DEPARTMENT OF WATER MANAGEMENT

CITY OF CHICAGO

December 12, 2018

Illinois Department of Natural Resources
Office of Water Resources
160 N. LaSalle Street, Suite S-703
Chicago, Illinois 60601-3117

James F. Kessen, P.E.
Lake Michigan Management Section

Mr. Kessen:

Enclosed are the completed annual water usage Report LMO-2 and the AWWA Water Loss Audit's Reporting Worksheet, Performance Indicators Sheet and the User Comments Sheet for the 2018 water accounting year from October 1, 2017 through September 30, 2018.

A supplemental sheet, attached to the report, details the average daily supply of water transferred to other entities.

A report detailing the activities of the Chicago Water System in regard to water conservation and accountability during the 2018 water accounting year is also attached. If you should have any questions regarding this report, please contact Kwok Ho at 312-742-3609.

Very truly yours,

Randy Conner
Commissioner

1000 EAST OHIO STREET, CHICAGO, ILLINOIS 60611

ILLINOIS
DEPARTMENT OF NATURAL RESOURCES

Illinois Department of Natural Resources

Bruce Rauner, Governor

One Natural Resources Way Springfield, Illinois 62702-1271
www.dnr.illinois.gov

Wayne A. Rosenthal, Director

Office of Water Resources, Michael A. Bilandic Building, 160 N. LaSalle St., S-703, Chicago, IL 60601
Office: (312) 793-0990

2018 Annual Water Use Audit Form (LMO-2)

This form must be completed by all Category IA and IB Permittees for the annual water use accounting year running from October 1, 2017 through September 30, 2018. This form must be completed and submitted to the Department by January 7, 2019.

Section I - General Information

Permittee Contact Information:

Permittee: The City of Chicago Department of Water Management
Address: 1000 East Ohio Street
Chicago, Illinois 60611

County: Cook
Phone: 312-744-7001
Email:

Contact Person Information:

Name: Randy Conner
Address: 1000 East Ohio Street
Chicago, Illinois 60611

Phone: 312-744-7001
Email:

Authorized Official _____

Title: Commissioner
Date:

Service Population: 2,695,598

"Service Population" is the total population the permittee serves with water related to their allocation, both inside and outside their corporate limits. This does not include population associated with water exported/sold to other systems.

The Illinois Department of Natural Resources is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Chapter 19, Section 120.2 of the Illinois Revised Statutes. Disclosure of this information is required. Failure to provide any information will result in this form not being processed. This form has been approved by the Forms Management Center, CMS.

Section II - Water Supplied:

In order to complete this form you will have to first complete the AWWA Free Water Audit Software. Lines 4, 8, 24 and 26 - 38 (highlighted below) must be taken directly from the AWWA Free Water Audit Software's "Reporting Worksheet" and "Performance Indicator" worksheets. A completed version of the AWWA Free Water Audit Software must be submitted along with the completed LMO-2 form (submit both as Microsoft Excel files). All amounts should be rounded to three decimal places.

Volume from own sources:

1. Shallow Well			mg/y	0.000 **mgd**
2. Deep Well			mg/y	0.000 **mgd**
3. Lake Michigan (Direct Diverters only)		251,160.150	mg/y	688.110 **mgd**
4. Total Volume From Own Sources		251,160.150	mg/y	688.110 **mgd**

Water imported from other sources:

	Supplier:			**Amount:**
5			mg/y	0.000 **mgd**
6			mg/y	0.000 **mgd**
7			mg/y	0.000 **mgd**
8. Total Water Imported		0.000	mg/y	0.000 **mgd**

Water exported to other systems:

	System:			**Amount:**
9	(See Attachment 1)	96,113.625	mg/y	263.325 **mgd**
10			mg/y	0.000 **mgd**
11			mg/y	0.000 **mgd**
12			mg/y	0.000 **mgd**
13			mg/y	0.000 **mgd**
14			mg/y	0.000 **mgd**
15			mg/y	0.000 **mgd**
16			mg/y	0.000 **mgd**
17			mg/y	0.000 **mgd**
18			mg/y	0.000 **mgd**
19			mg/y	0.000 **mgd**
20			mg/y	0.000 **mgd**
21			mg/y	0.000 **mgd**
22			mg/y	0.000 **mgd**
23			mg/y	0.000 **mgd**

24. Total Water Exported	96,113.625	mg/y	263.325 **mgd**
25. WATER SUPPLIED (Line 4 + Line 8 - Line 24)			424.785 **mgd**
26. WATER SUPPLIED (adjusted for master meter error)	148,430.962	mg/y	406.660 **mgd**

Section III; Authorized Consumption:

27. Billed Metered	72,126.555	mg/y	197.607 **mgd**
28. Billed Unmetered	54,130.230	mg/y	148.302 **mgd**
29. Unbilled Metered	4,961.810	mg/y	13.594 **mgd**
30. Unbilled Unmetered	2,798.820	mg/y	7.668 **mgd**
(If not using the AWWA default of 1.25% of Water Supplied, provide an explanation)			
31. AUTHORIZED CONSUMPTION	134,017.415		367.171 **mgd**

Section IV: Water Losses:

32. Apparent Losses	938.773 mg/y	2.572 **mgd**
33. Real Losses	13,474.775 mg/y	36.917 **mgd**
34. Water Losses	14,413.547 mg/y	39.489 **mgd**

Section V: Non Revenue Water:

35. NON REVENUE WATER	22,174.177 mg/y	60.751 **mgd**

Section VI: Performance Indicators:

36. Annual cost of Apparent Losses	3,698,764 **$/year**
37. Annual cost of Real Losses	2,511,024 **$/year**
38. Non-revenue water as percent by volume of Water Supplied	14.9%

Section VII - Conversion Table

Below are conversion calculations to convert the most commonly used units to units of million gallons per day (mgd).

To convert cubic feet per year (cf) to (mgd) use:
(cf x 7.48)/1,000,000/365 = mgd

To convert gallons per year (g) to (mgd) use:
g/1,000,000/365

To convert gallons per day (g/d) to (mgd) use:
(g/d)/1,000,000

To convert million gallons per year (mg) to (mgd) use:
mg/365 = mgd

AWWA Free Water Audit Software: Reporting Worksheet

WAS v5.0
American Water Works Association.

Click to access definition
Click to add a comment

Water Audit Report for: City of Chicago, Department of Water Management
Reporting Year: 2018 10/2017 - 9/2018

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (n/a or 1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

To select the correct data grading for each input, determine the highest grade where the utility meets or exceeds all criteria for that grade and all grades below it.

Master Meter and Supply Error Adjustments

WATER SUPPLIED

<---------- Enter grading in column 'E' and 'J' ---------->

				Pcnt:	Value:	
Volume from own sources:	9	251,160.150	MG/Yr	1.95%		MG/Yr
Water imported:	5	0.000	MG/Yr			MG/Yr
Water exported:	8	96,113.625	MG/Yr	-1.85%		MG/Yr

Enter negative % or value for under-registration
Enter positive % or value for over-registration

WATER SUPPLIED: 148,430.962 MG/Yr

AUTHORIZED CONSUMPTION

Click here: for help using option buttons below

				Pcnt:	Value:	
Billed metered:	8	72,126.555	MG/Yr			
Billed unmetered:	5	54,130.230	MG/Yr			
Unbilled metered:	9	4,961.810	MG/Yr			
Unbilled unmetered:	6	2,798.820	MG/Yr		2,798.820	MG/Yr

Unbilled Unmetered volume entered is greater than the recommended default value

Use buttons to select percentage of water supplied OR value

AUTHORIZED CONSUMPTION: 134,017.415 MG/Yr

WATER LOSSES (Water Supplied - Authorized Consumption) 14,413.547 MG/Yr

Apparent Losses

				Pcnt:	Value:	
Unauthorized consumption:		371.077	MG/Yr	0.25%		MG/Yr

Default option selected for unauthorized consumption - a grading of 5 is applied but not displayed

Customer metering inaccuracies:	7	387.379	MG/Yr	0.50%		MG/Yr
Systematic data handling errors:		180.316	MG/Yr	0.25%		MG/Yr

Default option selected for Systematic data handling errors - a grading of 5 is applied but not displayed

Apparent Losses: 938.773 MG/Yr

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses: 13,474.775 MG/Yr

WATER LOSSES: 14,413.547 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 22,174.177 MG/Yr

= Water Losses + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	9	4,236.7	miles	
Number of active AND inactive service connections:	9	520,974		
Service connection density:		123	conn./mile main	
Are customer meters typically located at the curbstop or property line?		No		
Average length of customer service line:	5	50.0	ft	(length of service line, beyond the property boundary, that is the responsibility of the utility)
Average operating pressure:	9	45.0	psi	

COST DATA

Total annual cost of operating water system:	9	$854,355,000	$/Year	
Customer retail unit cost (applied to Apparent Losses):	10	$3.94	$/1000 gallons (US)	
Variable production cost (applied to Real Losses):	7	$186.35	$/Million gallons	☐ Use Customer Retail Unit Cost to value real losses

WATER AUDIT DATA VALIDITY SCORE:

*** YOUR SCORE IS: 79 out of 100 ***

A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION:

Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Billed unmetered
2: Volume from own sources
3: Unauthorized consumption

AWWA Free Water Audit Software:
System Attributes and Performance Indicators

WAS v5.0
American Water Works Association.

Water Audit Report for: City of Chicago, Department of Water Management
Reporting Year: 2018 | 10/2017 - 9/2018

*** YOUR WATER AUDIT DATA VALIDITY SCORE IS: 79 out of 100 ***

System Attributes:

	Apparent Losses:	938.773	MG/Yr
+	Real Losses:	13,474.775	MG/Yr
=	**Water Losses:**	**14,413.547**	MG/Yr
?	Unavoidable Annual Real Losses (UARL):	2,267.76	MG/Yr
	Annual cost of Apparent Losses:	$3,698,764	
	Annual cost of Real Losses:	$2,511,024	Valued at **Variable Production Cost**

Return to Reporting Worksheet to change this assumpiton

Performance Indicators:

Financial:	Non-revenue water as percent by volume of Water Supplied:	14.9%	
	Non-revenue water as percent by cost of operating system:	0.9%	Real Losses valued at Variable Production Cost
Operational Efficiency:	Apparent Losses per service connection per day:	4.94	gallons/connection/day
	Real Losses per service connection per day:	70.86	gallons/connection/day
	Real Losses per length of main per day*:	N/A	
	Real Losses per service connection per day per psi pressure:	1.57	gallons/connection/day/psi
	From Above, Real Losses = Current Annual Real Losses (CARL):	13,474.77	million gallons/year
?	Infrastructure Leakage Index (ILI) [CARL/UARL]:	5.94	

* This performance indicator applies for systems with a low service connection density of less than 32 service connections/mile of pipeline

AWWA Free Water Audit Software:
User Comments

Use this worksheet to add comments or notes to explain how an input value was calculated, or to document the sources of the information used.

General Comment:	Non-Revenue Water exceeds the Department's current thresholds of 12% is due to the City of Chicago's Water Exemption Program for the schools, universities, churches, hospitals, nonprofit organizations and public facilities.

Audit Item	Comment
Volume from own sources:	
Vol. from own sources: Master meter error adjustment:	In the Chicago water system, the total dicharge flow measurements are accomplished with 58 venturi tube flowmeters. Their sizes are from 36"X22" to 60"X45". Their ages are from 1920 to 1997. The error tolerance of venturi tubes is +/-2% from the manufacture's specifications. In addition, the flowmeter devices (transmitters) have an accuracy of +/-0.25%. The total error tolerance of a discharge flow measuring system would be +/-2.25%. We blieve that estimated +1.95% accuracy is reasonable and practical.
Water imported:	
Water imported: master meter error adjustment:	
Water exported:	
Water exported: master meter error adjustment:	Our three bigest suburban consumers are DuPage Water Commission (DWC), Village of Oak Lawn and Northwest Suburban Municipal Joint Action Water Agency (JAWA). Their combined water usage is about 50% of our total amount of water exported. They are using the venturi tube flowmeters to measure water flow to their system. Those venturi tubes also have a +/-2% accuracy. the flow transmitters have an accuracy of +/-0.25% . The total accuracy for the flow measuring system would be +/-2.25%. The -1.85% accuracy for water exported is an estimated number.
Billed metered:	
Billed unmetered:	
Unbilled metered:	The total volume of water exemption for the schools, universities, churches, hospitals, nonprofit organizations and public facilities.

Audit Item	Comment
Unbilled unmetered:	The summation of Fire Hydrant water usages for firefighting, new water main flushing, sewer cleaning, street cleaning, public construction, and water quality request flushing.
Unauthorized consumption:	Unauthorized consumption is due to unauthorized and illegal open fire hydrants.
Customer metering inaccuracies:	
Systematic data handling errors:	
Length of mains:	
Number of active AND inactive service connections:	
Average length of customer service line:	
Average operating pressure:	
Total annual cost of operating water system:	
Customer retail unit cost (applied to Apparent Losses):	
Variable production cost (applied to Real Losses):	The variable production cost doen't include labor costs.

Attachment 1

CITY OF CHICAGO
DEPARTMENT OF WATER
SUPPLEMENT TO FORM LMO-2

WATER METERED AND BILLED DIRECTLY BY CHICAGO WATER DEPARTMENT
OCTOBER 1, 2017 TO SEPTEMBER 30, 2018

ENTITY	MGD
ALSIP *	5.421
BEDFORD PARK *	21.707
BERWYN	5.047
BLUE ISLAND	1.993
BRIDGEVIEW	2.161
BROOKFIELD-N. RIVERSIDE W.C. *	4.416
BURNHAM	0.079
CALUMET CITY	0.302
CALUMET PARK	0.594
CENT. STICKNEY SD	0.108
CICERO	7.127
DES PLAINES *	1.735
DOLTON	2.412
DUPAGE W.C. *	74.068
ELMWOOD PARK	2.167
EVERGREEN PARK	1.607
FOREST PARK	2.165
FOREST VIEW	0.158
FRANKLIN PARK	2.463
GARDEN HOMES S.D.	0.058
HARVEY *	7.972
HARWOOD HEIGHTS	0.790
HILLSIDE-BERKELEY W.C. *	1.593
HOMETOWN	0.309
JUSTICE-WILLOW SPRINGS W.C. *	2.456
LINCOLNWOOD	1.516
MAYWOOD	2.602
McCOOK *	4.702
MELROSE PARK *	8.117
MERRIONETTE PARK	0.177
MIDLOTHIAN-MARKHAM W.C. *	2.645
MORTON GROVE *	2.775
NILES *	5.401
NORRIDGE	1.464
NORTHWEST SUB JOINT ACTION W. A. *	28.078
AQUA ILLINOIS INC Total	0.007
OAK LAWN *	28.363
OAK PARK	5.214
PARK RIDGE	3.981
RIVER FOREST	1.159
RIVER GROVE	1.035
RIVERDALE	1.414
ROBBINS	1.350
ROSEMONT	1.543
SCHILLER PARK	1.354
SOUTH HOLLAND *	2.059
SOUTH STICKNEY S.D.	2.270
STICKNEY	1.382
SUMMIT	1.244
WESTCHESTER-BROADVIEW W.C. *	3.698
WORTH	0.848
METRO WATER RECLAMATION DIST. Total	0.022
TOTAL	263.325

* INCLUDES OTHER MUNICIPALITIES
ALL METERS ARE READ BETWEEN THE 20TH AND 30TH DAY OF EACH MONTH

CITY OF CHICAGO 2018 LMO-2 **Attachment 2**

Explanation for the Report (LMO-2) Line No. 30.
(not using the AWWA default of 1.25% of Water Supplied.)

Excessive unbilled unmetered water usage was due to the following factors:

	Estimated Usage	Percentage of water supplied
1. NEW WATER MAIN FLUSHING. An accelerated water main replacement program is in progress. More hydrant flow is needed for water main flushing.	3.507 mgd	0.83%
2. FIREFIGHTING & TRAINING	2.124 mgd	0.50%
3. SEWER CLEANING	0.100 mgd	0.02%
4 STREET CLEANING	0.100 mgd	0.02%
5. PUBLIC FACILITIES CONSTRUCTION	0.425 mgd	0.10%
6. WATER MAIN FLUSHING FOR WATER QUALITY PURPOSES	0.788 mgd	0.19%
7. EXEMPTED UNMETERED ACCOUNTS	0.624 mgd	0.15%
TOTAL UNBILLED UNMETERED WATER USAGE	7.668 mgd	1.81%
	2,798.820 MG/Yr	

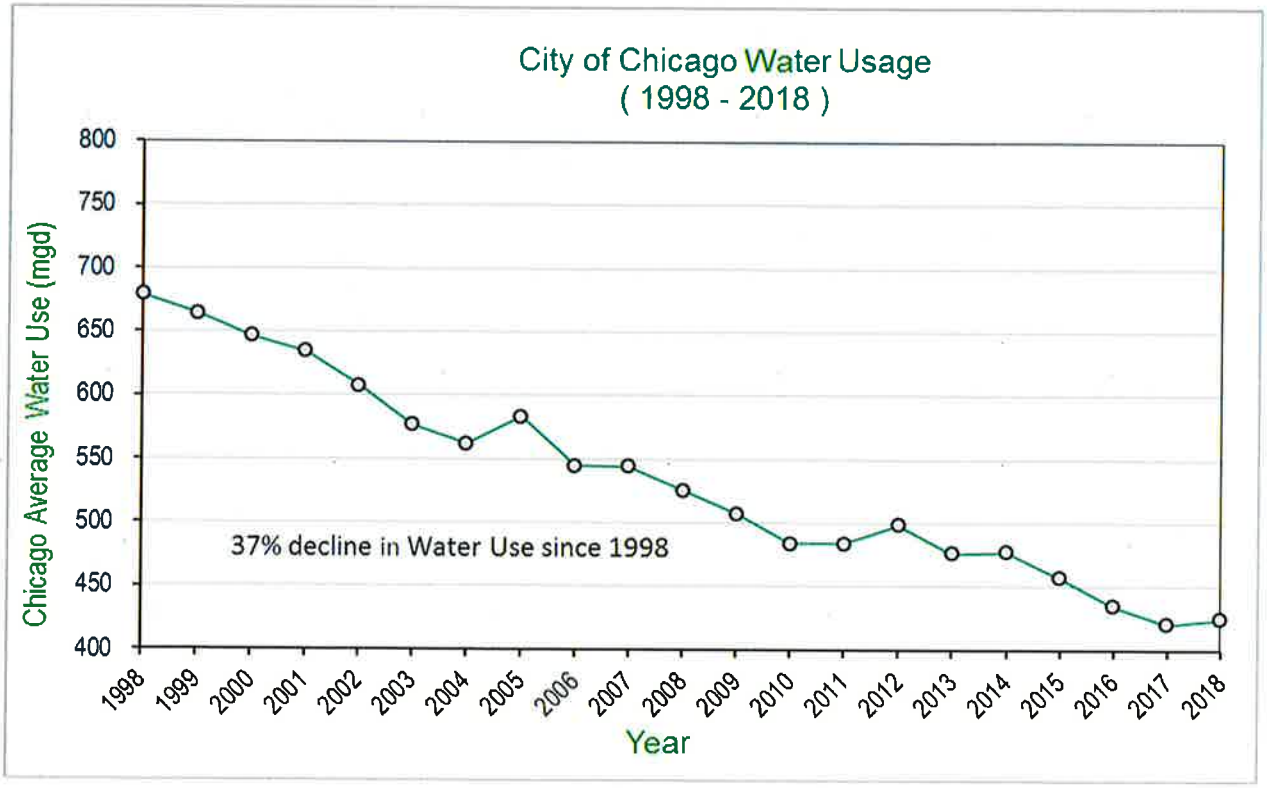
Attachment 3

REPORT BY THE CITY OF CHICAGO DEPARTMENT OF WATER MANAGEMENT TO THE ILLINOIS DEPARTMENT OF NATURAL RESOURCES FOR THE 2018 WATER ACCOUNTING YEAR

During Water Year 2018, the City of Chicago has continued to promote water conservation through a number of initiatives and policies to better conserve our fresh water and to wisely manage storm water. Our water conservation plan is a partnership among public and private sectors, and each resident of Chicago. It includes investing in infrastructure upgrades, working with our sister agencies and large industrial customers to promote conservation, and developing a plan to meter all residential water users. With the exception of drought years, the Department continues to see declining water usage due to its continued efforts to reduce water waste by investing in the following programs:

1.) Water Main Replacement
2.) Hydrant Custodian Installation
3.) Education and Public Awareness
4.) Volunteer Metering Program
5.) Meter Repair and Replacement
6.) Elimination of Unused Services
7.) Underground Leak Detection and Repair
8.) SCADA System Upgrade
9.) Installation of Variable Speed Pumps

The chart below demonstrates our progress with a plan that has had significant results in reducing water usage for the City of Chicago.



WATER MAIN REPLACEMENT

The Water Main Replacement Program was designed to address the City's aging water mains which were installed over 100 years ago at the height of Chicago's exponential growth rate. The selection of water mains to be replaced is based primarily from analyzing break history records to determine where replacement would most benefit the water system. The City has placed a high priority on this key component of the Water Conservation Program, and believes it has had a large impact on the reduction of unaccounted for water, and a significant impact on the decline in water pumpage. Prior to 2012, the program had targeted a replacement rate of approximately 1% of the system's 4,350 miles of pipe each year. We are now on a path to target over 2% per year allowing us to mirror the installation rates over 100 years ago. The following table shows the past and current miles of main replaced per year.

We are pleased to report that through the leadership and support of Mayor Rahm Emanuel, the funding to address the needs of our aging infrastructure has become available through a series of water rate increases starting in 2012 with 25% and continuing the next 3 years with 15% each year. Water mains are critical assets to deliver safe potable water to not just Chicago but to its wholesale customers. These unprecedented water rate increases were based on the fact that over 25% of our water mains are over 100 years old and demonstrate our Mayor's vision and commitment to focus on the long term needs of this aging water system. The rate increases will allow us to continue this successful program to reduce water waste as well as fund critical treatment plant and pumping station upgrades. Our long term goals have been set to replace nearly 900 miles of water mains in the 10 year period, from 2012 through 2021

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Miles of Pipe Laid	35.9	23.0	33.7	20.7	34.0	32.0	30.0	30.0	70.0	75.0	85.0	90.0	90.0	90.0	90.0

HYDRANT CUSTODIANS

The City has historically experienced difficulty in deterring people from opening hydrants during hot summer days. The opening of hydrants creates hazardous traffic situations, may damage adjacent property, and wastes water. In addition, open hydrants reduce the pressure and amount of water available for fire fighting.

In order to minimize this problem, the City began installing hydrant custodians in areas where previous experience indicated that open hydrants may be a problem. This program had to be coordinated with the Fire Department to insure that the hydrants would always be available for fighting fires. The installation of hydrant custodians is a repetitive and evolutionary process. The City develops a locking mechanism and the water thieves develop methods of removal. This has occurred multiple times with the City attempting to stay one lock ahead of the thieves.

The City has experimented with various locking devices throughout the years and has developed two types of technologically advanced custodians that are fairly effective. In addition, the City has developed a stem design that makes it difficult to turn the hydrant valve by reaching through the ports and manually turning the stem. In the 1990's, the City investigated and tried many other deterrents and have found them to be readily defeatable by determined vandals. Over 20,000 of the City's 48,000 hydrants now have custodians. A total of 8,400 of these 19,000 are the newer "NEO" version which operates with a stronger magnet. In areas where repeated open hydrants occur, the City is retrofitting the custodian with an additional spider guard deterrent to prevent damage to the operating mechanism. These retrofits installed since 1998, have demonstrated their effectiveness by a reduction in their frequency of opening. The City has found that the newer "NEO" version of the custodian has had a very significant impact on illegal hydrant openings. The City will still install the additional spider guard retrofits, but only in the areas where the "NEO" has not been successful.

EDUCATION AND PUBLIC AWARENESS

The Department of Water Management engages in public education and awareness on a continuing basis. Conservation messages are conveyed through a variety of channels, including community meetings, literature distribution, and extensive use of the World Wide Web. Over the past years, we have included themes from the Chicago Water Agenda. This is a gathering of local initiatives, policies, programs and proposals that address issues of conservation, water quality and storm water management in a coordinated way. The Agenda applies not just to the City of Chicago, but to suburban communities and other cities across the Great Lakes region. We have also ramped up efforts in a promotional campaign to get conservations messages out to the public through various transportation ads and street signage advertising. Our metersave program message is quite visible throughout the city.

Coordinating with other City departments, the Department of Water Management has been including Agenda messages in the annual Consumer Confidence Report, in development of an educational program for schools, in grass roots presentations to community groups and Chambers of Commerce, and in other appropriate settings. Topics range from techniques of conservation to fire hydrant usages to the prospect of universal customer metering.

VOLUNTEER METERING PROGRAM

The City has continued to make great strides with its volunteer metering program. Accounts which are currently unmetered can have a meter installed free of charge. By the end of 2018, the City has installed over 130,000 meters, under this program, since its inception in 2009, and plan to install additional 15,000 meters in 2019. To keep up with the program, we have continued to engage in a contract to allow a private contractor to install meters from the volunteer program and supplement our in-house work force. As this program is continuously promoted and more customers realize the financial and water resource benefits, we anticipate a stronger participation, in the years to come, from our unmetered customer base. The Department of Water Management is fully committed to making this a successful program. Also, additional highlights of this program are presented on our promotional website at www.metersave.org.

METER REPAIR AND REPLACEMENT

The City continued to service those meters presently installed on suburban, commercial, industrial, and municipal accounts. The total installed meter base in Chicago is in excess of 326,000 units. As new housing is erected and rehabilitation continues, the number of meters is increasing. Maintenance of this large installed meter base requires a considerable commitment of manpower and equipment. The City is committed to maintaining its meters in conformance with the recommendation of the meter manufacturers and the AWWA.

ELIMINATION OF UNUSED SERVICES

The City continued its efforts to cut and seal unused services. The following table shows the data for termination of unused services since 2005.

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of Services Terminated	620	422	297	488	510	692	342	476	635	1540	1521	2256	1892	2510

A major effort has been made to eliminate these potential sources of leakage. These water services were terminated by both City forces and by private contractors. Although the termination of unused water services is very expensive, the continued reduction in the number of unused services should help reduce the amount of unaccounted for water.

LEAK DETECTION AND REPAIR

The Department has maintained a high level of effort in its leak detection program over the past years. The Department employs one TriCorr TM 2001 correlator and in 2009 purchased some of the newer Digicorr correlators from FCS which is considered the product of choice by most professional leak detection firms and consultants, particularly in North America. These models are more sensitive in detecting leaks and have better noise filtering capabilities. In addition to our in house forces, the Department also contracts out services for leak detection. The services include not only an ongoing systematic coverage for leak detection of our distribution system every 3-4 years, but also the monitoring for leak noises while performing an ongoing valve inspection program. Through our leak detection consultant, we have been able to employ various technologies to detect and pinpoint underground leakage. One of these technologies: the "Radcom SoundSens" leak noise correlator system combines sound logging and correlation by installing three or more correlating pods within an area. The units pick up sound during the night and are then analyzed the next day by downloading the sounds to a central correlator. A multipoint correlation can then be performed between the units resulting in higher degrees of accuracy and allowing nighttime sounding without the need to work during the nighttime.

The Department is also employing the latest technology in the leak detection field for feeder mains. During 2005 and 2006, we started to survey sections of 36-inch and 60-inch mains with the Sahara® leak detection technology, where a tether-controlled Sahara® sensor is deployed inside a pipeline without any disruption to pipeline service. It moves through the pipeline with the flow and pinpoints even the smallest leaks in water mains. More documentation on this technology can be found at http://www.puretechltd.com/products/sahara/sahara_leak_gas_pocket.shtml . In 2007 we started using another newer technology for large diameter pipeline leak detection. This technology is Echologics and it differs from traditional leak correlators in that it uses the water column inside the pipeline to transmit the sound wave generated from a leak. This technology allows greater distances to between transmitters and has proven to be worthwhile. More documentation on this technology can be found at http://www.echologics.com/leakfinder_overview.html. Since then, we have been using a similar product, the Primayer leak correlator system and have made an effort to systematically survey our older trunk main systems to assure no leaks are occurring on these mains which could cause catastrophic failures and extensive damage. More documentation on this technology can be found at http://www.primayer.co.uk/wlc_leak_location_eureka_digital.htm

The following table demonstrates the Department's efforts toward leak detection.

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Miles of Pipe Surveyed	700	734	1220	1700	1460	1220	1600	1900	1760	1162	1179	1501	1820	1773
Number of Underground Leaks Located	400	320	356	590	477	402	300	660	637	380	611	702	833	656

SCADA SYSTEM

The SCADA system was upgraded during 1996-97. At that time new well gauges, discharge pressure gauges, and flow meters were installed. In 2006, the SCADA system was upgraded again with new equipment and software to improve the operations and allow even better pressure management. Today there are 84 remote pressure sensors installed in the distribution system. The sensors are continuously monitoring water pressure in real time for the entire service area of the City of Chicago. Also, there are eight additional continuously monitored points located mainly in the outlying areas to monitor supply pressure and suburban flow demand patterns. These pressure sensors have proven to be a great aid with pumping station

operation, by avoiding over pressurizing the system that in turn is believed to contribute to significant savings in water usage. The upgraded SCADA system provided a more complete monitoring and control of pressures and flows in the distribution system on a real time basis.

VARIABLE SPEED ELECTRIC DRIVES

The Chicago water system has 12 pumping stations. Nine of the pumping stations have pumps that are driven by electric motors, and five of these electric stations are equipped with electronically controlled variable speed drives. The variable speed drives allow the operating staff to efficiently adjust water pumpage without over pressurizing the water distribution system, which reduces water main breaks and wasting of water. The remaining three stations are steam powered with manually controlled pumps. The plan is to convert these stations to electrical power with variable speed drives. The Department has completed the conversion of Springfield Pumping Station in 2016. The design plans have been completed for the conversion of the Central Park Pumping Station, this project will go into construction in 2019. The next steam powered station, Western Ave. Pumping Station, will follow soon after the start of construction of the Central Park Pumping Station construction. The design for the conversion of the final steam pumping station, Mayfair Ave. Pumping Station, is slated to begin in 2022.