MONITORING AND RESEARCH DEPARTMENT

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MONITORING AND RESEARCH DEPARTMENT

2015

ANNUAL REPORT

December 2016

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

MONITORING AND RESEARCH DEPARTMENT

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ANNUAL REPORT

Monitoring and Research Department
Thomas C. Granato, Director

December 2016

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LIST OF ACRONYMS

Abbreviation/Acronym	Definition
ALD	Analytical Laboratories Division
Argonne	Argonne National Laboratory
BMPs	Best Management Practices
BOD	Biochemical Oxygen Demand
CAWS	Chicago Area Waterway System
CDC	Center for Disease Control and Prevention
CIP	Capital Improvement Program
DO	Dissolved Oxygen
EC	E. coli
EBPR	Enhanced Biological Phosphorus Removal
EM&RD	Environmental Monitoring and Research Division
FC	Fecal Coliform
GIS	Geographical Information System
HASMA	Harlem Avenue Solids Management Area
IDPH	Illinois Department of Public Health
IEPA	Illinois Environmental Protection Agency
Strategy	Illinois Nutrient Reduction Loss Strategy
IT	Information Technology
IWD	Industrial Waste Division
Kirie	James C. Kirie
Egan	John C. Egan
LIMS	Laboratory Information Management System
LASMA	Lawndale Avenue Solids Management Area
M&O	Maintenance and Operations
District	Metropolitan Water Reclamation District of Greater Chicago
M&R	Monitoring and Research
NELAC	National Environmental Laboratory Accreditation Conference
NPDES	National Pollutant Discharge Elimination System
P	Phosphorus
PIMS	Pretreatment Information Management System
Planning Section	Process Facilities Planning Section
O'Brien	Terrence J. O'Brien
RAB	Revolving Algae Biofilm System
TOC	Total Organic Carbon
TARP	Tunnel and Reservoir Plan
UIUC	University of Illinois at Urbana-Champaign
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WASSTRIP®	Waste Activated Sludge Stripping to Remove Internal Phosphorus

LIST OF ACRONYMS (Continued)

Abbreviation/Acronym	Definition
WEF	Water Environment Federation
WERF	Water Environment Research Foundation
WRP	Water Reclamation Plant

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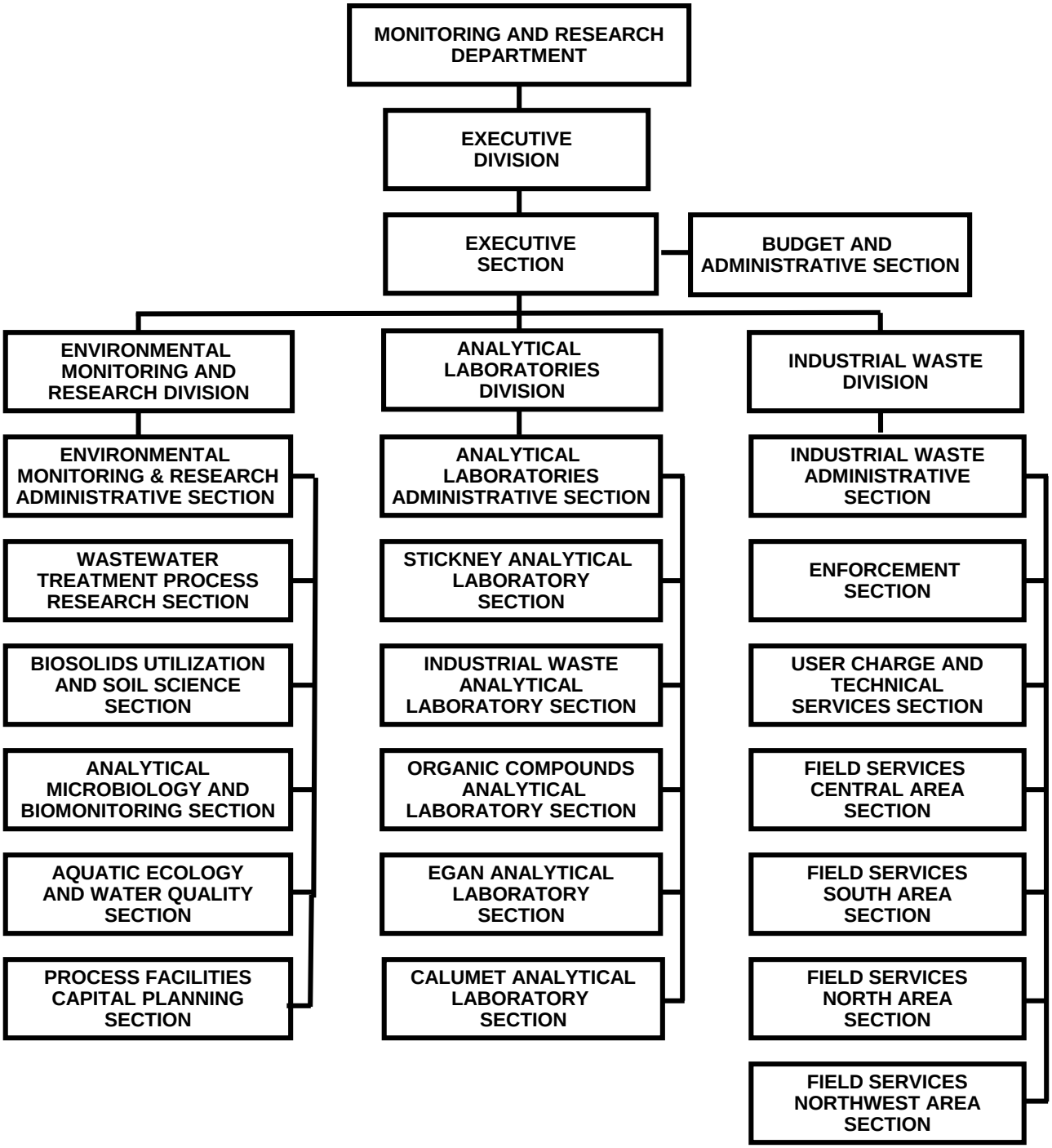
MONITORING AND RESEARCH DEPARTMENT
ORGANIZATION CHART FOR 2015



ACKNOWLEDGMENT

Special thanks to all staff in the Monitoring and Research Department for their tireless contribution to the department and the District.

DISCLAIMER

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

ADDING VALUE

Customer Service and Service Level Agreements

Managing Service Level Agreements. The Analytical Laboratories Division (ALD) continued to meet with its internal customers, the Environmental Monitoring and Research Division (EM&RD) and the Maintenance and Operations (M&O) Department, by holding Service Level Agreement meetings to maintain efficiency by discontinuing services that were no longer needed. The ALD introduced a new Support Request Dashboard to help the EM&RD and other sample submitters have a "real time" view of the division's ability to take on additional projects and sample load. Each section in the division calculated their maximum sample load and as the requests are added to the dashboard, the client can see the ability of ALD to handle their request.

The ALD has five National Environmental Laboratory Accreditation Conference (NELAC) accredited laboratories, generating accurate, reliable, and defensible data for samples from various District functional programs. The laboratories are audited internally by the Monitoring and Research (M&R) Department's Quality Assurance Coordinator annually and by the Illinois Environmental Protection Agency (IEPA) biennially. The laboratories are also audited annually by the Chemical Hygiene Officer for compliance with fire and safety requirements.

In 2015, the total number of analyses performed by the laboratories was 1,465,377 (Table 1). Most of ALD tests have multiple components within the analysis that run simultaneous and this gives a more accurate account. The ALD continues to provide support to all new and existing projects in the M&O and Engineering Departments, as well as the Industrial Waste Division (IWD) and EM&RD within the M&R Department.

The Analytical Microbiology and Biomonitoring Section has five state-of-the-art laboratories: Analytical Bacteriology Laboratory; Molecular Microbiology Laboratory; Parasitology Laboratory; Virology Laboratory; and Wastewater Microbiology Laboratory that provide high quality microbiological monitoring and research support services for various District programs. These laboratories conducted a total of 6,424 (Table 2) microbial analyses in 2015.

The five sections of the ALD in the M&R Department maintained their NELAC accreditation. The Analytical Bacteriology Laboratory of the EM&RD maintained the Illinois Department of Public Health (IDPH) certification standards. In 2015, the Analytical Bacteriology Laboratory operations were moved to a trailer without any delay or disruption in analyses. The laboratory in trailer was inspected by the IDPH and passed the certification standards.

Providing Analytical and Technical Support to Water Reclamation Plant Operations. The M&R Department continued to provide quality control data to the M&O Department for various materials purchased by the District, which allows verification that contract requirements are met. These materials, such as lubricants, sodium hypochlorite, bisulfites, Bioxide™, polymers, and ferric chloride, are used for such purposes as operating water reclamation plant (WRP) machinery, disinfection, odor control, and biosolids processing.

TABLE 1: TOTAL NUMBER OF ANALYSES PERFORMED BY THE MONITORING AND RESEARCH DEPARTMENT'S NELAC ACCREDITED LABORATORIES IN 2015

Program	Nutrients	Oxygen Demands	Metals	Solids	Organic Compounds	Others	Program Total
4652 Liquid Monitoring*	157,019	70,211	163,032	67,205	26,104	99,671	583,242
TARP Reservoirs	93	0	22	0	0	33	148
Treatment Facilities	156,926	70,211	163,010	67,205	26,104	99,638	583,094
4653 Solids Monitoring	11,573	504	16,969	123,395	5,534	25,941	183,916
4666 Sewage & Waste Control	2,727	44	353,141	1,456	37,553	10,005	404,926
4663 User Charge	12	30,393	0	9,060	0	18,838	59,995
4671 Lake Michigan	0	9	0	0	0	16	27
4672 Waterways	5,471	1,566	50,936	2,194	46,152	7,971	114,289
4674 Groundwater	4,676	1,439	3,761	611	0	3,325	13,812
4681 Assistance to M&O	6,125	640	4,871	805	0	6,503	18,944
4682 Assistance to Others	2,054	101	318	17	1,529	171	4,188
4684 Engineering	30,827	4,268	4,989	5,531	0	2,161	47,777
4690 Operations & Research	14,471	409	13,938	858	5,194	1,080	35,951
Total Group	234,955	109,585	611,955	211,134	122,066	175,681	1,465,377

*4652 Liquid Monitoring is the sum of TARP and Treatment Facilities.

TABLE 2: TOTAL NUMBER OF ANALYSES PERFORMED BY THE MONITORING AND RESEARCH DEPARTMENT'S ANALYTICAL MICROBIOLOGY LABORATORY IN 2015

Program	Total Coliform/ Fecal Coliform/ *E. coli*/ HPC[1]	Pathogens[2]/ Other[3, 4, 5]
4652 Liquid Monitoring	726	--[6]
4653 Solids Monitoring	88	83
4671 Lake Michigan (Bypass)	46	--
4672 Waterways	357	--
4674 Groundwater	558	--
4681 Assistance to M&O	--	3,213
4682 Assistance to Others	93	55
4690 Operations & Research	99	824
Total	1,967	4,175

[1]HPC = Heterotrophic Plate Count.
[2]*Salmonella, enteric virus, and Ascaris ova* (Helminth Ova).
[3]Filamentous bacteria, zooglea, shelled protozoa and phosphorus-accumulating organism (PAO).
[4]Coliphage, conductivity, UV transmittance and turbidity analyses for WERF-UV Project, biofilm analyses for ZeeLung™ project and mold assessment for safety support.
[5]Microbial Source Tracking Project analyses and qPCR PAO research.
[6]No analyses.

The M&R Department provided analytical support, primarily in the analysis of nutrients, for approximately 16 research projects to study Enhanced Biological Phosphorus Removal (EBPR) at all seven District WRPs. All of these projects are needed to study the optimization of phosphorous removal to meet future NPDES permit limits.

In preparation of disinfection (new chlorination-dechlorination treatment system installation) at the Calumet WRP, the M&R Department provided fecal coliform (FC) and *E. coli* (EC) testing of 51 secondary treated effluent samples at various times in October, November, and December. Microbiological analytical support to the disinfection of the John E. Egan (Egan) WRP for wet weather excess flow and the Lemont WRP's Wet Weather Treatment facility flow for required FC analyses was also provided.

The M&R Department works in partnership with the M&O and Engineering Departments to ensure regulatory compliance of the District's operations and to seek to continually increase the efficiency of the District's treatment processes to bring about progressive and sustainable improvement of the aquatic, terrestrial, and atmospheric environment in the District's service area and beyond.

Analytical Support for Employee Safety. The M&R Department provided drinking water quality assessment for District facilities on an as-needed basis. Drinking water samples were analyzed as requested for bacteriological quality assessment of new pipe construction projects at the Stickney and Terrence J. O'Brien (O'Brien) WRPs, the Lockport Powerhouse facility, and contamination checks at the O'Brien WRP drinking water pipe system.

Industrial Waste Pretreatment and Cost Recovery Program. The M&R Department is committed to stopping pollution at its source by operating an effective Industrial Waste Pretreatment and Source Control Program in full compliance with all federal and state statutes. During 2015, the administration of the District's Industrial Waste Pretreatment Program required the issuance or renewal of Discharge Authorizations for 76 Significant Industrial Users; the review of 709 Continued Compliance Reports; and 9 Spill Prevention, Containment, and Countermeasure Plans. As a result of the Industrial Waste Pretreatment Program, the District's biosolids continue to exceed the minimum requirements that define Exceptional Quality in the USEPA's federal regulations (Table 3).

TABLE 3: COMPARISON OF 2015 AVERAGE Cd, Hg, AND Pb CONCENTRATIONS IN STICKNEY AND CALUMET WATER RECLAMATION PLANT'S BIOSOLIDS WITH USEPA EXCEPTIONAL QUALITY CONCENTRATION LIMITS

	Cd	Hg	Pb
	----------mg/Kg----------		
USEPA Limit	39	17	300
Calumet WRP	2	0.83	84
Stickney WRP	3	1.10	114

During 2015, the M&R Department conducted 2,969 inspections associated with administering the District's Sewage and Waste Control Ordinance and randomly sampled and analyzed 528 of the 1,314 chemical toilet disposals at the Stickney WRP. In 2015, the M&R Department issued 71 Cease and Desist Orders to Industrial Users who were found to be in significant noncompliance with the District's Industrial Waste Pretreatment Program requirements (Table 4). In accordance with the public participation requirements of the Pretreatment Program, the identity of 27 significant violators of the program in 2015 will be published in 2016.

TABLE 4: FIVE-YEAR TREND IN ENFORCEMENT ACTIVITIES

Year	Pretreatment Inspections	Cease and Desist Orders	Board Orders	Legal Actions
2011	2635	87	0	0
2012	3229	118	0	0
2013	3050	94	0	0
2014	3683	75	0	1
2015	2969	71	0	0

The M&R Department provided first response services for hazardous materials emergencies and complaints of pollution by conducting 116 investigations in response to requests from federal, state and local agencies, municipalities, and private citizens; 22 investigations were conducted in response to self-reported industrial activities; and 12 investigations were conducted in response to requests from the M&O Department in 2015.

The IWD reorganized in 2015, merging the former User Charge Section with the former Enforcement Section to create a new Pretreatment and Cost Recovery Section with account representatives focused on providing support on all aspects of industrial accounts. In addition, new initiatives were developed in partnership with the Law and Finance Departments to provide more effective on-boarding support. These 2015 accomplishments are the latest steps to improve customer service that was begun with the User Charge Blue Ribbon Panel process that was conducted in 2012 and 2013. As a result, the number of administrative appeals of user account clearing and billing has declined over the past 5 years (Table 5).

As a result of the District's Industrial Pretreatment Program, all of the biosolids produced by the District met the highest quality criteria in USEPA's Part 503 Regulation and the WRP effluents met all National Pollutant Discharge Elimination System (NPDES) permit limits for regulated industrial pollutants.

TABLE 5: NUMBER OF USER CHARGE APPEALS 2011 – 2015

Year	Director Appeals	Board of Commissioners Appeals	Total
2011	35	1	36
2012	27	3	30
2013	13	1	14
2014	8	1	9
2015	8	0	8
Total	91	6	97

Real Estate

Revitalizing the Environment with Biosolids. The M&R Department conducted marketing activities and technical support on projects in the Chicago metropolitan area, where 19,282 dry tons of biosolids were used as a soil conditioner or fertilizer topdressing on various sites, including 3 District properties, 3 schools/athletic fields, 36 parks, 8 golf courses, 8 home owners, 2 community gardens, and 8 landscaping companies (Table 6).

TABLE 6: MARKETING EFFORTS ARE INCREASING LOCAL BIOSOLIDS USE UNDER THE CONTROLLED SOLIDS DISTRIBUTION PROGRAM

	2011	2012	2013	2014	2015
No. of Users[1]					
Total	60	48	35	37	45
New (1st Time)	20	11	13	13	22
Repeat Users	40	37	22	24	23
Biosolids Qty. - (dry tons)					
Total	7,279	11,050	6,231	8,844	19,282[2]

[1] Not all customers use biosolids every year.
[2] Includes 8,920 dry tons of Calumet WRP biosolids, of which 600 dry tons were composted and 10,362 dry tons of Stickney WRP biosolids, of which 2,170 dry tons were composted.

More than half of new users of each year became repeat users in the subsequent year, while some repeat users skipped the application of biosolids in some of the years

As part of pilot-scale testing for composting biosolids with wood chips obtained from the city of Chicago, the M&R Department conducted a pilot-scale evaluation of the GORE® Cover technology (Table 7), which is an integrated covered aerated static pile composting system, to determine if this technology will be suitable for adoption by the District. The pilot-scale tests of composted biosolids were conducted at the Harlem Avenue Solids Management Area (HASMA) in October 2014 to August 2015. The information on the operating cost of this technology and the compost quality obtained from the pilot-scale test have been evaluated to prepare a recommendation regarding the potential for adoption of the GORE® Cover technology for compost production.

Fulton County Biosolids Long-Term Study. 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 (Table 8). The experiment was designed to simulate biosolids application to fields at the site at agronomic and reclamation rates, and to provide information that can be used for management of biosolids and crops. During 2015, crop yields were measured and soil and plant tissue samples were collected from the plots for analysis.

Fulton County Nutrient Loss Reduction. In 2014, the District initiated a research and demonstration program at the Fulton County site to develop and test best management practices to reduce non-point source (agriculture) nutrient loss, leading to a reduction in the amount of nitrogen and phosphorus leaving the state. This program will also serve to foster the District's collaboration between point and non-point sources to address nutrient loss at a statewide level.

During 2015, the work plan, including the development of a cover crop system and testing and demonstration of a riparian buffer restoration, runoff irrigation, denitrifying bioreactors/ saturated buffer zone, and paired-watershed comparison of best management practices at the District's Fulton County site, was finalized. Cover crops (annual rye and hairy vetch) were interseeded with corn, and plant growth and soil conditions were monitored.

Flumes equipped with flow meters and automatic runoff samplers were set up in paired fields for monitoring nutrient loss through runoff. The field for installing bioreactors was selected and surveyed, and the structure of the bioreactor system was designed.

A partnership was established with researchers at the UIUC and other organizations under the program. A scientist from UIUC played an important role in the selection of site and designing of the structure for the denitrifying bioreactor system. An engineer from the Ecosystems Exchange Service, Iowa, evaluated the suitability of drainage-related practices (drainage water management, denitrifying bioreactor, saturated buffer, and sub-irrigation) for the fields at the Fulton County site.

TABLE 7: ANALYSIS OF COMPOSTED BIOSOLIDS AND LAGOON-AGED AIR DRIED EXCEPTIONAL QUALITY BIOSOLIDS (MEAN OF 2015)

Parameter	Unit	Composted Biosolids	EQ[1] Biosolids[1]
pH		6.4	6.6
Total Solids	%	51.9	64.6
Total Volatile Solids	"	50.1	44.0
Volatile Acids as Acetic Acid	mg/kg	133	4
Total Kjeldahl Nitrogen	"	21,773	24,878
NH_3-N	"	974	2,544
NO_2 + NO_3-N	"	78	76
Total P	"	21,105	21,978
As	"	7.2	8.0
Cd	"	2.4	4.8
Cr	"	104	102
Cu	"	461	437
Hg	"	0.9	0.9
K	"	3,475	3,556
Mn	"	675	630
Mo	"	6.5	9.0
Ni	"	46.3	42.3
Pb	"	63.1	83.4
Se	"	<5	<5
Zn	"	669	850

[1]·Exceptional Quality.

TABLE 8: GRAIN YIELD, STOVER DRY MATTER, AND ANALYSIS OF NUTRIENT AND TRACE METAL CONCENTRATIONS OF GRAIN FOR CORN GROWN IN 2015 AT THE BIOSOLIDS LONG-TERM EXPERIMENT AT THE FULTON COUNTY SITE

Treatment	Grain yield	Stover dry matter	Total N	Total P	Zn	Cd	Cu	Cr	Ni	Pb	K	Ca	Mg
	-------Mg/ha---		----------mg/kg----------										
Chemical fertilizer 220-50-50 (N-P-K) kg/ha/yr (Control 1)	6.15	3.33	13452	2803	23.3	0.068	3.24	0.26	0.80	1.17	3972	155	1106
Compost 33 Mg/ha/yr (Control 2)	6.05	2.47	10969	2585	23.6	0.084	2.84	0.28	0.46	1.09	4105	153	1123
Aged biosolids 33 Mg/ha/yr	6.52	3.78	11286	2491	23.6	0.086	2.75	0.31	0.57	1.24	4008	163	1134
Unaged biosolids 25 Mg/ha/yr	6.07	3.52	12161	2788	25.8	0.101	2.99	0.27	0.53	1.04	4253	169	1187
Aged biosolids 165 Mg/ha in 2013 thereafter 3/4 chemical fertilizer rate	7.94	5.25	12729	2696	24.9	0.101	2.74	0.30	0.58	1.18	3925	161	1136
Aged biosolids 330 Mg/ha in 2013 thereafter 1/2 chemical fertilizer rate	7.78	4.88	12164	2575	24.3	0.096	2.86	0.31	0.53	1.44	4068	163	1109
Aged biosolids 495 Mg/ha in 2013 thereafter 1/4 chemical fertilizer rate	7.25	4.02	11984	2629	25.1	0.103	2.66	0.31	0.50	1.25	3814	159	1167
Compost 165 Mg/ha in 2013 thereafter 3/4 chemical fertilizer rate	6.07	2.84	12707	2706	24.1	0.056	2.57	0.26	0.48	1.06	4030	155	1184

Aquatic Environment. The M&R Department continued to study three off-channel slips located in the South Branch of the Chicago River. This study will determine which areas are used most heavily by aquatic life and try to discern why. The research will inform how less productive slips might be modified to be more suitable and attractive for fish. A total of six cross-sectional DO profiles were completed in the slips and two locations in the adjacent main channel, during wet and dry weather. Fish sampling was completed in each slip three times between June and October 2015.

EXCELLENCE

Finances

The M&R Department's 2015 budget appropriation was $30,747,700 in the Corporate and Construction Funds, an increase of $378,739, or 1.25 percent from 2014. Approximately 85 percent, or $26,168,000, was appropriated for salaries and compensation-plan adjustments and the remaining appropriation of $4,579,700 was used to fund acquisition of equipment, supplies, and services to operate the M&R Department's laboratories, technical support projects, and environmental and industrial monitoring programs. The M&R Department efficiently met its goals and objectives in 2015 with a total expenditure of $28,251,916, or almost 92 percent of the total appropriation. The M&R Department has continuously sought to make improvements to its business practice and to maintain a clear focus on its mission. The M&R Department had 297 budgeted positions in 2015, down from 308 positions in 2010.

User Charge Program. The M&R Department's IWD generates an important revenue stream through recovery of operations, maintenance, and replacement costs incurred from providing treatment to discharges from Commercial, Industrial, and Tax-Exempt Users of the sewerage system, and the costs of administering the Metropolitan Water Reclamation District of Greater Chicago's (District) Pretreatment and User Charge Programs. The User Charge Program assesses charges to recover costs that are beyond those recovered through payment of *ad valorem* property taxes based on the volume of water discharged and the concentration of waste it contains. The 2015 User Charge revenue was $46,243,855 (Table 9).

TABLE 9: FIVE-YEAR TREND IN USER CHARGE REVENUE

Year	User Charge Receipts
2011	$57,342,607
2012	$69,513.501
2013	$49,167,649
2014	$50,658,470
2015	$46,243,855

In 2015, the M&R Department administered 3,787 accounts. Of these accounts, 954 (701 Commercial-Industrial and 214 Tax-Exempt Users) were processed manually. The remaining 2,833 accounts, which are all Tax-Exempt Users, were approved by the M&R Department for automated processing. The M&R Department conducted 1,217 inspection and sampling events, and processed 2,302 reports and filings to reconcile User Charge liabilities for these manual accounts. The M&R Department remains vigilant in identifying and classifying new users, and in

2015, 32 new Large Commercial-Industrial and Tax-Exempt Users and 37 Small Nonresidential Commercial-Industrial User accounts were created.

Through its industrial surveillance program, the M&R Department maintains records of loadings that result from discharge of wastewater from all user accounts (Table 10). In addition to formulating the basis for User Charge billing, this information is also useful for long-term capital planning. These data are maintained in the M&R Department's Pretreatment Information Management System (PIMS) database.

TABLE 10: FIVE-YEAR TREND IN INDUSTRIAL LOADINGS

Year	Volume (gal)	BOD (lbs)	SS (lbs)
2011	31,904,851,000	138,282,000	132,388,000
2012	28,293,852,000	125,881,000	82,417,000
2013	28,909,938,000	125,995,000	79,466,000
2014	28,705,297,000	138,907,000	74,823,000
2015	26,715,055,000	132,411,000	79,845,000
Average	28,905,799,000	132,295,000	89,788,000

Section 7f of the District's User Charge Ordinance makes provision for automated filing and clearing of User Charge accounts. An additional 80 users were placed on automatic billing in 2015, bringing the total now to 2,945. This reduces costs for the District and the Users. In 2015, the M&R Department also identified 95 Users who were eligible for reduced reporting and self-monitoring requirements under Sections 7g, 7h, 7i and 7l of the Ordinance, which reduces the District's oversight costs and the User's cost for determining their User Charges.

Treatment Process Control and Optimization

The M&R Department monitors the liquid and solids process trains daily at multiple critical control points for each of the seven WRPs to inform process control and to improve operations and the quality of effluents and biosolids. This includes chemical and microbiological monitoring including characterization of changes in microbial communities associated with operations performance metrics to assess process stability and provide early warning of process upset such as appearance of excess filamentous bacteria in mixed liquor. A total of 2,331 analyses were conducted on 259 activated sludge samples for microbial characterization.

In 2015, the M&R Department continued the microscopic examination of mixed liquor samples from the District's WRPs to determine the relative abundance of protozoan and metazoan

species; filamentous bacteria; and to characterize the health of the biological floc. The microscopic results guide the biological nutrient removal projects with information to address treatment system operation and/or upsets. A total of 109 mixed liquor samples were examined. Hanover Park and James C. Kirie (Kirie) WRP samples were collected on an as needed basis. Egan WRP mixed liquor was monitored weekly. The sludge volume index (SVI), a measure of sludge settleability, was associated with the abundance of the filamentous bacteria (Figure 1). *Microthrix parvicella* at the Egan and Hanover Park WRPs and the filament Type 021N was dominant at the Kirie WRP.

In 2015, the M&R Department assisted the M&O Department with improving their operations and maintenance on the South West Preliminary Scum Removal System. Significant operations efficiencies and maintenance cost reductions were realized through this exercise through improved communication, streamlined procedures and improved employee development (training).

The M&R Department conducted a new technology review and bench-scale test of THIOGUARD® (magnesium hydroxide solution) efficacy on hydrogen sulfide (H_2S) production and odor mitigation. This study was conducted to determine the potential application of this product in the Calumet WRP service area.

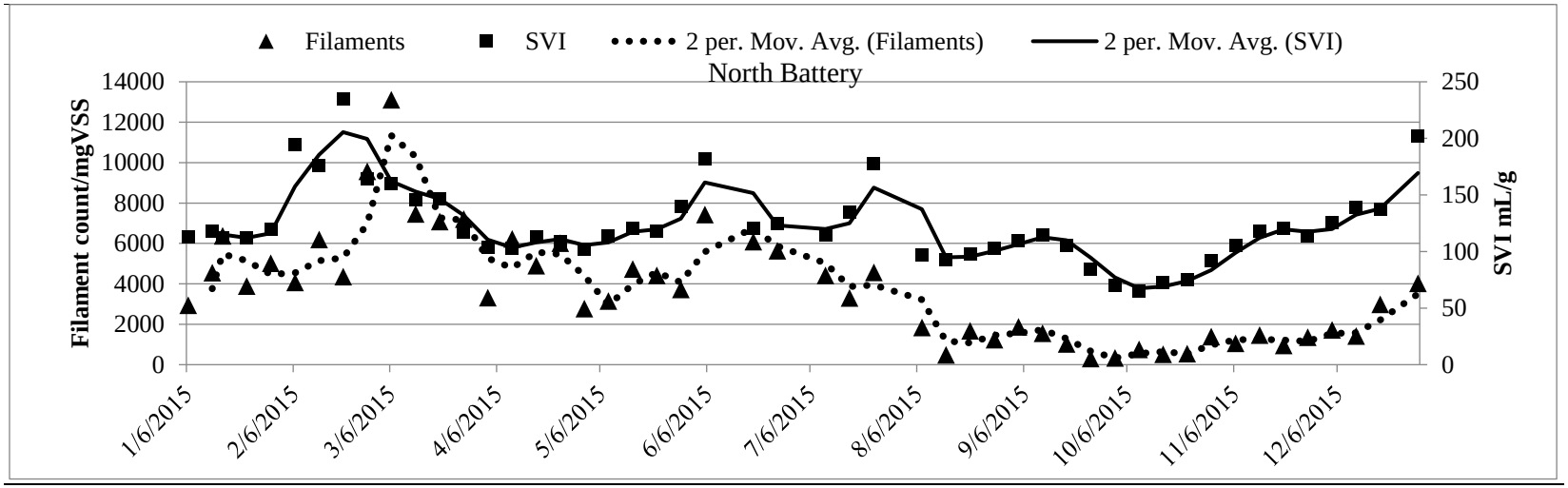
The M&R Department also provided emergency support to the Egan WRP in response to elevated fecal coliform (FC) levels in 2015 by conducting intensive monitoring to ensure that the effluent NPDES permit limits would be met.

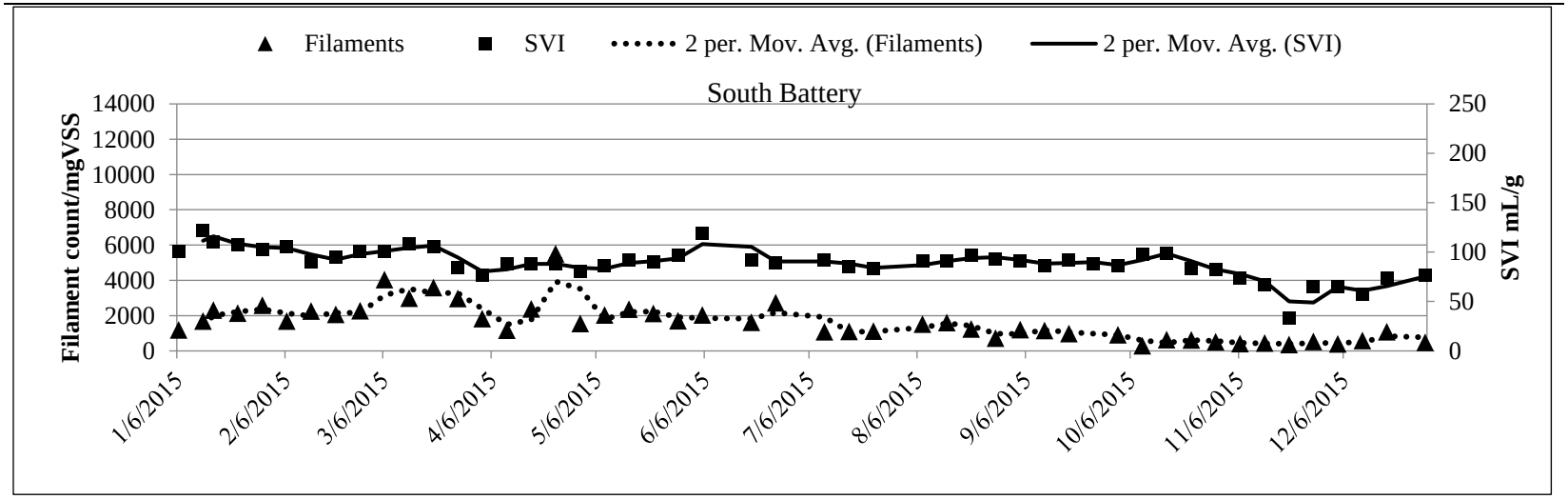
The Discharge Monitoring Report Quality Assurance test for whole effluent toxicity tests with fish (*Pimephales promelas*) and daphnids (*Ceriodaphnia dubia*), which are required by NPDES permits, were conducted in 2015.

Surface and Groundwater. The M&R Department monitors the effectiveness of the District operations in improving the environment and documents compliance with state and federal regulations and operating permits. In 2015, the M&R Department collected and analyzed over 1,000 water quality samples from the Chicago area waterways. Surface water quality was in substantial compliance with applicable water quality standards throughout the District service area during 2015.

The M&R Department also successfully met the requirements in the NPDES permit requirements for continuous dissolved oxygen (DO) monitoring and ambient water quality monitoring of the Chicago, Calumet, and Des Plaines River Systems.

FIGURE 1: COMPARISON OF THE FILAMENTOUS BACTERIA COUNTS AND SLUDGE VOLUME INDEX IN THE NORTH AND SOUTH BATTERIES OF THE JOHN E. EGAN WATER RECLAMATION PLANT IN 2015





The M&R Department's EM&RD continued enhanced water quality monitoring in the Calumet River System to document baseline conditions for two years preceding the completion of the Calumet Tunnel and Reservoir Plan (TARP) System's Thornton Composite Reservoir. Pre- and post-completion data under wet and dry weather conditions will be compared to water quality standards to assess the effectiveness of TARP. In 2015, data was collected during 18 sampling events under various dry and wet weather conditions.

In 2015, 522 samples from 115 TARP groundwater monitoring wells for the deep tunnels and 2 reservoirs (and their adjacent wells) were collected and analyzed. Based on the monitoring results, the M&R Department compiled 6 annual monitoring reports for the 4 TARP tunnel systems including Mainstream, Calumet, Des Plaines and Upper Des Plaines, and 2 reservoirs, including the Gloria Alitto Majewski Reservoir and the Thornton Transitional Reservoir to meet operating permit requirements of these facilities. The groundwater elevations in 44 observation wells were also recorded bi-weekly and included in these reports. The reports were submitted to the IEPA. During the year, major repairs, such as desilting, flushing, replacement of pumps, and retrofitting of plumbing were performed on 4 wells.

The M&R Department also conducts groundwater monitoring at seven biosolids management facilities, including the Hanover Park Fischer Farm, in accordance with permits issued by the IEPA. In 2015, 37 monitoring reports were submitted to IEPA.

Additionally, the M&R Department conducted general chemistry and microbiological analyses on samples collected in response to one storm event that resulted in backflow of combined sewer overflow to Lake Michigan.

The M&R Department's Aquatic Ecology and Water Quality Section collected fish at eight stations in the Des Plaines River System, and two stations in the West Branch of the DuPage River as part of the Biological Monitoring Program. The sampled fish were identified, weighed and measured, and examined for parasites and disease. Table 11 summarizes the fish species collected from each waterway during 2015.

The M&R Department, in collaboration with scientists from the U.S. Department of Energy's Argonne National Laboratory (Argonne), continued a seven-year Microbiome project, which began in 2013 to get information on the microbial sources in the Chicago Area Waterway System (CAWS) that can be used to guide decisions on water quality in the CAWS. This study will track the microbial sources in the CAWS and will aid in evaluating the impact of future disinfection activities and TARP reservoir operations on CAWS water quality. The study will be conducted in three phases. The years 2013–2014 will represent the pre-disinfection baseline condition, the years 2015–2017 will represent the completion of the TARP Thornton Reservoir and implementation of disinfection, and the years 2018–2019 will represent the completion of Phase I of the TARP McCook Reservoir and post-disinfection. Argonne is using the metagenomics approach to identify the sources of microorganisms in the CAWS.

TABLE 11: NUMBER OF FISH COLLECTED FROM SAMPLING STATIONS IN THE DES PLAINES RIVER SYSTEM AND THE WEST BRANCH OF THE DuPAGE RIVER DURING 2015

	Des Plaines River	Salt Creek	Higgins Creek	West Branch of the DuPage River
Black bullhead[1]	2	0	0	1
Black crappie[1]	2	5	0	0
Blackstripe topminnow	24	1	0	1
Bluegill[1]	3	28	1	15
Bluntnose minnow	2	0	0	0
Common carp	1	3	0	2
Channel catfish[1]	1	0	0	0
Fathead minnow	0	0	216	2
Golden shiner	2	0	0	2
Green sunfish[1]	42	18	10	20
Johnny darter	11	0	1	0
Largemouth bass[1]	6	5	0	5
Mosquitofish	15	0	0	0
Northern pike[1]	0	1	0	0
Rock bass[1]	1	0	0	0
Walleye[1]	0	1	0	0
White sucker	0	2	0	3
Yellow bullhead[1]	12	4	0	0
Total Number of Fish Species	14	10	4	4
Number of Game Fish Species	8	7	2	9
Total Number of Fish	124	68	228	51
Total Weight of Fish (kg)	5.53	7.98	0.40	7.97

[1]Game species.

A total of 1,156 water, final effluent, sediment, and other sources, including fish, pets and seagull samples were collected in the first three years from 2013-2015. In 2015, 506 samples (water, sediment, and effluent) were collected from 12 CAWS locations and FC and EC analyses were conducted. Samples were submitted to Argonne for genomic DNA extraction that gives information about the genetic composition of microbes present, and the functional potential of the microbial community. Data analysis is ongoing and the results will be summarized in an interim report in 2016.

All of the Ambient Water Quality Data and Continuous DO Monitoring Data for the local waterways is reported to the IEPA annually and is summarized on the District's website.

The M&R Department's Industrial Waste Analytical Laboratory investigated the use of the Total Organic Carbon (TOC) analysis in place of the Biochemical Oxygen Demand (BOD) analysis. A conversion factor was determined and the analysis change of BOD to TOC will be requested for the next NPDES permit. This allows for more rapid and economic permit compliance testing.

Air Quality. The M&R Department provides compliance monitoring and reporting support to the M&O Department for the District's Clean Air Act Permits. At the Egan WRP, the M&R Department performed monthly monitoring of hydrogen sulfide levels at the facility's compressor room in compliance with its Federally Enforceable State Operating Permit. The M&R Department also calculated the Hazardous Air Pollutant emissions from the liquid stream of all the District's WRPs, as required by its Title V and FESOP Air Quality Permits. Annual hazardous air pollutant emissions were calculated using a computer model and submitted to the M&O Department for reporting to the IEPA.

Additionally, as part of the IEPA's Environmental Emissions Reduction Market System, an Annual Hazardous Air Pollutants Report was prepared and filed. During 2015, the M&R Department also conducted odor monitoring at the District's Solids Management Areas in compliance with the IEPA permits for operation of the drying areas (Table 12).

TABLE 12: STRONG AND VERY STRONG ODOR OBSERVATIONS IN SOLIDS MANAGEMENT AREAS DURING 2015

Facility (Station Number)	Number of Strong Odor Observations	Number of Very Strong Odor Observations	Total Number of Observations
Calumet SDS			
Drying Cell #1 SW (14)	1	0	
Drying Cell #8 NW (16)	1	0	
Drying Cell #1 SE (19)	2	0	
Drying Cell #1 at Gate (20)	1	0	
West Drying Cell #4 (21)	1	0	
	Total 6	0	679
HASMA, Marathon, and Vulcan SDAs, and LASMA SPS			
HASMA (1)	1	0	
HASMA Center (1.5)	2	0	
Vulcan CS (4)	2	1	
LASMA Lagoon #16 (7)	1	0	
LASMA Lagoon #24 (8)	2	0	
Marathon (15)	1	0	
Marathon West (16)	1	1	
	Total 10	2	519
RASMA SDA	0	0	
	Total 0	0	112
Stony Island SDA	0	0	
	Total 0	0	108

[1]RASMA = Ridgeland Avenue Solids Management Area was not used as a biosolids drying site during 2015.
DS = Drop shaft.
HASMA = Harlem Avenue Solids Management Area.
LASMA = Lawndale Avenue Solids Management Area.
RASMA = Ridgeland Avenue Solids Management Area.
CS = Construction Site.
SDA = Solids Drying Area.
SDS = Solids Drying Site.
SPS = Solids Processing Site.

Process Facility Long-Term Planning. The M&R Department's Process Facilities Planning Section (Planning Section) completed the first iteration of the long-term capital plan, which is a 20-year outlook of regulatory drivers, business initiatives, and community service level expectations. The plan was developed through close coordination of all departments within the District and used against the long-term financial model developed by the Treasury Department to ensure affordability. The plan was designed so that yearly updates are incorporated every year to keep the plan current with the fluid nature of all the moving parts.

Odor Mitigation Planning. In 2015, the M&R Department finalized the District's odor mitigation strategy framework. The framework focuses on addressing known odor point sources through utilizing a multi-department team approach. The M&R Department delivered its project, "Odor Mitigation of the Calumet WRP Headworks and Grit Building," to the Executive Team in 2015. The solution for the Headworks Building is to replace the existing carbon odor control system with a bio-trickling filter more effetely to address the odors from the junction chamber. The existing carbon system was found to be significantly under-designed. Addressing the junction chamber odors is expected to significantly reduce the odors in the Headworks Building. The preliminary design for a bio-trickling filter was developed and passed on to the Engineering Department for implementation. The solution for the Grit Building involved making minor adjustments to the existing building ventilation system to more effectively utilize the existing odor control. The ventilation improvements were provided to the M&O Department for implementation. In late 2015, work was started on addressing known odorous hot spots at the Hanover Park, O'Brien, and Stickney WRPs, with projects scheduled for delivery in 2016.

Biosolids Planning. In 2015, the M&R Department, in collaboration with the M&O and Engineering Departments, completed the preliminary design for the final Biosolids processing technology at the Calumet WRP as part of the District-wide Biosolids Strategy. The Executive Team approved a covered composting system and the Engineering Department will lead the final design and construction. In addition, the Planning Section worked closely with the Engineering Department to develop the "Request for Expression of Interest 15-EOI-03 Beneficial Use of Biosolids and Composted Biosolids," which is intended to streamline and reduce operating costs of the distribution of the District's biosolids related products.

RESOURCE RECOVERY

Phosphorus Task Force

The M&R Department, in conjunction with the Engineering and M&O Departments, continued to head study activities conducted by the District's Phosphorus Task Force in order to assess and implement biological phosphorus removal and recovery at four District WRPs.

The site-specific enhanced biological phosphorus removal (EBPR) configuration by creating anoxic, anaerobic, and aerobic zones continued to be fully implemented at the Stickney WRP in 2015. The M&R Department continued to provide technical support to the improvement of the EBPR process including the length of the anaerobic zone, airlift operations, battery solids inventory, preliminary settling tank operation, DO controls at the end of aeration tanks, and understanding of the recycle stream impact. The study group also started the development of an EBPR operation guideline for the Stickney M&O Department to use. Finally, special projects to understand carbon needs, recycle streams, and the readily biodegradable chemical oxygen demand (rbCOD) in the Stickney primary effluent were also completed. The monthly average of total phosphorus effluent for 2013 – 2015 are shown in Table 13.

The District has selected the Ostara® technology to recover P from the pre- and post-digestion centrate streams at the Stickney WRP. To maximize the P content in the pre-centrate stream, the Waste Activated Sludge Stripping to Remove Internal Phosphorus (WASSTRIP®) process was also selected for implementation using available tankage. The WASSTRIP® process has three control parameters that can affect P release efficiency: degree of Waste Activated Sludge (WAS) thickening; the type and amount of carbon addition to the WASSTRIP® reactor; and retention time in both the thickening and WASSTRIP® tanks. In 2015, the M&R Department performed laboratory tests to understand the potential quantity of P-release available for harvesting in the Ostara® reactors.

The full-scale demonstration using an external carbon source, MicroC 2000™, a glycerin-based byproduct derived from renewable resources for promoting EBPR at the Calumet WRP was completed in 2014 and a summary report was prepared in 2015. The report concluded that sustainable EBPR could be achieved with the addition of external carbon. A study on Calumet WRP primary effluent readily biodegradable chemical oxygen demand (rbCOD) characteristics was completed. The study confirmed that the Calumet WRP was carbon deficit over 80 percent of the time relative to a minimum recommended rbCOD to total phosphorus (TP) ratio of 11. Seasonal soluble COD (solCOD) and rbCOD differences were found (Table 14). The phosphorus task force began to identify high strength organic wastes (HSOWs) from industries as possible carbon sources for sustainable EBPR at the Calumet WRP. Eight HSOWs were tested and two were identified as potential candidates of external carbon sources. Finally, further development of sludge fermentation options and testing of HSOWs will continue in 2016 in an effort to meet the carbon needs for sustainable EBPR at the Calumet WRP.

The Phosphorus Task Force started examining EBPR at the Kirie WRP using a similar approach as used at the Stickney and Calumet WRPs. Testing began in 2014 and continued in

TABLE 13: MONTHLY AVERAGE TOTAL PHOSPHORUS IN STICKNEY WATER RECLAMATION PLANT EFFLUENT

	Stickney Average Monthly Plant Outfall TP (mg/L)		
Month	2013	2014	2015
January	1.40	0.74	0.99
February	0.57	1.17	0.97
March	0.53	0.50	1.16
April	0.86	0.68	0.60
May	0.86	0.55	0.35
June	0.90	0.31	0.59
July	1.10	0.98	1.35
August	1.18	0.93	0.95
September	1.01	1.50	0.91
October	1.43	1.08	1.17
November	1.15	0.93	1.19
December	1.30	1.17	0.98

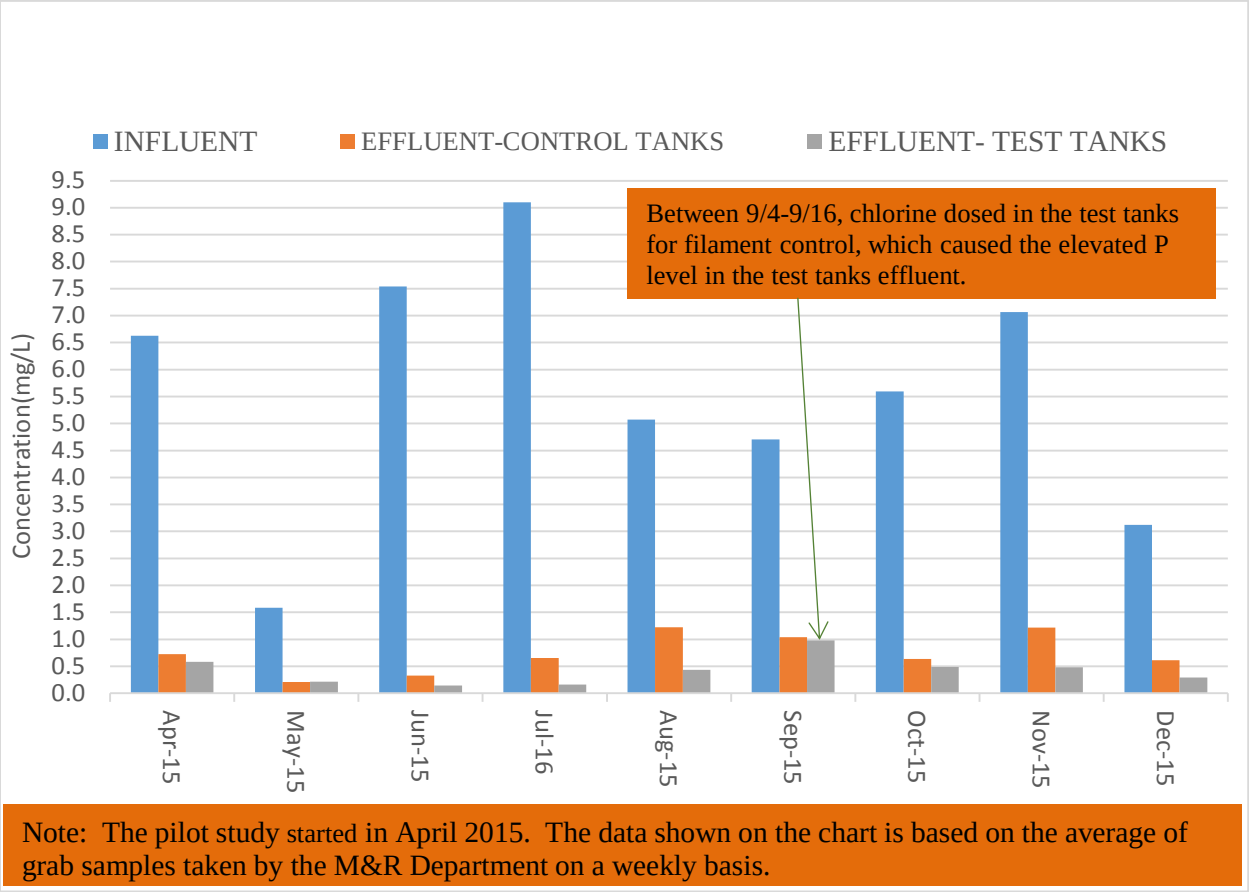
TABLE 14: DESIGN RANGE FOR CALUMET ENHANCED BIOLOGICAL PHOSPHORUS REMOVAL AND CARBON: PHOSPHORUS RATIOS FROM STUDIES

Parameter	EBPR Design Range/ Target	Battery E1 Study (5/2/12–7/31/12)	Battery A Study (2/19/13–6/30/13)
BOD:TP of PE	>20–25	15.2	13.2
rbCOD:TP PE	11–16	Not Measured	6.0

rbCOD=readily biodegradable COD.
PE=primary effluent.

2015. Actuated air control valves were installed in 2015 to evaluate intermittent air mixing in the anaerobic zone of the EBPR configuration. While results indicated that the test tanks with the current EBPR configuration were able to meet a TP limit of 1.0 mg/L during the study period, significant back mixing from the aeration to anaerobic zone was observed, which reduced the aeration tank efficiency and created an environment favorable for filament growth (Figure 2). Baffle walls will be added in 2016 to the test tanks to prevent back mixing and promote inline mixed liquor fermentation.

FIGURE 2: JAMES C. KIRIE WATER RECLAMATION PLANT ENHANCED BIOLOGICAL PHOSPHORUS REMOVAL PILOT STUDY – MONTHLY AVERAGE TOTAL PHOSPHORUS LEVEL IN INFLUENT AND EFFLUENT



Note: The pilot study started in April 2015. The data shown on the chart is based on the average of grab samples taken by the M&R Department on a weekly basis.

The task force is planning to convert the entire Kirie WRP to EBPR in 2016. However, in case unstable EBPR is observed, a number of infrastructure changes are planned including installing mechanical mixers, additional baffles, and pumps.

Unlike the three WRPs mentioned above, the approach to EBPR at the O'Brien WRP is still being evaluated. The following three P removal/recovery strategies at the O'Brien WRP are being investigated: (1) Reduction of P loading to the WRP through source control; (2) Using algae for P removal and recovery from the liquid stream; and (3) Implementing EBPR for P removal from the liquid stream by modifying and adding to the existing infrastructure. Starting in July 2015, the M&R Department conducted lab and field tests necessary to evaluate the O'Brien WRP's EBPR feasibility and potential based on the existing influent, infrastructure, and treatment capacity; these tests will conclude in 2016.

Outside of the direction of the Phosphorus Task Force, another pilot EBPR process was implemented at the Hanover Park WRP in 2015 by using baffles and mechanical mixers to create anoxic/anaerobic and aerobic zones in one of the aeration tanks. The preliminary analysis showed that the modified process and current operations were not able to reduce total phosphorus below a target of 1 mg/L. The plan for further expansion of this study is underway, and a new pilot trial is expected to start in spring 2016 through modifications of the pilot tank operations. Energy savings through reduction in air supply in the anoxic and anaerobic zones will also be evaluated.

The M&R Department in collaboration with the University of Illinois at Urbana-Champaign (UIUC), is conducting a molecular microbiology study to characterize and quantify phosphorus accumulating organisms (PAOs) in the Stickney WRP's full-scale EBPR process. Sample collection and processing for molecular microbiology analyses began on August 26, 2015. Sampling will continue through May 1, 2016. A total of 334 samples were processed and shipped to the UIUC for qPCR analyses and 80 samples for fluorescence in situ hybridization FISH/DAPI analyses.

The control of EBPR processes are complex and the demand for rapid PAO monitoring has increased. The DAPI and/or qPCR results from this study would improve the daily process management, as well as facilitate the detection of abnormal situations.

The M&R Department provided microbiological assessment and nutrient analysis support for the District's biological nutrient removal research projects at the Stickney, Kirie, O'Brien, Hanover Park, and Calumet WRPs. During 2015, a total of 558 samples were analyzed for PAOs as a monitoring tool to evaluate the EBPR process. Laboratory analyses included conventional microscopy and two staining methods for observation of poly-hydroxy butyrate granulated clusters in the anaerobic zone and poly-phosphate granulated clusters in the aerobic zone.

Bio-P Sludge Dewatering Data Analysis. Operating personnel inside and outside the District have anecdotally observed poor dewatering performance of anaerobically digested sludge after implementing an EBPR process. The M&R Department undertook a paper study in 2015 to examine the effects before and after the EBPR implementation at the Stickney WRP. This preliminary data analysis indicated that higher polymer usage at post-digestion dewatering may have been associated with the implementation of EBPR.

Stormwater Management

In support of the Engineering Department's Stormwater Management Program, the M&R Department continued its collaboration with the United States Geological Survey (USGS) in 2015 to evaluate the effect of green infrastructure Best Management Practices (BMPs), such as permeable pavements, bio swales and planters on stormwater flow, and pollutant load reduction in the Sustainable Streetscape Project located on west Cermak Road between south Halsted Street and south Ashland Avenue, and south Blue Island Avenue between south Ashland Avenue and south Western Avenue. Post-construction monitoring was started in 2013 and continued through

2015, with the goal to evaluate the effectiveness of BMPs. The monitoring ended in December 2015 and a final report of the project will be prepared in 2016.

Groundwater level and quality were monitored at four locations within the study area. A total of five monitoring wells were installed at these four locations. Water level sensors (submersible pressure transducers) were installed in curbside catch basins to quantify the effectiveness of best management practices (BMPs) in reducing runoff. Twice a year (spring and fall) tests on infiltration rate of permeable pavers and soil in both planter boxes and bioswales were conducted and changes in soil properties and accumulation of heavy metals in soil were also monitored. In 2015, heavy metal accumulation in plants grown in bioswales and planter boxes was also studied. Briefly, results showed that in general, BMPs were effective in retaining greater than 95 percent of rainwater and very small volumes of runoff entered the combined sewers during the study period. Infiltration rate of both permeable pavers and soils in bioswales declined with time highlighting the need for periodic cleaning of pavers and removing sediment deposits from close to inlet of bioswales and planter boxes. The analysis of tissue samples from representative plants grown in bioswales and planter boxes showed no significant accumulation of heavy metals.

Phycoremediation

In support of one of the District's resource recovery initiatives, the M&R Department continued to participate in the evaluation of phycoremediation-based technologies for nutrient recovery from side streams at some of the District's WRPs. In 2014, a collaborative project using a "Revolving Algae Biofilm System" (RAB) for recovery of nutrients was initiated in collaboration with Iowa State University. The RAB System has been running since September 2015 and two side streams, supernatant from the gravity thickening tanks from the O'Brien WRP and post-digestion Centrate from the Stickney WRP, are being tested. Most of the results on algal biomass and nutrient removal are from 2016 data and will be presented in the 2016 report. Below are highlights.

There were some toxicity issues with centrate from Stickney WRP most likely due to high ammonia concentrations in the Centrate (>600 mg/L). The RAB System running on Centrate only started developing algal biofilm when Centrate was diluted to bring concentrations of ammonia blow 50 mg/L. In general, Tall RAB System produced higher biomass as compared to Short RAB System for both supernatant and Centrate side stream wastewaters.

Support Energy Neutral Initiatives

The District has set a goal of achieving energy neutrality by 2023. An important component in achieving this goal is to maximize use of anaerobic digestion capacity to generate methane biogas. The M&R Department provided technical support to determine the available digester capacity that can be used to produce additional gas via co-digestion of high strength organic waste (HSOW) at the Calumet and Stickney WRPs. In order to efficiently evaluate numerous HSOWs,

spreadsheet models for both the Calumet and Stickney WRPs were developed using 2012 plant operations data. Stickney WRP has 24 digesters with a total volume of 61,648,605 gal, and Calumet WRP has 12 digesters with a total volume of 25,444,771 gal. Unused digester capacity was estimated at 1,350,000 gal/day for Stickney WRP and 500,000 gal/day for Calumet WRP. Co-digestion bench-scale tests were also conducted with and without a wet commercial waste supplied to determine biogas production potential of the waste. Additionally, a simple biochemical methane potential (BMP) test was developed to effectively screen HSOWs for possible full-scale co-digestion.

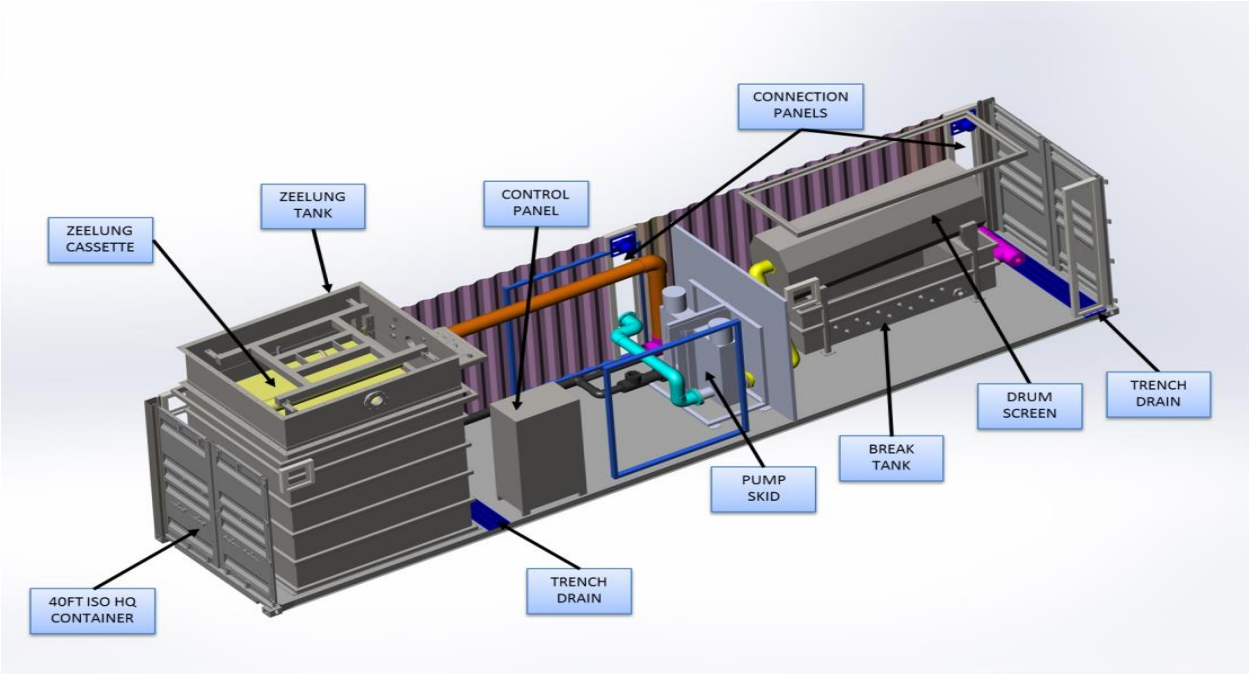
Mainstream Shortcut Nitrogen Removal. The M&R Department completed a technology review regarding mainstream shortcut biological nitrogen removal (SCBNR) to reduce aeration energy in the mainstream and promote total nitrogen removal. Four process options have been identified that will be further researched for potential energy savings, two at the laboratory and two at the WRP pilot level. The District has entered into a three-year agreement with Northwestern University to conduct bench scale studies of energy saving nitrogen removal processes. A multidepartment task force has been formed to oversee these studies. The laboratory level testing will start in 2016, and WRP pilot level testing is expected to begin in 2017. The testing results will be used to evaluate the next steps for full-scale implementation.

Aeration Optimization. The District is embarking on a project to optimize air supply to reduce aeration energy for secondary treatment. The approach is to develop ammonia-based aeration control, which is a more efficient method compared with the traditional DO-based aeration control. The M&R Department is assisting the M&O Department with developing a control algorithm and conducting a pilot study in selected Stickney WRP aeration tanks to determine instrument locations and set points for optimum control, evaluate the energy saving potentials, and understand the impact on EBPR. The field pilot study will start in 2016.

General Electric ZeeLung™ Technology Demonstration. ZeeLung™ is a membrane aerated biofilm reactor (MABR) process where nitrification of wastewater can occur at the membrane biofilm, while denitrification can occur in the bulk liquid. It posited that a portion of the nitrification capacity could be handled by the MABR at a lower energy cost compared to conventional suspended growth systems currently employed at the District. A small pilot unit was started at the O'Brien WRP in June 2015 and is being tested through June 2016 (Figure 3). The M&R Department is supporting this demonstration through analytical laboratory support and consultation on study direction with the General Electric Water Project leaders and the Engineering Department. Given the success of this pilot, ZeeLung™ may be a process to incorporate into the phosphorus removal design at the O'Brien WRP.

Microbiology monitoring support was provided to the ZeeLung™ Project at the O'Brien WRP. The M&R Department staff inspected the membranes, collected samples and provided analytical support to identify dominant microorganisms growing on the ZeeLung™ membrane.

FIGURE 3: PILOT DIAGRAM OF THE GENERAL ELECTRIC ZEELUNG™ PROCESS AT THE TERRENCE J. O'BRIEN WATER RECLAMATION PLANT



DEVELOP EMPLOYEES

The M&R Department is committed to providing continuing education and professional development to all of its employees. The employees of the M&R Department benefited from attendance at 83 local, regional, and national professional society meetings and workshops (Appendix I), and often participated on the meeting programs as speakers, session chairs and moderators, or committee chairs or members.

The M&R Department also economizes where possible by providing its employees access to web-based learning and/or webinars, which are presented by the Water Environment Federation (WEF), Water Environment Research Foundation (WERF), United States Environmental Protection Agency (USEPA), American Chemical Society, and others.

In 2015, M&R staff made 28 presentations at conferences and meetings (Appendix II), published 3 papers in conference proceedings or peer-reviewed journals (Appendix III), and the M&R Department published 44 numbered reports (Appendix IV), which are available on the District website.

The M&R Department conducts a monthly environmental issues and research seminar series at the Lue-Hing Research and Development Complex, which is video-conferenced to the Main Office Building Board Room and five other facilities, and is archived in streaming on-line video format through the web portal.

The M&R Department's Seminar Series (Appendix V) is approved by the Illinois Society of Professional Engineers for professional development credits and is available to all employees and the local community. The seminars are also available through streaming video archives. In 2015, attendance at the Lue-Hing Research and Development Complex Auditorium, the Main Office Building Board Room, the Calumet, Egan, O'Brien, and Kirie WRPs and the Lawndale Avenue Solids Management Area (LASMA) was 2,078.

The M&R Department administers the District's Radiation Safety Program, including maintaining a Radioactive Material License issued to the District by the Illinois Emergency Management Agency, Division of Nuclear Safety, assuring that activities are conducted according to the license conditions and regulations. The M&R Department also maintains a Chemical Hygiene Plan for its laboratories and conducts bacteriological monitoring of drinking water sampled from various District facilities to ensure the safety of drinking water to District employees.

The M&R Department supported the internship program to college students by providing a unique hands-on learning opportunity in the District's Analytical Microbiology, Wastewater Treatment Process Research, and Biosolids Utilization and Soil Science monitoring and research programs. The internship program is a learning opportunity for students who want to develop essential career skills in environmental science and engineering.

In 2015, the M&R Department underwent a redesign of its Laboratory Technician series to meet the needs of current and future changes to the District's operations. The redesign included expanding promotional opportunities to its personnel and created an environment of cross-training and advanced employee development. The redesign created two career paths for technicians; one laboratory and chemical analysis focused and the other focused on environmental monitoring and research sampling in the field. Because the redesign consolidated classifications with the technician series, it also provides more interchangeability across organizational units, which will enable the M&R Department to refocus its human resources as work demand dictates.

LEADING PARTNERSHIPS

Improving Public Image

The M&R Department engages in activities to benefit the public and in the process, strives to improve the District's image. The major activities include odor monitoring, the Biosolids Controlled Solids Distribution Program, maintaining native prairie landscapes, participating in local parades with the District float, and providing waterway boat tours.

The M&R Department staff continued to promote public awareness and acceptance of District operations. On a regular basis, the M&R Department staff attended meetings and provided support to public outreach activities such as participation in science fairs and hosting tours of the M&R Department's laboratories.

In 2015, the M&R Department supported participation in 13 local parades with the District float and provided 7 tours of the CAWS on the M&R Department research and monitoring vessel to various groups, including area legislators.

The District conducts an Odor Monitoring Program to assist in minimizing or eliminating nuisance to the communities surrounding its facilities. During 2015, the M&R Department, in collaboration with the M&O Department, monitored unit processes at the District's wastewater treatment facilities, as well as Solids Management Areas for odors. Odor conditions were reported to the respective WRP managers. An annual summary report of 2015 monitoring results of the biosolids processing areas has been finalized and is posted on the District's website as M&R Department Report No. 16-39.

The annual odor reports and data from the Solids Management Areas are provided to the Planning Section to help identify problem areas, understand the odor concerns, and to develop mitigation measures for their Odor Strategy.

The District conducts a Biosolids Controlled Solids Distribution Program under a permit issued by the IEPA. Under this program, exceptional quality air-dried biosolids are used as a soil amendment mainly to improve turf in the Chicago metropolitan area. During 2015, the M&R Department staff worked with 45 biosolids users to ensure regulatory compliance and help them derive economic and agronomic benefits from biosolids use. The M&R Department staff conducted a Sustainability Workshop and distributed promotional materials to park districts, school districts, golf courses, landscapers, and other land managers to expand the program and make the public aware of the benefits of utilizing biosolids.

The M&R Department's professional staff served as a resource and presented at the Water Environment Federation Technical Exhibition and Conference (WEFTEC), sharing knowledge on wastewater microbes in interactive hands-on workshop sessions.

The M&R Department's staff assisted high school students with science fair research projects by providing resources and technical assistance on three methods of drinking water

disinfection. Our professional staff has been continuously supporting public affairs and outreach events, such as meeting with high school students and describing the wastewater microbe's role in the wastewater treatment process. Professional staff also participated in the WBEZ Curious City Live Radio event providing video and information on microorganisms in wastewater treatment.

The USEPA, National Science Foundation, and WERF Collaborative Workshop on Handling, Management, and Treatment of Bio-contaminated Wastewater by Water Resource Recovery Facilities was related to issues surrounding "Bio-contaminated wastewater" that contains pathogens (e.g., bacteria, spores, viruses and other pathogens) introduced into wastewater either intentionally or inadvertently in discharge, resulting from natural disasters, etc. The M&R Department's professional staff was invited to provide the District's perspective on Bio-contaminated Wastewater. The M&R Department staff are also reviewing and contributing to the national research and guidance for hospitals and management of waste from Ebola patients.

Technical Support for Biosolids Program

The M&R Department provides technical support to the District's Biosolids Farmland Application Program in which biosolids are applied by a contractor as a fertilizer for production of row crops in nearby counties. Technical support includes implementing a Public Relations Program and review and approval of fields for biosolids application. Farmland application oversight activities in 2015 included:

- Review of 187 field information packages to evaluate suitability for land application of biosolids
- Field inspections in response to public complaints regarding land application activities. Sixty-eight fields as shown in the figure above, received biosolids application in 2015.
- Participation in a field day organized by the land application contractor.

Provide Technical Assistance to Other Departments and Agencies

Polymer Studies. The District's dewatering polymer chemical costs are in excess of $5,000,000 annually. The M&R Department is working with the M&O Department to optimize post-digestion centrifuge operations at the Stickney WRP with respect to reducing polymer consumption. Additionally, preliminary full-scale centrifuge testing was conducted at the Egan WRP to understand if the WRP could eliminate/minimize ferric chloride use in order to preserve alkalinity for the Anita Mox™ process scheduled for operation in spring 2016. The preliminary tests indicated that ferric chloride use may be reduced but cannot be eliminated from dewatering operations using the current polymer. Laboratory bench-scale tests were also conducted to evaluate if a switch to a different type of polymer could eliminate ferric chloride use. A number of polymers passed the laboratory screening, and full-scale tests are planned for 2016. Additionally, the M&R

Department conducted polymer quality control testing throughout the year for the Stickney WRP to verify the consistency of polymer quality and provided the M&O Department with a monthly summary of results.

Addressing USEPA Changes to the Recreational Water Quality Bacteria Criteria Methods

In response to the 2012 USEPA changes to the recreational water quality standards, which require adaptation of the modified mTEC method for EC bacteria, instead of the FC test currently used, the M&R Department analyzed the final effluent samples by membrane filtration onto different media – mFC agar for FC determination and modified mTEC agar Quanti-Tray® 2000 (IDEXX Laboratories, Westbrook,, Maine) for EC growth. In 2015, final disinfected effluent samples were collected from the Egan, Hanover Park, and Kirie WRPs. The secondary treated effluent from O'Brien and Calumet WRPs were also part of the comparison study. The FC and EC comparison results were shared with the IEPA (Table 15). The EC and FC data comparison will continue in 2016 after the implementation of disinfection systems at Calumet and O'Brien WRPs. This will allow the District to ensure that the Analytical Microbiology Laboratory is adequately staffed, staff is sufficiently trained, and to further understand the performance goal achievable to meet the NPDES compliance.

Assistance to Outside Agencies

The M&R Department provided assistance to the USGS for water sampling on the Chicago Sanitary and Ship Canal at the Lockport Powerhouse. This work was part of a national study to assess the complexity of chemical mixtures and their biological activity in streams.

The M&R Department's Microbiology Laboratory provided in-kind support to a WERF project titled, "Design and Validation Protocol for UV Disinfection Systems Used in Municipal Wastewater Treatment and Reuse Applications" (ENER16T15). As part of the support, FC, EC, coliphage, UVT%, conductivity, and turbidity analyses were performed on the O'Brien WRP secondary treated final effluent samples. Staff also participated in the technical review of the WERF project on *Next Generation Tools for Assessing Death and Decay of Critical Wastewater Bacteria*.

The M&R Department provided assistance to the United States Fish and Wildlife Service with electro-fishing to investigate the presence of Asian Carp in the Des Plaines River near Lemont and Willow Springs. This effort is part of a multi-agency strategy to study and control the migration of invasive aquatic species and was conducted as part of the "Monitoring and Response Plan for Asian Carp in the Upper Illinois River and Chicago Area Waterways System."

TABLE 15: ESCHERICHIA COLI AND FECAL COLIFORM DATA FOR DISINFECTION AND NON-DISINFECTION CONDITIONS FROM FIVE WATER RECLAMATION PLANTS

Treatment Facility	Geometric Mean FC CFU/ 100 mL	Geometric Mean EC CFU or MPN/100 mL	EC/FC[1] Ratio	EC Method
John E. Egan WRP				
Chlorine/De-chlorine	1.00	01.00	1.00	^{mf}*E. coli* - EPA 1603
		.03	1.50	IDEXX Quanti-Tray, 24h (MPN)
Hanover Park WRP				
Chlorine/De-chlorine	8.00	08.14	1.02	^{mf}*E. coli* - EPA 1603
		43.77	1.63	IDEXX Quanti-Tray, 24h (MPN)
James C. Kirie WRP				
Chlorine/De-chlorine	2.02	1.95	00.96	^{mf}*E. coli* - EPA 1603
		1.49	22.00	IDEXX Quanti-Tray, 24h (MPN)
Terrence J. O'Brien WRP				
Secondary treated effluent[2]	14,768.00	11,053.00	00.74	^{mf}*E. coli* - EPA 1603
Secondary treated effluent	14,444.00	10,766.00	00.86	^{mf}*E. coli* - EPA 1603
Calumet WRP				
Secondary treated effluent[2]	8,287.00	6,037.00	00.73	^{mf}*E. coli* - EPA 1603

[1] $(EC/FC)_{gm}$ denotes geometric mean ratio of EC and FC.
[2] Data collected in 2013-2014; mf=membrane filtration.
All FC analyses performed by mFC membrane filtration method (Standard Methods 9222D).

The M&R Department provided in-kind support to St. Cloud State University, the University of St. Thomas, and the College of Wooster for a project funded by a National Science Foundation grant to investigate the fate and impact of endocrine active compounds after disinfection is initiated at the O'Brien and Calumet WRPs. In 2015, the M&R Department conducted monthly water sampling, four mobile exposure laboratory trailer experiments, two wild fish collections, and two caged fish experiments. Data analysis will begin after the 2016 disinfection-sampling season and this project will conclude in 2017.

The M&R Department played a leadership role on behalf of Illinois POTWs and participated in the development of the Illinois Nutrient Loss Reduction Strategy (Strategy) jointly developed by the IEPA and Illinois Department of Agriculture. The Strategy establishes statewide goals and a strategy for reducing nitrogen and phosphorus discharge from the state as part of a national effort to reduce the Gulf of Mexico hypoxic zone. As part of the execution of the Strategy, M&R Department staff served on the Nutrient Policy Workgroup, Nutrient Monitoring Council and the Performance Benchmarks Committee and contributed to the selection of Nutrient Science Advisory Committee.

In April through October of 2015, the M&R Department's Aquatic Ecology and Water Quality Section collected and analyzed monthly water samples from a sampling location on Buffalo Creek for the Buffalo Creek Clean Water Partnership (BCCWP). The BCCWP partners include the Lake County Stormwater Management Commission, Lake County Department of Public Health, the District, all of the municipalities within the watershed, residents, and other interested parties. The goal of the group is to make Buffalo Creek a sustainable watershed with reduced erosion, improved water quality, thriving wildlife, decreased flooding, and native vegetation. The parameters analyzed included fecal coliform, chloride, dissolved oxygen, total dissolved solids, total Kjeldahl nitrogen, calcium, conductivity, biochemical oxygen demand, total phosphorus, total suspended solids, temperature, and pH. The monitoring data was needed as part of their process to develop a watershed-based action plan and to track the progress to eliminate water quality impairments on Buffalo Creek.

The M&R Department provided sampling support to the Northwestern University's joint partnership with the University of Oklahoma on the Global Water Microbiome Consortium on global water microbiome studies. Under this consortium on municipal wastewater microbiome research, the M&R Department's Microbiology staff coordinated the sampling from four of our north side area WRPs to determine the temporal dynamics of functionally divergent taxonomic groups of organisms (i.e., bacteria, Archaea, fungi, protists) in wastewater systems, and the mechanisms controlling their dynamics.

In response to the Village of Oak Lawn's Midwest Medical Center's inquiry regarding the Centers for Disease Control and Prevention (CDC) guidance on Ebola preparedness, the M&R Department staff prepared a factsheet addressing concerns and questions as a guide to address potential public health emergencies. The factsheet is based on information from the World Health Organization and CDC reports and webcast sponsored by the WEF and the WERF on the spread and safety of the Ebola virus to wastewater workers.

TECHNOLOGY

The M&R Department is committed to automating and streamlining its business practices throughout the department.

Implementation of the new Pretreatment Information Management System (PIMS) was completed in 2014. This updated and enhanced PIMS enables the M&R Department to maintain its Industrial Waste Program data in a single database and increase staff efficiency. The M&R Department will streamline its programs through implementation of electronic industrial user reporting and electronic management of District and industrial user records and correspondence a soon as PIMS fully stabilizes.

The M&R Department has been working with the Information Technology (IT) Department to create geographical information system (GIS) layers for its industrial and tax-exempt user databases to facilitate more efficient inspection, surveillance, and sampling, and to conduct forensic operation during facility-upset events. The M&R Department's GIS will also be useful for future planning, including identification of potential water reuse corridors. In 2015, the M&R Department updated the list of users and updated flagging of users in significant noncompliance.

In 2015, the M&R Department continued to work with the IT Department to use the new upgraded Laboratory Information Management System (LIMS) to its fullest capabilities, which was originally developed in 1995, and is one of the longest, continuously running LIMS in the United States.

LOOKING AHEAD

In 2016, the M&R Department will continue implementation of the redesign of the laboratory technician series and will initiate a redesign of its environmental chemist and instrumentation chemist series. It is envisioned that this will entail creating an expanded technical support team in the Analytical Laboratories Division to provide enhanced customer service for special projects. The redesign of these series will provide greater promotional opportunity, will foster greater cross training and flexibility of staffing, and will enable the M&R Department to most efficiently shift the focus to its human resources as the nature of its mission critical work changes over time.

The M&R Department will contribute to developing all employees in 2016 by continuing to offer its monthly seminar series, maintaining its chemical hygiene plan, and increasing access to webinars and web-based training. During 2016, the M&R Department will also be proactive in taking advantage of any relevant training opportunities to meet the twenty-four hours of professional development training for employees. The M&R Department is developing and implementing an ambitious plan to rehabilitate its facilities at the Stickney WRP Lue-Hing R&D Complex, the Egan WRP laboratory and the Calumet WRP Industrial Waste Division field office.

In 2016, the M&R Department will contribute to developing a better understanding of water quality in the CAWS by continuing its microbial source tracking study with Argonne, the completion of a 3-dimensional hydrodynamic and water quality model with the University of Illinois, and its ambient water quality monitoring to characterize conditions prior to and following the completion of the TARP reservoirs. The M&R Department will also utilize its one dimensional unsteady state hydraulic and water quality DuFlow model to inform optimization and automation of discretionary Lake Michigan water diversion to contribute to water quality in the CAWS.

The M&R Department workgroups will continue to implement guidelines for document generation and management redesign to streamline the department's business flow. This will include fully implementing paperless distribution of work products.

In 2016, the M&R Planning Section will coordinate the first yearly update to the District's long-term capital plan. The section will also continue to work on the District's Biosolids Strategy and look to improve the solids dewatering process through a capital improvement project recommendation to reduce operation and maintenance costs while producing a product to suit the District's current and planned distribution paths. The Planning Section will also continue to address known odorous point sources District-wide with anticipated recommendations for the Hanover Park, O'Brien, and Stickney WRPs to be presented by the end of the year.

The M&R Department will implement a monitoring and quality assurance program to support full-scale production of a value-added product consisting of co-composted biosolids and wood chips. The M&R Department will lead the completion of the development of the District's new Resource Recovery Program including an ordinance and program guidelines.

In 2016, the M&R Department will continue to lead the phosphorus removal and recovery task force, and will continue developing non-point source nutrient loss reduction research and demonstration at the Fulton County site. Through these endeavors the M&R Department will make significant contributions to leading partnerships.

APPENDIX I

MEETINGS, SEMINARS, WEBINARS AND TRAINING - 2015

APPENDIX I

MEETINGS, SEMINARS, WEBINARS, AND TRAINING – 2015

January 2015

Calumet Area Industrial Commission, Alsip, Illinois.

Chicago Area Waterway System Chloride Stakeholder Workgroup Meeting, Stickney, Illinois.

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

Illinois Water Environment Association and the Illinois Section of the Central States Water Environment Association, 2015 Government Affairs in Water Pollution Control Conference, Burr Ridge, Illinois.

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

Midwest Water Analysts Association 2015 Winter Exposition, Kenosha, Wisconsin.

February 2015

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

Illinois Water Environment Association 36th Annual Conference and Exposition, Champaign, Illinois.

Partnership for River Restoration and Science in the Upper Midwest 2015 Upper Midwest Stream Restoration Symposium, Dubuque, Iowa.

March 2015

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

American Water Works Association, Illinois Section, 2015 WATERCON Total Water Conference, Springfield, Illinois.

DuPage River Salt Creek Workgroup Bi-monthly Meetings, Lombard, Illinois.

Fox River Study Group Monthly Meeting – March-November, Oswego, Illinois.

Illinois Commerce Commission, Water Policy Roundtable, Chicago, Illinois.

APPENDIX I

MEETINGS, SEMINARS, WEBINARS, AND TRAINING – 2015 (Continued)

NELAC Institute, TNI National Environmental Monitoring Conference, Chicago, Illinois.

OSHA Safety Day Conference, Maintaining Safe Work Environments, Dixon, Illinois.

Pipeline Safety, Arlington Heights, Illinois.

Society for Ecological Restoration Midwest Great Lakes Chapter Annual Meeting, Glencoe, Illinois.

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

WERF Challenge Group, Linking Receiving Water Impacts to Sources Meeting, Westminster, Colorado.

April 2015

Agilent LC/MS Seminar, Schaumburg, Illinois.

Illinois Association of Water Pollution Control Operators Annual Conference 2015, Springfield, Illinois.

May 2015

American Management Association, Mastering Excel Pivot Tables, Chicago, Illinois.

American Society for Microbiology General Meeting, New Orleans, Louisiana.

Argonne National Laboratory's Discussing Immunology and the Microbiome at Microbiology 2015 Virtual Event, Stickney Water Reclamation Plant, Cicero, Illinois.

Central States Water Environment Association, Inc. 88th Annual Meeting, Oakbrook Terrace, Illinois.

Horizon Technology Seminar, Schaumburg, Illinois.

Illinois Environmental Protection Agency, Illinois Bacteria Water Quality Standards Stakeholder Meeting, Springfield, Illinois.

APPENDIX I

MEETINGS, SEMINARS, WEBINARS, AND TRAINING – 2015 (Continued)

Midwest Water Analysts Association, Spring Meeting, River Restoration Projects, Milwaukee, Wisconsin.

National Association of Clean Water Agencies, Annual Pretreatment and Pollution Prevention Workshop, Greenville, South Carolina.

Society for Freshwater Science Annual Meeting, Milwaukee, Wisconsin.

University of North Carolina Water Microbiology Conference 2015, Chapel Hill, North Carolina.

June 2015

Asian Carp Technical and Policy Workgroup Meeting, Chicago, Illinois.

Basic Research Needs Workshop on Energy and Environmental Applications of Accelerators, U.S. Department of Energy, Argonne National Laboratory, Lemont, Illinois.

Hazardous Materials Emergency Response Training Briefing, Chicago, Illinois.

JPK Group, Business Forecasting and Innovation Forum, Chicago, Illinois.

USDA W-3170 Committee Meeting, Beltsville, Maryland.

Water and Energy 2015: Opportunities for Energy and Resource Recovery in Changing World, Washington, DC.

Water Environment Federation Seminar, "Making Scents Out of Wastewater Odors: A Step-By-Step Guide to Managing Your Odor Problems," Washington, D.C.

WEF/IWA Residuals and Biosolids Conference 2015: The Next Generation of Science, Technology, and Management, Washington, DC.

July 2015

Ammonia Water Quality Standards Stakeholders Workgroup held by IEPA, Springfield, Illinois.

National Association of Clean Water Agencies Summer Conference, Providence, Rhode Island.

Friends of the Chicago River, Take Your Lunch to the River Speaker Series, Chicago, Illinois.

NEMC, Chicago, Illinois.

APPENDIX I

MEETINGS, SEMINARS, WEBINARS, AND TRAINING – 2015 (Continued)

RIGHTS-OF-WAY As Habitat Working Group Meeting held by Energy Resources Center, University of Illinois Chicago, Chicago, Illinois.

Technical Writing Seminar, Illinois Institute of Technology, Chicago, Illinois.

Urban Flood Management through No Adverse Impact and Green Infrastructure workshop held by Resilient Chicago, Chicago, Illinois.

WEF/WERF/CWEA/BACWA Nutrient Symposium 2015, San Jose, California.

August 2015

Deskins Quickdry Filter System Site Visit, Casey, Illinois.

Illinois Nutrient Loss Reduction Strategy Policy Workgroup Meeting, Springfield, Illinois.

Illinois Nutrient Loss Reduction Strategy Stakeholder Meeting, Champaign, Illinois.

Water Environment and Research Foundation Intensification of Resource Recovery (IR^2) Forum, Manhattan College, New York.

Webinars: Revisiting Organic Agriculture Webinar Series (August 4, September 1, October 6, and November 3) ASA Webinar Series.

September 2015

88th Annual Water Environment Federation Technical Exhibition and Conference (WEFTEC), Chicago, Illinois.

Cook County Department of Homeland Security and Emergency Management (and follow-up meetings throughout the year) HAZMATIIQ Federal Resources, LaGrange, Illinois.

Illinois Water Environment Association, the Illinois Association of Wastewater Agencies, and the Illinois Association of Water Pollution Control Operators Joint 2015 Nutrient Removal and Recovery Workshop, Addison, Illinois.

Laboratory Fraud: Why Should I Worry…What Could Happen? Webinar, Stickney Water Reclamation Plant, Cicero, Illinois.

Northwest Biosolids Management Association's 28th Annual Biosolids Management Conference; Biofest 2015: Walk the Talk, Campbell's Conference Center, Chelan, Washington.

APPENDIX I

MEETINGS, SEMINARS, WEBINARS, AND TRAINING – 2015 (Continued)

Nutrient Monitoring Council Meeting, Springfield, Illinois.

Water Quality Standards Regulatory Revisions Final Rule Informational Webinar, Stickney Water Reclamation Plant, Cicero, Illinois.

October 2015

15th Biennial Governor's Conference on the Management of the Illinois River System, Peoria, Illinois.

2015 Stakeholder Webinar on the Environmental Protection Agency's Development of Ambient Water Quality Criteria for Coliphage – A Viral Indicator, Stickney Water Reclamation Plant, Cicero, Illinois.

AirPrex Pilot Site Visit, Fox River Water Reclamation District, South Elgin, Illinois.

Hydraulic Engineering for Professionals, Madison, Wisconsin.

Illinois Environmental Protection Agency Ammonia Water Quality Standards Implementation Committee Meeting, Springfield, Illinois.

Illinois Nutrient Loss Reduction Strategy Implementation Workshop at the Illinois River Council Meeting, Peoria, Illinois.

Illinois Nutrient Loss Reduction Strategy Policy Workgroup Meeting, Champaign, Illinois.

Illinois Section of the American Water Works Association Annual Regulatory Update Meeting, Elgin, Illinois.

Illinois Water Conference 2015, Urbana, Illinois.

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

LEAD Leadership Development Program, Lake Forest Graduate School of Management, Willow Springs, Illinois.

Northern/Central Illinois Pipeline Association, 2015 Pipeline Safety Meeting for Emergency Responders and Public Officials, Alsip, Illinois.

APPENDIX I

MEETINGS, SEMINARS, WEBINARS, AND TRAINING – 2015 (Continued)

Pryor Seminars - Leadership, Team-building and Coaching Skills for Managers and Supervisors, Elk Grove Village, Illinois.

Workshops at Urbana-Champaign Sanitary District and Glenbard Wastewater Authority, Urbana, Illinois.

November 2015

Michigan Department of Environmental Quality Linking Fecal Bacteria in Rivers to Environmental Factors and Sources Webinar, Stickney Water Reclamation Plant, Cicero, Illinois.

Midwest Water Analysts Association, Fall Tour, Chicago, Illinois.

Project Management Training, University of Wisconsin, Stickney Water Reclamation Plant, Cicero, Illinois.

Synergy in Science, ASA/CSSA/SSSA/ESA 2015 Joint Annual Meeting, Minneapolis, Minnesota.
The Government Finance Officers Association of the United States and Canada, Budgeting Best Practices in the Field of Finance, Chicago, Illinois.

Trace Metals Analysis Productivity Seminar, Schaumburg, Illinois.

United States Environmental Protection Agency, National Science Foundation and Water Environment Research Foundation Collaborative Workshop on Bio-Contaminated Wastewater, Alexandria, Virginia.

December 2015

Chicago Wilderness Priority Species Workshop, Chicago, Illinois.

IIT School of Applied Technology, Advanced Excel and Pivot Table Training, Chicago, Illinois.

Nutrient Management and Edge of Field Conference, Memphis, Tennessee.

Nutrient Monitoring Council Meeting, Urbana, Illinois.

Pryor Seminars - Managing Multiple Priorities, Projects and Deadlines, Elmhurst, Illinois.

APPENDIX II

PRESENTATIONS - 2015

APPENDIX II

PRESENTATIONS – 2015

January 2015

"Enhanced Biological Phosphorus Removal and Recovery at the MWRD's Stickney WRP: Startup, Transition, and Progress." Presented at the Illinois Water Environment Association Government Affairs Conference, Burr Ridge, Illinois, by J.A. Kozak., Y. Lefler, D. Qin, and B. Garelli. PP

"Microbiological Monitoring of Biological Nutrient Removal Systems." Presented at the Midwest Water Analysts Association 2015 Exposition, Kenosha, Wisconsin, by A. Glymph-Martin. PP

"Technical Re-evaluation of Local Limits for Industrial Discharges in the Metropolitan Water Reclamation District of Greater Chicago (District) Service Area." Presented at the January 2015 M&R Seminar, Stickney Water Reclamation Plant, Cicero, Illinois, by K. Kumar. PP

February 2015

"Biosolids Planning at the Metropolitan Water Reclamation District of Greater Chicago." Presented at the 2015 IWEA 36th Annual Conference, Champaign, Illinois, by M. McGregor. PP

"Biosolids Beneficial Reuse Programs: SWOT and PEST Evaluations to Ensure Sustainability." Presented at the 2015 IWEA 36th Annual Conference, Champaign, Illinois, by O. O. Oladeji, D. Brose, K. Kumar, L. Hundal, D. Collins, and T. C. Granato. PP

"Microbiological Innovations for Wastewater Process Control." Presented at the Illinois Water Environment Association Annual Conference and Exposition 2015, Champaign, Illinois, by A. Glymph-Martin. PP

"MWRDGC Contracting Experience: John E. Egan ANITA™ Mox." Presented at WEF/WERF 2015 LIFT Forum Webinar: Contracting Experience with New Technologies, by J. A. Kozak. PP

March 2015

"Updates on the User Attainability Analysis for the Chicago Waterway System." Presented at the March 2015 M&R Seminar, Stickney Water Reclamation Plant, Cicero, Illinois, by J. Wasik. PP

APPENDIX II

PRESENTATIONS – 2015 (Continued)

April 2015

"Development of a Wastewater Microbiology Program at the Metropolitan Water Reclamation District of Greater Chicago." Presented at the Illinois Association of Water Pollution Control Operators Annual Conference 2015, Springfield, Illinois, by A. Glymph-Martin. PP

"Opportunities and Challenges at the Metropolitan Water Reclamation District of Greater Chicago." Presented at the UIUC Agricultural & Biological Engineering Department Spring Seminar, by K. Patel. PP

"Phosphorus Testing, Investigation, Capture and Recovery." Presented at the Central States Water Environment Association, Laboratory Pre-treatment Seminar, Geneva, Illinois, by T. Liston. PP

May 2015

"Developing a Long Term Capital Improvement Plan and Vetting Capital Improvement Projects Using an Organization-wide, Transparent and Objective Approach." Presented at the May 2015 M&R Seminar, Stickney Water Reclamation Plant, Cicero, Illinois, by E. Podczerwinski and J. Grabowy. PP

"Multi-Jurisdictional Agreements: Pretreatment Program and Obligations and Responsibilities." Presented at the 2015 National Association of Clean Water Agencies Annual Pretreatment and Pollution Prevention Workshop, Greensville, South Carolina, by M. Goldrich. PP

"Pretreatment Staff Turnover: Handling Retirement and Hiring." Presented at the 2015 National Association of Clean Water Agencies Annual Pretreatment and Pollution Prevention Workshop, Greensville, South Carolina, by M. Joseph. PP

"Scientific Basis for Defining Microbiological Health of Chicago River System." Presented at the Water Institute at University of North Carolina Conference: Where Science Meets Policy, Chapel Hill, North Carolina, by G. K. Rijal. PP

June 2015

"Uptake of Trace Metals in Vegetables Grown in Exceptional Quality Biosolids Amended Soil." Presented at the USDA W-3170 Committee Annual Meeting, Beltsville, Maryland, by L. Hundal. PP

APPENDIX II

PRESENTATIONS – 2015 (Continued)

July 2015

"Challenges to Achieving Stable Performance in a Site-Specific EBPR Configuration (AAnO) at the Stickney Water Reclamation Plant." Presented at the WEF/WERF/CWEA/BACWA Nutrient Symposium 2015, San Jose, California, by H. Zhang; J.A. Kozak; D. Qin; Y. Lefler; B. Garelli; R. Dring; J. Cummings; C. O'Connor and G. Rohloff. PP

"River Clean-Up Efforts – MWRD." Presented at the Friends of the Chicago River Take Your Lunch to the River Speaker Series, Chicago, Illinois, by T. C. Granato.

August 2015

"Point Source Efforts on Nutrient Loss Reduction." Presented at the Illinois Nutrient Loss Reduction Strategy Policy Workgroup Meeting, Springfield, Illinois, by T. C. Granato. PP

September 2015

"A Framework to Prioritize Trace Organics for Human and Eco-Toxicity Studies." Presented at NBMA's 28th Annual Biosolids Management Conference; Biofest 2015: Walk The Talk, Campbell's Conference Center, Chelan, Washington, by K. Kumar. PP

"Activated Sludge and Biological Nutrient Removal Process Control: Hands-On in the Real World." Presented at the 88th Annual Water Environment Federation Technical Exhibition and Conference Activated Sludge Workshop #20, Schaumburg, Illinois, by A. Glymph-Martin. PP

"Maximizing the Potential of Your Mesophilic Anaerobic Digesters - Operating Procedures and Practical Concerns", Presented at the 88th Annual Water Environment Federation Technical Exhibition and Conference Digestion Workshop #16, Chicago, Illinois, by H. Zhang. PP

"Recovering Resources: Transforming Water." Presented at NBMA's 28th Annual Biosolids Management Conference; Biofest 2015: Walk The Talk, Campbell's Conference Center, Chelan, Washington, by K. Kumar. PP

"Total Culturable Virus Monitoring at the Metropolitan Water Reclamation District of Greater Chicago." Presented at the 88th Annual Water Environment Federation Technical Exhibition and Conference Pathogen Workshop #24, Stickney Water Reclamation Plant, Cicero, Illinois, by G. Rijal. PP

APPENDIX II

PRESENTATIONS – 2015 (Continued)

October 2015

"Developing a Long -Term Capital Plan." Presented at October 14, 2015 Marquette Environmental Engineering Seminar Series, Marquette University, Milwaukee, WI, by J. Grabowy. PP

"MWRD Efforts on Nutrient Loss Reduction." Presented at Illinois Nutrient Loss Reduction Strategy Implementation Workshop at Illinois River Council Meeting, Peoria, Illinois, by T.C. Granato. PP

November 2015

"Industrial Waste Ordinances and the District's Regulatory Authority Update." Presented at the DePaul University Student Symposium, Chicago, Illinois, by G. Yarnik. PP

"Nitrogen Phytoavailability of Composted Biosolids." Presented at the Synergy in Science, ASA / CSSA / SSSA / ESA 2015 Joint Annual Meeting, Minneapolis, Minnesota, by O. O. Oladeji, G. Tian, P. Lindo, L. Hundal, A. Cox, H. Zhang, and T. C. Granato. PP

"Stagnation of Soil Organic Carbon Equilibrium in the United States Midwest and Transcendence by Biosolids." Presented at the American Society of Agronomy Annual Conference, Minneapolis, Minnesota, by G. Tian and C. Y. Chiu. PP

"The Metropolitan Water Reclamation District of Greater Chicago's Perspective on Bio-Contaminated Wastewater." Presented at the United States Environmental Protection Agency, National Science Foundation and Water Environment Research Foundation Collaborative Workshop on Bio-Contaminated Wastewater, Alexandria, Virginia, by G. Rijal. PP

"Trace Metals in Vegetables Grown in Soil Amended with Exceptional Quality Biosolids." Presented at the Synergy in Science, ASA / CSSA / SSSA / ESA 2015 Joint Annual Meeting, Minneapolis, Minnesota, by K. Kumar, L. Hundal, A. Cox, H. Zhang and T. C. Granato. PP

December 2015

None

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* PP = Available as PowerPoint Presentation

APPENDIX III

PAPERS PUBLISHED IN 2015

APPENDIX III

PAPERS PUBLISHED IN 2015

Barber L., J. Loyo-Rosales, C. Rice, T. Minarik, A. Oskouie, "Endocrine Disrupting Alkylphenolic Chemicals and Other Contaminants in Wastewater Treatment Plant Effluents, Urban Streams, and Fish in the Great Lakes and Upper Mississippi River Regions." *Science of the Total Environment*, 517 (2015) 195 - 206.

Tian G., C. Y. Chiu, A. J. Franzluebbers, O. O. Olawale, T. C. Granato, and A. E. Cox. "Biosolids Amendment Dramatically Increases Sequestration of Crop Residue-Carbon in Agricultural Soils in Western Illinois." *Applied Soil Ecology*, 85: 86 - 93.

Zhang, H., J.A. Kozak, D. Qin, Y. Lefler, B. Garelli, R. Dring, J. Cummings, C. O'Connor and G. Rohloff. "Challenges to Achieving Stable Performance in a Site-Specific EBPR Configuration (AAnO) at the Stickney Water Reclamation Plant", Proceedings of WEF Nutrient Symposium 2015, San Jose, California, July 26-28, 2015.

APPENDIX IV

MONITORING AND RESEARCH DEPARTMENT REPORTS

PUBLISHED DURING 2015

APPENDIX IV

MONITORING AND RESEARCH DEPARTMENT NUMBERED REPORTS PUBLISHED DURING 2015

Report No.	Report Title	Author(s)	Date	Organization or Conference
15-01	Controlled Solids Distribution Report for Fourth Quarter 2014	M&R Department Oladeji, O.	January 2015	IEPA
15-02	2014 Report of the Fulton County Environmental Protection System	M&R Department Tian, G.	January 2015	IEPA
15-03	Lawndale Avenue Solids Management Area Monitoring Report for Fourth Quarter 2014	M&R Department Brose, D.	February 2015	IEPA
15-04	122nd and Stony Island Avenue Solids Management Area Monitoring Report for Fourth Quarter 2014	M&R Department Brose, D.	February 2015	IEPA
15-05	Harlem Avenue Solids Management Area Monitoring Report for Fourth Quarter 2014	M&R Department Brose, D.	February 2015	IEPA
15-06	Calumet West Solids Management Area Monitoring Report for Fourth Quarter 2014	M&R Department Brose, D.	February 2015	IEPA
15-07	Calumet East Solids Management Area Monitoring Report for Fourth Quarter 2014	M&R Department Brose, D.	February 2015	IEPA
15-08	Hanover Park Water Reclamation Plant Fischer Farm Monitoring Report for Fourth Quarter 2014	M&R Department Brose, D.	February 2015	IEPA
15-09	Annual Biosolids Management Report for 2014	M&R Department Lindo, P., L. Hundal, M. Patel, A. Cox, H. Zhang	February 2015	USEPA, Region 7

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MONITORING AND RESEARCH DEPARTMENT NUMBERED REPORTS PUBLISHED DURING 2015

Report No.	Report Title	Author(s)	Date	Organization or Conference
15-10	Controlled Solids Distribution Program: Trend of Biosolids Distributed	M&R Department Oladeji, O. D. Brose, L. Hundal, A. Cox, H. Zhang and T. Granato	March 2015	Internal District Report
15-11	2013 Annual Report	M&R Department Granato, T.	March 2015	Internal District Report
15-12	Potential Impacts on Treatment Processes and Biosolids Quality That May Result From Use of a Copper Based Product for Controlling Odors at the Calumet Water Reclamation Plant	M&R Department Kumar, K. and L. Hundal	June 2015	Internal District Report
15-13	Hanover Park Water Reclamation Plant Fischer Farm Monitoring Report for First Quarter 2015	M&R Department Brose, D.	June 2015	IEPA
15-14	Calumet East Solids Management Area Monitoring Report for First Quarter 2015	M&R Department Brose, D.	June 2015	IEPA
15-15	Harlem Avenue Solids Management Area Monitoring Report for First Quarter 2015	M&R Department Brose, D.	June 2015	IEPA
15-16	Lawndale Avenue Solids Management Area Monitoring Report for First Quarter 2015	M&R Department Brose, D.	June 2015	IEPA
15-17	122nd and Stony Island Avenue Solids Management Area Monitoring Report for First Quarter 2015	M&R Department Brose, D.	June 2015	IEPA

APPENDIX IV

MONITORING AND RESEARCH DEPARTMENT NUMBERED REPORTS PUBLISHED DURING 2015

Report No.	Report Title	Author(s)	Date	Organization or Conference
15-18	Calumet West Solids Management Area Monitoring Report for First Quarter 2015	M&R Department Brose, D.	June 2015	IEPA
15-19	Odor Monitoring Program at the Metropolitan Water Reclamation District of Greater Chicago's Solids Drying and Solids Processing Facilities During 2014	M&R Department Oskouie, A. and W. An	June 2015	IEPA
15-20	Tunnel and Reservoir Plan Mainstream Tunnel System Annual Groundwater Monitoring Report for 2014	M&R Department Lindo, P.	July 2015	IEPA
15-21	Tunnel and Reservoir Plan Thornton Transitional Flood Control Reservoir and Wells Annual Groundwater Monitoring Report for 2014	M&R Department Lindo, P.	July 2015	IEPA
15-22	Tunnel and Reservoir Plan Calumet Tunnel System Annual Groundwater Monitoring Report for 2014	M&R Department Lindo, P.	July 2015	IEPA
15-23	Tunnel and Reservoir Plan Des Plaines Tunnel System Annual Groundwater Monitoring Report for 2014	M&R Department Lindo, P.	July 2015	IEPA
15-24	Tunnel and Reservoir Plan Gloria Alitto Majewski Chicagoland Underflow Plan Reservoir Water Quality Monitoring Wells Annual Groundwater Monitoring Report for 2014	M&R Department Lindo, P.	July 2015	IEPA
15-25	Tunnel and Reservoir Plan Upper Des Plaines Tunnel System Annual Groundwater Monitoring Report for 2014	M&R Department Lindo, P.	July 2015	IEPA

APPENDIX IV

MONITORING AND RESEARCH DEPARTMENT NUMBERED REPORTS PUBLISHED DURING 2015

Report No.	Report Title	Author(s)	Date	Organization or Conference
15-26	122nd and Stony Island Avenue Solids Management Area Monitoring Report for Second Quarter 2015	M&R Department Brose, D.	August 2015	IEPA
15-27	Lawndale Avenue Solids Management Area Monitoring Report for Second Quarter 2015	M&R Department Brose, D.	August 2015	IEPA
15-28	Harlem Avenue Solids Management Area Monitoring Report for Second Quarter 2015	M&R Department Brose, D.	August 2015	IEPA
15-29	Hanover Park Water Reclamation Plant Fischer Farm Monitoring Report for Second Quarter 2015	M&R Department Brose, D.	August 2015	IEPA
15-30	Calumet East and West Solids Management Areas Monitoring Report for Second Quarter 2015	M&R Department Brose, D.	August 2015	IEPA
15-31	Controlled Solids Distribution Report for Second Quarter 2015	M&R Department Oladeji, O.	August 2015	IEPA
15-32	2014 Annual Report	M&R Department Granato, T.	September 2015	Internal District Report
15-34	Style and Format Guide for Letters, Memoranda, and Reports	M&R Department Scrima, K. and T. Granato	October 2015	Internal District Report
15-35	2014 Annual Summary Report, Water Quality Within the Waterway System of the Metropolitan Water Reclamation District of Greater Chicago	M&R Department Abedin, Z.	October 2015	Internal District Report

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MONITORING AND RESEARCH DEPARTMENT NUMBERED REPORTS PUBLISHED DURING 2015

Report No.	Report Title	Author(s)	Date	Organization or Conference
15-36	Continuous Dissolved Oxygen Monitoring in the Deep-Draft Chicago Waterway System During 2014	M&R Department Minarik, T. D. W. Gallagher, J. A. Vick, and J. L. Wasik	October 2015	IEPA
15-37	Controlled Solids Distribution Report for Third Quarter 2015	M&R Department Oladeji, O.	December 2015	IEPA
15-38	122nd and Stony Island Avenue Solids Management Area Monitoring Report for Third Quarter 2015	M&R Department Brose, D.	December 2015	IEPA
15-39	Calumet East and West Solids Management Areas Monitoring Report for Third Quarter 2015	M&R Department Brose, D.	December 2015	IEPA
15-40	Lawndale Avenue Solids Management Area Monitoring Report for Third Quarter 2015	M&R Department Brose, D.	December 2015	IEPA
15-41	Harlem Avenue Solids Management Area Monitoring Report for Third Quarter 2015	M&R Department Brose, D.	December 2015	IEPA
15-42	Hanover Park Water Reclamation Plant Fischer Farm Monitoring Report for Third Quarter 2015	M&R Department Brose, D.	December 2015	IEPA
15-43	Environmental Monitoring and Research Division 2014 Annual Report	M&R Department Granato, T.	January 2016	Internal District Report
15-44	Uptake of Perfluoroalkyl Acids into Edible Crops Grown in Biosolids-Amended Soil	M&R Department Kumar, K.	December 2015	Internal District Report

APPENDIX V

MONITORING AND RESEARCH DEPARTMENT

2015 SEMINAR SERIES

APPENDIX V
METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
MONITORING AND RESEARCH DEPARTMENT 2015 SEMINAR SERIES

January 30, 2015 ***Technical Re-evaluation of Local Limits for Industrial Discharges in the Metropolitan Water Reclamation District of Greater Chicago (District) Service Area,*** Dr. Kuldip Kumar, Senior Environmental Soil Scientist, District, Chicago, Illinois

February 27, 2015 ***Wastewater Worker Safety – Addressing Concerns on Ebola in Wastewater,*** Dr. Matthew J. Arduino, Team Lead, Center for Disease Control Ebola Response Environmental Infection Control Team, Atlanta, Georgia

March 27, 2015 ***Updates on the User Attainability Analysis for the Chicago Waterway System,*** Ms. Margaret Conway, Principal Attorney, Law Department and Ms. Jennifer Wasik, Supervising Aquatic Biologist, Monitoring and Research Department, District, Chicago, Illinois

April 24, 2015 ***Algal-sludge Granules: An Innovative Wastewater Treatment and Energy Recovery Process,*** Dr. Chul Park, Associate Professor, Department of Civil and Environmental Engineering, University of Massachusetts, Amherst, Massachusetts

May 29, 2015 ***Developing a Long Term Capital Improvement Plan and Vetting Capital Improvement Projects Using an Organization-wide, Transparent and Objective Approach,*** Mr. Edward Podczerwinski, Managing Civil Engineer and Mr. Jonathan Grabowy, Principal Civil Engineer, Monitoring and Research Department, District, Chicago, Illinois

June 26, 2015 ***Development of the Illinois Nutrient Loss Reduction Strategy,*** Mr. Sanjay Sofat, Manager of the Division of Water Pollution Control, Illinois Environmental Protection Agency, Springfield, Illinois

July 31, 2015 ***Recent Progress in Development of Mainstream Deammonification - A Potential Low Energy Option for Nitrogen Removal,*** Dr. George Wells, Assistant Professor, Department of Civil and Environmental Engineering, Northwestern University, Evanston, Illinois

August 28, 2015 ***Green Infrastructure Program at DC Water,*** Ms. Bethany Bezak, Green Infrastructure Manager, DC Clean Rivers Project, District of Columbia Water and Sewer Authority, Washington, DC

September 25, 2015 ***Waste Activated Sludge Stripping to Remove Internal Phosphorus (WASSTRIP®) Application at Clean Water Services,*** Mr. Peter Schauer, Principal Process Engineer, Clean Water Services, Hillsboro, Oregon

October 30, 2015 ***The MWRD's Perspective on Co-Digestion and Biogas Utilization,*** Mr. Thomas Kunetz, Assistant Director of Engineering, Engineering Department, District, Chicago, Illinois

November 20, 2015 ***Investigation of Antibiotic-Resistant Genes in Reclaimed Water,*** Professor Amy Pruden, Department of Civil and Environmental Engineering & Associate Dean for Interdisciplinary Graduate Education, Virginia Tech, Blacksburg, Virginia

December 18, 2015 ***Development and Utilization of a Customized Model for Evaluating Performance of the Calumet, Mainstream and Des Plaines Tunnel and Reservoir Plan Systems,*** Mr. Patrick Jensen, PE, Associate Civil Engineer and Ms. Ann Gray, Associate Civil Engineer, Collection Facilities/TARP, Engineering Department, 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