

Massachusetts Water Resources Authority

**Triennial Report of the Consulting Engineer - Conditions & Operations
October, 2017**



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October 27, 2017

Mr. Frederick Laskey
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Subject: Triennial Report of the Consulting Engineer to the
Massachusetts Water Resources Authority

Dear Mr. Laskey:

Enclosed herewith is the Triennial Report of the Consulting Engineer to the Massachusetts Water Resources Authority (the "Authority" or the "MWRA"). The Triennial Report was prepared in accordance with Section 714(c) of the Authority's General Revenue Bond Resolution.

In the preparation of the report, we inspected the Authority's major water and wastewater facilities, reviewed and analyzed various reports and studies, operating and capital budgets and other statistical and financial information prepared by others. We also interviewed key members of the Authority staff regarding the matters presented in this report.

In addressing the specific requirements of the Triennial Report, as set forth in Section 714(c) of the General Revenue Bond Resolution, CDM Smith finds that:

- The properties of the Authority's water and wastewater systems (collectively, the "System") have been maintained in good operating condition during the past three fiscal years or adequate steps are being taken to make them so;
- The adopted FY 2018 Capital Improvement Program (CIP) and the adopted FY 2018 Current Expense Budget (CEB), along with planned current expense projections through FY 2023, provide appropriate expenditure levels to maintain the System in good operating condition through the three-year period ending in FY 2017;
- The Authority's planned funding of the Renewal and Replacement Reserve Fund Requirement and the adopted FY 2018 CIP and FY 2018 CEB are adequate to meet the Authority's current projected needs; and



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- The Authority's rates, fees, rentals, and other charges appropriately provide for the necessary cash revenue requirements of the System and comply with the requirements of the General Revenue Bond Resolution.

It has been a pleasure being of service to the Authority in fulfilling the role of the Consulting Engineer.

Very truly yours,

CDM Smith Inc.

A handwritten signature in black ink that reads "Joseph T. Ridge". The signature is written in a cursive, slightly slanted style.

Joseph T. Ridge
Vice President



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Section 1

Introduction

1.1 Purpose and Scope

Under Section 714(c) of the Resolution, the Authority is required to file, with the Trustee, every three years, a copy of a certificate of a Consulting Engineer that sets forth in reasonable detail:

(1) its findings as to whether the properties of the System have been maintained during such three year period, and are then being maintained, in good repair and sound operating condition, (2) its estimate of the amount, if any, required to be expended to place such properties in such condition and the approximate time therefore, (3) its recommendation, if any, as to improved management and proper maintenance, repair, and operation of and capital improvements to the System during the ensuing three year period, (4) its recommendations as to the adequacy of the Renewal and Replacement Reserve Fund Requirement and the then current Operating Budget and Capital Budget and its recommendations as to the adequacy of the Authority's rates, fees, rentals and other charges. If such certificate sets forth that the properties of the System are not then being maintained in good repair and sound operating condition, the Authority shall restore the properties to good repair and sound operating conditions as promptly as is practicable.

The purpose of this report is to respond to these requirements of the Resolution and to present financial projections for the Authority's FY 2018 to FY 2023. In the process of compiling this document we have visited and evaluated key facilities, have interviewed key Authority personnel responsible for the operation and management of the System, have evaluated the Current Expense Budget ("CEB") and the FY 2018 Capital Improvement Program ("CIP") and have assessed the adequacy of the Authority's required Reserves.

The report is organized in the following fashion:

Section 1: Describes the purpose and scope of the report, together with relevant background information concerning the Authority and its management.

Section 2: Describes the Authority's System, assesses its condition and makes recommendations with respect to improvements where appropriate.

Section 3: Presents the costs and estimated time for completion of the recommended improvements.

Section 4: Discusses the adequacy of the Authority's Renewal and Replacement Reserve Fund Requirement, the Operating Reserve Fund, the CEB and the CIP.

Section 5: Discusses the adequacy of the Authority's rates, fees, rentals and other charges.

1.2 Background

The Authority was established by a special act of the Commonwealth of Massachusetts (the "Commonwealth"), Chapter 372 of the Acts of 1984, as amended (the "Enabling Act"). The Enabling Act sets forth the obligations and powers of the Authority and establishes the general form of governance. Under the terms of the Enabling Act, the Authority is governed by an eleven-person Board of Directors (the "Board") chaired by the Commonwealth's Secretary of Energy and

Environmental Affairs. The Secretary and two other members are appointed by the Governor. Three members are appointed by the Mayor of the City of Boston and three members are appointed by the MWRA Advisory Board. One member is appointed by the Mayor of Quincy and one member appointed by the Winthrop Town Council.

The Enabling Act also created the Massachusetts Water Resources Authority's Advisory Board (the "Advisory Board") to review the Authority's budget and operation and to serve as a liaison with the Local Bodies. The Advisory Board is composed of representatives from 60 of the 61 communities (Lancaster is not represented on the Advisory Board) that receive water and/or sewer service from the Authority, plus a representative from the Metropolitan Area Planning Council (a regional planning organization established by the Massachusetts legislature). In addition, six people are appointed by the Governor to include a person with skills and expertise in matters relating to environmental protection, one representative each from the Connecticut River basin, the Quabbin/Ware watershed areas, and the Wachusett watershed area, plus two persons qualified by membership or affiliation in organizations concerned with the recreational or commercial uses of the Boston Harbor.

In 1985, the Authority assumed possession and control from the Metropolitan District Commission (the "MDC"), which became part of the Department of Conservation and Recreation (the "DCR") in July 2003, a department of the Commonwealth, of a water distribution system (the "Waterworks System") and a sewer system (the "Sewer System") (collectively, the "System"), which provide wholesale services in a service area encompassing, in whole or in part, 61 communities located primarily in eastern Massachusetts, including most of the metropolitan Boston area. Fifty-two cities, towns, and special purpose entities (known as "Local Bodies") currently are authorized to receive water from the Waterworks System; however, the newest community to receive such authorization – the Town of North Reading – has deferred action on completing the membership process. Forty-three Local Bodies connect their local sewer systems to the regional sewage collection and treatment facilities constituting the Sewer System. Approximately 3.0 million people, who comprise approximately 44 percent of the Commonwealth's total population, live in the communities served or potentially served by the System. The Authority has had and continues to have discussions with additional communities and Local Bodies regarding potential water sales to meet various needs and has added five Local Bodies to the Waterworks System since its inception.

Since its creation, the Authority has demonstrated its capacity to successfully manage its complex affairs. The Deer Island Treatment Plant ("DITP"), one of the nation's largest and most complex wastewater treatment improvement projects, was completed on time and below its original cost estimate. Measurable improvements have occurred in the water quality of Boston Harbor as a result of this project. Shortly after the creation of the Authority, the Safe Drinking Water Act (the "SDWA") amendments were enacted, increasing the regulatory requirements for many water utilities, including the Authority. The Authority has developed and implemented a program to comply with the requirements of the SDWA. This includes the construction of the John J. Carroll Water Treatment Plant (the "Carroll WTP") and redesigning the transmission system so that all treated water is stored in covered storage facilities. The Authority also constructed the Norumbega Covered Storage Facility and the MetroWest Water Supply Tunnel (the "MWWST"), providing redundancy to the existing Hultman Aqueduct. The Authority continues to scrutinize its capital program to determine whether certain elements are necessary, or if alternatives exist to attain the same objective at a lower cost.

As these major programs have been developed and construction implemented, the Authority has worked to ensure that the long-term integrity of the System through a proactive maintenance program and systematic replacement of aging facilities. Based on our review of the CIP, a physical inspection of the systems, and interviews with staff, we believe the Authority is acting appropriately to ensure the long-term viability of the System. In December 2006, the Authority developed and presented its initial Master Plan, a long-term strategy which identified and prioritized potential Sewer

System needs through FY 2048. The Authority updated the Master Plan in 2013 to ensure that it reflected the anticipated needs of the Sewer System as identified at that time. Much of the Master Plan targets for upgrade existing infrastructure that is at or would be nearing the end of its useful life. In recent years, the Authority has focused much of its capital spending towards the completion of the long-term combined sewer overflow (“CSO”) control plan to comply with federal mandates in the so-called Clean Water Act Case. The Authority substantially completed the CSO control program in 2015. The Authority anticipates that future capital spending will focus on asset protection and water redundancy initiatives.

The Authority has been sensitive to the economic and public implications of financing its capital program and properly operating and maintaining its existing and newly constructed infrastructure. The Authority, with the Advisory Board and many other stakeholders, has continuously sought state and federal financial assistance for its construction program and has also aggressively sought alternative, less expensive means of achieving compliance with the various legal and regulatory requirements imposed upon it. The Authority continues to strive to improve its operating efficiency and minimize or reduce operating expenses. To maintain public support, the Authority has sought to educate the public at large to the tangible real benefits that have resulted or will result from its programs.

In addition, the Authority has established a five-year CIP spending cap intended to ensure that it effectively balances its facility needs with financial realities. This cap provides a mechanism for determining what the Authority can afford and requires the Authority to establish and enforce spending priorities. The baseline cap for the period FY 2014 – FY 2018 was set at \$791.7 million. Each year the Authority assesses annual CIP cash flow requirements and its ability to meet that cap. As part of the FY 2018 CIP, the Authority estimated that total CIP requirements during the cap time period would total \$543.9 million, the reduction due largely to lower projected expenditures and excluding two Community Financial Assistance Programs from the cap calculation, at the direction of the Advisory Board. The proposed spending does not reflect certain items where costs could change as a result of additional regulatory requirements in the SDWA compliance area or from a new NPDES permit for the DITP.

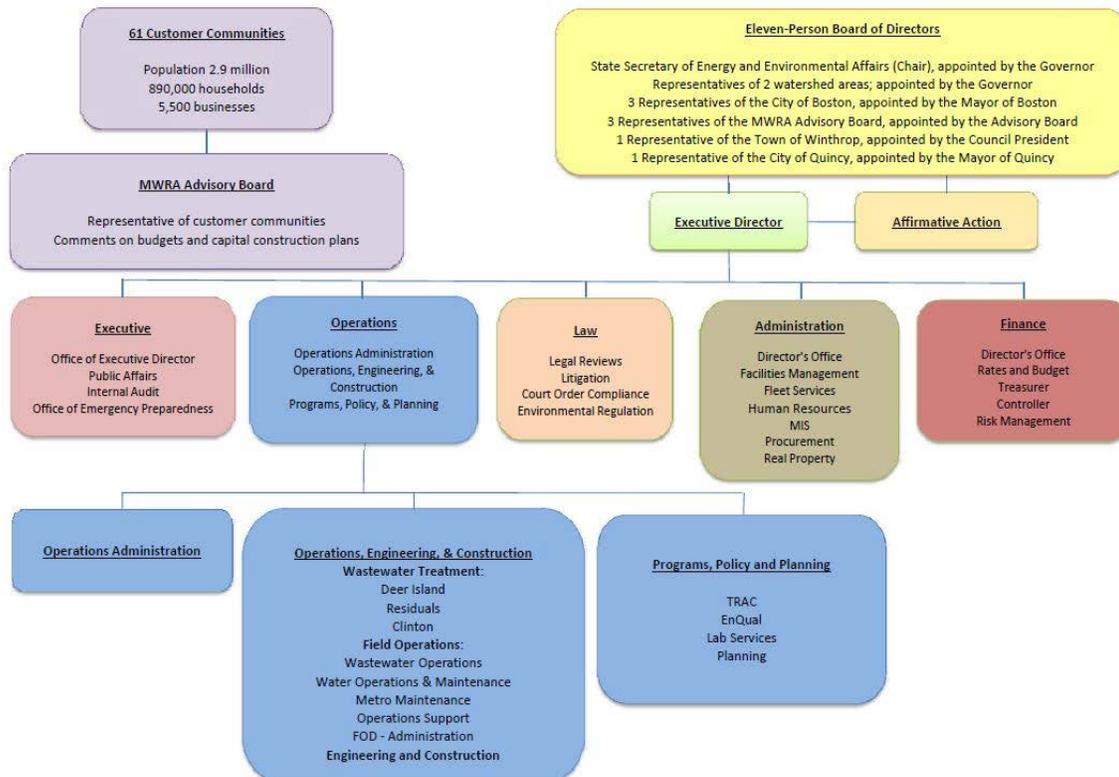
The Authority is currently in the discussion and planning phase regarding the feasibility and impacts of long-term redundancy improvements for the Metropolitan Tunnels that supply water to the metropolitan Boston area. The Authority, based on a Board vote in February 2017, is moving forward with permitting and design for the redundancy project, which anticipates the construction of two deep rock tunnels to provide redundant potable water conveyance to the Authority’s metro Boston service area. The CIP includes \$1.4 billion for the long-term redundancy project, which the Authority anticipates expending over 15-years or longer.

In assessing the organization’s ability to address the many real challenges that face the Authority, we believe its record of achievement over the past 30 years is an important consideration.

1.3 Organizational Structure

The Authority is organized in a divisional structure designed to establish clear lines of authority and responsibility and to promote organizational efficiency. Figure 1-1 provides the Authority's current organizational structure. The Authority periodically evaluates and modifies its organizational structure as appropriate. The Authority estimates that FY 2018 staffing will be 1,150 filled positions.

Figure 1-1: MWRA Organizational Chart



The responsibilities of each Division:

- **Executive Division** - The Executive Division supports the Office of the Executive Director, the chief executive officer of the Authority, responsible for the implementation and coordination of Authority programs, policies, and procedures at the direction of the Board. The Office of the Executive Director also supports the Board of Directors, the Advisory Board, and other advisory committees. For FY 2018 the Office of the Executive Director includes five authorized positions. The Executive Division also includes the Office of Emergency Preparedness, the Affirmative Action Compliance Unit, Internal Audit, and Public Affairs.
 - *Office of Emergency Preparedness* - The Office of Emergency Preparedness directly reports to the Executive Director. The Department's role consists of providing Authority-wide planning and implementation of security and emergency responses. For FY 2018, this department includes eight authorized positions.

- *Affirmative Action and Compliance Unit* - The Affirmative Action and Compliance Unit is responsible for developing, administering, and monitoring compliance of affirmative action programs and policies, and directly reports to the Executive Director. For FY 2018, this department includes six authorized positions.
- *Internal Audit Department* - The Internal Audit Department is responsible for auditing financial and program operations, reviewing compliance with accounting and management control systems, and coordination of policy revision. The department reports directly to the Executive Director. For FY 2018, this department includes seven authorized positions.
- *Public Affairs Department* - The Public Affairs Department is responsible for community relations, communications, education and intergovernmental affairs. For FY 2018, this department includes 13 authorized positions.
- **Operations Division** - The Operations Division is responsible for the planning, policy decision support, design, construction, operation and maintenance of the System. The Operation Division is discussed further below. For FY 2018, this division includes 919 authorized positions.
- **Law Division** - The Law Division provides legal analysis and counsel to the Authority's operating and administrative divisions and represents the Authority in court-related matters. For FY 2018, this division includes 16 authorized positions.
- **Administration Division** - The Administration Division is responsible for administrative support functions such as human resources, management information systems, procurement, real property and environmental management, and fleet services. For FY 2018, this division includes 142 authorized positions.
- **Finance Division** - The Finance Division manages the financial services of the Authority. The division is responsible for rates and revenue management, budgeting, treasury, capital financing, investment management, accounting, grant and loan management, risk management, and coordination of Authority financial planning. For FY 2018, this division includes 36 authorized positions.

The Operations Division is responsible for 73 percent of the Authority's operating costs and 80 percent of total staffing. As seen in Figure 1-1, the Operations Division currently includes a department that consolidates field operations for both the Waterworks System and the Sewer System, a department for planning and decision support, a department for wastewater treatment (including the Deer Island Treatment Plant), and centralized engineering, construction, laboratory and administrative support units. The Field Operations Department is also responsible for the operation and maintenance of the Carroll WTP. The Chief Operating Officer heads the Operations Division.

We believe that the Authority is effectively organized to perform its mission. The Authority has shown its willingness and ability to modify its organizational structure to address emerging issues and demonstrate management's commitment to adjust the organization in light of shifting priorities and conditions. This is evidenced by the Authority having previously engaged a consultant to evaluate the Authority's staffing levels and adherence to the five-year recommended staffing goal.

1.4 Management Processes

Since its inception the Authority has continuously modified its management processes to ensure that its programs and policies are conducted in accordance with Authority directives, in a cost conscious manner, and in a way that is effectively communicated to the interested public. On an annual basis the Authority produces a comprehensive CIP and a CEB, both of which are subject to public review and comment. The Authority also undertakes management initiatives that are intended to enhance the efficiency of its operations.

The Authority has a capital budgeting process that addresses the significant needs of the Authority while minimizing future rate increases to the extent possible. The CIP is prepared every year, and includes five years of planned expenditures on capital improvement projects. The CIP is funded primarily through the issuance of revenue bonds, which are repaid over a number of years through inclusion of debt service amounts in each fiscal year's CEB.

The progress of capital projects is continually monitored for purposes of managerial control, decision-making, financial planning, and management. Each Division is responsible for monitoring and reporting on the projects for which it is responsible, including explanations for both schedule and expenditure variance.

The Authority annually prepares a CEB with detailed expenditure information for several prior fiscal years and the upcoming fiscal year. The CEB reflects the operating and maintenance costs of existing water and sewer facilities, administrative and support activities, and current expenses supporting the additional expenses associated with the operation of the Authority's extensive capital improvement projects. The operating budget is balanced by revenue and income derived mostly from user charges to the Local Bodies that receive water and/or sewer services from the Authority.

The Authority uses a monthly and quarterly management indicators reporting system to measure actual performance against objectives, including a budget variance analysis of both the CIP and the CEB, and reports on progress in achieving program performance objectives. Monthly and quarterly budget reports are prepared for internal review. These reports provide Authority managers and the Board of Directors with a mechanism for evaluating both favorable and unfavorable changes in circumstances. We believe that the management indicators variance analysis reporting system is a good management tool that allows assessment of planning and implementation performance, and identifies opportunities to improve future performance. It also enables the Authority to control costs and ensures that expenses do not exceed its limited resources.

The Authority has identified and focused on rates as a central management issue. The Authority has worked closely with the Advisory Board to contain expenses. At the same time, the Authority has devised and implemented strategies to minimize rate increases, and continues to take steps to minimize future rate requirements. The Authority's rate relief strategy includes several major components:

- Ensuring that all capital and operating costs are kept to a minimum, and that each dollar invested adds to the value of water and sewer services.
- Continuing to seek federal support for the Authority's capital program, including funding from both the Clean Water Act and the Safe Drinking Water State Revolving Funds.
- Continuing to seek the receipt of Commonwealth debt service assistance ("DSA") for the capital improvement program. The Authority's projections include \$391,580 of DSA that was received in FY 2017, which has been applied as an offset for FY 2018 to reduce rates. The

availability or extent of future assistance is unknown at this time. The Authority's projections assume that additional DSA will not be received through the current forecast period.

- Using a variety of financing options such as revenue bonds, tax exempt commercial paper ("TECP"), bond anticipation notes, variable rate debt, bond refundings, low interest Massachusetts Clean Water Trust loans ("SRF loans" - formerly, the Massachusetts Water Pollution Abatement Trust), and escrowing debt with operating surpluses to manage the rate of growth in the Authority's revenue requirement.

We are of the opinion that the Authority is properly organized to respond to the management challenges it faces and is taking reasonable and prudent steps to optimize the efficiency of its operations.

1.5 Summary

In summary, we have reached the following conclusions regarding the Authority's management of the System.

The Authority is well organized to effectively carry out its various duties. Of equal importance, the Authority continually evaluates and adjusts its organizational structure to properly address emerging issues and shifting priorities.

The Authority continues to attract and retain managerial and technical staff to supervise its planning, design, and construction programs. Key members of the staff have the qualifications and experience commensurate with their responsibilities and have demonstrated their ability to make organizational and staffing changes as required, maintaining a cost-effective and efficient operational structure.

The Authority continues to shift its focus from constructing new facilities to developing programs and procedures for effectively operating and maintaining new and existing facilities. The Authority is also devoting substantial attention to how best to maintain and enhance drinking water quality, as well as implementing programs to improve water redundancy as it operates existing and develops new drinking water facilities.

Through a business planning process, the Authority is strengthening its management focus to improve operational efficiency and control the growth of expenses in the future.

Section 2

Condition of Existing Facilities and Recommended Improvements

This section presents information pertinent to the Authority's Sewer System and Waterworks System. It describes the planning conducted by the Authority, provides information concerning the Authority's service areas, and discusses and evaluates existing and planned facilities.

2.1 Sewer System Overview

Over its first two decades, the Authority was committed to an ambitious program for the planning, design, construction, and operation of a secondary treatment plant located at Deer Island. This program was executed concurrently with the planning, management, operation, and upgrading of the Authority's other wastewater facilities located upstream of Deer Island, including pumping stations, CSO control and headworks facilities for the removal of grit and screenings. The Authority also implemented an aggressive program for processing and distributing the product through beneficial reuse of wastewater residuals ("sludge").

The Authority's initial wastewater investments were guided by several detailed planning level engineering documents. The documents provided the definition and the timetables for the Authority's wastewater CIP and included the Secondary Treatment Facilities Plan, the Residuals Management Plan, and the CSO Conceptual Plan and System Master Plan. The improvements recommended in all of the above documents are complete, with the CSO Control Plan being the last to conclude in 2015. The Authority will commence a three-year performance assessment of the CSO improvements starting in January 2018.

The CSO Control Plan was developed to provide a framework for investments in the collection and treatment systems and to ensure compliance with the National CSO Policy. The CSO Control Plan recognized the leadership role that the Authority must play with regards to integration of system-wide programs that involve the Local Bodies. The Authority's plan identified those elements of each Local Bodies combined sewer systems that, if upgraded and improved, will not only improve local systems, but also improve the operations of the System. All 35 original CSO Control Plan projects have been completed.

In 2013 the Authority updated the original Master Plan for its Sewer System. The purpose of the wastewater Master Plan was to assess the long-range capital needs of the Authority, with an emphasis on the need for rehabilitation and renovation of all of the System's assets, including the cyclical replacement of those elements of the new facilities constructed in recent years that are anticipated to reach the end of their useful lives within approximately 10-15 years due to the aggressive corrosive environment found in wastewater facilities. Beginning with the FY 2014 CIP, the Master Plan has provided the framework for all capital planning and budgeting. The Authority intends to update the Master Plan periodically to reflect changing conditions and requirements and the FY 2018 CIP notes development of an update to the 2013 Master Plan will begin soon.

2.2 Sewer Service Area and System Facilities

The Authority provides wastewater treatment services to two geographic regions of the state. By far the larger of the two, the greater Boston metropolitan area, consists of 43 communities proximate to

Boston. The second area includes the Town of Clinton and the Lancaster Sewer District in Central Massachusetts, and is referred to as the Clinton Service Area.

2.2.1 Boston Metropolitan Sewer Service Areas

The Authority's Boston metropolitan sewerage system currently serves a 502 square mile region with a total sewered population of approximately 2.5 million. The system is divided into two major drainage basins with both the north and south sewer systems conveying flows to the DITP. Figure 2-1 shows the service areas and location of major wastewater treatment facilities. With an area of approximately 212 square miles, the north system serves approximately 65 percent of the population in the sewered area, with approximately 97 percent of those connected to the Sewer System.

The south system encompasses approximately 290 square miles and services approximately 35 percent of the total population, of which approximately 90 percent are connected to and contribute wastewater to the Sewer System. The remainder of the population use septic systems.

2.2.2 Clinton Service Area

The Clinton Wastewater Treatment Plant (the "Clinton Plant") was constructed to provide sewer service to the Town of Clinton and the Lancaster Sewer District located in Central Massachusetts, in conjunction with the development of the Wachusett Reservoir. The Clinton Plant, originally constructed in 1955, was upgraded to provide advanced wastewater treatment in 1992. It presently has a connected population of approximately 14,000 and the capacity to serve a design population of 23,500.

2.2.3 Boston Metropolitan Sewer System Facilities

The Boston metropolitan sewer system facilities include sewers, pump stations, headworks and treatment facilities located throughout eastern Massachusetts. The following summarizes the major components of the system. More detailed evaluations are presented in later sections.

2.2.3.1 Wastewater Transport System

The Boston metropolitan wastewater transport system consists of approximately 230 miles of sewers, ranging in size from 4 inches to 11 feet in diameter. The Authority does not provide collection services to retail customers; rather the Local Bodies connect to the Authority's Sewer System at over 1,800 locations. The Local Bodies are then responsible for service to retail customers through the local collection systems.

The Authority operates 12 sewage pumping stations in the Boston metropolitan sewerage system. Over the past 25 years the Authority has either replaced or significantly renovated all of the pumping stations in the system. In concert with the pump station projects, the Authority has replaced approximately 40 miles of associated interceptors and forcemains.

2.2.3.2 Headworks

The Authority currently has six headworks—the Winthrop Terminal Facility at Deer Island and five remote headworks including the headworks facility at the Braintree-Weymouth Intermediate Pumping Station—that provide screening and coarse grit removal to protect major conveyance tunnels and other facilities. The North Metropolitan Relief Tunnel conveys wastewater from the Chelsea Creek Headworks. Wastewater from East Boston, Chelsea, Revere, and Winthrop is conveyed in the North Metropolitan Trunk Sewer to the Winthrop Terminal Headworks and Pumping Facility. The Boston Main Drainage Tunnel conveys wastewater from both the Ward Street and Columbus Park headworks. Screening and grit removal for south system flows prior to transport through the Inter-

Island Tunnel to the DITP is provided at the Nut Island Headworks and at the Intermediate Pumping Station in Quincy.

2.2.3.3 Treatment Plant

Primary and secondary treatment is provided at the DITP. The DITP includes primary clarifiers, cryogenic oxygen plant, aeration reactors, secondary clarifiers, odor control systems, residual thickening and sludge digesters, administration buildings, maintenance and laboratory buildings, as well as required on-island pumping facilities, power and site utilities. The DITP has capacity to provide secondary treatment for flows up to 700 million gallons per day (“mgd”) and primary, chlorination and dechlorination treatment for flows up to 1,270 mgd.

2.2.3.4 Combined Sewer Overflow Facilities

Four of the 43 Local Bodies in the MWRA wastewater service area (Boston Water and Sewer Commission, Cambridge, Somerville and Chelsea) are served by combined sewers (sewers that carry sanitary flow and stormwater) and have permits from the United States Environmental Protection Agency (the “US EPA”) to discharge CSOs to area surface waters. Flows exceeding the capacity of the locally owned collection system or the Authority’s transport system can discharge directly to Boston Harbor, the Alewife Brook, the Mystic River, the Charles River Basin and the Neponset River at CSO outfalls. Parts of the Town of Brookline are also served by combined sewers, but Brookline does not have its own CSO outfall. There were 84 CSO outfalls in existence at the beginning of the CSO program permitted to the MWRA and the four CSO Local Bodies. Upon completion of the CSO Control Plan in 2015, 35 of those have been closed; five are maintained to 25-year storm control virtually eliminating events; 40 are reduced to a minimal number of CSO discharges per year; and each of the remaining four receive treatment at one of three Authority CSO facilities (there are two outfalls associated with the Somerville Marginal CSO Facility). In addition, a portion of flows to an otherwise untreated outfall receives treatment at a fourth Authority CSO facility. The four CSO facilities treat over 93 percent of all remaining CSO flow. The MWRA has taken a leadership position with regard to the resolution of CSO discharges by assuming responsibility for the development of an abatement plan for all CSOs. The details of this plan are presented in Section 2.3.6.

2.2.3.5 Residual Facilities

Sludge produced by the DITP is processed at a sludge pelletizing plant located at the former Quincy Shipyard site in Quincy, Massachusetts. The pellets produced at the facility are distributed locally and nationally for beneficial reuse and disposal. The facility was placed into service in December 1991. It is owned by the Authority, with operations and product disposal/distribution the responsibility of New England Fertilizer Company (“NEFCO”). The 15-year NEFCO contract was scheduled to expire in December 2015, but was extended through December 2020 to quantify the impacts of co-digestion programs implemented at Deer Island and dryer operations using larger, more efficient dryer trains. This extension is anticipated to save roughly \$1.25 million in operational costs. The Authority intends to then procure an operator for new 15-year contractual term.

2.3 Sewer System Facilities Evaluation

2.3.1 Boston Harbor Project Facilities

The primary portion of the DITP has been designed and constructed to receive and treat up to 1,270 mgd; the secondary portion of the DITP is constructed with a treatment capacity of 700 mgd, which is sufficient to meet effluent limits for all flows received. The overall treatment process consists of influent degritting of north system flows, primary clarification, aeration with pure oxygen, secondary clarification, and hypochlorite disinfection followed by dechlorination.

Influent from the north system is pumped into the DITP plant from either the North Main Pump Station or the Winthrop Terminal facility. Influent from the south system is pumped into the DITP plant by the South System (Lydia Goodhue) Pump Station. The northern flows are degrittied on island,

and southern flows are screened and degrittied at the Nut Island Headworks Facility. Primary sedimentation is provided by four batteries of stacked primary clarifiers. The clarifiers and all grit facilities are covered and the exhaust air is treated to remove odor. Primary sludge that settles to the bottom of the clarifiers is collected and pumped out of each clarifier to the gravity thickeners. Primary scum that floats to the top of the clarifiers is collected and pumped to primary scum screens. The reject material is collected and sent to landfills while the liquid scum continues on to scum concentrators.

The DITP's activated sludge secondary treatment aeration process uses pure oxygen mixed with wastewater to biologically reduce the waste concentration. The oxygen is generated on-site by a cryogenic oxygen plant. There are three batteries of oxygen aeration tanks (reactors) and three batteries of stacked secondary clarifiers. The treatment process is an activated sludge system with a portion of the sludge that is settled out in the secondary clarifiers recycled back to the oxygen aeration basins. The excess sludge is then pumped to the centrifuge thickening facility. The effluent is chlorinated at disinfection basins, dechlorinated after appropriate detention and discharged to Massachusetts Bay through the Effluent Outfall Tunnel.

The thickened primary and secondary sludges are pumped into sludge anaerobic digestion tanks. The sludge anaerobic digesters blend and biologically stabilize the sludge. Anaerobic digestion converts a portion of the sludge to methane gas to be used as a fuel source at the plant's thermal facility. The digested sludge is pumped through an underwater pipeline to the pelletizing plant, located at the former Quincy Shipyard site.

The Authority has instituted a detailed automated maintenance management program at the DITP. The staff keeps track of equipment availability and the completion of scheduled and required maintenance. A thorough maintenance management and asset management program to optimize performance, maximize useful lives and control maintenance costs has been instituted (the "asset management program"). The asset management program identifies the mechanical portions of the primary and sludge processing facilities, originally put into service in 1995, that are approaching the ends of their useful lives, primarily due to the aggressive, corrosive environment found in wastewater facilities, and plans for their rehabilitation or replacement. Accordingly, the Master Plan identifies projects for the cyclical replacement of critical assets such as the primary clarifier's collectors, gates, and sludge pumping equipment. Through the CIP, Phase I of the asset management program, replacement of clarifier components, was completed in 2013. Phase II of the program, the replacement of clarifier drives and other components, has been funded and is currently in design. The construction schedule for Phase II has been extended based on an expanded scope of work, and is scheduled to be completed by 2022. The Authority's asset management program is well conceived and its implementation is assuring the Authority that the plant's capacity is reliably available. The DITP is well maintained and in excellent condition overall.

Energy efficiency and management has been a focus both in the initial design, including hydro-electric generation and methane reuse, as well as ongoing improvements to DITP operation. The Authority estimates that it now self-generates 27 percent of its electrical demand and greater than 62 percent of its total combined heating, cooling and electrical energy demand. Two wind turbines have been installed at the site, which are providing 1,200kw of power. Photovoltaic systems installed on rooftops and in a parking lot provide 756kw of power. Within the CIP, the Authority is replacing existing lighting at the DITP with high efficiency fluorescent or LED type lighting; the hydro turbine facility was the most recent facility to receive new LED lighting. The DITP minimizes electrical demand costs by maximizing the utilization of the two on-site 26 megawatt power generation turbines and participates in a demand response program to drop off the grid during times of peak power demand in the region.

2.3.2 Discharge Permit Compliance and Facility Performance

The DITP has been designed to achieve an effluent with an average monthly CBOD concentration of 25 mg/l and an average monthly TSS concentration of 30 mg/l, consistent with the discharge permit (the “NPDES Permit”) issued by the US EPA and the Massachusetts Department of Environmental Protection (the “DEP”). The NPDES Permit, which became effective most recently on August 10, 2000, incorporates federal secondary treatment requirements and other limits necessary to meet water quality standards established by the Commonwealth. Although the NPDES Permit technically remained effective through August 9, 2005, it continues in full force and effect until the US EPA issues a new replacement permit. The new NPDES Permit, once reissued, is anticipated to have essentially the same numeric permit limits for conventional pollutants with the possibility of adding a limit for enterococcus bacteria which the MWRA has planned for. The Authority has no indication from US EPA when a new permit may be issued.

The DITP facilities have provided treatment meeting or bettering the numeric limits of the permit on a consistent basis. Average daily plant flows averaged 282.34 million gallons per day during calendar year 2016 which was a calendar year low flow record, as compared to the permit limit of 436 mgd. The DITP’s average dry weather flow has been decreasing gradually over the last several years, attributable to both the ongoing elimination of infiltration in the sewers and water conservation on the water supply side as well as continued dry weather and low groundwater levels.

The DITP consistently complies with the NPDES Permit’s numeric limits. Through the most recent monthly report, there were no reported violations at DITP during FY 2017 and none to date in FY 2018. For the past six years, Deer Island has received the National Association of Clean Water Agency’s (“NACWA”) Platinum Award for Peak Performance for meeting permit for each of the last ten calendar years.

2.3.3 Clinton Wastewater Treatment Facilities

In addition to the plant that discharges to Boston Harbor, the Authority also operates a treatment plant in the Town of Clinton. In 1987, special legislation transferred ownership of the Clinton Plant from the MDC to the Authority and obligates Clinton to pay up to \$500,000 to the Authority per year for wastewater treatment service. The Clinton Plant is an advanced wastewater treatment facility with a design flow of 3.0 mgd and hydraulic capacity for peak flows of 12.0 mgd. Consisting of a combination of new facilities and upgraded elements from an existing plant, the Clinton Plant has been fully operational since 1992, and performance and operation have been very good.

The sludge, grit, and screenings from the plant are disposed at an eight-acre lined landfill site that was constructed in Clinton as part of the plant’s upgrade. The site is owned by the Authority and was originally designed to provide a 20-year capacity for sludge from the plant; although the landfill has been in operation for 25 years, the Authority estimates it has five to 10 years remaining life as current constructed. Leachate from the landfill is collected and pumped back into the Sewer System and returned to the plant for treatment.

The average daily flow to the Clinton Plant for 2016 and 2017 was approximately 2.4 mgd. The Clinton Plant had a draft discharge NPDES Permit issued on September 27, 2010 to which the Authority has appropriately responded. A new permit was issued in December 2016 and will be effective in 2019. The new permit contains a more stringent phosphorus limit of 0.15 mg/L seasonally, and 1.0 mg/L during the summer. A project is currently underway constructing a new tertiary treatment facility and building which includes flocculation tanks and disc filters. Tertiary treatment will include polymer and ferric chloride addition to aid in performance of the filters. Performance testing of the new filter facilities is scheduled to be completed in November 2017.

Since 2014, the Authority has rehabilitated needed portions of the Clinton Plant and replaced equipment including at the influent pump station, the intermediate pump station, the aeration basins and the digesters.

In 2015 and 2016, the Clinton Plant received NACWA's Gold Award for Peak Performance for meeting permit for each entire calendar year.

The Authority's wastewater Master Plan anticipates that the Local Bodies served by the Clinton Plant will undertake programs to control excessive inflow and infiltration (I/I).

2.3.4 Pumping Stations Facility Evaluation

In addition to the pumping stations on Deer Island, the Authority has 12 wastewater pump stations; four in the north system and eight in the south system. All of the pumping stations are well maintained and functioning properly; however five of the facilities have been in operation for 19 years or longer since they have been put into service, or since their most recent major upgrade, and are nearing the end of their design life. The oldest of these stations without a major rehabilitation has been in operation for 30 years (Allison C Hayes); one station (Caruso) which was recently renovated in 2017 has been in operation for 26 years prior, and a second (Alewife Brook) is currently being upgraded and had been in operation for 23 years since its previous upgrade. Key data on the pump stations is summarized in Table 2-1. In viewing the table, it is important to note that the term "upgrade" refers to a major rehabilitation/renovation project and does not include minor maintenance or installation items such as pump replacement. Further, the FY 2018 CIP includes a Pump Stations and CSO Assessment, which started in December 2017 and is scheduled to be completed by December 2019 as well as a Pump Station Rehab – Preliminary Design/Study scheduled for 2019 through 2020. The Authority is aware of the age of these facilities and is planning to address it as appropriate. Generally, we have found that the pump stations are efficient and in proper working condition and that the pumping systems appear to be well operated and maintained.

**Table 2-1
Pump Station Summary**

<i>Pump Station</i>	<i>Pump Description</i>	<i>Built</i>	<i>Most Recent Upgrade</i>
Alewife Brook	3 – 26 mgd electric 1 – 14 mgd electric	1951	Upgraded in 1994 On-going (2017-2019)
Allison C. Hayes	3 – 5.5 mgd electric	1987	None
Braintree-Weymouth Replacement	3 – 14 mgd electric	2008	None
Braintree-Weymouth Intermediate (IPS)	3 – 23 mgd electric 1 - 14 mgd electric (Lead)	2004	None
Caruso	4 – 21 mgd electric (dry-weather) 3 – 50 mgd electric (wet-weather)	1991	2017
DeLauri	3 – 65 mgd electric (46.5 mgd max allowed per pump)	1993	2011
Hingham	3 – 4.89 mgd electric	1957	Upgraded in 1992
Hough's Neck	2 – 1.4 mgd electric	1998	None
Quincy	3- 14.4 mgd electric	2002	None
Squantum	4 - 2.9 mgd electric	2003	None
Neponset	3 – 34.6 mgd electric	1995	None
Framingham	3 – 14 mgd electric	1998	None

2.3.5 Headworks Facilities

In the north service area, there are three remote headworks that protect the tunnel system by providing screening and coarse degritting of the wastewater at the drop shafts to the tunnels that feed the North Main Pump Station at Deer Island. In the south service area there are remote headworks facilities at Nut Island in Quincy and at the Intermediate Pump Station in Quincy. Screening and degritting are provided at these locations to protect the interisland tunnel that feeds the South System Pump Station at Deer Island. There is a headworks at Deer Island, the Winthrop Terminal facility, that was upgraded as part of the Boston Harbor Project.

The remote headworks on the north system function as flow regulators. Operators regulate flow to correspond to available capacity at the DITP. Flows in excess of capacity are either stored within the interceptor system or discharged as CSOs.

The three remote headworks in the north service area are Chelsea Creek Headworks, the Ward Street Headworks, and the Columbus Park Headworks. All three headworks with the exception of elevation and minor dimensional differences are functionally identical to each other. In the FY 2015 CIP, the Authority had identified future projects for major upgrades to all three of the North System

Headworks facilities. The Authority began construction on a complete rehabilitation project of the Chelsea Creek Headworks facility in November 2016 and construction is projected to be complete by November 2020. The contract price for these improvements is approximately \$73.1 million and includes all change orders to date. The designs for Ward Street and Columbus Park are included in the FY 2018 CIP and design is anticipated to begin in July 2018, while the construction of Chelsea Creek is underway. Construction of the Ward Street and Columbus Park facilities is projected to begin in August 2020 and be completed in January 2025. Summary information on the size, capacity, and year of construction for the headworks is presented in Table 2-2.

**Table 2-2
Headwork Facilities Summary**

<i>Facility</i>	<i>Discharges to</i>	<i>Capacity (mgd)</i>	<i>Year Built</i>
Winthrop Terminal Facility	Deer Island Treatment Plant	125	1968
Columbus Park Headworks	Boston Main Tunnel	182	1968
Ward Street Headworks	Boston Main Tunnel	256	1967
Chelsea Creek Headworks	North Metro Tunnel	350	1967
Nut Island Headworks	Inter-Island Tunnel	360	1996
Braintree-Weymouth Intermediate Pumping Station (IPS)	Inter-Island Tunnel	45	2004

The remote headworks are adequate to handle the projected flows. They are well maintained, with equipment replaced on or before it wears out. Operations staff at each facility do an excellent job of keeping the facilities clean. The staff are knowledgeable in the maintenance and operation of the facilities. The operation of these facilities is labor intensive due to their remote locations and equipment configurations.

2.3.6 CSO Facilities

CSOs are discharges during large storm events from combined sewers that were designed to carry sanitary flows and a limited quantity of street runoff and drainage. These untreated CSO discharges are no longer allowed under current regulatory standards since they generally cause water quality standards to be exceeded and may compromise beneficial uses of the receiving waters. Within the Authority service area, there were 84 permitted CSOs when the Authority commenced CSO control planning in 1992 to comply with the evolved regulatory requirements. The Federal District Court in the Boston Harbor Case mandated that CSO discharges be brought into compliance with the federal Clean Water Act and state water quality standards. The Court maintains active oversight of the Authority's activities to correct CSOs.

As of October 2015, CSO discharges were eliminated (or, for the North Dorchester Bay outfalls, "effectively eliminated," i.e. eliminated up to the 25-year design storm) at all 34 of the outfalls recommended to be closed in the CSO Control Plan. Six additional outfalls have been closed to CSOs by the Boston Water and Sewer Commission (three), the City of Cambridge (two) and the City of Chelsea (one). At or upstream of the Authority's five permitted outfalls, the Authority operates four CSO treatment facilities that were constructed or upgraded under the CSO Control Plan. Each of the CSO facilities provides preliminary treatment (screening), disinfection with sodium hypochlorite and

dechlorination with sodium bisulfite. The four facilities have the following capacities: Somerville Marginal: 145 mgd; Cottage Farm (210 mgd); Prison Point: 385 mgd and Union Park (330 mgd). Three other treatment facilities, Fox Point, Commercial Point and Constitution Beach, were decommissioned under the CSO Control Plan by 2007.

Table 2-3 shows the present cost and status of the projects included in the CSO Control Plan.

Table 2-3
Status of Long-Term CSO Control Plan
(\$ in million)

<i>Project (# of distinct projects identified)</i>	<i>Current Budget</i>	<i>Status</i>
North Dorchester Bay Storage Tunnel	\$218.3	Completed
Pleasure Bay Storm Drain Improvements	3.2	Completed
Morrissey Blvd Storm Drain	32.2	Completed
Reserved Channel Sewer Separation	70.5	Completed
Hydraulic Relief Projects at CAM005 and BOS017 (2)	2.3	Completed
East Boston Branch Sewer Relief	85.6	Completed
BOS019 (Charlestown) Storage Conduit	14.3	Completed
Chelsea Trunk Sewer and Branch Sewer Relief (3)	29.8	Completed
Union Park Detention Treatment Facility	49.6	Completed
Upgrades to Existing CSO Facilities and MWRA Floatables Control (5)	22.4	Completed
South Dorchester Bay Sewer Separation	118.6	Completed
Stony Brook Sewer Separation	44.3	Completed
Neponset River Sewer Separation	2.5	Completed
Constitution Beach Sewer Separation	3.7	Completed
Cambridge Alewife Brook Projects (4)	104.6	Completed
Fort Pt. Channel Sewer Separation	11.9	Completed

Brookline Sewer Separation	24.7	Completed
Bulfinch Triangle Sewer Separation	9.1	Completed
Somerville Manhole Separation	0.4	Completed
MWRA003 Gate, Rindge Ave. Siphon Relief and SOM01A Relief (2)	4.4	Completed
Prison Point CSO Facility Optimization	-	Completed
Charles River (Cottage Farm) CSO Controls (2)	3.6	Completed
Region-wide Floatables Control	2.1	Completed
TOTAL	\$858.1	

We believe that the Authority's approach to CSO control has been reasonable and prudent. Unlike other water pollution control programs, CSO pollution abatement is a complicated process involving widely dispersed facilities primarily in dense urban, waterfront areas, relatively expensive solutions, and imprecise benefits with respect to water quality standards and uses due to other sources of pollution that will continue to impair water quality, such as urban stormwater. The Authority's approach maximizes benefits while minimizing costs, eliminating, or effectively eliminating, CSO discharges to sensitive use waters (swimming and shellfishing), and bringing CSO discharges into compliance with "fishable/swimmable" water quality standards at least 98 percent of the time in less sensitive receiving waters.

The Authority will begin a three-year performance assessment of its CSO Control Plan beginning in January 2018 and is required to submit the report to US EPA and DEP by December 2020. This report is to verify attainment of the required long-term levels of control, including frequency of CSO activation and volume of discharge, as specified in the approved CSO Control Plan. Continued tracking and reporting over the previous 10 years have allowed the Authority to monitor the system performance as it continued to implement the LTCP. Modeling efforts are maintained and consist of actual rainfall events and "typical year" rainfall with updated system conditions. The model allows the Authority to perform a detailed review of the discharges.

2.3.7 Interceptor Evaluation

The Sewer System includes large interceptor sewers that were constructed over the past century. The focus of the Authority's sewerage program is to renovate those aging portions of the system and to accommodate growth in the service area by providing additional conveyance capacity where needed.

The focus of sewerage improvements in the south service area has been to increase capacity to relieve hydraulic under-capacities that have developed as a result of growth within certain segments of the service area. Improvements in the north service area were principally focused on the renovation of existing facilities to restore hydraulic capacity and to ensure the structural integrity of the Sewer System.

In addition to correcting deficiencies within the Sewer System, the Authority has provided leadership and financial assistance to the Local Bodies through a grant/loan program to support the identification and elimination of inflow and infiltration (“I/I”) within the sewers of Local Bodies. This program completed eight funding cycles through FY 2014 and is reauthorized for funding cycles nine and 10 beginning in FY 2015 through FY 2025. The original grant/loan percentage split has been revised from a 45/55 split, where the loan portion was to be repaid over five years, to a 75 percent grant, combined with a zero-interest rate loan on the remaining 25 percent to be repaid over 10 years. The Authority to date has committed over \$333 million for this program which has funded nearly 530 I/I identification and sewer rehabilitation projects. Phases nine and 10 were approved for \$80 million per phase, and the program presently has a budgeted upper limit of \$493 million. The program has achieved measurable reduction in I/I as evidenced by the gradual drop in average daily flow to the DITP. The objective of this program is to assist Local Bodies identify and accelerate the elimination of I/I, thereby reducing the potential need for expansion of Sewer System facilities and optimizing the efficiency of the existing Sewer System.

We believe that the Authority’s program both for financially assisting the Local Bodies with the elimination of I/I and for constructing, renovating, rehabilitating and maintaining its interceptor sewers is properly focused. Given the overall age of the Sewer System, the Authority will need to make continued investments in rehabilitation and renovation.

2.3.8 Maintenance Facilities and Initiatives

2.3.8.1 Centralized Maintenance Facilities

Wastewater and water distribution maintenance activities for the metropolitan systems are located at a leased facility located in Chelsea. The facility also houses the operations control centers. Included are the machine shops, storage areas, and garage facilities. In addition to the centralized facility for maintenance, individual facilities have maintenance areas, tools, and limited storage for routine maintenance items. The DITP has its own maintenance facility.

2.3.8.2 Maintenance Management Activities

The Authority has adopted an asset management program that has been implemented system wide. The Authority has recognized the need to conduct cost-effective preventative maintenance and to be able to identify the appropriate timing for equipment replacement. As part of the asset management program, a maintenance management information system has been deployed, preventative maintenance programs using real time condition monitoring are being installed throughout the Authority’s facilities and reliability centered maintenance strategies are being instituted. This initiative is targeted to manage maintenance costs and to ensure that the Authority’s equipment and assets can be cost effectively operated and maintained over at least their anticipated design lives.

2.3.9 Residuals Facilities

Sludge produced by the Authority’s DITP is processed for beneficial use or disposal at the Authority’s sludge pelletizing plant located on an eight-acre site at the former Quincy Shipyard. Sludge is pumped from the DITP to the pelletizing plant via redundant pipelines within the Inter-Island Tunnel under Boston Harbor. NEFCO is under contract to operate the plant through December 2020, after the initial 15-year contract was extended five years to quantify the impacts of new piloting and new dryer operations.

Until the spring of 2005, sludge was barged from Deer Island to the pelletizing plant. With the completion of the new interceptor facilities on the south service area, the Authority began pumping sludge to the facility via redundant pipelines within the Inter-Island Tunnel.

Dewatered sludge is normally fed to a heat dryer that produces fertilizer pellets. The dryers have an operational capacity of 4,000 lbs/hr. Fertilizer pellets are stored in silos prior to shipment off-site. When the heat dryers and/or downstream facilities are out of service, dewatered sludge may be loaded into either a rail car or a truck for off-site shipment. Currently, less than five percent of the pellet product is transported via rail; the majority is transported using trucks. Air streams from process areas are treated prior to discharge to the atmosphere. Wastewater, recycle flows, and filtrate from the facility are pumped back to the DITP for treatment.

The pelletizing plant is sized to produce up to 180 tons per day of pellets. For FY 2017, the operating budget is based on 105 dry tons per day, consistent with recent historical values for sludge received at the pelletizing plant, with dried sludge being converted to pellets suitable for beneficial reuse. The operational reliability of the pelletizing plant, as well as the beneficial use of finished product from its initial startup in 1991 to the present time, provides a clear indication of the Authority's ability to meet its long-term objectives for sludge processing and reuse through effective management, long range planning, and a willingness to address and resolve operational problems as they occur.

We believe that the pelletizing plant is well operated and maintained and that adequate management attention is given to continued reliable operation of the plant.

2.3.10 Summary of Wastewater System Condition and Operation

We have visited all of the major facilities in the Sewer System, and have interviewed key staff associated with the planning, design, construction and operation of the individual facilities, as well as the maintenance of those facilities. It is our opinion that the Authority facilities are all in operable condition and are well maintained. The Authority's senior management has in place a system for assessing the adequacy of staff, equipment and both capital and maintenance needs. Overall the Authority's staff understands that maintenance of the investment made in major capital projects, along with a continuous reassessment of how to efficiently operate the facilities, will optimize the useful life and minimize the costs to operate and maintain the Authority's Sewer System.

2.4 Waterworks System Overview

The Waterworks System serves, or potentially serves, approximately 2.5 million people in 52 cities, towns, and special purpose entities. Most of the communities (48 in Greater Boston and Metro West) are located in eastern Massachusetts, with a limited number (three) in central parts of the state. The Enabling Act charges the Authority with the responsibility to modernize, maintain, and operate the metropolitan Boston area water conveyance and treatment systems, as well as to provide service to several communities in central and western Massachusetts. The Authority is responsible for the delivery of water to the distribution systems of its Local Bodies. The Local Bodies are responsible for distribution of water to individual customers. The Commonwealth retains ownership of the supply sources.

The Waterworks System consists of three primary water sources: the Quabbin, the Wachusett and the Ware River watersheds. It consists of two major reservoirs, the Quabbin and the Wachusett, and two water treatment plants (the Carroll WTP and the William A. Brutsch Water Treatment Facility (the "Brutsch WTF"). Treated water is delivered to Local Bodies through a large transmission and distribution system. The transmission and distribution system consists of approximately 129 miles of tunnels and aqueducts and 300 miles of pipelines that transport water from the treatment plants to the user communities. The system also includes 13 active covered storage facilities, six back-up distribution open surface reservoirs, two back-up supply sources and ten active pumping stations. Key elements of the Authority's water supply system are shown in Figure 2-2.

2.5 Waterworks System Facilities Evaluation

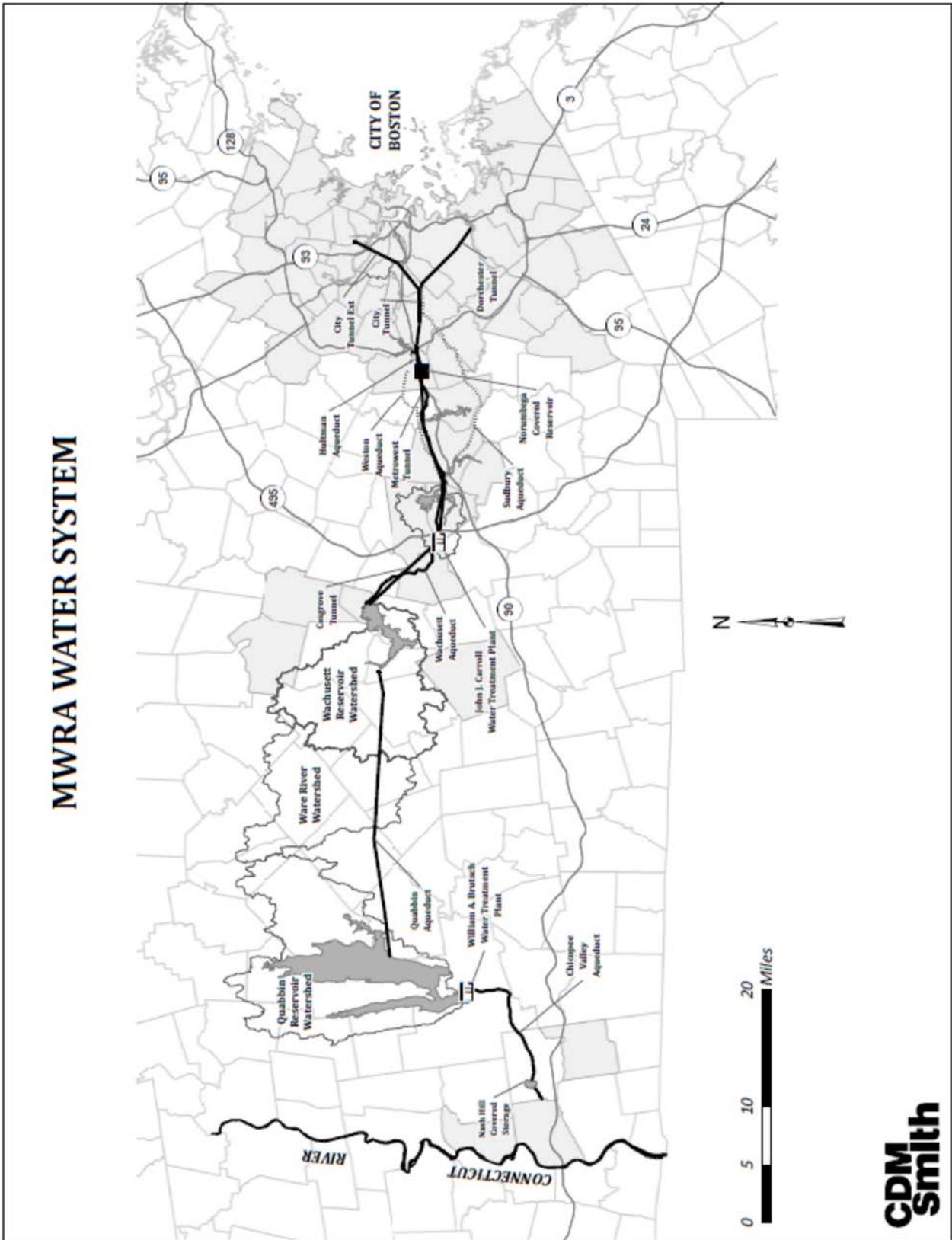
2.5.1 Water Supply

The Waterworks System consists of three primary water sources located in central Massachusetts: the Quabbin Reservoir watershed, the Wachusett Reservoir watershed, and the Ware River watershed. The system has a combined safe yield (the maximum rate at which the system can be expected to continuously deliver water under extended dry conditions) of approximately 300 mgd. In addition, certain Local Bodies or partially served user communities provide approximately 69 mgd from local sources for their own use. Existing supply facilities are summarized in Table 2-4.

**Table 2-4
Existing Water Supply Sources**

<i>Watershed</i>	<i>Reservoirs</i>	<i>Year Complete</i>	<i>Capacity (mg)</i>	<i>Supplies</i>
Swift River	Quabbin	Completed by 1939; filled by 1946	412,300	Chicopee Valley Aqueduct (“CVA”) communities; and the Metropolitan Boston Service Area through the Wachusett Reservoir
Ware River	None	1931	NA	Quabbin or Wachusett Reservoirs
Nashua	Wachusett	Completed by 1906; filled by 1908	65,000	Metropolitan Boston Service Area
Sudbury	Sudbury Framingham No. 3	1878-1898	8,400	Currently in standby status

MWRA WATER SYSTEM



The Quabbin Reservoir, completed in 1939 and filled by 1946, is the largest water supply reservoir in the Waterworks System, and is located 65 miles west of Boston. The reservoir storage capacity is approximately 412 billion gallons, with a surface area of 39 square miles. The watershed (drainage area) of the reservoir is approximately 186 square miles and extends into the Towns of Belchertown, Hardwick, New Salem, Pelham, Petersham, Shutesbury, and Ware. The reservoir receives inflow from its watershed, and from the Ware River watershed via the Quabbin Aqueduct. Outflow from this reservoir is to the Swift River, a tributary to the Connecticut River; to the Chicopee Valley Aqueduct; and to the Quabbin Aqueduct.

The Wachusett Reservoir is located 35 miles west of Boston in the Clinton area. The reservoir storage capacity is approximately 65 billion gallons, with a surface area of 6.5 square miles. The reservoir's watershed is approximately 110 square miles. The reservoir receives inflow from its watershed, which includes the Stillwater and Quinapoxet Rivers; and from the Quabbin Reservoir via the Quabbin Aqueduct. Inflow can also be received directly from the Ware River watershed, although this diversion is seldom implemented. Outflow from this reservoir is to the Nashua River, the Wachusett Aqueduct, and the Cosgrove Aqueduct. The Town of Clinton withdraws water directly from the Wachusett Reservoir. The City of Leominster can withdraw water from the Wachusett Reservoir. In addition, the City of Worcester can withdraw water from the Wachusett Reservoir or Quabbin Tunnel and owns several reservoirs within the Wachusett watershed.

The Ware River watershed is located between the Quabbin and Wachusett watersheds, with a 98-square mile drainage area to the intake. The intake is located at the midpoint of the Quabbin Aqueduct in the Town of Barre. From this point, water can be diverted in either direction—to Quabbin or Wachusett; however, diversions are generally routed through the Quabbin Reservoir to maintain adequate water quality. Diversions from the Ware River watershed are limited to periods when flow exceeds 85 mgd in the river and are prohibited between June 15 and October 15. The Ware River is tributary to the Chicopee River, which is tributary to the Connecticut River.

The Authority maintains an emergency supply source of approximately 8.4 billion gallons within the Sudbury Reservoir system.

2.5.2 Water Treatment

The Authority currently provides treatment at two locations to control pathogens and other organisms that could present public health problems. Table 2-5 presents a summary of the existing treatment facilities. The facilities are clean and well maintained, and adequately operated to maintain water quality commensurate with local, state and federal regulations.

Both treatment facilities have recently completed upgrades to the treatment scheme to provide ultraviolet disinfection as a second means of disinfection, in addition to the disinfection already provided. The second means of disinfection ensures the facilities were in compliance with the EPA's Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR, or LT2) prior to the regulatory compliance date of April 2014 for the Carroll WTP and October 2014 for the Brutsch WTF.

MWRA's current treatment systems include the following:

- *William A. Brutsch Water Treatment Facility.* Located in Ware, disinfection is provided at this facility for water delivered to the three communities in the western part of the state supplied by the Chicopee Valley Aqueduct. The facility has a design capacity of 16 mgd, and uses ultraviolet disinfection followed by chlorine, to disinfect the high quality water drawn from the Quabbin Reservoir. In 2016, the facility produced an average daily quantity of eight mgd with a peak hourly

demand of 16 mgd. The Local Bodies served by the Brutsch WTF provide further treatment prior to delivery to their customers.

- *Carroll Water Treatment Plant.* Located in Marlborough, the Carroll WTP is one of the three major components completed as part of MWRA's Integrated Water Supply Improvement Program. The plant was placed into service in July 2005.

The Carroll WTP has a maximum treatment capacity of 405 mgd. The design average flow for the plant is 270 mgd. To date, typical operating targets for the plant have ranged from 180 to 340 mgd depending upon demand. To date in 2017, the average daily flow is below 200 mgd. The historical peak hourly flow for the facility is 380 mgd.

The Carroll WTP has two disinfectant processes. First the water is disinfected with ozone, and since April 2014, is then disinfected with ultraviolet light (UV). Downstream of the disinfection processes the water has both soda ash and carbon dioxide added for alkalinity and pH adjustment for corrosion control. Hydrofluosilicic acid, aqua ammonia and hypochlorite are also added to the finished water to provide for further public health protection. The plant has two below-grade storage tanks each nominally 22.5 mg in capacity that fluctuate diurnally allowing the plant's ozonation, UV and chemical addition processes to be operated in an optimum steady state condition.

The plant distributes water to the MWWST and the Hultman Aqueduct for conveyance to the Boston service area. The Carroll WTP also has a 30-inch distribution main that conveys finished water by gravity to the Towns of Marlborough and Southborough. Those two communities own and operate their own pump stations. The plant also provides finished water to the Town of Northborough and to the Westborough State Hospital via a connection off of the plant's water system.

The Authority began construction on the Wachusett Aqueduct Pumping Station in March of 2016 that has been designed to convey 240 mgd from the Wachusett Aqueduct to the Carroll WTP for treatment to provide redundancy in the event the Cosgrove Tunnel is removed from service or during an emergency. Currently, this portion of the Wachusett Aqueduct between the Wachusett Reservoir and the Carroll WTP is a stand-by (back-up) transmission path, and does not have the ability to deliver adequate water to the Carroll WTP.

The Authority has instituted a number of energy generation and energy saving initiatives at the Carroll WTP. The Carroll WTP avoids electrical demand charges by monitoring both plant energy usage as well as energy usage on the supply grid and switches to on site power generators during peak demand periods. The Authority has also installed on the open areas of the plant site a 500 kw array of power generating solar panels and is installing an additional solar array at the Wachusett Aqueduct Pumping Station site.

**Table 2-5
Water Treatment Facilities Summary**

<i>Reservoir</i>	<i>Facility</i>	<i>Year in Use</i>	<i>Treats</i>
Quabbin	Brutsch WTF	2000	Water to CVA Aqueduct Communities
Wachusett	Carroll WTP	2005	Water to Metropolitan Boston Service Area and Marlborough, Southborough and Northborough

2.5.3 Water Transmission

Seven major aqueducts are used regularly to transport water from the reservoirs to the Local Bodies' distribution systems. Existing water transmission facilities are summarized in Table 2-6.

The Quabbin Aqueduct transports water between the Quabbin and Wachusett Reservoirs. Completed in 1932, this pressure tunnel extends 24.6 miles between the Quabbin and Wachusett Reservoirs. There are 13 shafts to the tunnel; one is the inlet from the Ware River located about midway between the Quabbin and Wachusett Reservoirs. Water can flow from the Ware River into the tunnel at Shaft 8 to the Wachusett or Quabbin. Whenever water is conveyed from the Quabbin to Wachusett Reservoir, hydroelectric power is generated at the Oakdale Station.

The Chicopee Valley Aqueduct ("CVA") transports water to three Local Bodies in central Massachusetts from the Quabbin Reservoir: Chicopee, Wilbraham, and South Hadley Fire District No. 1. The CVA, a pressure aqueduct, was constructed between 1947 and 1949 and was first operated in 1950. The aqueduct extends from the Quabbin Reservoir to the Nash Hill covered storage tanks. The Nash Hill covered storage tanks have a combined capacity of 25 million gallons. From these two partially buried concrete tanks, the aqueduct runs to the Chicopee City line. Flow in the aqueduct is by gravity and is controlled with valves at the Brutsch WTF between the Quabbin and Nash Hill tanks. The two partially buried tanks replaced the former open Nash Hill Reservoir in 1999.

The Cosgrove Tunnel, completed in 1967, is a deep rock tunnel approximately eight miles long. Water leaving the Wachusett Reservoir passes through two hydroelectric turbines at Cosgrove Station prior to entering the tunnel. The Cosgrove Tunnel connects to the Carroll WTP.

The Wachusett Aqueduct, completed in 1897, is a gravity aqueduct that extends approximately 9 miles from the Wachusett Reservoir to the Hultman Aqueduct. The Wachusett Aqueduct is not presently hydraulically connected to the Carroll WTP. As mentioned above, the Wachusett Aqueduct Pumping Station is under construction which will provide connectivity to the Carroll WTP.

The MWWST carries treated water from the Carroll WTP to the existing City Tunnel and supplies the Norumbega Covered Storage Facility. The MWWST is 14 feet in diameter, 17.5 miles long, and 200 to 500 feet below ground surface along the alignment. Constructed to provide redundant capacity for the Hultman Aqueduct, the MWWST was completed in 2004. The MWWST together with the Hultman Aqueduct convey water to the metropolitan Boston service area.

**Table 2-6
Existing MWRA Transmission Facilities**

<i>Facility</i>	<i>Completed</i>	<i>Purpose</i>
Quabbin Aqueduct	1932	Transports water from Quabbin to Wachusett; transports water from Ware River to either Quabbin or Wachusett Reservoirs
Chicopee Valley Aqueduct	1949	Transports water to CVA communities via the Nash Hill Reservoirs
Cosgrove Tunnel	1967	Transports water from Wachusett Reservoir to the Carroll WTP
Wachusett Aqueduct	1897	Transports water from Wachusett Reservoir to the Hultman Aqueduct. Presently off-line and ultimately to connect to the Carroll WTP and serve as back-up to the Cosgrove Tunnel.
Weston Aqueduct	1903	Standby status
Hultman Aqueduct	1940	Transports water from Carroll WTP to Norumbega Covered Storage Reservoir and on to the City Tunnel
City Tunnel	1950	From the Hultman Aqueduct to the service area
Sudbury Aqueduct	1878	Standby status
MetroWest Water Supply Tunnel	2004	Delivers water to the Norumbega Covered Storage Reservoir and on to the City Tunnel

The Hultman Aqueduct is a pressure aqueduct constructed in 1940. Originally constructed to convey water from the Cosgrove Tunnel and Wachusett Aqueduct to the metropolitan Boston service area, it now serves as a redundant means to convey treated water from the Carroll WTP to the metropolitan Boston service area. The Aqueduct is operated in tandem with the MWWST to provide redundancy and flexibility in supply to the metropolitan Boston service area. Portions of the Hultman Aqueduct were taken off line in 2003 when the MWWST was completed and then completely taken out of service in 2009 when the Authority rehabilitated the entire 13.4 miles. The Aqueduct was placed back into service in 2014.

The City Tunnel, installed in 1950, is a deep-rock facility, 12 feet in diameter and the major connection to the metropolitan service area. It connects the MWWST/Hultman Aqueduct with Chestnut Hill. At Chestnut Hill, there are links to large distribution mains conveying water to several communities. A 10-foot diameter branch of the City Tunnel extends 7.1 miles from Chestnut Hill to Malden, serving

most communities north of Boston. The Dorchester Tunnel, also extending from Chestnut Hill, is a 10-foot diameter, deep-rock tunnel running 6.6 miles to the Boston-Milton line at Dorchester Lower Mills. It is designed to serve the southern sections of the service area.

The Sudbury Aqueduct, also a gravity aqueduct, is currently not in use. Constructed in 1878, it extends from the Sudbury system to Chestnut Hill.

The Weston Aqueduct, constructed in 1903, is a gravity aqueduct that supplies the Weston Reservoir and the Low Service Area. Both the Sudbury and Weston Aqueducts are retained for emergency use.

2.5.4 Water Pumping and Distribution

Seven water distribution service areas are used to serve Local Bodies in the metropolitan Boston area: Low, Intermediate High, Northern Intermediate High, Southern High, Northern High, Southern Extra High, and Northern Extra High Service Areas. All service areas are supplied from the aqueducts and augmented by 10 active pump stations and 14 active distribution storage facilities. To service these facilities the Authority maintains a distribution system of approximately 300 miles of pipelines, 96 percent of them ranging from 16 to 60 inches in diameter. Local Bodies are responsible for delivery of water to their customers, through approximately 6,600 miles of pipeline.

Existing, proposed and standby storage facilities are summarized in Table 2-7. Total distribution storage is approximately 3,781.4 mg including those in emergency standby status. As part of the Integrated Water Supply Plan, the Authority constructed new covered distribution storage facilities that replaced several open reservoirs. The major facility constructed was the 115 million gallon Norumbega Covered Storage Tank. This tank covers approximately 17 acres, and stores water that has been fully treated at the Carroll WTP. The open reservoirs that have been replaced are being kept in emergency standby status, meaning that they could be brought back into service should the need arise.

**Table 2-7
Water Storage Facilities Summary**

<i>Reservoir/Tank</i>	<i>Capacity (mg)</i>	<i>Use</i>
Norumbega Covered Storage	115	Low Service
Loring Road	20	Low Service
Fells Reservoir Covered Storage	20	Low, Northern High
Bear Hill Tank	6	Northern Intermediate High
Walnut Hill Elevated Tank	2	Northern Extra High
Turkey Hill Standpipe	2	Northern Extra High
Arlington Heights Standpipe	2	Emergency Standby Status
Arlington Covered Reservoir	2	Intermediate High
Bellevue Standpipe 1	2	Emergency Standby Status
Nash Hill	25	CVA Aqueduct
Carroll	45	Low Service
Blue Hills Covered Storage	20	Southern High
Deer Island Tank	2	DITP
Spot Pond Covered Storage	20	Low Service
Spot Pond	1.9	Emergency Standby Status
Chestnut Hill	500	Emergency Standby Status
Waban Hill	14	Emergency Standby Status

Norumbega Reservoir	200	Emergency Standby Status
Weston Reservoir	200	Emergency Standby Status
Fells Reservoir No. 1 & 2	67	Emergency Standby Status
Bellevue Standpipe 2	3.7	Southern Extra High
Blue Hills Reservoir	44	Emergency Standby Status
Sudbury Reservoir	7,200	Emergency Standby Status
Framingham Reservoir #3	500	Emergency Standby Status
Schenck's Pond	50	Emergency Standby Status

The Authority has 10 active pumping stations to provide water to distribution areas that cannot be served by gravity alone, and one emergency pump station. An additional pump station at the Spot Pond covered storage facility was completed in 2015 to provide redundancy for the Gillis pump station and service to the Northern Intermediate and Northern High service areas. These stations are presented in Table 2-8. Between 1997 and 2010 the Authority undertook renovations of the pump stations in order to bring them up to current standards and to install instrumentation systems.

**Table 2-8
Existing MWRA Pumping Stations**

<i>Pumping Station</i>	<i>Year Built/Renovated</i>
Arlington No. 1 Brattle Court	1890s/2010
Arlington No. 2 Spring Street	1958/2009
Belmont	1980's/2009
Commonwealth Avenue	/1999
Dudley Road	1954/2008
Hyde Park	1890/2010
Lexington Street	/1999
Newton Street	/1997
Reservoir Road	1936/2010
James Gillis (Spot Pond)	1901/2012
Chestnut Hill Emergency (Inactive)	2001
Spot Pond Pump Station	2015

2.5.5 System Demand

When the Authority was established in 1985, the existing water system had been exceeding its safe yield of 300 mgd for almost 20 years. In response to the increasing water demand during the 1960s, 1970s, and 1980s, several water supply studies were undertaken by the MDC. These studies projected a demand of 410 mgd by 2020. In 1986, the Board of Directors opted to pursue demand management strategies rather than pursue options for increasing the water supply. With the help of the Local Bodies, the MWRA reduced average demand from 326 mgd in 1987 to 285 mgd in 1990, below the system's safe yield for the first time in more than 20 years.

The Authority has instituted a series of ongoing programs designed to reduce water demand. These programs include long range planning; leak detection and repair of MWRA and Local Body distribution systems; rehabilitation and replacement of MWRA and Local Body distribution system components; water metering and monitoring; distribution of residential water conservation fixtures

and conservation outreach; public education and information distribution; school education; and industrial, commercial, and institutional audits.

As a result of these efforts, demand has continued to decline. During calendar year 2016, the average daily demand for the Waterworks System was 208.01 mgd. Of that total, approximately eight mgd was provided to the CVA communities, two mgd was provided to Clinton, and 198 mgd was treated at the Carroll WTP. Water was distributed to a total of 51 Local Bodies, of which 36 are fully supplied by the MWRA and 14 are partially supplied. Only one Local Body – the BWSC at 28 percent in 2015 – used more than five percent of the total supply.

The Authority has made projections of long-term demand trends, taking into consideration changes in the regional economy, the price of water, investments in transmission and distribution systems to reduce leakage, and potential additional demands and local sources of supply. These forecasts indicate that demand will remain well below the Waterworks System's safe yield.

2.5.6 Summary of Water System Condition and Operation

CDM Smith has visited all of the major facilities in the Waterworks System, and has interviewed key staff associated with the planning, design, construction and operation of the individual facilities, as well as the maintenance of those facilities. It is our opinion that the Authority facilities are all in operable condition and are well maintained. The Authority's senior management has in place a system for assessing the adequacy of staff, equipment and both capital and maintenance needs. The Authority is implementing and refining asset management tools and has set a reasonable timetable for that process.

Section 3

Cost and Time Estimate for Recommended Improvements

The Authority has ongoing plans for significant investments in repairs, renovations and improvements to the System. The FY 2018 CIP, summarized in Table 3-1, provides for expenditure of approximately \$1.3 billion over the next five years and for a total of approximately \$3.02 billion in the next 10 years, including contingencies.

In addition, the Authority's FY 2018 CEB provides funds for routine, planned maintenance as well as emergency maintenance of the System. In total, the FY 2018 CEB contains approximately \$32.2 million for maintenance projects, exclusive of Authority personnel costs.

As discussed in Section 2, many of the projects contained in the CIP make provision for renovation or replacement of existing facilities where those facilities will remain in service. We believe that the major areas for improvements to the System are presented in the CIP, or are provided for in the CEB, and thus have no additional specific recommendations with respect to the System are warranted at this time.

The Wastewater CIP for the cap period FY 2014 – FY 2018 is projected to total \$351.3 million and provides adequate funds to properly maintain the Sewer System, while complying with the five-year and annual cap requirements. Treatment represents approximately 35 percent of improvements for the FY 2014 – FY 2018 period, which includes projects for asset protection at DITP. In the recent past, the Authority's resources have been targeted towards legally mandated projects such as the Authority's CSO Control Plan. The Authority anticipates focusing future wastewater capital projects on asset protection.

The Waterworks CIP is projected to total \$236.4 over the period from FY 2014 to FY 2018 and reasonably reflects capital expenditure needs and provides adequate funds to properly maintain the Waterworks System. As the major treatment and storage projects have been completed, the Authority's Waterworks CIP appropriately emphasizes long-term redundancy, transmission, distribution and pumping, which now represent approximately 67 percent of the improvements for the FY 2014 – FY 2018 period. Consistent with the Authority's focus on long-term redundancy, in FY 2017 the Board approved the permitting and design of a \$1.4 billion project for long-term redundancy improvements for the Metropolitan Tunnels that supply water to the Boston metropolitan area. The Authority anticipates the construction of two deep rock tunnels to provide redundant potable water conveyance to the Authority's metro Boston service area.

Contingency amounts are included as part of an Authority-wide contingency fund. The capital budget contingency is set at seven percent of the annual expenditures for all Waterworks and Wastewater capital projects, except for all tunnel-related projects for which the contingency is set at 15 percent. The higher contingency for tunnel related projects reflects the relatively more risky construction associated with tunnel construction. We believe this represents a reasonable approach to contingency budgeting.

Based on our review of the Authority's facilities, our understanding of the regulatory requirements, the Authority's Consent Orders, and our professional judgment, we believe that the Authority is targeting appropriate projects in the CIP, and that the process for updating the CIP is adequate.

As the Authority develops specific plans for expenditure of monies for repair and maintenance from the CEB, we believe that highest priority should be given to those projects that will protect the health and safety of workers, and to those which serve to preserve the Authority's ability to deliver an adequate supply of potable water and to provide waste treatment consistent with prudent public health practices. Table 3-1 shows the breakdown of capital expenditures by Waterworks and Wastewater CIP category as contained in the FY 2018 CIP, with a breakdown of the full contract values and the expenditures completed as of the end of FY 2016.

Table 3-1
FY 2018 CIP Summary

Project	Contract Amount <i>In Thousand Dollars</i>	Remaining Balance as of 6/30/16
Total MWRA	\$7,383,672	\$3,394,624
Wastewater System Improvements	\$3,241,686	\$1,310,423
<u>Interception & Pumping</u>		
S.102 Quincy Pump Facilities	25,907	0
S.104 Braintree-Weymouth Relief Facilities	234,493	6,788
S.105 New Neponset Valley Relief Sewer	30,300	0
S.106 Wellesley Ext Replacement Sewer	64,359	0
S.107 Framingham Extension Relief Sewer	47,856	0
S.127 Cummingsville Replacement Sewer	8,999	0
S.130 Siphon Structure Rehabilitation	6,881	5,941
S.131 Upper Neponset Valley Sewer System	54,174	0
S.132 Corrosion & Odor Control	48,323	44,950
S.136 West Roxbury Tunnel	11,314	1,000
S.137 Wastewater Central Monitoring	27,482	7,700
S.139 South System Relief Project	4,939	1,500
S.141 Wastewater Process Optimization	10,416	8,915
S.142 Wastewater Meter System - Equip Replace	28,438	23,300
S.143 Regional I/I Management Planning	169	0
S.145 Facility Asset Protection	393,657	354,987
S.146 DI Cross Harbor Tunnel	5,000	5,000
<u>S.147 Randolph Trunk Sewer Relief</u>	<u>750</u>	<u>750</u>
Total Interception and Pumping	1,003,457	460,830
<u>Treatment and Residuals</u>		
S.182 DI Primary and Secondary Treatment	(958)	0
S.200 DI Plant Optimization	33,279	0
S.206 DI Treatment Plant Asset Protection	859,105	634,460
S.210 Clinton WWTP	23,494	15,865
S.211 Laboratory Services	2,228	0
S.261 Residuals	63,811	0
<u>S.271 Residuals Asset Protection</u>	<u>103,832</u>	<u>103,000</u>
Total Treatment and Residuals	1,084,790	753,325

<u>Combined Sewer Overflow Program</u>		
<i>MWRA Managed</i>		
S.339 North Dorchester Bay & Reserve Channel	221,510	0
S.347 East Boston Branch Sewer Relief	85,637	0
S.348 BOS019 Conduit	14,288	0
S.349 Chelsea Trunk Sewer	29,779	0
S.350 Union Park Detention Treatment Facility	49,583	0
S.353 Upgrade Existing CSO Facilities	22,385	0
S.354 Hydraulic Relief Projects	2,295	0
S.355 MWR003 Gate & Siphon	4,425	146
<u>S.357 Charles River CSO Controls</u>	<u>3,633</u>	<u>0</u>
Total MWRA Managed CSO	433,535	146
<i>Community Managed</i>		
S.340 S. Dorchester Bay Sewer Separation (Fox Pt.)	54,626	0
S.341 S. Dorchester Bay Sewer Separation (Comm. Pt.)	64,009	3,467
S.342 Neponset River Sewer Separation	2,549	0
S.343 Constitution Beach Sewer Separation	3,731	0
S.344 Stony Brook Sewer Separation	44,268	22
S.346 Cambridge Sewer Separation	104,552	8,683
S.351 BWSC Floatables Controls	946	0
S.352 Cambridge Floatables Controls	1,127	0
S.356 Fort Point Channel Sewer Separation	11,872	(45)
S.358 Morrissey Boulevard Drain	32,186	(2)
S.359 Reserved Channel Sewer Separator	70,517	122
S.360 Brookline Sewer Separation	24,715	0
S.361 Bulfinch Triangle Sewer Separation	9,054	0
<u>S.324 CSO Planning and Support</u>	<u>52,886</u>	<u>4,682</u>
Community Managed CSO	477,039	16,928
<u>Other Wastewater</u>		
S.128 I/I Local Financial Assistance	242,585	79,194
<u>S.138 Sewerage System Mapping Upgrade</u>	<u>281</u>	<u>0</u>
Total Other Wastewater	242,866	79,194
Waterworks System Improvements	\$4,010,951	\$2,045,872
<u>Drinking Water Quality Improvements</u>		
S.542 John J Carroll Water Treatment Plant	439,799	20,984
S.543 Brutsch Water Treatment Facility	19,973	0
S.544 Norumbega Covered Storage	106,674	0
S.545 Blue Hills Covered Storage	40,083	0
<u>S.550 Spot Pond Covered Storage Facility</u>	<u>60,262</u>	<u>862</u>
Total Drinking Water Quality Improvements	666,791	21,846
<u>Transmission</u>		
S.597 Winsor Station Pipeline Improvements	34,243	31,665
S.601 Sluice Gate Rehabilitation	9,158	0

S.604 MetroWest Tunnel	701,189	4,143
S.615 Chicopee Valley Aqueduct Redundancy	8,666	0
S.616 Quabbin Transmission System	16,419	8,962
S.617 Sudbury/Weston Aqueduct Repairs	6,477	5,105
S.620 Wachusett Reservoir Spillway Improvements	9,287	0
S.621 Watershed Land	24,000	4,723
S.622 Cosgrove Tunnel Redundancy	54,316	45,185
S.623 Dam Projects	4,066	951
S.625 Metropolitan Tunnel Redundancy	1,357,686	1,354,677
S.628 Metropolitan Redundancy Interim Improvements	180,731	180,228
<u>S.630 Watershed Division Capital Improvements</u>	<u>17,300</u>	<u>17,300</u>
Total Transmission	2,423,540	1,652,938
<u>Distribution and Pumping</u>		
S.618 Peabody Pipeline Project	12,910	12,910
S.677 Valve Replacement	20,115	8,098
S.678 Boston Low Service - Pipe & Valve Rehab	23,691	0
S.683 Heath Hill Road Pipe Replacement	19,358	0
S.689 James L. Gillis Pump Station Rehab	33,419	0
S.692 NHS - Section 27 Improvements	1,134	1,010
S.693 NHS - Revere & Malden Pipeline Improvements	65,373	38,418
S.702 New Connecting Mains - Shaft 7 to WASM 3	38,841	27,525
S.704 Rehab of Other Pumping Stations	50,258	20,200
S.706 NHS - New Connecting Mains from Section 91	2,360	0
S.708 Northern Extra High Service - New Pipelines	8,045	4,413
S.712 Cathodic Protection of Distribution Mains	1,704	1,496
S.713 Spot Pond Supply Mains Rehabilitation	66,858	3,257
S.714 Southern Extra High - Sections 41 & 42	3,657	0
S.719 Chestnut Hill Connecting Mains	33,094	15,608
S.720 Warren Cottage Line Rehabilitation	1,205	0
S.721 Southern Spine Distribution Mains	76,281	39,598
S.722 NIH Redundancy & Storage	113,121	97,776
S.723 Northern Low Service Rehabilitation - Section 8	56,889	54,568
S.725 Hydraulic Model Update	598	0
S.727 SEH Redundancy and Storage	109,410	100,466
S.730 Weston Aqueduct Supply Mains	80,696	1,110
S.731 Lynnfield Pipeline	5,626	0
S.732 Walnut St. & Fisher Hill Pipeline Rehab	2,717	0
<u>S.735 Section 80 Rehabilitation</u>	<u>12,185</u>	<u>12,185</u>
Total Distribution and Pumping	839,544	438,637
<u>Other Waterworks</u>		
S.753 Central Monitoring System	39,040	21,235
S.763 Distribution Systems Facilities Mapping	2,299	1,263
S.764 Local Water Infrastructure Rehabilitation	7,488	0
S.765 Local Water Pipeline Assistance Program	0	(121,568)
<u>S.766 Waterworks Facility Asset Protection</u>	<u>32,249</u>	<u>31,523</u>
Total Other Waterworks	81,076	(67,548)

Business and Operations Support	131,036	38,328
S.881 Equipment Purchase	29,408	10,919
S.925 Technical Assistance	1,150	1,150
S.930 MWRA Facility - Chelsea	9,812	(2)
S.931 Business Systems Plan	24,563	35
S.932 Environmental Remediation	1,479	0
S.933 Capital Maintenance Planning & Development	15,208	2,664
S.934 MWRA Facilities Management & Planning	2,151	1,780
S.935 Alternative Energy Initiatives	23,271	5,816
S.940 Application Improvement Program	9,980	8,504
S.942 Information Security Program (ISP)	2,822	1,641
S.944 IT Management Program	923	923
<u>S.946 IT Infrastructure Program</u>	<u>10,271</u>	<u>4,897</u>
Total Business and Operations Support	131,036	38,328
Note: Totals may not add due to rounding		

Section 4

Adequacy of the Renewal and Replacement Reserve Fund, Operating Reserve Fund and Operating and Capital Budget

The purpose of this section is to evaluate the Adequacy of the Renewal and Replacement Reserve Fund, Operating Reserve Fund, Operating Budget and Capital Budget of the Authority. The Authority also has an Insurance Reserve Fund; however, the Authority has a specialized insurance consultant review the adequacy of that Fund.

4.1 Renewal and Replacement Reserve Fund Requirement

Under section 714(c) of the Resolution, the Consulting Engineer must make its recommendation as to the adequacy of the Renewal and Replacement Reserve Fund Requirement.

The current Renewal and Replacement Reserve Fund Requirement is \$35 million. The Authority maintains a cash balance of \$10 million, with the remaining \$25 million balance met through any short-term loan capacity, such as commercial paper or a committed line of credit. As of the end of FY 2017, the fund balance meets the Fund Requirement. The purpose of the Renewal and Replacement Reserve Fund (the "R&R Reserve Fund") is to pay the costs of construction of projects that have not been provided for in the Construction Fund or the Operating Fund, and which are reasonably necessary for the continued operation of the System and maintenance of revenues. Projects of this nature will generally be classified as emergency repairs of a major nature, as the CEB contains provisions for minor, recurring emergency repairs.

The establishment of a recommended value for the R&R Reserve Fund is not amenable to precise analysis. Several reviews of the practices of various water and wastewater utilities across the country have shown a variety of techniques are used to size such funds. These range from establishing the reserve at some percentage of the current year's renewal and replacement expenditures, to establishing the reserve at some fraction of the net asset value of the applicable system.

The R&R Reserve Fund is intended to provide the Authority with sufficient financial resources so that it can undertake emergency projects expeditiously, without being forced into a financing plan at times, or in ways, that may be disadvantageous to the Authority. For example, the R&R Reserve Fund should be of sufficient size to avoid the need to immediately change planned capital expenditures in a way that displaces otherwise necessary projects. Also, it should be of sufficient size so that the Authority is not forced into the financial markets at times that are disadvantageous to the Authority. The size of the R&R Reserve Fund should thus be large enough so that repair of major facilities can be commenced and continue for a period of several months without significant changes to the Authority's planned capital program.

The size of such a fund necessary to sustain several months of construction without hampering the Authority's ongoing capital plan can be evaluated by an analysis of the annual cash requirements of the Authority's current and historical capital projects. This supposes that draws on the R&R Reserve Fund will be similar in nature to those originally experienced in constructing the facilities. Using information from the FY 2018 CIP, the largest annual cash requirement for any project in the current

CIP is approximately \$42.9 million, for Facility Asset Protection. The majority of annual cashflows are, however relatively small, with a large number of projects having cashflows of less than \$5 million per year. Only seven active projects have annual cashflows in excess of \$10 million for FY 2017. A review of earlier CIP's revealed similar trends: the cashflows of most projects are low, but there are a lesser number of projects with relatively large cashflows. Under all but the most drastic of circumstances it is unlikely that the Authority would experience a need to draw on over \$35 million of R&R Reserve Fund balances in any one year.

The appropriate size of the R&R Reserve Fund is also influenced by the Authority's asset management program that has been established and identifies the funding required to replace or rehabilitate equipment at or near the end of its useful life reducing the frequency of emergency repairs.

In addition, if the Authority were an infrequent borrower in the capital markets, it would be important to have a relatively larger R&R Reserve Fund, to provide flexibility regarding the timing of issuing debt to fund repairs. However, the Authority has been, and will continue to be, a frequent issuer of debt giving it an ability to obtain capital to meet replacement needs should available fund balances be insufficient. Moreover, the Authority has available to it a tax-exempt commercial paper program that can provide rapid access to short term funds. In practice, the Authority maintains a minimum available capacity of approximately \$50 million against the upper limit of its tax-exempt commercial paper authorization. As of the beginning of FY 2018, the Authority had \$172 million in available capacity for tax-exempt commercial paper. The Authority also seeks to maintain a minimum balance of \$30 million in its construction fund, providing additional flexibility.

Given the above factors, it is our opinion that the \$35 million R&R Reserve Fund Requirement is adequate for the purposes intended.

4.2 Operating Reserve Fund

The Resolution establishes an Operating Reserve Fund, with a requirement that the reserve be equal to one sixth of the operating budget of the Authority. At the beginning of FY 2018, the Operating Reserve Fund balance was \$39.2 million, meeting the fund balance requirement. The purpose of the Operating Reserve Fund is to provide contingency funds in the event of unanticipated expenditures for operation and maintenance. In addition to the Operating Reserve Fund, the Resolution requires that the Operating Fund established under the Resolution carry, at the beginning of each month, an amount equal to the projected expenditures for the next three months. These monies can serve as a working capital allowance, as well as sources of short-term funds in extraordinary circumstances.

By comparison, the amounts of operating contingency funds typically carried by other major utilities range from 30 days of expected system expenditures to two months of operating expenses.

The level of such reserves is sometimes tied directly to the predictability of the revenues of the system, with reserves being higher in regions where supply deficits may seriously curtail sales, and hence revenues. In such instances the operating reserves serve as a contingency against both unanticipated increases in expenses and shortfalls in revenues.

The sufficiency of the Operating Reserve Fund requirement is a function of: the uses to which it might be put, other contingency funds available to the Authority for operating purposes, and the predictability of revenues flowing from the application of the Authority's rates and charges. Based upon our review of the operating expenses of the Authority, the monies in the Operating Reserve Fund are sufficient to cover any reasonable unanticipated operating event. Moreover, because the Authority's rates and charges are applied retroactively (the assessments against any particular Local Body are a function of this fiscal year's budget and last fiscal year's use of the System) and are thus known with precision, there is little probability that shortfalls in sales, owing, for example to supply

deficits, will directly impact the revenues of the Authority. Because the Authority has the ability to intercept state aid for most Local Bodies, there is little probability of a continued shortfall of revenues. The Authority does, however, need reserves to provide for increased expenses or revenue shortfalls. It is our opinion that the Operating Reserve Fund Revenue Requirement is adequate for these purposes.

4.3 Current Expense Budget

The Authority is required, under Section 8 of the Enabling Act, to adopt an annual budget for its current expenses. The budget must be provided to the Advisory Board for comment and recommendation not less than 60 days prior to its adoption. Amendments to the budget may be made during the year, provided the Advisory Board is provided a copy of revisions not less than 30 days prior to the adoption of the modifications.

The process for the development of the budget begins in September of each year, when initial budget targets, guidelines and procedures are distributed. From September through January the budget undergoes internal development by divisional managers, budget analysts and senior management. Budgets for individual programs within the divisions are developed based on a combination of information from prior years, current budgetary targets and the CIP. The CIP budget process requires that each project include an estimate of the impact of the project on the operating budget.

The Authority then transmits the proposed current expense budget to the Advisory Board in February. In April the Authority holds public hearings on the budget and in May receives comments and recommendations from the Advisory Board. In June of each year the Board of Directors adopts the final current expense budget for the next fiscal year.

For FY 2018, the CEB provides for approximately \$743.6 million in gross current expenses, net of debt service assistance and bond redemption savings. Historically, the Authority has successfully operated below its budgeted amounts. The Authority received \$391,580 in Commonwealth debt service assistance (“DSA”) in FY 2017, and has applied these funds as an offset to debt service in FY 2018.

Based on our review of the FY 2018 CEB, we are of the opinion that the budget is adequate for the continuance of the System in sound operating condition. Following the adoption of the CEB, the Authority produces monthly reports comparing actual spending to budget, and produces a comprehensive report which presents CEB spending and variances from budgeted expenditures.

4.4 Capital Improvement Budget

The Resolution requires that the Authority prepare an annual CIP, covering a five-year period and a capital improvement budget for the projects to be undertaken in the first year of the five-year period. The CIP must identify the projects to be carried out, and the costs and period of construction of these projects. The capital improvement budget must also show the sources of money projected to be available to meet the budgeted expenditures.

Because of the size and complexity of the Authority's construction program, the development and maintenance of the CIP is a continuous process within the Authority. Initial steps in the development of the capital budget are undertaken early in the prior fiscal year, with the distribution of various planning and budgeting forms and instruction. During the period of July through December, divisional staff, capital budget staff and senior management review proposed projects, evaluate sources of funding and develop a preliminary CIP for transmittal to the Board and thence to the Advisory Board. During January through March, the Advisory Board reviews the proposed CIP and makes comments and recommendations to the Authority, following which the Board holds public hearings on the

proposed CIP. During the month of June the Board adopts a final CIP for the subsequent five fiscal year period, having taken various comments on the draft documents into consideration. Following the adoption of the CIP, the Authority produces monthly reports comparing capital spending to budget, and produces a comprehensive report every six month which presents capital improvement progress and variances from budgeted expenditures.

The FY 2018 CIP provides for estimated capital spending of \$543.9 million for the five-year cap period between FY 2014 – FY 2018, which includes contingency and offsets for Community Financial Assistance programs and Chicopee Valley Aqueduct projects. This is a decrease from the original estimate for the cap period FY 2014 – FY 2018 period by \$174.1 million due largely to the excluding the Community Financial Assistance programs from the total. Over this five year period approximately 57 percent of the expense is for improvements to the Sewer System, 38 percent for improvements to the Waterworks System, and the remainder for contingency and other expenses.

Based on our review of the FY 2018 CIP, the needs of the System with respect to renovation and redundancy, and the regulatory requirements imposed on the System, we are of the opinion that the current CIP adequately provides for the proper and efficient operation of the System.

Section 5

Adequacy of Rates, Fees, Rentals and Other Charges

5.1 Introduction

Our financial evaluation and projections are based on a review of the Authority's audited financial statements and various budget documents, current and historical. Our analysis is based on the following documents and data sources: the Authority's actual operating results through FY 2017, the FY 2018 CEB, the FY 2018 CIP, and the Authority's projections of grant receipts, escrows, and participation in the SRF loan program.

We have reviewed the Authority's projected revenue requirements for a five-year forecast period, taking into account present expenditures, anticipated schedules for capital improvements, FY 2017 year-end balances in various funds and accounts, FY 2017 operating results, the Authority's FY 2018 CIP and CEB, and the covenants of the Resolution.

The purposes of this section are to describe:

- Projected Authority expenses for FY 2018 through FY 2023.
- Projected non-rate revenues for the same period.
- Projected rate increases.
- Impacts of such rate increases on customers.
- Projected compliance with various Resolution covenants.

The Authority's projections reflect assumptions regarding the schedule, timing and cost of certain key capital projects.

5.2 Key Assumptions

This section describes the key assumptions that have been used by the Authority in developing its own projections which are the basis of the projections contained herein. CDM Smith has reviewed the Authority's assumptions and believes that they are reasonable for developing these financial projections. These projections consider the data and information described above, assumptions regarding economic conditions, Authority policies and spending practices, and the Authority's most recent financings. These projections consider Authority-developed projections on the use of debt escrows and TECP. The projections are developed such that the Authority's projected revenues and expenses meet the various requirements of the Resolution.

As described in subsequent subsections, the Resolution requires the Authority to comply with two rate covenants regarding the adequacy of rate revenue. The covenants require that the Authority generate sufficient revenue to meet all annual revenue requirements including operation and maintenance expenses, pro rata debt service fund deposits, and reserve fund requirements; and

provide revenue available for revenue bond debt service payments in each fiscal year equal to the sum of the Primary and Supplemental Coverage Ratios. The key assumptions and inputs used for these projections include:

- Variable rate debt is assumed to carry an interest rate of 3.25 percent in FY 2018, 3.50 percent in FY 2019, 3.75 percent in FY 2020, and 4.0 percent thereafter. Future senior debt is assumed to be 30-year debt, with interest rates of 5.0 percent for FY 2018, 5.25 percent for FY 2019, 5.50 percent for FY 2020, 5.75 percent for FY 2021, and 6.0 percent for subsequent fiscal years.
- SRF loans for water projects will carry an effective interest rate of 2.0 percent with a 20-year term. SRF loans for sewer projects will carry an effective interest rate of 2.5 percent with a 30-year term.
- Capital costs are projected to inflate at an average annual rate of 2.5 percent for projects not yet under contract. It should be noted that changes to this assumption will not have a significant impact on the Authority's projected increases in total expenses over the forecast period, but will have a greater impact over the longer term.
- Labor costs are projected to inflate at an average annual rate of 2.7 percent for FY 2018 and subsequent fiscal years. Other operating and maintenance costs for existing facilities are projected to inflate at an average annual rate of 3.0 percent for all future years. Projects scheduled to come on line from FY 2018 to FY 2022 are projected to have a modest impact on the Authority's total operating expenses.
- Capital spending is based on the FY 2018 CIP, and it is assumed that the Authority's expenditure rate will average 85 percent of the budgeted cash expenditure rate. However, two-thirds of the deferred expenditures are expected to be spent three years later. Thus, the amount deferred in FY 2018 is added to FY 2021 anticipated CIP expenditures.
- The Authority received \$391,580 in DSA in May 2017, which was applied as an offset to FY 2018 capital financing costs. The Authority's projections assume that no additional debt service assistance will be received during the projection period.
- These projections assume that the Authority does not use Rate Stabilization funds until FY 2022. The projections include the use of \$4.4 million in Rate Stabilization funds in FY 2022.
- The Authority executed a debt defeasance of \$36.2 million in FY 2017 which will prepay debt service due in FY 2018 through FY 2022.

5.3 Rate Revenue Requirements

In describing the projected rate revenue requirements as shown in Tables 5-1 through 5-3, we have followed the Authority's CEB format with expenditures classified as direct, indirect and capital financing. Non-rate revenue is then applied against total expenses to determine the Authority's rate revenue requirement for a fiscal year.

5.3.1 Direct Expenses

Projected direct expenses are summarized in Table 5-1 and discussed in the following sections. Direct expenditures are projected to increase from approximately \$232.6 million in FY 2018 to approximately \$268.1 million in FY 2023, an average annual increase of 2.9 percent. These projections reflect the costs of operating and maintaining the System, as well as the net incremental costs associated with new facilities and projects that the Authority anticipates becoming operational during this time. The increase in direct expenses largely reflects the anticipated inflationary increases in labor and other operating costs. The Authority has been pursuing various cost saving measures including, but not limited to, lease space reductions, staff cross-training, negotiating competitive agreements for energy and chemicals, and increasing energy self-generation to further control costs over the short- and long-term. The Authority has also experienced an increase in chemical costs above historical assumptions, as it renews multi-year supply contracts.

Table 5-1
Budgeted and Projected Direct Expenses, By Fund, FY 2018-2023
(\$ in 000's)

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Sewer Fund Direct Expenses ¹	\$154,508	\$158,710	\$163,470	\$167,863	\$172,626	\$178,263
Waterworks Fund Direct Expenses ²	<u>\$78,068</u>	<u>\$80,351</u>	<u>\$82,649</u>	<u>\$84,972</u>	<u>\$87,365</u>	<u>\$89,843</u>
Total Direct Expenses	\$232,576	\$239,061	\$246,119	\$252,835	\$259,992	\$268,105

¹Includes Sewerage Division, excluding the Clinton Plant, plus the Environmental Quality Department, wastewater portions of the Field Operations Division, and allocated Engineering and Construction, Laboratory Services and Administrative.

²Includes Waterworks Division, water portions of Field Operating Division, the Clinton Wastewater Treatment Plant and allocated Engineering and Construction, Laboratory Services and Administrative.

Note: Details may not add exactly due to rounding.

Sewer Fund direct expenses, as presented in Table 5-1, exclude the Clinton Plant expenses, but include allocated administrative expenses. (The Clinton Plant is treated as a Waterworks Fund expense because the facility was constructed to mitigate the impact of certain Waterworks System facilities). Sewer Fund direct expenses are projected to increase at an average annual rate of approximately 2.9 percent from FY 2018 to FY 2023, reflecting primarily the impact of assumed inflation increases for operating existing facilities. Net incremental costs on Sewer Fund direct expenses from capital improvements are projected through FY 2023.

Administrative and support expenses are allocated between the Waterworks Fund and the Sewer Fund, based on the total direct annual costs in each Fund. Approximately 62 percent of allocable direct administrative expenses were assigned to the Sewer Fund for FY 2018 and throughout the forecast period.

The Waterworks Fund direct expenses are projected to increase at an average annual rate of 2.9 percent between FY 2018 and FY 2023. The Waterworks Fund expenses include the costs of the Clinton Plant.

Table 5-2 presents a detailed breakdown of the Authority's projected combined direct expenses, by expense category. These expenses are presented by CEB line item for the period FY 2018 through FY 2023. Excluding capital financing expenses, labor costs are the Authority's largest line item expense representing 56.4 percent of total operating expenses over the projection period, and are projected to increase from \$131.7 million in FY 2018 to \$150.5 million in FY 2023. Labor costs are expected to have an average annual increase of 2.7 percent over the period between FY 2018 and FY 2023.

Table 5-2
Budgeted and Projected Direct Expenses, by Category, FY 2018-2023
(\$ in 000's)

Category	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Labor	\$131,718	\$135,274	\$138,927	\$142,678	\$146,530	\$150,486
Chemicals	\$9,837	\$10,132	\$10,436	\$10,749	\$11,072	\$11,404
Utilities	\$21,735	\$22,398	\$23,070	\$23,729	\$24,441	\$25,058
Maintenance & Materials	\$38,893	\$39,825	\$41,099	\$42,332	\$43,602	\$45,779
<u>Services</u>	<u>\$30,392</u>	<u>\$31,433</u>	<u>\$32,588</u>	<u>\$33,347</u>	<u>\$34,348</u>	<u>\$35,378</u>
Total Direct Expenses	\$232,576	\$239,061	\$246,119	\$252,835	\$259,992	\$268,105

Note: Details may not add exactly due to rounding.

Chemical costs account for approximately 4.3 percent of direct expenses and are estimated to increase at an average annual rate of 3.0 percent between FY 2018 and FY 2023, reflecting assumed inflation for future costs. The Authority is in discussions with the regulatory agencies regarding a new NPDES permit for DITP; however as of the end of FY 2017, the Authority has not been given an indication of the timing for the issuance of the new NPDES permit, nor insights into what substantive changes, if any, may be included in the permit. Therefore, the Authority's FY 2018 budget does not include increased chemical costs for any additional permit requirements.

Utilities, which represent 9.4 percent of direct expenses, are expected to increase at an average annual rate of 2.9 percent between FY 2018 and FY 2023, reflecting the Authority's fixed price energy agreements, as well as most recent pricing outlook and trends in fuel and electricity market prices and planned usage. Maintenance and materials, which represent 16.8 percent of direct expenses over the projection period, are projected to increase an average annual rate of 3.3 percent from FY 2018 to FY 2023. Services represent 13.2 percent of the direct expenses, and are projected to increase at an average annual rate of 3.1 percent over the projection period.

5.3.2 Indirect Expenses

Indirect expenses for FY 2018 through FY 2023 are summarized in Table 5-3. Indirect expenses include a number of cost items that reflect financial commitments by the Authority, but which are not directly controlled by an operating division of the Authority. As an example, the Authority has agreed to compensate certain Local Bodies because of the adverse impacts caused by the operation of large facilities. These mitigation payments are financial obligations of the Authority and are allocated specifically to either the Waterworks System or the Sewer System.

Table 5-3
Budgeted and Projected Indirect Expenses, FY 2018-2023
(\$ in 000's)

Category	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Insurance	\$2,013	\$2,094	\$2,178	\$2,265	\$2,355	\$2,450
Watershed/PILOT	\$25,164	\$25,835	\$26,525	\$27,233	\$27,959	\$28,706
Cable Substation Lease	\$957	\$1,690	\$4,124	\$5,706	\$5,382	\$8,936
Mitigation	\$1,597	\$1,637	\$1,678	\$1,720	\$1,763	\$1,807
OPEB (GASB 45)	\$5,035	\$5,205	\$5,387	\$5,580	\$5,787	\$6,008
Reserves Additions	\$821	\$1,248	\$1,629	\$1,432	\$1,190	\$1,998
Pension Fund Deposits	\$3,277	\$3,429	\$3,587	\$3,752	\$3,925	\$4,106
Total Indirect Expenses	\$38,866	\$41,139	\$45,106	\$47,687	\$48,362	\$54,010

Note: Details may not add exactly due to rounding.

The major indirect expenses are:

Insurance: The Authority purchases property and casualty insurance from external insurance carriers, and self-insures for significant levels of property and general liabilities.

Watershed/PILOT: The Enabling Act requires the Authority to pay the Commonwealth for two obligations. The first obligation is to reimburse the Commonwealth for the operating costs and debt service associated with land acquisitions of the DCR's Division of Water Supply Protection. The second obligation is to make payments in lieu of taxes ("PILOT") to each city or town with lands located in the Authority's watersheds. PILOT payments are revalued every four years, the most recent occurring in FY 2014, which resulted in a 14 percent increase in the PILOT. Since FY 2018 is a re-evaluation year, the Authority's projections assume that PILOT payments will increase 14 percent for FY 2018. Subsequent fiscal years are assumed to increase at 3.0 percent annually.

Cable and Substation Facilities: NSTAR Electric Company (successor to Boston Edison Co. and now doing business as Eversource) together with Harbor Electric Energy Company ("HEEC"), an NSTAR subsidiary, completed installation of a cross-harbor power cable and built a power substation in 1990-1991 to supply electric power for the construction and operation of the DITP. The Authority paid HEEC's capital investment for the cross-harbor electrical cable over a 25-year schedule governed by a written agreement, with contractual obligations ending in FY 2015. At the conclusion of the term of that agreement, HEEC petitioned the Massachusetts Department of Public Utilities to establish a tariff formalizing the terms for continued supply of power to the DITP. The Authority fully participated in that 2015 tariff proceeding and is engaged with HEEC in modifying that tariff to incorporate the terms of a May 2017 agreement whereby HEEC will install and MWRA will pay for a replacement power cable to allow the existing cable to be de-commissioned thereby removing the risk of damage to it from planned harbor dredging activities and the creation of deep draft ship berths within the Reserved Channel where the existing cable enters Boston harbor. Additional costs related to capacity charges for the new cable are projected to start in FY 2020. The Authority has allocated \$6.5 million in FY 2018 for a HEEC cable capacity reserve

fund, intended to be utilized in FY 2021 and FY 2022 to partially mitigate the rate impact of the increased costs related to the capacity charges for the new cable.

Mitigation: The Authority is a party to an agreement that requires the Authority to make payments to the Town of Winthrop to ameliorate the adverse physical, social, and economic impacts of the DITP. The FY 2018 CEB estimates that this mitigation payment will equal \$779,000 in FY 2018. The Authority also has a mitigation agreement with the City of Quincy that requires the Authority to make payments for police, fire, and other municipal services for several Authority water and sewer facilities located in Quincy, and the Authority has budgeted \$779,000 for FY 2018. The projections assume both agreements remain in effect in substantially their current forms throughout the forecast period, and includes an annual increase of not more than 2.5 percent.

Additions to Reserves: The Authority is required by the terms of the Resolution to maintain reserve funds for operations, insurance, and renewal and replacement. These reserves are incrementally funded each year, as necessary, to bring them to stipulated levels. These are discussed in more detail in the following section and in Section 4 of this Report.

Pension Fund Contribution: The Authority's methodology for assessing retirement liability is to comply with Chapter 32 of the Massachusetts General Laws, although current Authority policy is to reach full-funding more quickly than the statutory deadline. For FY 2018, the Authority anticipates contributing \$3.3 million to the Pension Fund, which is the required contribution based on the actuarial evaluation completed January 2015. In June 2017, the Authority received an updated actuarial valuation which reflected a reduction to the actuarial rate of return from 7.75% to 7.5%. In addition to the reduced actuarial accrued rate of return, the report also reflected the impact of the actuarial gains and losses over the prior five years. The combination of those factors, as well as other actuarial assumptions, resulted in an increase to the liability and thus the annual required contribution to meet full funding by 2024.

Other Post-Employment Benefits: The Authority has adopted GASB 45, which requires accounting and reporting of post-employment benefits other than pensions ("OPEB"). The Authority has elected to use funds that would otherwise be allocated to OPEB to prefund its unfunded pension liability reducing the 17-year funding schedule. Because of the high funding level of the pension system in FY 2015, the Authority's Board of Directors created the Massachusetts Water Resources Authority Irrevocable Other Post-Employment Benefits Trust (the "OPEB Trust"). The Authority has deposited approximately \$20.9 million into the OPEB Trust. This includes \$10.0 million related to amounts released from reserves as a result of amendments to the General Bond Resolution that were effective in April 2015, \$800,000 in FY 2011 funds set aside for OPEB related expenses, a \$5.2 million deposit on June 30, 2016, and a \$4.9 million deposit on June 30, 2017. Under its current plan, the Authority anticipates depositing between \$5 and \$6 million in each year of the forecast period, but this may change based on the anticipated review of pension fund contributions noted above.

5.3.3 Reserve Funds

The Authority is required by the Resolution to meet funding requirements for certain funds. The Authority is required to maintain an Operating Reserve Fund to be used in the event of unexpected or extraordinary fluctuations in monthly operation and maintenance expenses. The Authority is required to have on deposit in the Operating Reserve Fund at the end of each fiscal year an amount equal to one-sixth of that fiscal year's operating expenses. (Operating expenses are the total of direct

and indirect expenses found in the Tables 5-2 and 5-3, less the amounts expended for Watershed/PILOT, Reserve fund additions, and OPEB Trust contributions).

At the end of FY 2017, the Operating Reserve had a balance of \$39.2 million. In FY 2018, a required contribution of \$821,000 is projected to be required to comply with the Resolution. In order to maintain a balance in compliance with the Resolution, contributions of \$1.2 million, \$1.6 million, \$1.4 million, \$1.2 million, and \$2.0 million are projected for FY 2019 through FY 2023, respectively.

The Resolution requires the Authority to fund an Insurance Reserve Fund to a level confirmed by a qualified insurance consultant. The Insurance Reserve Fund was reviewed in February 2017 by the Authority's insurance consultant and that report confirmed the adequacy of the \$14 million fund balance. The Authority expects the fund balance to remain level at \$14 million throughout the forecast period. The Insurance Reserve Fund Requirement has not been independently reviewed or evaluated by CDM Smith.

The Resolution also requires the Authority to fund a Renewal and Replacement Reserve Fund, based on the recommendations of the Consulting Engineer. The Renewal and Replacement Reserve Fund is established to pay the costs of emergency repairs or capital improvements to the System when funds are not available in either the Construction Fund or the Operating Fund. Projects financed from the Renewal and Replacement Reserve Fund must be necessary to ensure the continual operation of the System, and not previously identified to be financed from the Operating Fund. The Renewal and Replacement Reserve Fund requirement is presently established at \$35 million, as most recently determined in the 2014 Triennial Report, and confirmed in this report. The Resolution, as amended, requires the Authority to maintain a minimum cash balance of \$10 million in the Renewal and Replacement Reserve Fund. The remaining balance will be met through unused capacity in TECP. Based on the current funding requirement, no additional deposits are projected to be required over the forecast period.

The Authority has in the past and may in the future pre-fund required reserve fund deposits.

5.3.4 Capital Spending

The projected capital spending for FY 2018 through FY 2023 is presented in Table 5-4, based on the FY 2018 CIP. The capital expenditures presented in this table are presented on a cash basis, and represent the anticipated actual expenditures for various projects. The projected capital expenditures are based on contracts that are currently underway, as well as projected future projects reflected in the CIP. Inflated estimates are based on a 2.5 percent average annual inflation rate for all projects that will not be under contract until after the end of FY 2018. In our opinion, the assumed inflation rate is reasonable given anticipated inflation trends. This inflation rate should provide an adequate allowance for currently unforeseen factors that could increase inflation pressures on construction costs.

Contingency amounts shown in Table 5-4 are based on projected cash expenditures. The contingency in a particular year is estimated to be 7.0 percent of projected spending, except for tunnel related projects which carry a 15 percent contingency. We believe that the Authority's contingency assumptions are reasonable and appropriate and provide sufficient allowances to cover unanticipated events.

Table 5-4
Projected Capital Spending, Inflated and Uninflated, FY 2018-2023
(\$ in 000's)

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Sewer System¹						
Contracted ^{2,3}	\$66,870	\$39,696	\$28,377	\$8,504	(\$9,525)	(\$11,008)
Uncontracted ²	\$12,073	\$74,292	\$140,030	\$152,073	\$152,010	\$131,244
Contingency ²	\$6,404	\$8,923	\$12,853	\$12,345	\$11,118	\$9,627
Subtotal²	\$85,347	\$122,912	\$181,260	\$172,922	\$153,603	\$129,863
Waterworks System¹						
Contracted ²	\$54,389	\$22,020	\$10,746	\$3,460	\$1,956	\$1,234
Uncontracted ²	\$18,847	\$64,137	\$111,673	\$131,834	\$103,490	\$84,245
Contingency ²	\$6,387	\$11,694	\$13,650	\$8,261	\$11,891	\$21,118
Subtotal²	\$79,623	\$97,851	\$136,069	\$143,556	\$117,337	\$106,597
Total CIP— Uninflated ²	\$164,971	\$220,763	\$317,329	\$316,478	\$270,940	\$236,460
Total CIP—Inflated	\$165,798	\$228,425	\$338,153	\$347,658	\$307,225	\$275,422
Total CIP Spending	\$165,798	\$228,425	\$338,153	\$347,658	\$307,225	\$275,422

¹ Includes allocated Administrative Division expenses.

² Stated in 2018 dollars throughout forecast period.

³ Negative values for FY 2022 and FY 2023 reflect infrastructure rehabilitation loan repayments from Local Bodies.

In June 2013, the Authority established a capital spending cap for FY 2014 to FY 2018 with baseline capital expenditures totaling \$718.0 million and a total baseline cap of \$791.7 million. Projected spending for the FY 2014 to FY 2018 period based on the FY 2017 Final Budget is \$617 million compared to the baseline of \$718 million. The Authority is expected to establish a new cap to cover the FY 2019 to FY 2023 period and that may impact the anticipated spending during the forecast period.

The CIP identifies water system redundancy, asset protection, support for Community Financial Assistance programs, and pipeline replacement and rehabilitation as the primary focus of the Authority's capital spending going forward.

In recent years, a large amount of the Authority's capital spending has been for CSO control projects to comply with federal legal mandates. This program accounted for 38.2 percent of total CIP spending over the 2009-2013 spending cap period. For the FY 2014-FY 2018 cap period, this program is estimated to account for only 10.7 percent of total capital spending.

The Authority is currently in the discussion and planning phase regarding the feasibility and impacts of long-term redundancy improvements for the Metropolitan Tunnels that supply water to the metropolitan Boston area. The Authority, based on a Board vote in February 2017, is moving forward with permitting and design for the redundancy project, which anticipates the construction of two deep rock tunnels to provide redundant potable water conveyance to the Authority's Boston metropolitan service area. The CIP includes \$1.4 billion for the long-term redundancy project which the Authority anticipates expending over 15 years or longer.

Table 5-5 presents the projected flow of funds within the Construction Fund from FY 2018 through FY 2023. Most construction funding is projected to be financed with long-term debt or SRF loans; however, the Authority intends to fund \$94.2 million in capital expenditures through pay-as-you-go current year funding during the projection period. The assumption for future years is that SRF loan availability remains stable beyond FY 2018, but that no grant funding will be available.

Table 5-5
Construction Fund Projected Cash Flow, FY 2018-2023
(\$ in 000's)

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Construction Needs ¹	\$155,280	\$207,061	\$302,434	\$312,089	\$283,983	\$267,924
Financed by:						
Balance: Begin. of Year	\$127,140	\$114,843	\$38,723	\$40,589	\$38,678	\$37,972
Long Term Debt	\$87,782	\$74,742	\$247,099	\$251,979	\$224,077	\$221,196
SRF	\$42,000	\$42,000	\$42,000	\$42,000	\$42,000	\$42,000
Pay As You Go	\$13,200	\$14,200	\$15,200	\$16,200	\$17,200	\$18,200
Balance: End of Year²	\$114,843	\$38,723	\$40,589	\$38,678	\$37,972	\$51,444

¹ Construction needs is approximately 85 percent of Total CIP--Inflated line shown on bottom of Table 5-4, plus two-thirds of the 15 percent deferred three years earlier.

² The Balance: End of Year is equal to the sum of the available sources, less projected construction needs.

Note: Details may not add exactly due to rounding.

The Authority has developed its projections of borrowing amounts in a fiscal year, such that it begins the following fiscal year with a Construction Fund starting balance that, when combined with SRF loans, grants, and pay-as-you-go capital, is at least 10 percent of the next fiscal year's construction requirement. This, coupled with the availability of TECP, provides a sufficient cushion to prevent disruption of the Authority's capital program from unanticipated or unfavorable capital market conditions.

The capital spending program described in the preceding paragraphs affects the Authority's revenue requirement in two ways:

- Debt service must be paid on the bonds issued to fund the program.
- Sufficient revenues must be generated to comply with the Primary and Secured Coverage requirements.

Table 5-6 presents existing and projected debt service resulting from the projected capital spending program and assumes that the Authority is not constrained by its statutory debt limitation. Annual debt service in a fiscal year is based on the monthly debt service deposits that are required in accordance with the Resolution. As noted previously, no DSA is assumed for the projection period beyond FY 2018.

Table 5-6
Current and Projected Debt Service, FY 2018-2023
(\$ in 000's)

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Senior Debt						
Principal to be Issued in FY ¹	\$100,000	\$85,922	\$275,256	\$281,201	\$251,049	\$247,873
Existing Senior Debt Service	\$261,060	\$270,675	\$219,298	\$310,457	\$309,935	\$368,645
<u>Future Senior Debt Service</u>	<u>\$3,500</u>	<u>\$2,875</u>	<u>\$9,470</u>	<u>\$9,943</u>	<u>\$9,119</u>	<u>\$9,004</u>
Total Senior Debt Service	\$264,560	\$273,549	\$228,768	\$320,399	\$319,054	\$377,649
Debt Service Assistance	(\$222)	\$0	\$0	\$0	\$0	\$0
<u>Bond Redemption Account</u>	<u>\$0</u>	<u>\$0</u>	<u>(\$500)</u>	<u>(\$250)</u>	<u>\$0</u>	<u>\$0</u>
Net Senior Debt Service	\$264,338	\$273,549	\$228,268	\$320,149	\$319,054	\$377,649
Subordinated/SRF Debt						
Principal to be Issued in FY ¹	\$42,000	\$42,000	\$42,000	\$42,000	\$42,000	\$42,000
Existing Debt Service	\$153,286	\$159,674	\$239,563	\$166,997	\$193,629	\$141,890
<u>Future Debt Service</u>	<u>\$17,089</u>	<u>\$18,287</u>	<u>\$20,506</u>	<u>\$22,687</u>	<u>\$24,909</u>	<u>\$27,034</u>
Total Subordinated/SRF Debt Service	\$170,375	\$177,961	\$260,069	\$189,683	\$218,538	\$168,924
<u>Debt Service Assistance</u>	<u>(\$170)</u>	<u>\$0</u>	<u>\$0</u>	<u>\$0</u>	<u>\$0</u>	<u>\$0</u>
Net Subordinated/SRF Debt Service	\$170,206	\$177,961	\$260,069	\$189,683	\$218,538	\$168,924
Total Debt Service	\$434,544	\$451,510	\$488,337	\$509,833	\$537,592	\$546,573

¹Total principal amount represents the amount of bonds required to provide the Construction Fund Deposit shown on line 1 of Table 5-5, plus repayment of TECP issued in prior fiscal year(s). This amount is increased to reflect Debt Service Reserve Fund Requirements and cost of issuance.

Note: Details may not add exactly due to rounding.

Total Senior Debt Service is projected to increase from approximately \$264.6 million in FY 2018, to approximately \$377.6 million in FY 2023 before accounting for proceeds from the Bond Redemption Account, and DSA in FY 2018. In Table 5-6, Net Senior Debt Service reflects the senior debt service

with the reduction of the current and anticipated DSA and the Bond Redemption Account. The Bond Redemption Account is a valuable rate-smoothing tool available to the Authority, and the Authority estimates that it will have nearly \$26.1 million in the Bond Redemption Account at the beginning of the forecast period. The Authority projects withdrawals from the account in FY 2020 and FY 2021, in the amounts of \$500,000 and \$250,000, respectively. The timing and amount of actual usage may vary.

Subordinated debt service, including both SRF loans and other outstanding subordinated Authority debt, is projected to decrease from \$170.4 million in FY 2018 to \$168.9 million in FY 2023. No future variable rate debt is assumed to be issued over the timeframe of these projections, an assumption that may change based on market conditions. Projected SRF loan debt service assumes an interest rate of 2.5 percent for sewer related debt for and a rate of 2.0 percent for water related debt throughout the projection period.

5.3.5 Non-Rate Revenues

The Authority receives revenues from a variety of sources that offset the amount that must be collected from the Local Bodies. Total non-rate revenues are budgeted at \$26.6 million in FY 2018 and are projected to increase to a total of \$36.6 million in FY 2023. Table 5-7 summarizes these sources from FY 2018 through FY 2023.

Table 5-7
Projected Non-Rate Revenue, FY 2018-2023
(\$ in 000's)

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Rate Stabilization Fund Withdrawal	\$0	\$0	\$0	\$0	\$4,383	\$0
Miscellaneous	\$16,370	\$15,656	\$15,842	\$16,151	\$16,470	\$16,384
<u>Investment Income</u>	<u>\$10,206</u>	<u>\$12,995</u>	<u>\$14,363</u>	<u>\$16,754</u>	<u>\$19,140</u>	<u>\$20,241</u>
Total Non-Rate Revenue	\$26,576	\$28,651	\$30,205	\$32,905	\$39,992	\$36,626

Note: Details may not add exactly due to rounding.

Major non-rate revenue sources are briefly described in the following:

Rate Stabilization Fund Withdrawal: When annual revenues exceed expenses, the Authority may deposit the money in the Rate Stabilization Fund. In future years, money may be withdrawn from the fund to reduce rate revenue requirements. The projections cap Rate Stabilization Fund withdrawals at an amount no greater than 10 percent of the Required Debt Service Fund Deposits, net of DSA credited to Senior Debt for such year, consistent with the Resolution, and use such amounts as available to moderate projected rate increases consistent with Authority practice. The Rate Stabilization Fund balance at the end of FY 2017 was approximately \$36.5 million. For FY 2018, the Authority does not anticipate withdrawals from the Rate Stabilization Fund. The projections include withdrawals of \$4.4 million in FY 2022.

Investment Income: The Authority earns interest by investing fund balances in a variety of interest-bearing securities. These amounts are transferred to the Revenue Fund and are available to meet the ongoing obligations of the Authority. Total investment income is projected to increase from approximately \$10.2 million in FY 2018 to approximately \$20.2

million in FY 2023. The fluctuations in investment income between FY 2018 and FY 2023 partially reflect changes in the Construction Fund, Rate Stabilization Fund, and Debt Service Reserve Fund balances.

Miscellaneous: The Authority also receives certain amounts from Local Bodies, primarily the CVA communities that are provided water under various contracts, as well as payments from the Town of Clinton for partial operation of the Clinton Plant. Between FY 2018 and FY 2023, the Authority is projected to receive approximately \$30.8 million from the CVA communities under the contractual service agreements. The Authority estimates that over the same period of time it will collect \$10.9 million in water revenue from sewer customers to offset water usage at the DITP. The Authority also receives a variety of fees, penalties and charges in their normal course of business.

5.4 Rate Revenue Requirement and Retail Customer Impacts

5.4.1 Rate Revenue Requirement

Table 5-8 summarizes the projected rates for FY 2018 through FY 2023 based on the CEB and other factors described herein. For FY 2018, the Authority's rate revenue requirement increased by approximately 3.2 percent over FY 2017 levels to a total of approximately \$717.1 million. The rate revenue requirement equals the total amount of expenses in a fiscal year (including required reserve deposits and any amounts required to meet coverage requirements) less non-rate revenues. Of this amount, approximately \$474.6 million will be required to meet the expenses of the Sewer System, including allocated administrative and indirect expenses, and approximately \$242.4 million for the Waterworks System.

Rate revenues are projected to increase to approximately \$859.2 million in FY 2023, an average annual increase of 3.7 percent from FY 2018 levels. For the Sewer System, the rate revenue requirement is projected to increase from \$474.6 million to approximately \$565.3 million, an average annual increase of approximately 3.6 percent. The Waterworks System revenue requirement is projected to increase from \$242.4 million in FY 2018 to approximately \$294.0 million in FY 2023, an average annual increase of 3.9 percent.

The Authority historically has attempted to smooth total rate increases to mitigate significant short-term rate increases. Recognizing that smoothing total rate increases is beneficial to Local Bodies receiving both water and sewer service only, in FY 2017 the Authority began to smooth rates at the Sewer System and Waterworks System level. Rate smoothing at the system level will create sustainable and predictable rates for each system, which will help mitigate short term rate spikes and provide consistent rates for the Local Bodies that only receive one service from the Authority.

Table 5-8
Projected Rate Revenue Requirement Increases, FY 2018-2023
(\$ in 000's)

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Sewer Fund Rate Revenue	\$474,638	\$492,793	\$511,690	\$530,975	\$550,935	\$565,254
<u>Water Rate Revenue</u>	<u>\$242,416</u>	<u>\$251,828</u>	<u>\$261,565</u>	<u>\$272,011</u>	<u>\$282,845</u>	<u>\$293,980</u>
Total Rate Revenue	\$717,054	\$744,621	\$773,254	\$802,986	\$833,780	\$859,234
Annual Rate Increase	3.2%	3.8%	3.8%	3.8%	3.8%	3.1%

Note: Details may not add exactly due to rounding.

These projected rate revenue increases are the product of a large number of assumptions, including the rate of growth in Authority operating expenses and economic and financial assumptions. They also assume that the Authority uses the Rate Stabilization Fund consistent with the Resolution and the Bond Redemption Account to smooth future projected rate increases.

5.4.2 Rate Allocation Methodology

The Authority's charges for the services of the Waterworks System and Sewer System, identified as Total Rate Revenue in the preceding table, are billed to Local Bodies on a wholesale basis. This means that the Authority bills Local Bodies, including special districts, rather than the individual residences or businesses served by the System. Separate charges applicable to the Sewer System and the Waterworks System are established each year as required by the Enabling Act; these charges are established at levels at least sufficient, together with other available revenue, to pay the full annual revenue requirement, as described in subsequent sections.

5.4.2.1 Water Rate Methodology

Using an average cost methodology, the Authority's net annual Waterworks System costs for the current fiscal year, including operation and maintenance, debt service, and reserve fund requirements are recovered from Local Bodies in proportion to their prior calendar year annual water consumption. For FY 2017, the unit cost of water was \$3,472 per million gallons; in FY 2018, the unit cost equals \$3,582 per million gallons; and based on the Authority's projections the unit cost will equal approximately \$3,721 per million gallons in FY 2019.

5.4.2.2 Contractual Agreements for Water Service

Twenty-five of the 52 Local Bodies authorized to receive water are "contract communities" in which water is supplied pursuant to water supply agreements. The water supply agreements contain terms and conditions agreed to by the respective Local Body and the Authority. Twenty of the 25 contract communities pay for water at the full water rates. The three CVA communities have a separate assessment. Southborough receives its first 150 million gallons per year at no charge. Clinton is also considered a water-served community; Clinton withdraws its first 800 mg of water per year from the Authority's water supply reservoirs via its own infrastructure free of charge under special legislation. There are four additional entities served by the Authority, including a state hospital and the DCR. The Authority has had and continues to have discussions with additional communities and Local Bodies regarding potential water sales to meet various needs and has added five Local Bodies to the Waterworks System since its inception. Most recently, the Town of North Reading has been authorized to receive water service as a Local Body, but has delayed completing the application process.

5.4.2.3 Wastewater Rate Methodology

The Authority's wastewater rate methodology encompasses the following elements:

Operation and Maintenance Expense: Each Local Body's annual allocation in FY 2018 is based upon the average total annual metered flow for the prior three years from each Local Body taking into account three separate prices for each portion of wastewater: total annual flow, pounds of suspended solids, and pounds of biochemical oxygen demand.

Capital Costs: A flow-based method, adjusted for strength, is used to recover one-quarter of the capital costs, and a population-based method is used to recover the remaining three-quarters. For each Local Body in FY 2018, flow calculations are based on the average of the month in the prior three calendar years in which the highest average daily flows occurred for that Local Body. The remaining share of capital costs is allocated based on population: 50 percent of the balance (37.5 percent of the total) assigned on the basis of the Local Body's

total or census population, and 50 percent of the balance (37.5 percent of the total) on the basis of the presently served population.

5.4.2.4 Enforceability of Charges

The Authority's charges to Local Bodies are a general obligation of the Local Bodies. Local Bodies fund payment of the Authority's wholesale rates and charges from a number of revenue sources, including local retail water and wastewater charges, real and personal property taxes, Commonwealth local aid distributions, or a combination of the preceding. In the event any charge to a Local Body is not paid when due, the Enabling Act authorizes the Authority to recover the amount due, together with interest and other actual damages, by action in the state Superior Court. Without suit, the Authority may also certify to the State Treasurer the amount of any unpaid charge from a Local Body (except the Boston Water and Sewer Commission, the Lynn Water and Sewer Commission, the Dedham-Westwood Water District, and the Lynnfield Water District, which collectively will account for approximately 31.1 percent of total rate revenues in FY 2018), whereupon the State Treasurer is required by the Act to deduct the amount due from any distribution of local aid then payable to such Local Body by the Commonwealth, if any, and instead to pay such amount to the Authority. The Authority has collected 100 percent of its rates and charges in each year of its existence. This local aid intercept has been used only eight times in total, and not since FY 1993. To date, 100 percent of the Authority's rates and charges were collected within 30 days of due dates, except for one instance in which the Authority made special arrangements with a Local Body to extend the due date.

The availability of Commonwealth local aid distributions in the future to satisfy unpaid charges imposed by the Authority with respect to those Local Bodies eligible to receive such distributions will be dependent upon, among other things, the aggregate amount actually appropriated to each Local Body by the state legislature in a fiscal year for local aid distribution, and to the extent to which a Local Body's local aid distribution may have already been accessed under other valid intercept mechanisms.

5.4.3 Retail Customer Impacts

The Local Bodies and their retail customers will continue to be impacted by the projected increases in the Authority's charges for water and wastewater service over the next several years. Local Bodies will be required to increase their contributions through retail user fee increases. Due to the variety of revenue sources used by the Local Bodies and the differences in service levels, it is difficult to accurately assess the impact of the projected increases in the Authority's charges on the average household in the Authority's service area. The Advisory Board annually surveys the Local Bodies, and on the basis of the 2016 *Annual Water and Sewer Retail Rate Survey*, the Advisory Board has estimated that during FY 2016 the average annual household charges for water and wastewater service across the 61 communities served by the Authority will total \$1,525 using an industry standard benchmark that the average household consumes 90,000 gallons per year. For FY 2018 and FY 2019 we project that the average household bill assuming 90,000 gallons average annual consumption will increase to approximately \$1,682 and \$1,757, respectively. When making these projections, we have assumed (1) that the Local Body that provides retail services receives both water and sewer services from the Authority, (2) that the Local Body passes on to each household 100 percent of any Authority increases in the form of retail user fees, (3) that the Local Body's charges increase by 5.0 percent annually through FY 2020, and (4) that the Authority's charges constitute approximately 43 percent of the Local Bodies' charges in FY 2018.

Table 5-9 summarizes the projected annual household bills through FY 2023 assuming average household consumption of 90,000 gallons per year. Typical annual household bills are projected to increase to approximately \$2,092 in FY 2023. Of this amount, \$865 is the Authority wholesale charge and \$1,227 is the projected local charge.

These estimates of household charges are based on the assumptions regarding inflationary increases, long-term debt interest rates, state and federal assistance, estimates of additional operating expenses related to new facilities, and construction costs of new facilities. These estimated charges are, therefore, subject to change.

We believe that assuming average annual consumption of 90,000 gallons per year overstates residential consumption in many of the Local Bodies, and that most residential customers consume significantly less. Another benchmark that the Authority is using is based on 61,000 gallons per year per household, or 68 percent of the industry benchmark which the Authority believes tracks closer to actual consumption in its service area. Consequently, the average annual household bills described above and presented below may not be reflective of the actual cost of water and sewer service being incurred by the Local Bodies' residential customers. At the consumption level of 61,000 gallons, the average retail bill during FY 2018 would be approximately \$1,140, and in FY 2023 the average bill is estimated to be \$1,418.

Table 5-9
Projected Typical Household Bills, FY 2018-2023
(\$ in 000's)

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Combined						
Local	\$962	\$1,010	\$1,060	\$1,113	\$1,169	\$1,227
<u>MWRA</u>	<u>\$720</u>	<u>\$748</u>	<u>\$777</u>	<u>\$807</u>	<u>\$838</u>	<u>\$865</u>
Total	\$1,682	\$1,757	\$1,837	\$1,920	\$2,007	\$2,092
Water						
Local	\$351	\$369	\$387	\$407	\$427	\$448
<u>MWRA</u>	<u>\$322</u>	<u>\$335</u>	<u>\$348</u>	<u>\$362</u>	<u>\$376</u>	<u>\$391</u>
Total	\$674	\$704	\$735	\$768	\$803	\$839
Sewer						
Local	\$610	\$641	\$673	\$706	\$742	\$779
<u>MWRA</u>	<u>\$398</u>	<u>\$413</u>	<u>\$429</u>	<u>\$445</u>	<u>\$462</u>	<u>\$474</u>
Total	\$1,008	\$1,054	\$1,102	\$1,151	\$1,204	\$1,253

The retail rates within the Authority's service area are among the highest in the country according to the Advisory Board's 2016 *Annual Water and Sewer Retail Rate Survey*. The survey found an average annual combined water and sewer household bill of approximately \$1,525 assuming 90,000 gallons of water use for all 61 communities served by the Authority. However, comparing the costs to households of water and sewer services across jurisdictions is difficult given differing methodologies in establishing user fees, capital assessments, general tax support, and the availability of state and federal financial assistance. In addition, it is important to take into account regional variations in water consumption and household income when assessing the impact of such bills on residential customers. The Authority believes that with these factors taken into account its service costs are comparable to many utilities across the country.

For certain segments of the Authority's service area population, especially those with low and/or fixed incomes, we believe that the retail rates may be burdensome. If these increases are not mitigated in some fashion, certain demographic groups within the retail customer base may find the projected

increases unaffordable. However, Local Bodies have a variety of means for mitigating these impacts, including lifeline rates, subsidization from other revenue sources, and discounts for seniors and low-income households. Several of these measures have already been implemented by certain Local Bodies to mitigate the burden on the most vulnerable retail customers.

Based upon our review, and recognizing the availability and use of retail rate alternatives by the Local Bodies, we are reasonably confident that the Authority's projected rates and charges will be within the ability of the individual Local Bodies and their collective retail customer base to afford.

5.5 Compliance with the General Bond Resolution

Table 5-10 summarizes our evaluation of the Authority's compliance with certain terms of the Resolution from FY 2018 through FY 2023. The data included in this table regarding non-rate revenues, operating expenses, debt service assistance and reserve fund deposits are described in prior sections. Rate revenue is described in the preceding section. In general, the Authority must generate sufficient rate revenue to meet all operating and capital expenses after accounting for non-rate revenue, such as debt service assistance and investment income. In addition, the Authority's total revenues must be sufficient to comply with the debt service coverage requirements of the Resolution.

Projected annual revenue requirements of the Authority, including operation and maintenance expenses, debt service, and deposits into the various reserve funds are discussed previously. The Authority may deposit certain year-end surpluses from operations into the Rate Stabilization Fund (line 18) and use the accumulated balance in this fund to mitigate the impact of future increases in revenue requirement, subject to the terms of the Resolution and management discretion. Year-end surpluses have resulted from favorable variances of capital financing, operating expenses, and non-rate revenues.

In addition to meeting its yearly cash requirements, the annual revenues of the Authority must be adequate to comply with certain covenants of the Resolution, including the covenants prescribed in Section 705 of the Resolution as to annual level of rates and charges and the required annual debt service coverage ratio (the "Rate Covenant"), as well as the covenants outlined in Section 206 of the Resolution concerning conditions precedent to the issuance of additional revenue bonds (the "Additional Bonds Test").

In order to comply with the Rate Covenant, annual revenues of the Authority must be adequate to: (1) meet all annual revenue requirements including operation and maintenance expenses, *pro rata* debt service fund deposits, and reserve fund requirements; and (2) provide revenue available for revenue bond debt service payments in each fiscal year equal to the sum of the Primary and Supplemental Coverage Ratios. Revenue available from current year operations must provide the Primary Bond Coverage Ratio of 120 percent.

The Authority is also required to maintain Revenues Available for Bond Debt Service at a level equal to 110 percent of debt service on all senior and secured bonds, including bonds issued to the SRF (Secured Bond Rate Covenant).

As shown on lines 23 through 25 of Table 5-10, the Authority is projected to generate sufficient revenues to comply with the applicable coverage requirements. The projected Primary Bond Coverage Ratio (line 24) exceeds the 120 percent requirement for all forecasted years. The Secured Bond Coverage Ratio (line 25) is projected to equal or surpass the 110 percent level in all forecasted years.

Table 5-10
Projected Compliance with Resolution, FY 2018-2023
(\$ in 000's)

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Revenues						
1 Non-Rate Revenues:						
2 Investment Income	\$10,206	\$12,995	\$14,363	\$16,754	\$19,140	\$20,241
3 Rate Stabilization Fund	\$0	\$0	\$0	\$0	\$4,383	\$0
4 Miscellaneous	\$16,370	\$15,656	\$15,842	\$16,151	\$16,470	\$16,384
5 <u>Rate Revenue Requirement</u>	<u>\$717,054</u>	<u>\$744,621</u>	<u>\$773,254</u>	<u>\$802,986</u>	<u>\$833,780</u>	<u>\$859,234</u>
6 Total Revenue	\$743,630	\$773,273	\$803,459	\$835,890	\$873,772	\$895,860
7 Operating Expenses	\$240,421	\$247,911	\$257,685	\$266,277	\$273,417	\$285,404
8 Chelsea Facility Lease	\$3,217	\$3,217	\$3,217	\$3,217	\$3,217	\$3,217
9 <u>Other Post-Employment Benefits</u>	<u>\$5,035</u>	<u>\$5,205</u>	<u>\$5,387</u>	<u>\$5,580</u>	<u>\$5,787</u>	<u>\$6,008</u>
10 Net Operating Revenues	\$494,956	\$516,939	\$537,170	\$560,816	\$591,351	\$601,231
Debt Service						
12 Senior Debt Service	\$264,560	\$273,549	\$228,768	\$320,399	\$319,054	\$377,649
13 Debt Service Assistance & Bond Redemption Account	(\$392)	\$0	(\$500)	(\$250)	\$0	\$0
14 <u>Secured Debt Service</u>	<u>\$170,375</u>	<u>\$177,961</u>	<u>\$260,069</u>	<u>\$189,683</u>	<u>\$218,538</u>	<u>\$168,924</u>
15 Total Debt Service	\$434,544	\$451,510	\$488,337	\$509,833	\$537,592	\$546,573
16 Watershed and PILOT	\$25,164	\$25,835	\$26,525	\$27,233	\$27,959	\$28,706
17 Reserve Fund Deposits	\$821	\$1,248	\$1,629	\$1,432	\$1,190	\$1,998
18 Rate Stabilization Fund Deposits	\$0	\$0	\$0	\$0	\$0	\$0
19 Current Revenue for Capital	\$13,200	\$14,200	\$15,200	\$16,200	\$17,200	\$18,200
20 CP Interest for Water Pipeline Program	\$3,795	\$3,795	\$3,795	\$3,795	\$3,795	\$3,795
21 Debt Service Defeasance	\$17,432	\$20,350	\$1,685	\$2,324	\$3,615	\$1,959
22 Balance Available Year End	\$0	\$0	\$0	\$0	\$0	\$0
Rate Covenant Test						
24 Primary Coverage¹	1.87	1.89	2.34	1.75	1.85	1.59
25 Secured Coverage²	1.14	1.14	1.10	1.10	1.10	1.10

1 Primary Coverage equals Net Revenues divided by Senior Debt.

2 Secured Coverage equals Net Revenues divided by Total Debt.

Note: Details may not add exactly due to rounding.