Detect Pathogen Presence, Webinar, Stickney Water Reclamation Plant, Cicero, Illinois.

Water Environment Federation and Water Environment Research Foundation, Wastewater Worker Safety: Addressing Concerns on Ebola in Wastewater, Webinar, Stickney Water Reclamation Plant, Cicero, Illinois.

December 2014

Great Lakes Commission Coastal Science Strategy Workshop, Mount Prospect, Illinois.

Northeastern Illinois Public Safety Training Academy, Hazardous Materials Incident Management System Event, Glenview, Illinois.

Public Health District, Ebola Response Table Top Exercise (TTX), Berwyn, Illinois.

APPENDIX AIII
PRESENTATIONS 2014, ENVIRONMENTAL MONITORING
AND RESEARCH DIVISION

PRESENTATIONS 2014, ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

January 2014

None

February 2014

None

March 2014

"Fate and Behavior of Pharmaceuticals and Personal Care Products in Land Applied Biosolids," Presented at the Michigan Water Environment Association Annual Conference, Big Rapids, Michigan, by L. S. Hundal. PP

April 2014

"Converting Biosolids to Fertilizer, Where it Comes from, How it's Treated for Safe and Beneficial Uses, and Some Examples of Various Applications," Presented at the 4th Annual Earth Awareness Day and Exposition, South Suburban College, South Holland, Illinois, by L. S. Hundal. PP

"Monitoring Stormwater Best Management Practices in the Chicago Streetscapes Program," Presented at the Chicago Wilderness Congress, Track Greening Infrastructure, by J. Duncker, K. Kumar, and D. Leopold. PP

May 2014

"The Chicago River Microbiome Project: Tracking Microbial Sources," Presented at the American Society for Microbiology 2014 General Meeting, Boston, Massachusetts, by G. Rijal. PS

"Fate and Risk Characterization of Trace Organic Compounds in Land Applied Biosolids," Presented at the Water Environment Federation Residuals and Biosolids 2014, Sustainability Made Simple: Facilitating Resource Recovery, by L. S. Hundal. PP

June 2014

"A Research Recovery Perspective for Improving Quality and Productivity of Urban Soils," Presented at the Soil in the City Decennial Conference 2014, Chicago, Illinois, by D. Brose, K. Kumar, L.S. Hundal, A. Cox, H. Zhang, and T. Granato. PP

"Challenges to Urban Stormwater Management in the 21st Century." Presented at the Soil in the City Decennial Conference, Chicago, Illinois, by T. C. Granato. PP

"Performance and Challenges of Stormwater Management Using Green Infrastructure at Sustainable Greenscapes," Presented at the Soil in the City Decennial Conference, Chicago, Illinois, by J. Duncker and K. Kumar. PP

July 2014

None

August 2014

None

September 2014

None

October 2014

"Brownfields and Renewing Urban Soils: A Resource Recovery Approach," Presented at Purdue University, West Lafayette, Indiana, by D. Brose. PP

"Fate and Risk Characterization of Trace Organic Compounds in Land Applied Biosolids," Presented at the Marquette University's Two Day Short Course "Fate, Effects, regulations and Public Relations related to Micropollutants in Drinking Water, Wastewater and Land Applied Biosolids," Milwaukee, Wisconsin, by L. S. Hundal and K. Kumar. PP

"Implementation of a Site-Specific Enhanced Biological Phosphorus Removal Process (AAnO) Using Existing Infrastructure at the Stickney Water Reclamation Plant." Presented at the Water Environment Federation, Technical Exhibition and Conference 2014, New Orleans, Louisiana, by D. Qin. PP and PS

"Introduction to Activated Sludge: Microbiology, Processes and Modeling," Presented at the International Water Association Specialist Conference on Global Challenges: Sustainable Water Treatment and Resource Recovery, Kathmandu, Nepal, by G. Rijal. PP

"Microbiological Assessment of Enhanced Biological Nutrient Removal Processes at the Metropolitan Water Reclamation District of Greater Chicago," Presented at the International Water Association Specialist Conference on Global Challenges: Sustainable Water Treatment and Resource Recovery, Kathmandu, Nepal, by G. Rijal. PP

"Shortcut Biological Nitrogen Removal for Sustainable Wastewater Treatment and Achieving Energy Neutrality." Presented at 2014 Illinois Water Conference in Champaign-Urbana, Illinois, by F. Yang. PP

"Utility Forum: the Metropolitan Water Reclamation District of Greater Chicago," Presented at the International Water Association Specialist Conference on Global Challenges: Sustainable Water Treatment and Resource Recovery, Kathmandu, Nepal, by G. Rijal. PP

November 2014

"Metropolitan Water Reclamation District Initiatives and Regulatory Update." Presented at the Industrial Water, Waste and Sewage Group, November Monthly Meeting, Chicago, Illinois, by T. C. Granato. PP

December 2014

"Metropolitan Water Reclamation District of Greater Chicago's Efforts of Implementing Enhanced Biological Phosphorus Removal at Its Major Water Reclamation Plants." Presented at the Metropolitan Water Reclamation District of Greater Chicago's Monitoring and Research Department's Monthly Seminar, Cicero, Illinois, by D. Qin and Y. Lefler. PP

PP=Available as PowerPoint Presentation.
PS=Poster Presentation.

APPENDIX AIV
PAPERS PUBLISHED 2014, ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

PAPERS PUBLISHED 2014, ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

Lukicheva, I., K. Pagilla, G. Tian, A. Cox, and T. Granato. "Enhanced Stabilization of Digested Sludge During Long-Term Storage in Anaerobic Lagoons." *Water Environment Research,* 86: 291-295, 2014.

Minarik T., J. Vick, M. Schultz, S. Bartell, D. Martinovic-Weigelt, D. Rearick, and H. Schoenfuss, "On-Site Exposure to Treated Wastewater Effluent Has Subtle Effects on Male Fathead Minnows and Pronounced Effects on Carp." *Journal of the American Water Resources Association*, 50(2): 358-375, 2014.

Zarraoniandia, I., J. Marcel, H. Ssegane, M. Urgun Demirtas, G. Rijal, M.C. Negri, J.A. Gilbert, "The Chicago River Microbiome Project: Tracking Pathogen Sources." *American Society for Microbiology,* General Meeting, Abstract Proceedings, 2014.

Zhai, W., D. J. Moschandreas, G. Tian, D. Venkatesan, and K. E. Noll. "Degradation Rate Model Formulation to Estimate Soil Carbon Sequestration from Repeated Biosolids Application." *Soil Science Society of America Journal,* 78: 238-247, 2014.

APPENDIX AV
MONITORING AND RESEARCH DEPARTMENT 2014 SEMINARS

APPENDIX AV

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
MONITORING AND RESEARCH DEPARTMENT 2014 SEMINAR SERIES

January 31, 2014 ***What is Community-Associated Methicillin-Resistant Staphylococcus Aureus (MRSA)?*** Professor Michael David, Assistant Professor of Medicine, Department of Medicine, University of Chicago, Chicago, Illinois

February 21, 2014 ***Metropolitan Water Reclamation District of Greater Chicago (District) Stickney Water Reclamation Plant Nitrification Upset and Response,*** Mr. Brett Garelli, Deputy Director of Maintenance and Operations, Maintenance and Operations Department (M&O), Mr. Joseph Cummings, Assistant Treatment Plant Operator I, M&O and Ms. Auralene Glymph-Martin, Senior Environmental Microbiologist, Monitoring and Research Department (M&R), District, Chicago, Illinois

March 28, 2014 ***Research in Algae for Nutrient Uptake,*** Professor Belinda Sturm, Department of Civil, Environmental, and Architectural Engineering, University of Kansas, Laurence, Kansas

April 25, 2014 ***Generating Energy through Co-Digestion Using Anaerobic Digesters at Wastewater Resource Recovery Facilities in the City of Fort Worth,*** Dr. Ana J. Pena-Tijerina, Technical Services Manager, Village Creek Water Reclamation Facility, Fort Worth, Texas

May 30, 2014 ***Fluorescence Spectroscopy to Quantify Treatment of Wastewater by Ozonation and Advanced Oxidation Processes: On Line Measurement of Trace Organics Removal,*** Professor Gregory Korshin, Department of Civil and Environmental Engineering, University of Washington, Seattle Washington

June 27, 2014 ***Maximizing Community Value: Social, Environmental and Financial Benefit/Cost Analysis at Seattle Public Utilities,*** Mr. Tim Steel, Principal Economist, Seattle Public Utilities, Seattle Washington

July 25, 2014 ***Chicago Beaches Innovative Water Quality Monitoring Approach to Predict Water Quality,*** Ms. Meredith Nevers, Research Ecologist, United States Geological Survey, Porter, Indiana and Ms. Cathy Breitenbach, Director of Green Initiatives, Chicago Park District, Chicago, Illinois

August 22, 2014 ***Fate of Engineered Nanomaterials in Wastewater Biosolids, Land Application and Incineration,*** Professor Paul Westerhoff, School of Sustainable Engineering and The Built Environment, Arizona State University, Tempe, Arizona

September 26, 2014 **Using Thermal Energy in Treated Wastewater Effluent for Building Heating and Cooling,** Mr. Gary Thalken, Sanitary Engineer, Waste Water Treatment Plant, Lincoln, Nebraska

October 24, 2014 ***Science of Climate and Change,*** Professor David Archer, Department of Geophysical Sciences, University of Chicago, Chicago, Illinois

November 21, 2014 **2014 Report Card for Illinois Infrastructure-Including Wastewater Sector**, Mr. Patrick Lach, President of the Illinois Section, American Society of Civil Engineers, Chicago Illinois

December 12, 2014 ***District's Endeavor to Implement Enhanced Biological Phosphorus Removal Update,*** Dr. Joseph Kozak, Supervising Environmental Research Scientist, M&R, District, Chicago Illinois

RESERVATIONS REQUIRED (at least 24 hours in advance); PICTURE ID REQUIRED FOR PLANT ENTRY
CONTACT: Dr. Heng Zhang, Assistant Director of Monitoring and Research, EM&R Division, (708) 588-4264 or (708) 588-4059
LOCATION: Stickney Water Reclamation Plant, Lue-Hing R&D Complex, 6001 West Pershing Road, Cicero, IL 60804; TIME: 1:30 P.M.
NOTE: These seminars are eligible for Professional Development Credits/CEUs