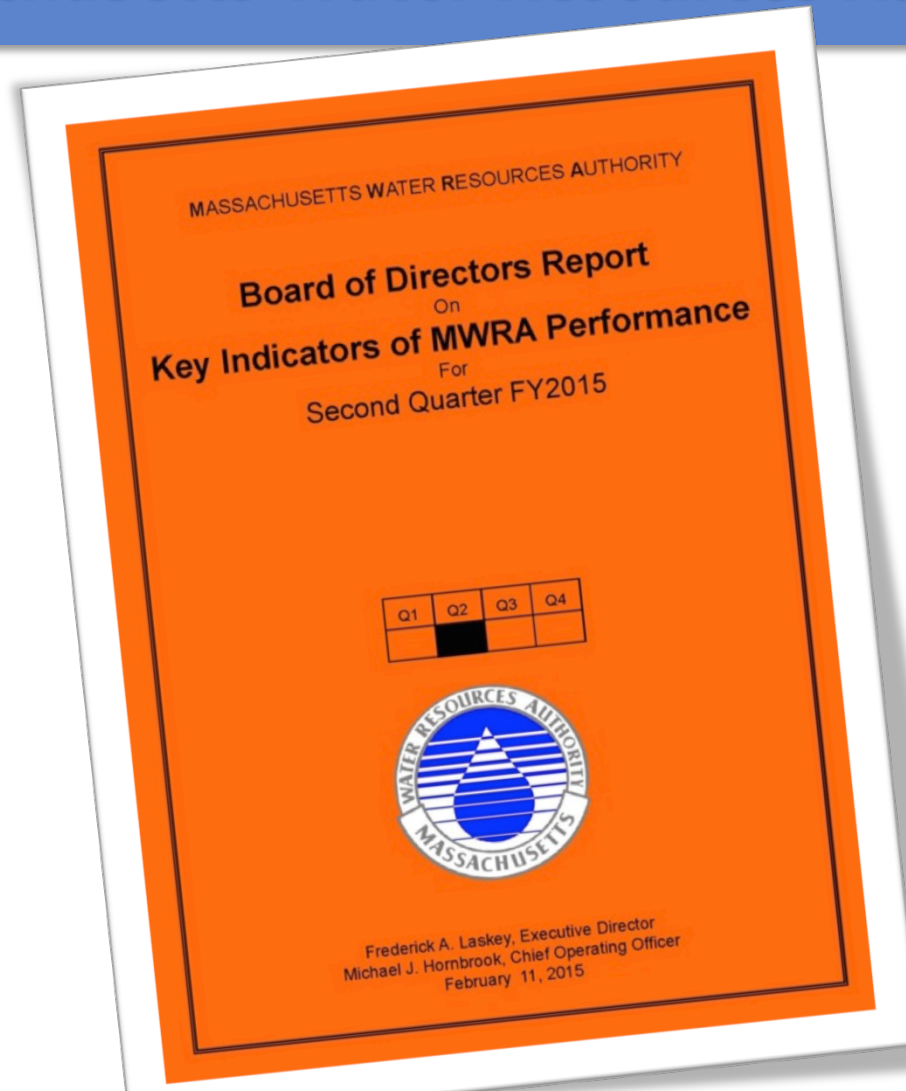


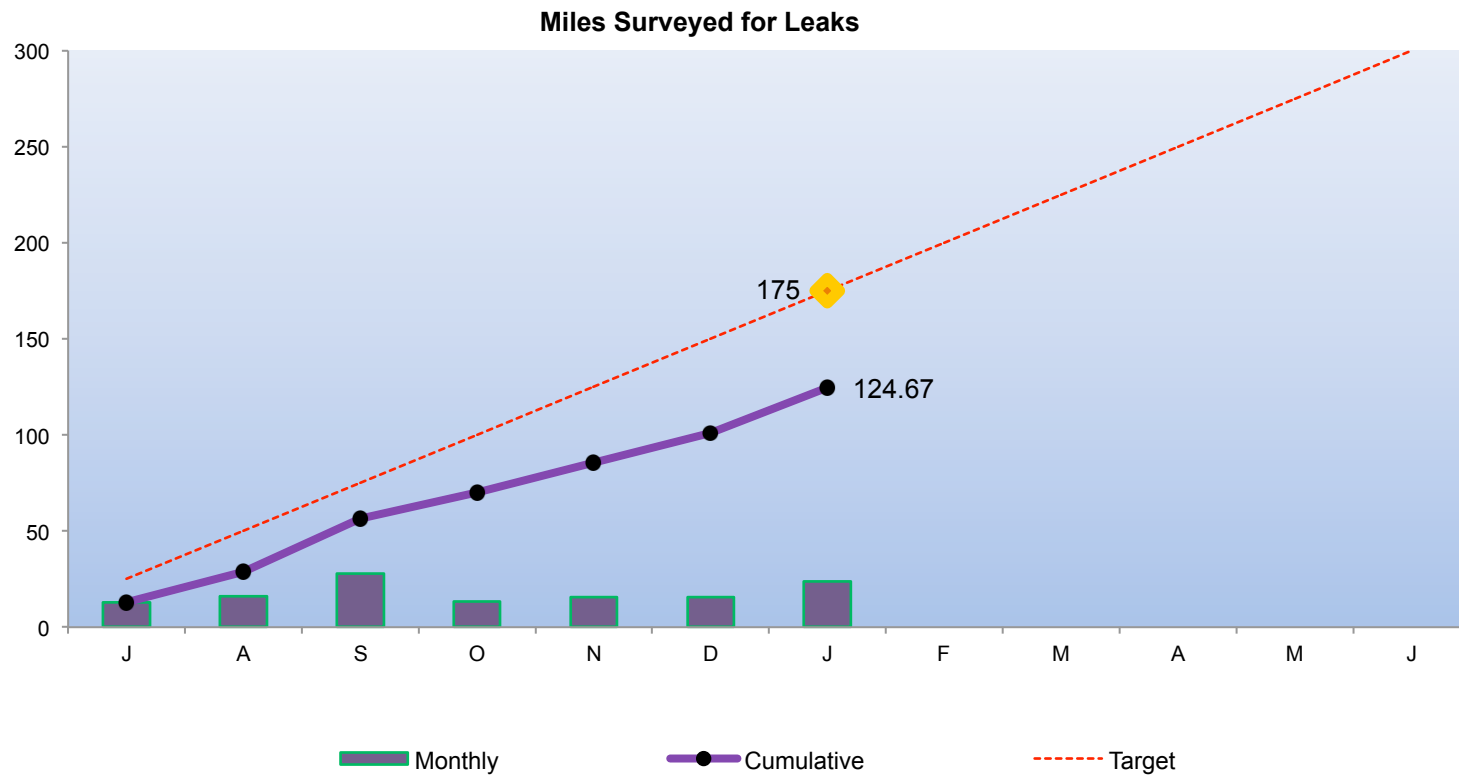


Massachusetts Water Resources Authority





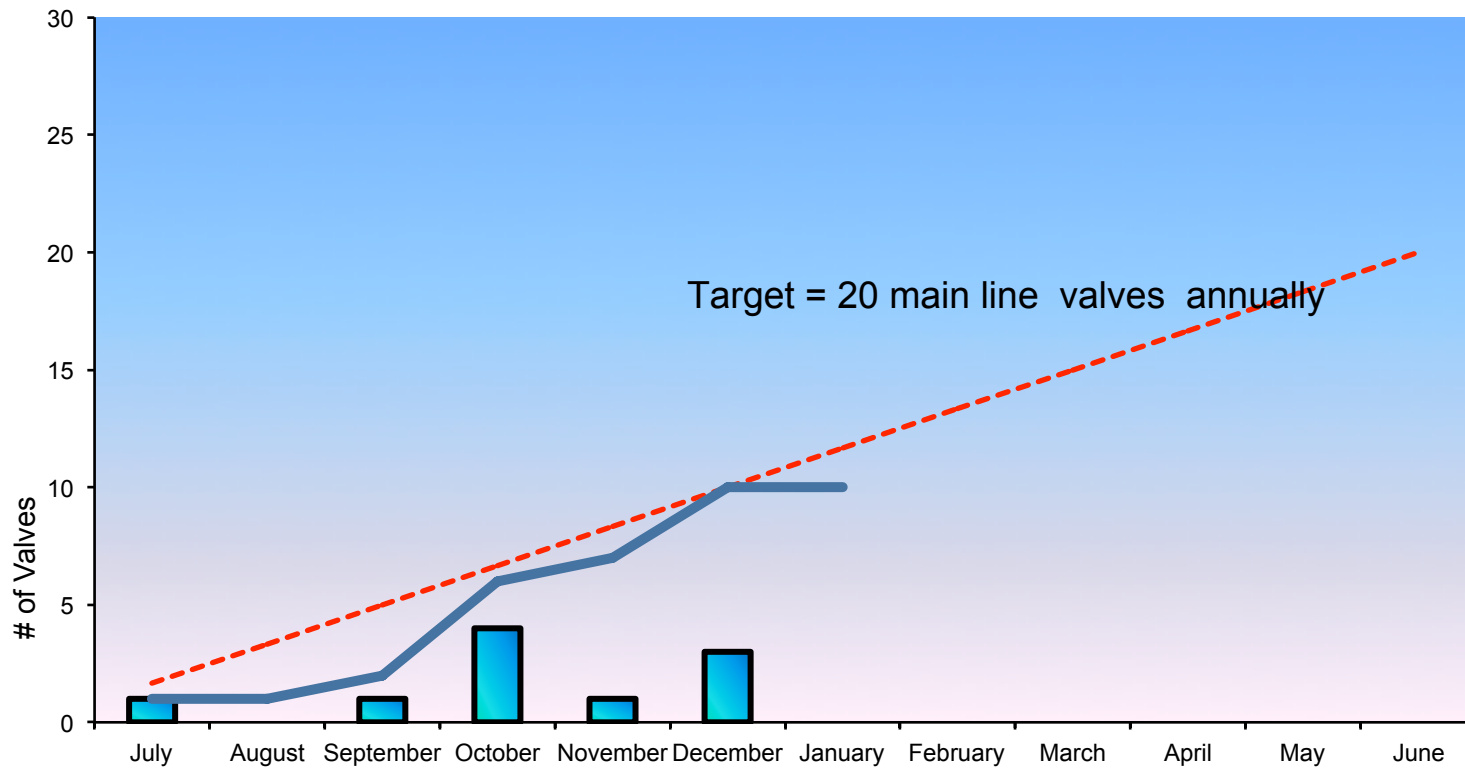
Water Distribution System: Leak Detection





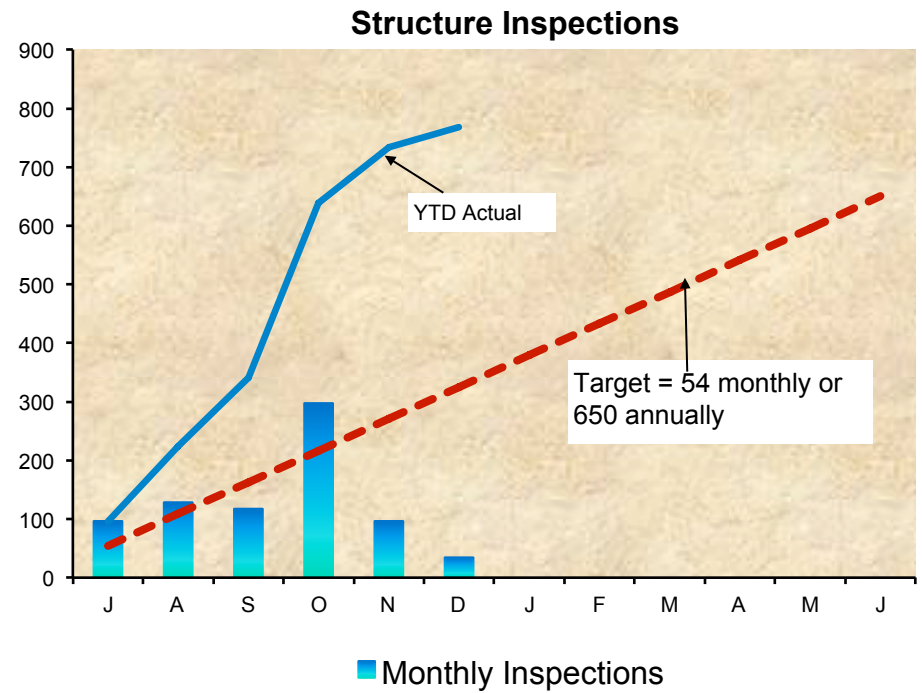
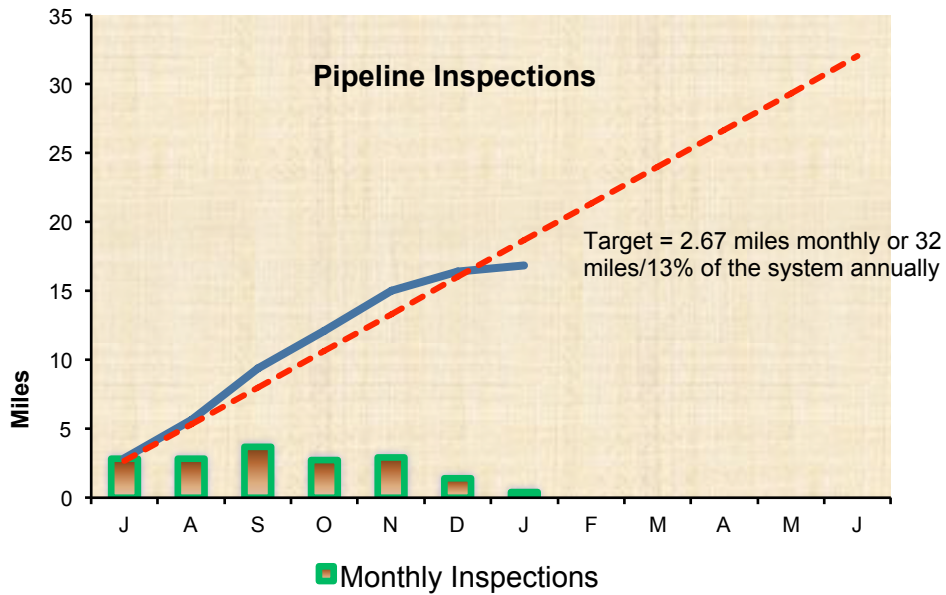
Water Distribution System: Valve Replacement

Main Line Valves Replaced



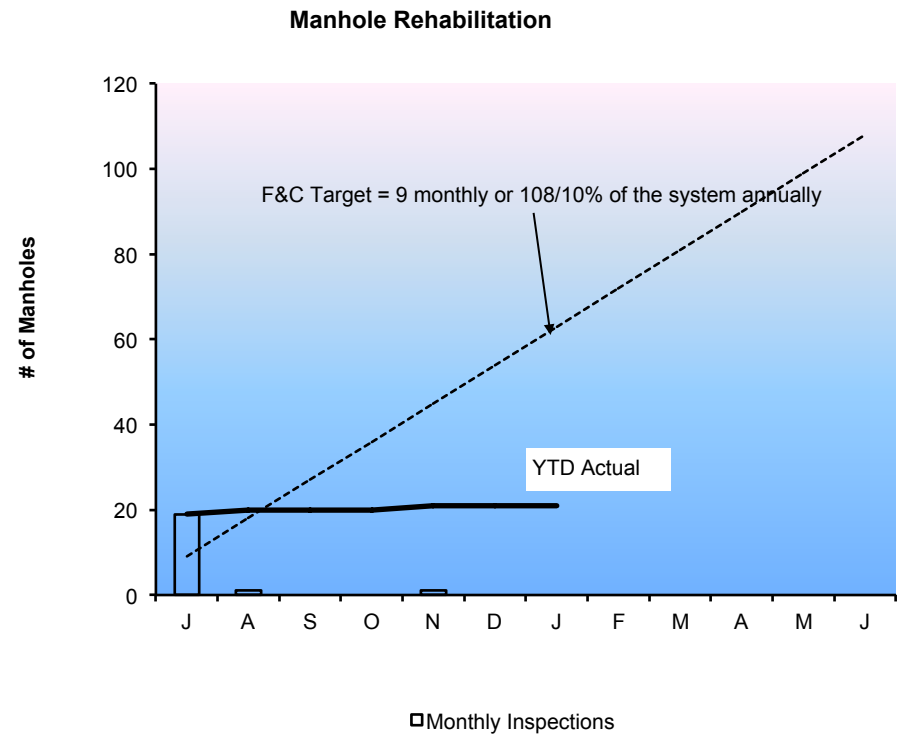
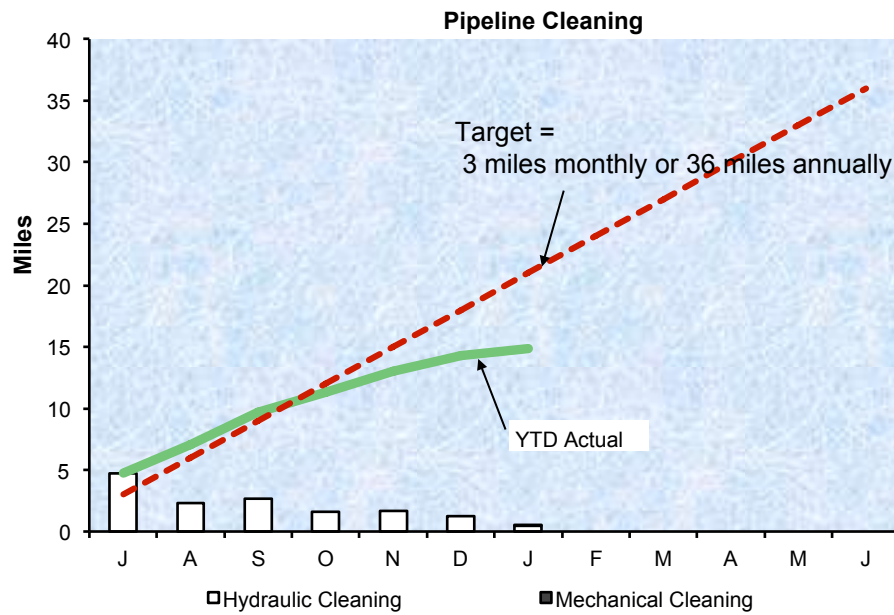


Wastewater Pipeline and Structure Inspections





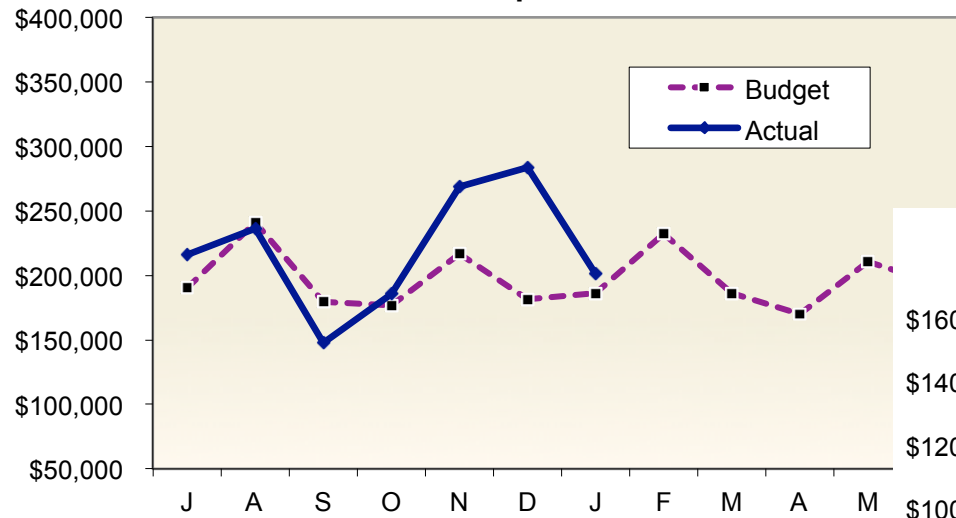
Wastewater Pipeline and Structure Maintenance



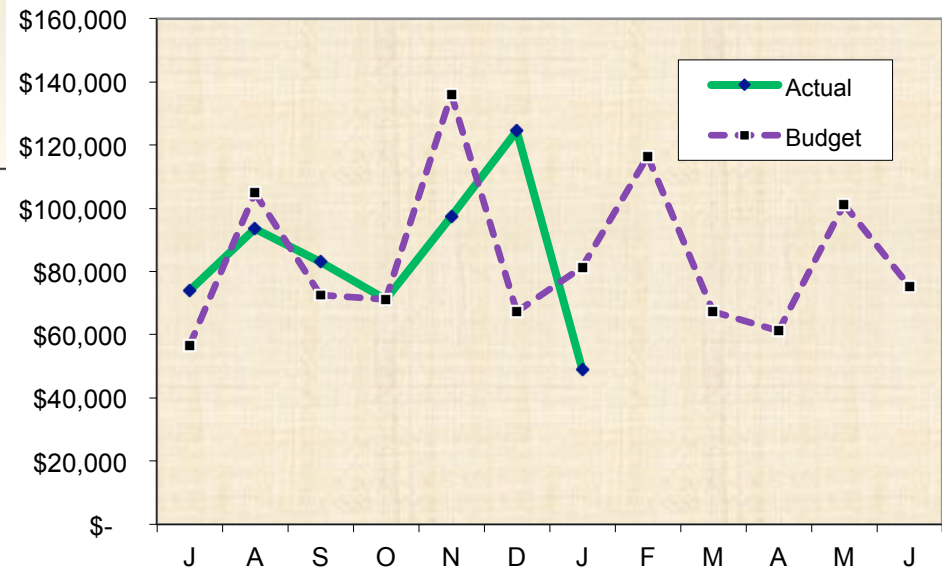


Overtime Through January 2015

Field Operations

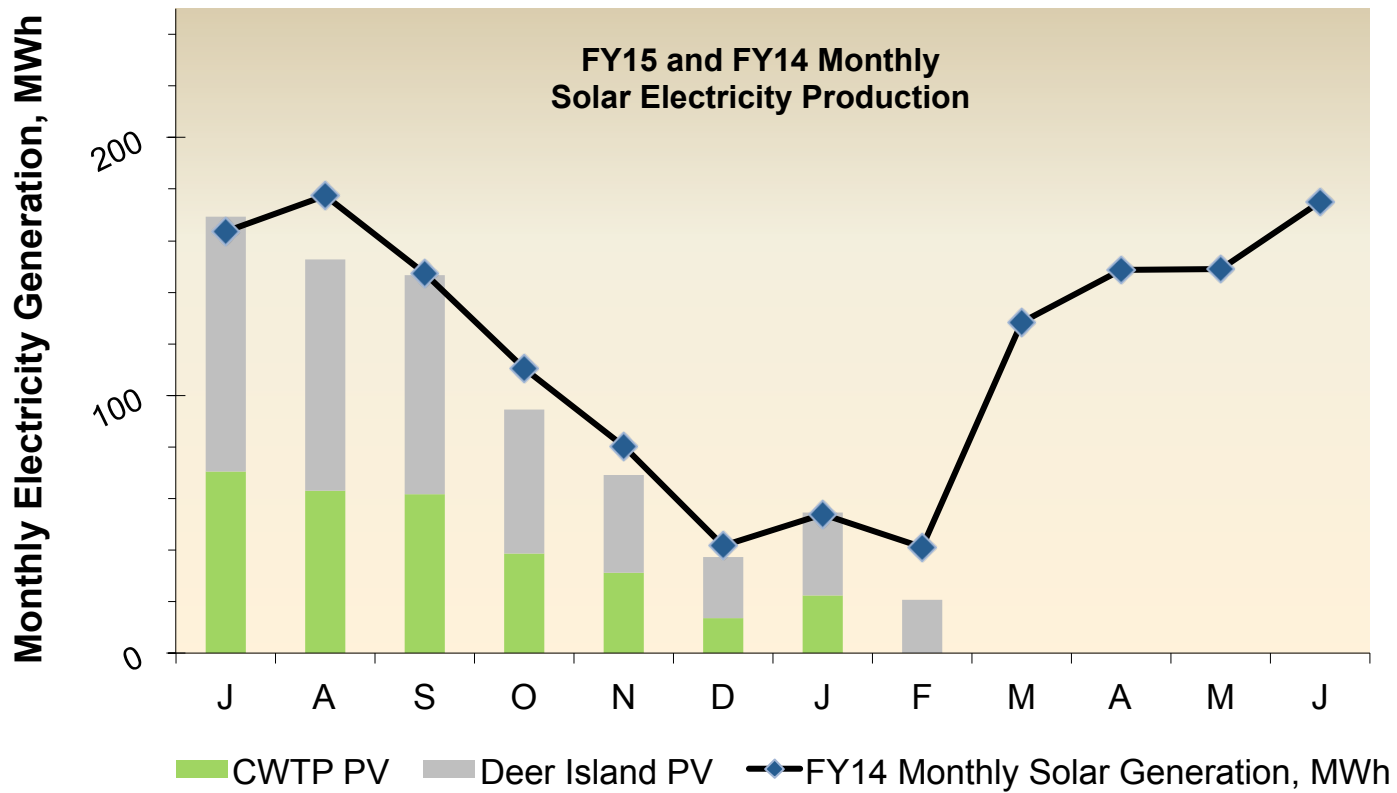


Deer Island Treatment Plant





Solar Electricity Production Comparison to Last Year







February 2014 Snow Storms - Chelsea





February 2014 Snow Storms – Deer Island





February 2014 Snow Storms – Charlestown





Spot Pond Tanks – Construction Site







Massachusetts Water Resources Authority

**MWRA Fiscal Year 2016
Proposed
Current Expense Budget**

March 2015



Fiscal Year 2016 Year of Milestones

- Bond Resolution Changes become effective – Reserves Release
- Pension Fund achieves virtual Full Funding
- Other Post Employment Benefits (OPEB)
- New England Fertilizer Company (NEFCO)



Fiscal Year 2016 - Milestones

Bond Resolution changes become effective – Reserves Release

- Debt Service Reserves
- Community Obligation and Revenue Enhancement (CORE)
- Renewal and Replacement Reserve (RRR)



Fiscal Year 2016 - Milestones

Pension Fund achieves virtual Full Funding

- 95% Funded ratio 1/1/2015 anticipated
- Other Post Employment Benefits (OPEB)
 - Staff to recommend OPEB Trust
 - Shift to funding OPEB



Fiscal Year 2016 - Milestones

New England Fertilizer Company (NEFCO)

- Contract Expires December 2015
- Negotiations are complete
- Over the five-year term, expenses are expected to decrease by \$1.25M



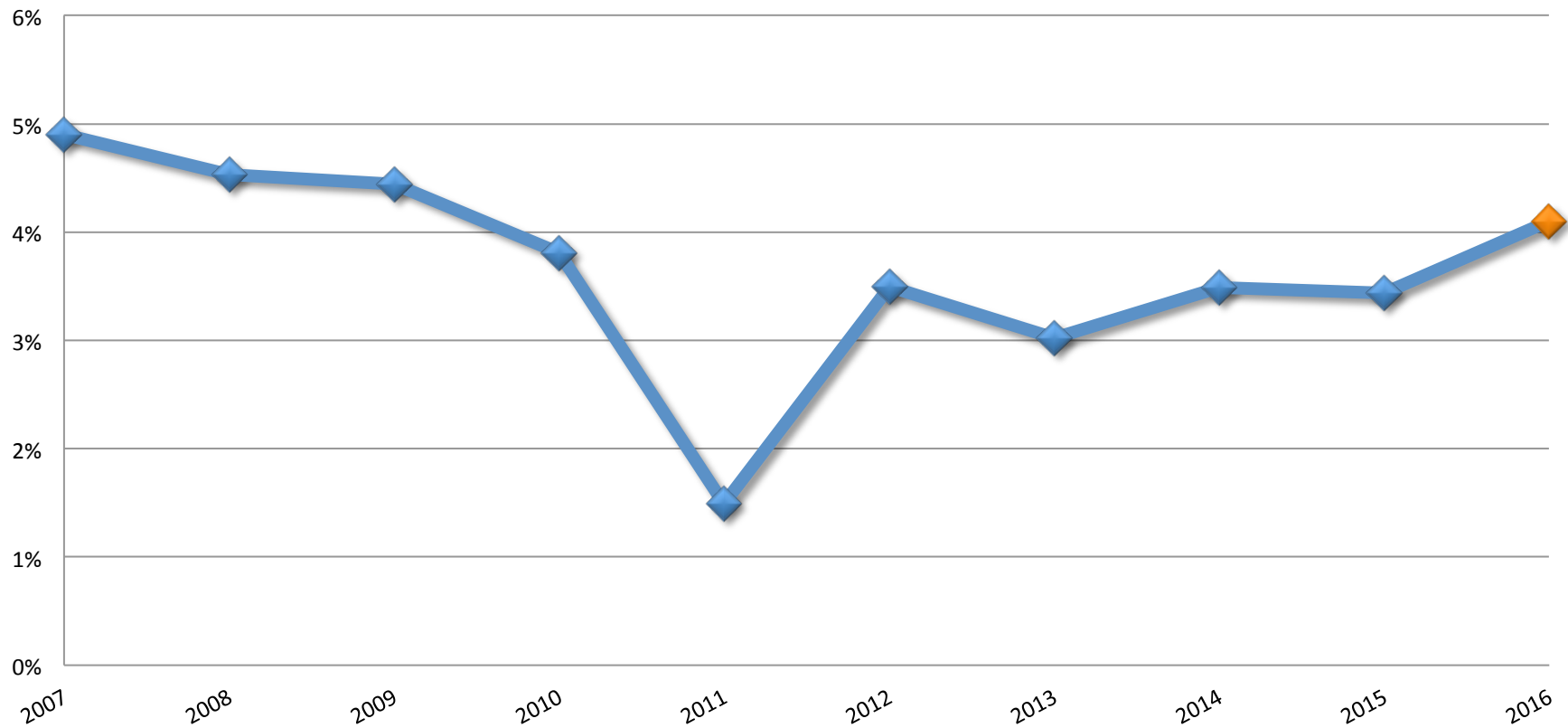
Mission

“Sustainable and Predictable”



Mission - *Sustainable and Predictable*

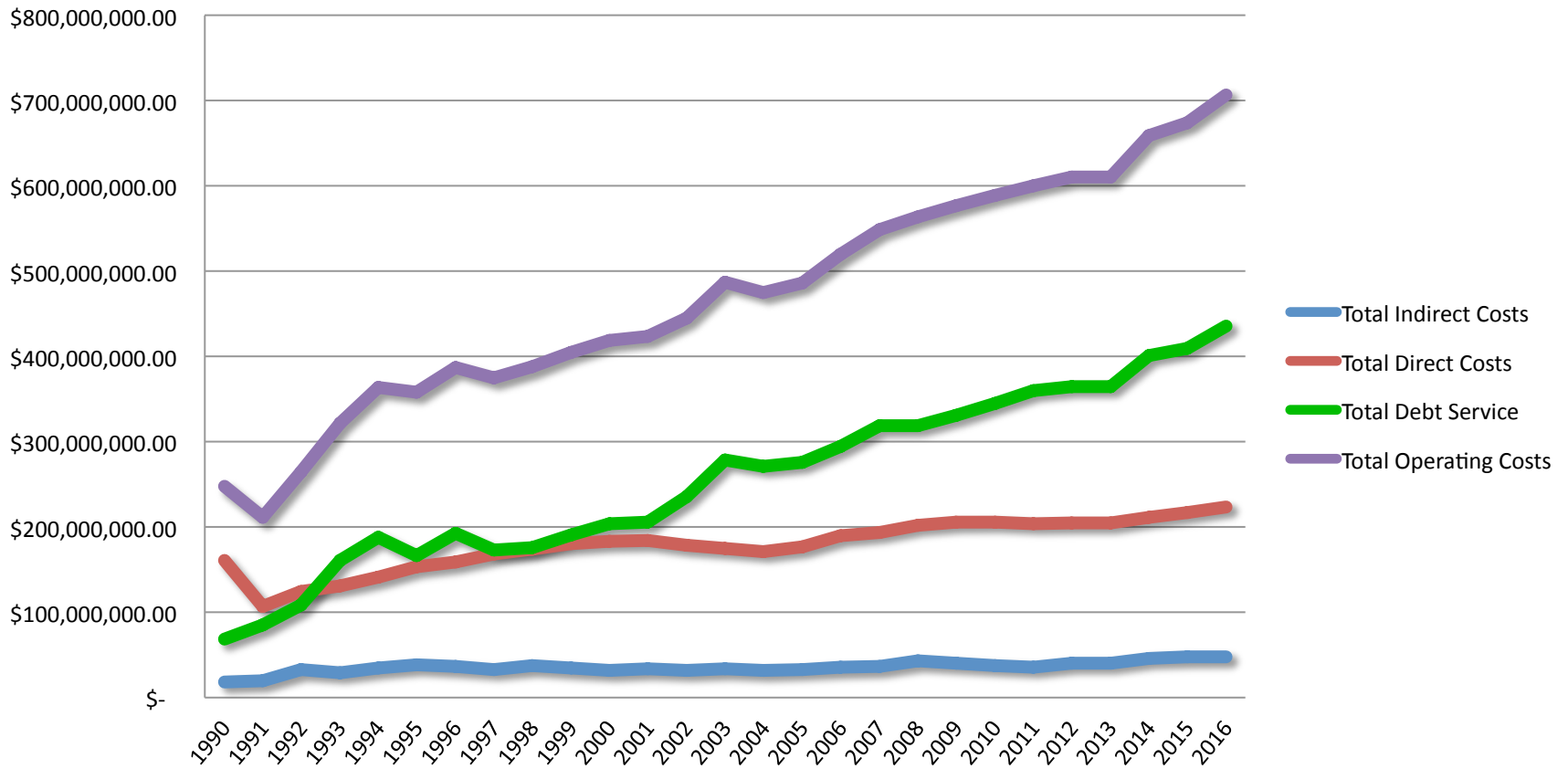
Assesment Increases





Historical Spending Chart

Major Budget Elements





Mission - *Sustainable and Predictable*

Causes of volatility

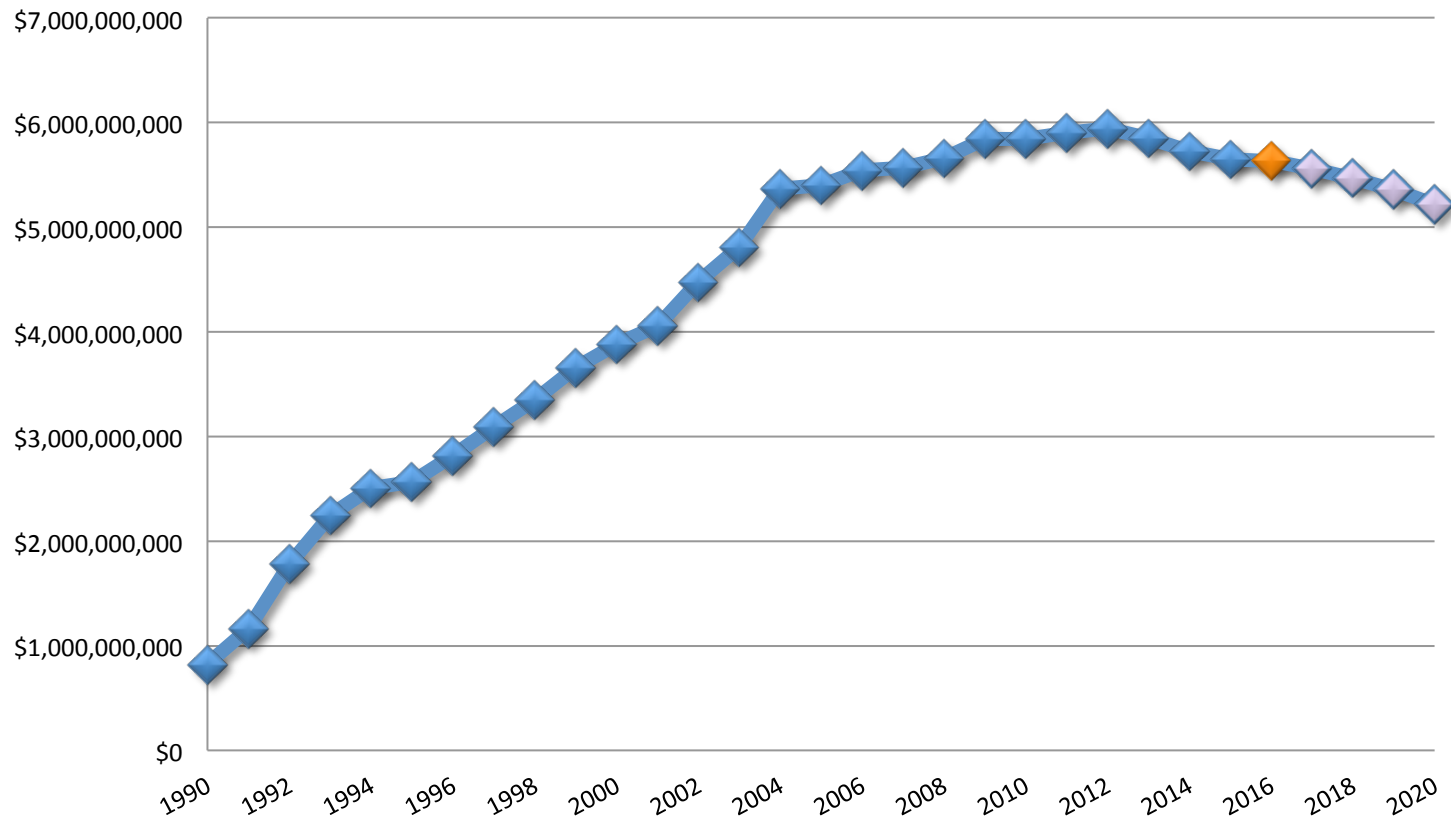
- Current Debt Profile
 - Repayment structure aligned with Debt Service Assistance
- Increasing Debt Service

“Debt Management Agency”



Outstanding Debt

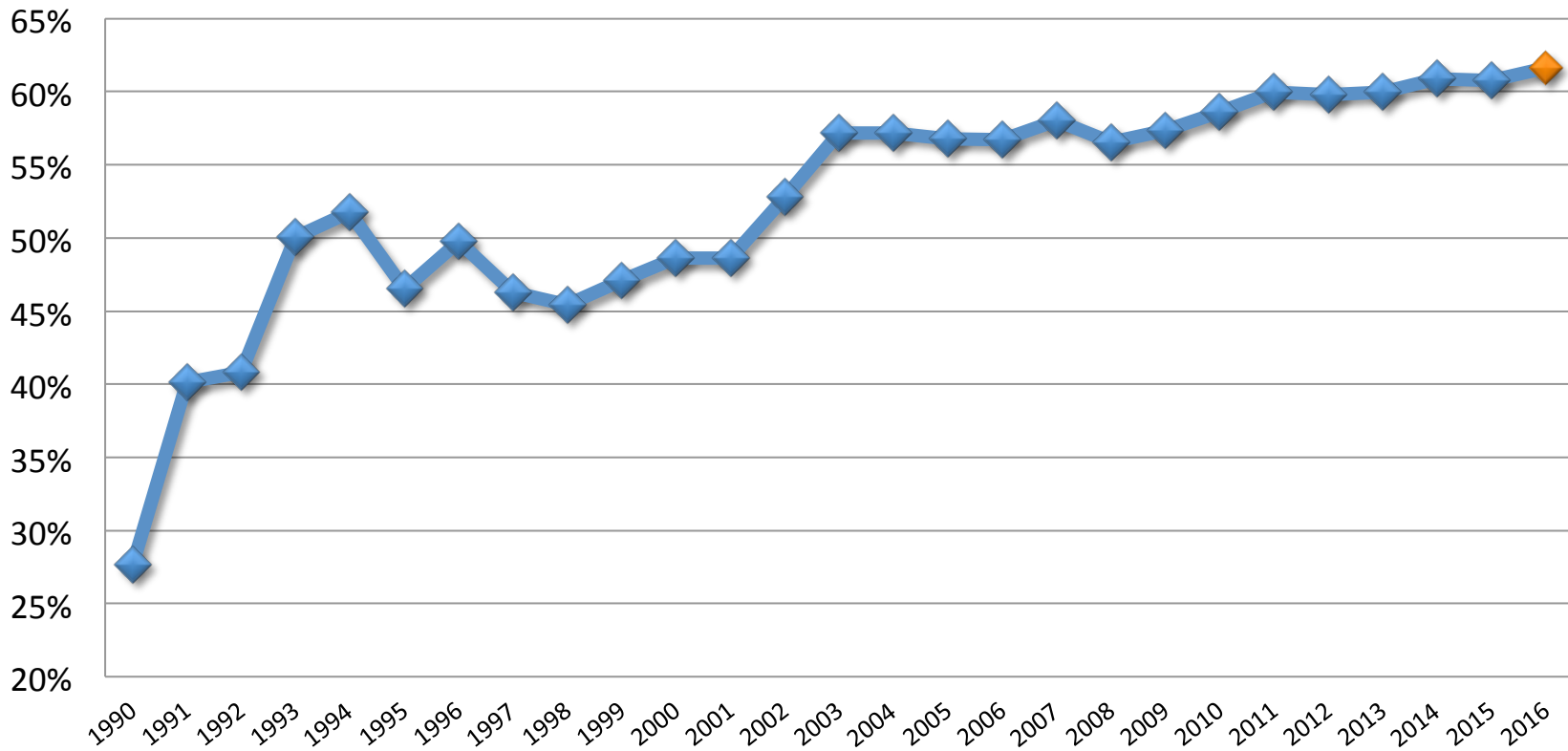
Outstanding Debt History





Debt % is growing

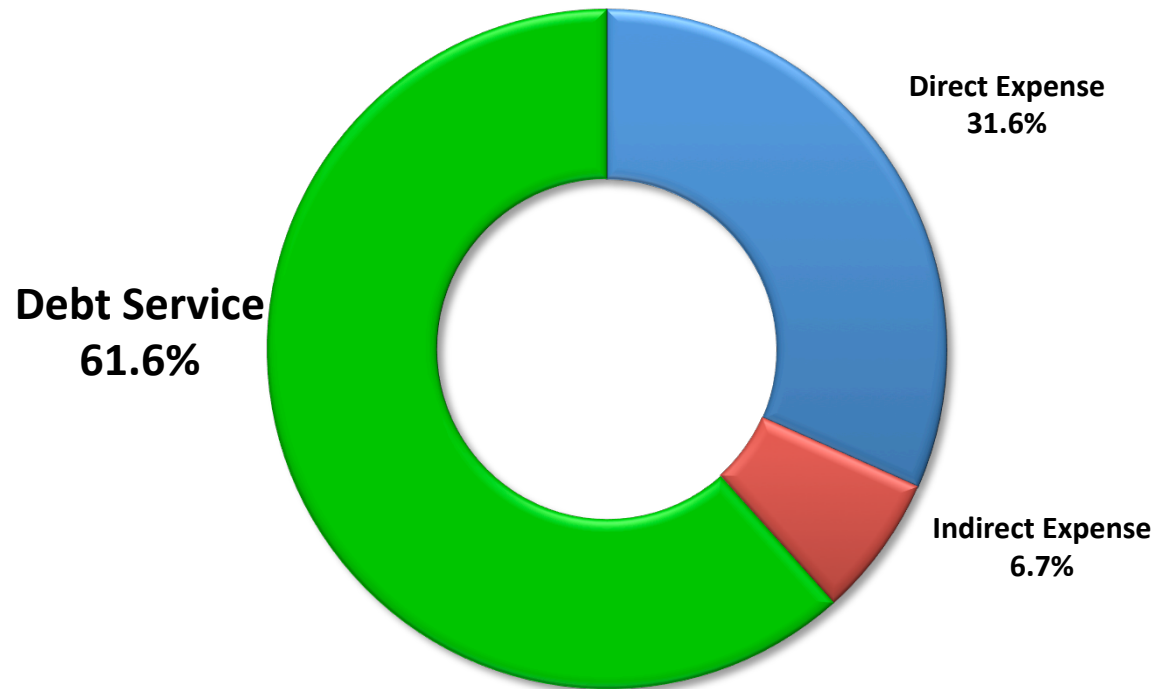
Debt Service as % of Total Budget





FY16 Proposed Current Expense Budget (CEB)

FY16 Current Expense Budget





Debt Challenge

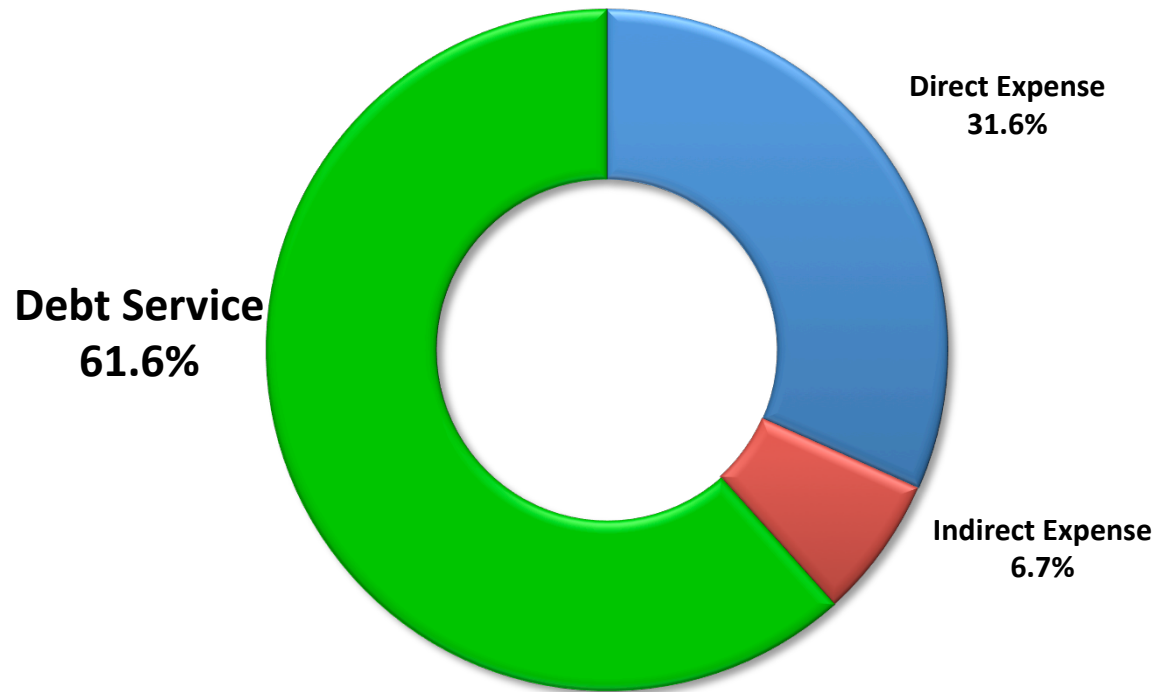
Ways to address the Debt Service challenge

- Defeasance
- Use of Bond Resolution Reserves Release
- Use of Reserves
 - Rate Stabilization Fund
 - Bond Redemption Fund
- Tactical Issuance – Repayment Structure
- Control Capital Spending



FY16 Proposed Current Expense Budget (CEB)

FY16 Current Expense Budget





CEB Budget Structure

- Direct Expenses
- Indirect Expenses
- Debt Service Expenses

ATTACHMENT A
FY16 Proposed vs FY15 Budget

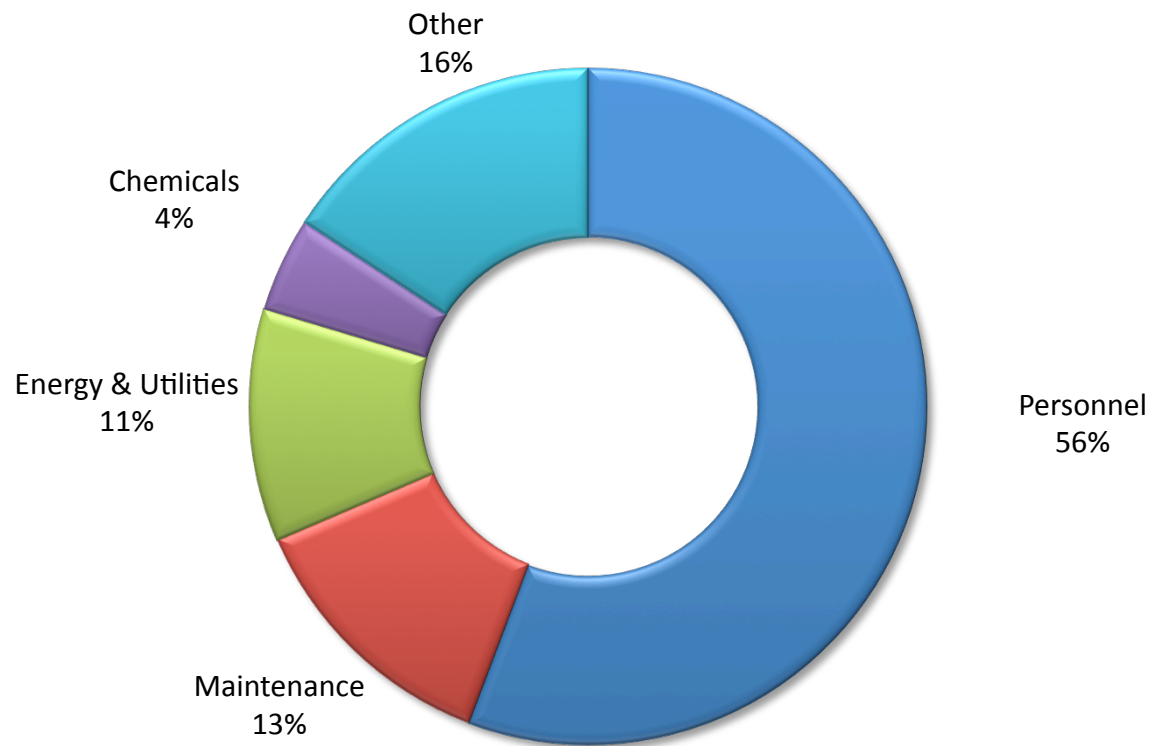
TOTAL MWRA	FY15 Budget	FY16 Proposed	Change FY16 Proposed vs FY15 Budget	
			\$	%
EXPENSES				
WAGES AND SALARIES	\$ 96,554,749	\$ 99,185,938	\$ 2,631,189	2.7%
OVERTIME	3,620,600	4,219,293	598,693	16.5%
FRENCH BENEFITS	18,299,405	19,006,475	707,070	3.9%
WORKERS' COMPENSATION	2,290,000	2,343,000	53,000	2.3%
CHEMICALS	10,219,580	10,149,911	(69,669)	-0.7%
ENERGY AND UTILITIES	23,472,354	24,804,554	1,392,200	5.9%
MAINTENANCE	27,972,607	28,611,968	639,361	2.3%
TRAINING AND MEETINGS	361,019	413,714	52,695	14.6%
PROFESSIONAL SERVICES	5,957,201	5,681,504	(275,697)	-4.6%
OTHER MATERIALS	5,952,729	5,881,553	(71,176)	-1.2%
OTHER SERVICES	22,538,498	23,308,351	859,853	3.8%
TOTAL DIRECT EXPENSES	\$ 217,448,742	\$ 223,796,361	\$ 6,067,619	2.8%
INSURANCE	\$ 2,128,155	\$ 2,160,797	\$ 32,642	1.5%
WATERSHED/PILOT	27,466,790	28,061,183	594,393	2.2%
HEEC PAYMENT	3,198,174	1,948,157	(1,250,017)	-39.1%
MITIGATIONS	1,605,967	1,480,000	(205,967)	-12.8%
ADDITIONS TO RESERVES*	482,953	962,449	479,496	99.3%
RETIREMENT FUND	7,868,155	8,139,521	271,366	4.5%
POSTEMPLOYMENT BENEFITS/ADDITIONAL PENSION DEPOSIT	4,821,320	5,062,470	241,150	5.0%
TOTAL INDIRECT EXPENSES	\$ 47,591,914	\$ 47,752,874	\$ 241,063	0.5%
STATE REVOLVING FUND	\$ 78,400,635	\$ 81,365,988	\$ 2,965,353	3.7%
SENIOR DEBT	220,855,626	283,415,656	62,578,030	28.3%
SUBORDINATE MWRA DEBT	99,686,105	49,222,442	(50,463,663)	-50.6%
LOCAL WATER PIPELINE CP	4,148,453	4,140,242	(8,211)	-0.2%
CURRENT REVENUE/CAPITAL	10,200,000	11,200,000	1,000,000	9.8%
CAPITAL LEASE	3,217,000	3,217,000	-	0.0%
CORE FUND DEPOSIT	876,507	6,663,038	5,786,531	660.2%
BOND REDEMPTION	(6,745,598)	(5,548,064)	3,198,614	-47.4%
VARIABLE RATE DEBT SAVINGS	-	-	853,660	-100.0%
DEFERANCE ACCOUNT	-	(853,660)	-	6.3%
DEBT SERVICE ASSISTANCE	\$ 409,825,118	\$ 435,684,435	\$ 25,859,316	4.8%
TOTAL DEBT SERVICE	\$ 674,485,384	\$ 707,193,272	\$ 32,707,888	4.8%
TOTAL EXPENSES	\$ 674,485,384	\$ 707,193,272	\$ 32,707,888	4.8%
REVENUE & INCOME				
RATE REVENUE	\$ 650,315,782	\$ 676,995,000	\$ 26,679,218	4.1%
OTHER USER CHARGES	8,239,693	8,781,391	541,698	6.6%
OTHER REVENUE	6,180,451	11,950,563	5,770,112	93.4%
RATE STABILIZATION	-	-	-	-
INVESTMENT INCOME	9,729,450	9,086,318	(733,132)	-7.4%
TOTAL REVENUE & INCOME	\$ 674,485,384	\$ 707,193,272	\$ 32,707,888	4.8%

* Reserves estimated based on OPEB being deposited into the Pension fund



CEB Budget Structure

Direct Expenses

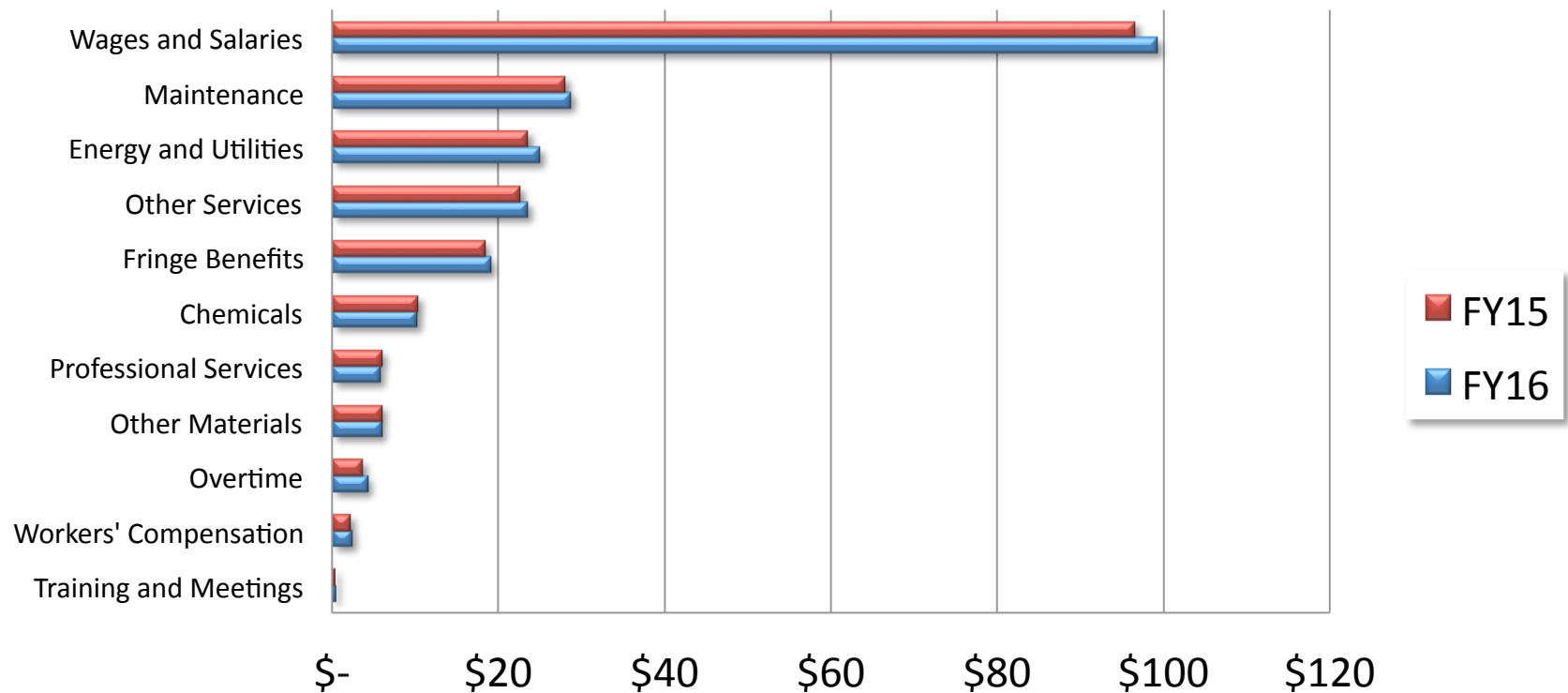




Direct Expenses Comparison

Direct Expenses Comparison FY15 -FY16

\$ in Millions





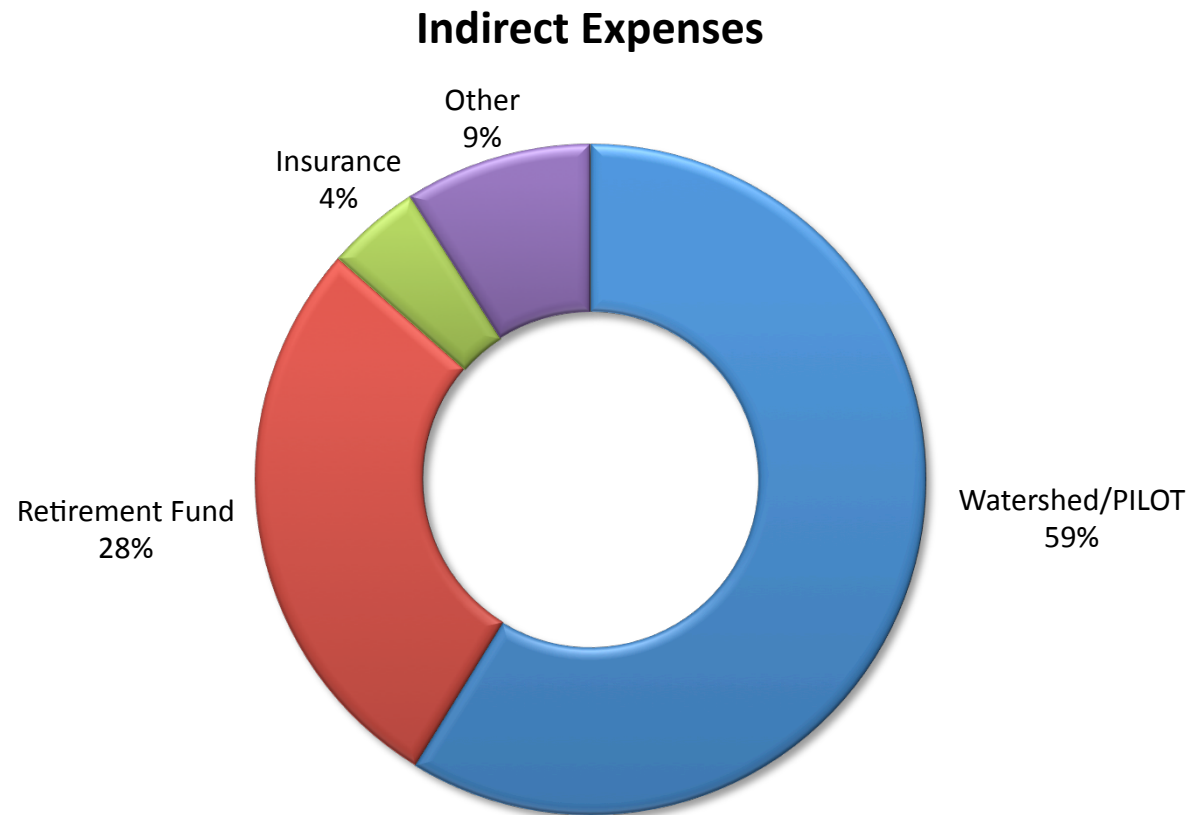
FY16 Proposed Current Expense Budget (CEB)

Highlights – Direct Expenses

- Wages and Salaries \$99.2M – Budgeted Positions: 1,170; 5 fewer than FY15;
- Maintenance \$28.6M – in line with FY14 Actual Spending;
- Utilities - \$24.9M – increases for electricity pricing;
- Other Services - \$23.4M – mainly for NEFCo contract and Leases; and
- Fringe Benefits of \$19.0M – mainly for Health Insurance.



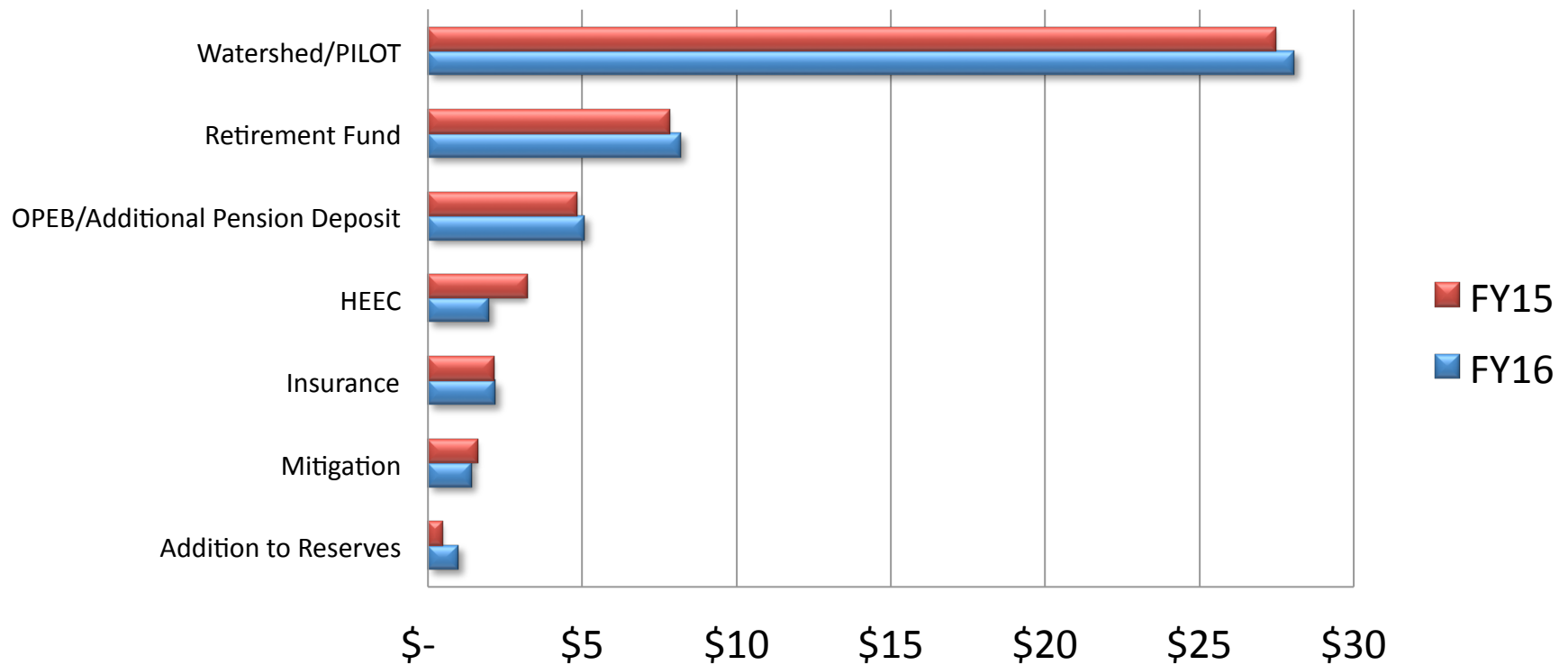
CEB Budget Structure – Indirect Expenses





Indirect Expenses Comparison

Indirect Expenses Comparison FY15 -FY16 \$ in Millions





FY16 Proposed Current Expense Budget (CEB)

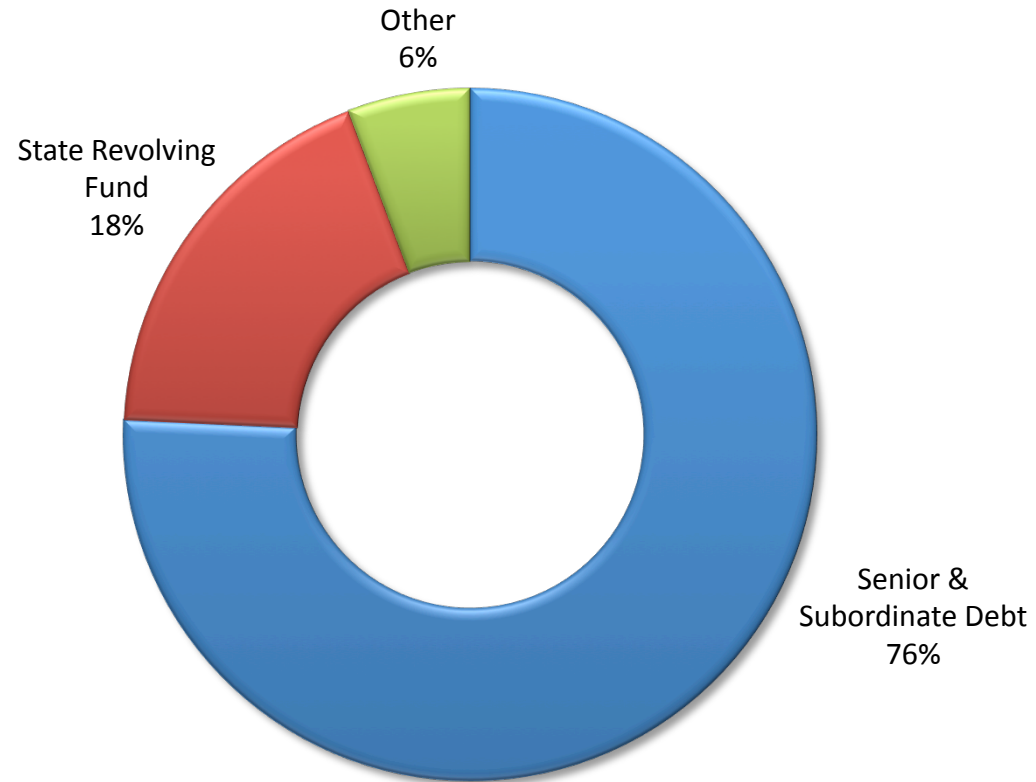
Highlights – Indirect Expenses

- Watershed Program for operating, PILOT and debt \$28.1M;
- Pension Fund required contribution \$8.2M;
- Additional Payment to Pension (OPEB) \$5.1M;
- HEEC contract \$1.9M; and
- Addition to Operating Reserve Fund \$962K.



CEB Budget Structure

Debt Service Expenses

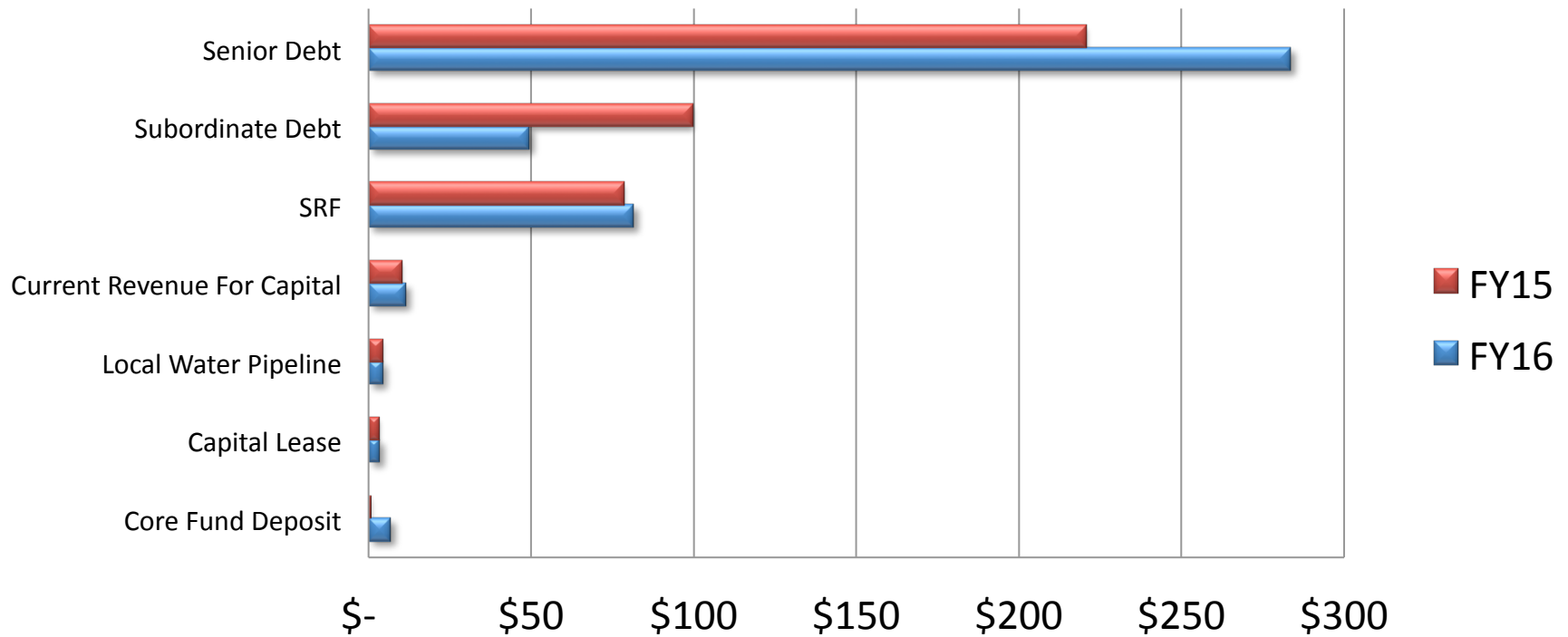




Debt Service Expenses Comparison

Debt Services Expenses Comparison FY15 -FY16

\$ in Millions





FY16 Proposed Current Expense Budget (CEB)

Highlights – Debt Service Expenses

- Variable Rate Debt Assumption 3.25%;
- Required CORE Fund Deposit \$6.7M;
- Bond Redemption \$3.5M; and
- No Debt Service Assistance.



FY16 Proposed Current Expense Budget (CEB)

Revenue

- Non Rate Revenue
- Investment Income
- Rate Revenue Requirement (Assessments)



Planning Estimate Assumptions

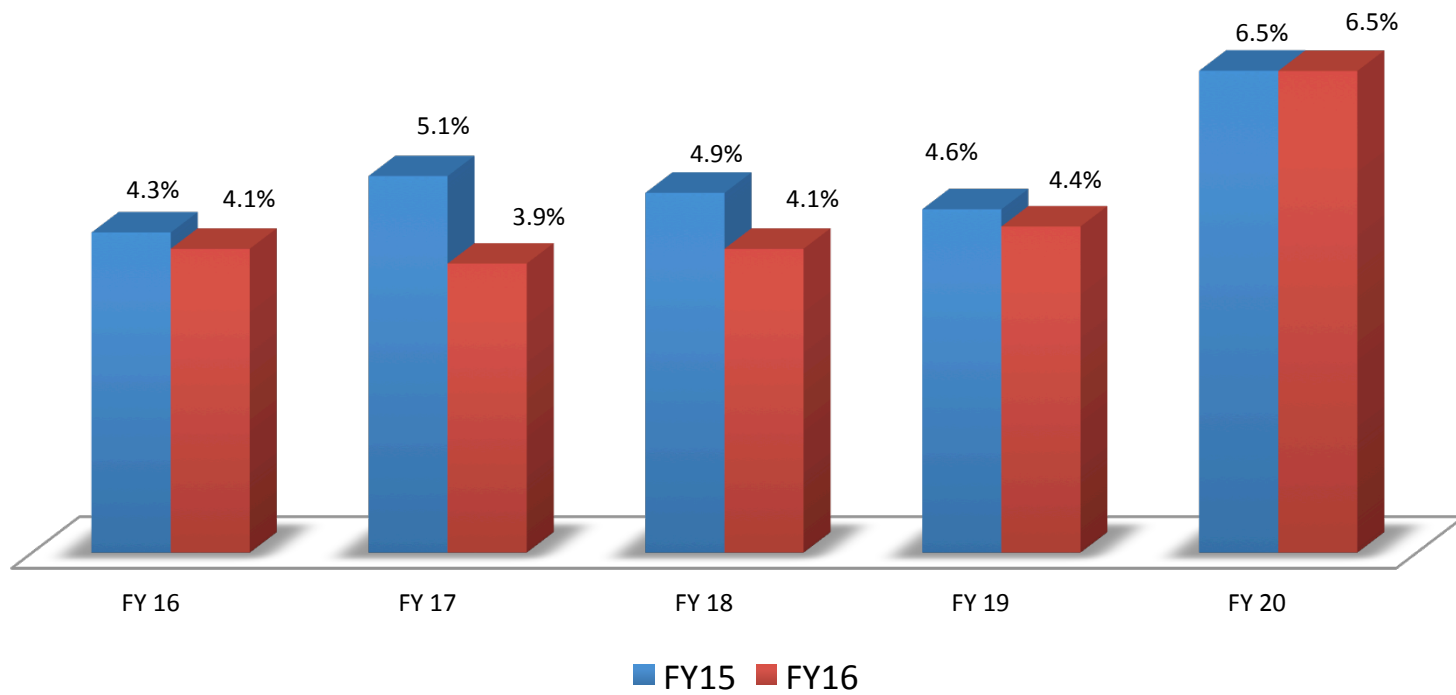
Assumptions

- Direct Expenses Inflation
- Indirect Expenses Inflation
- Capital Spending Levels
- Variable and Fixed Debt Interest Rates
- Investment Income Interest Rates
- Level of Pension/OPEB Funding
- Use of Reserves



Effects on Assessments

Assessment Increase Forecast Comparison





FY16 Proposed Current Expense Budget (CEB)

Challenges / Opportunities

- Short-Term Market Rates
 - Variable Rate Debt
 - Investments
- Regulatory Changes
- System Expansion
- Utility Pricing



FY16 Current Expense Budget Next Steps

- Transmit Proposed Budget to Advisory Board for 60 day review
- Reconvene Long-Term Rates Management Committee
- Public Hearings
- Staff will present Draft Final Budget in June



FY16 Current Expense Budget Closing

Thank You





MWRA Annual CSO Progress Report 2014

Massachusetts Water Resources Authority



Combined Sewer Overflow Control Plan



Annual Progress Report 2014

March 2015

This is the 19th annual report.

Report includes:

- Progress in 2014 and Q1 2015
- CSO control achievements and benefits to-date
- Remaining activities and court/regulatory requirements
- Spending, updated costs and schedules.



MWRA's Approved Long-Term CSO Control Plan

- 35 projects address site specific conditions
- \$898 million total capital cost (Prop. FY16 CIP)
- 20-year implementation schedule (1996-2015)
- >100 CSO milestones in federal court order require full implementation by 2015 and performance assessment by 2020



Summary of Achievements to Date

- ✓ 32 of 35 projects in the CSO plan are complete.
- ✓ Last 3 projects are well into construction.
- ✓ CSO is eliminated at 38 of 84 CSO outfalls.
- ✓ Average annual CSO volume is reduced by 86%.
(3.3 billion gallons in 1988 to 0.45 billion gallons today)
Goal is 0.40 billion gallons.
- ✓ 89% of the remaining volume is treated at MWRA's four CSO facilities.
Goal is 93% treated.



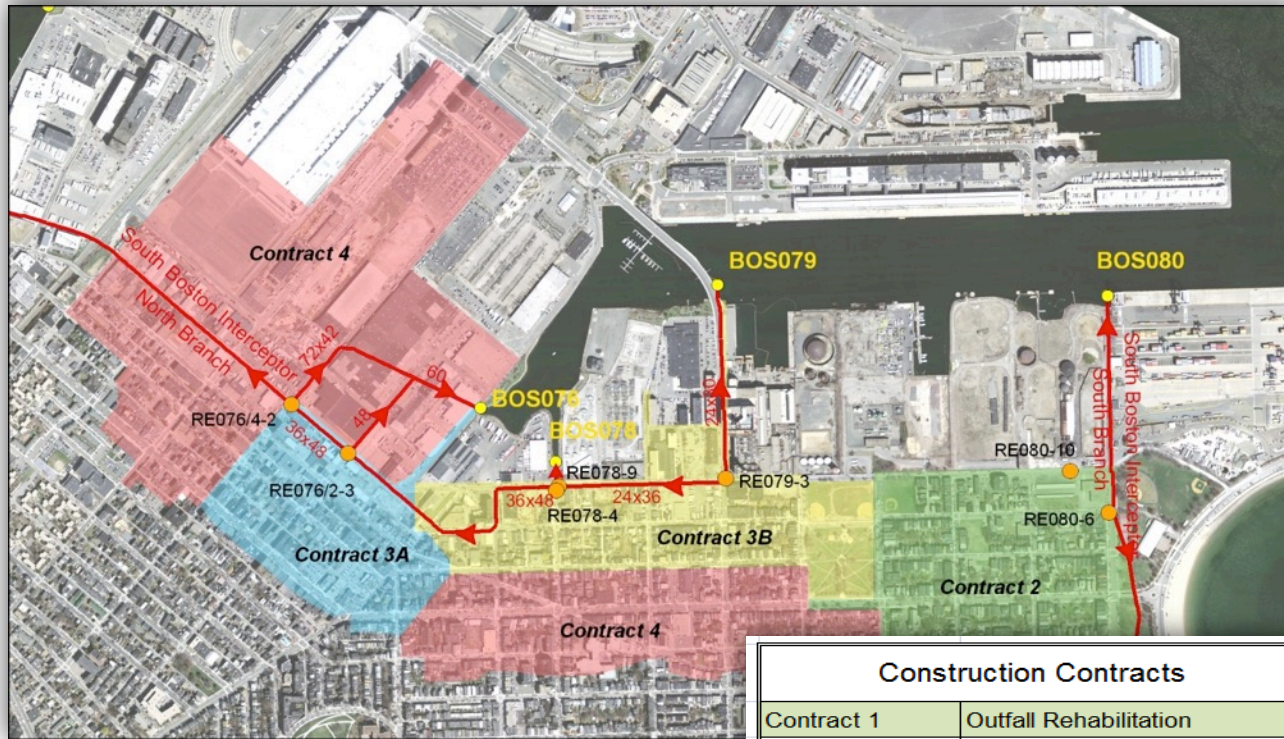
Construction Progress

- MWRA spent \$22.1 million on CSO projects in calendar year 2014 .
- 47,550 linear feet (9 miles) of drain and sewer pipe in 2014.
- 497,500 linear feet (94.2 miles) of drain and sewer pipe since 1996.





\$69M BWSC Reserved Channel Sewer Separation



3 of 4 major sewer separation contracts are substantially complete.

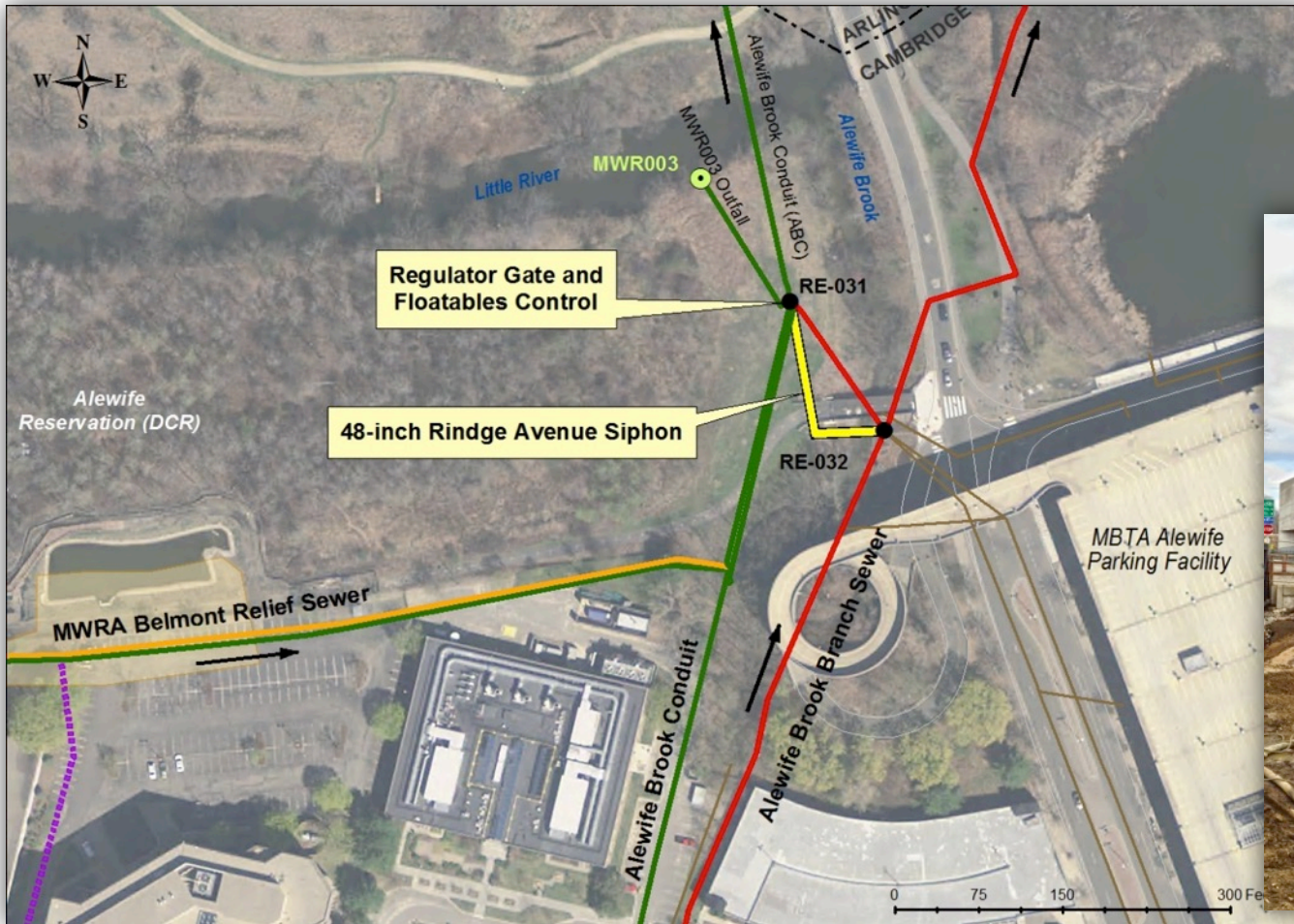
Contract 4 complete this month.

Remaining work on schedule for completion by Dec 2015 court milestone.

Construction Contracts		% Complete	Construction Dates
Contract 1	Outfall Rehabilitation	100%	2010-2011
Contract 2	Sewer Separation	100%	2009-2011
Contract 3A	Sewer Separation	100%	2010-2012
Contract 3B	Sewer Separation	100%	2011-2014
Contract 4	Sewer Separation	95%	2012-2015
Contract 5	Sewer Cleaning/Lining	On-going	2014-2015
Contract 6	Downspout Disconnections	On-going	2015
Contract 7	Paving	100%	2010-2012
Contract 8	Paving	50%	2012-2015



\$2.7M Outfall MWR003 Gate and Siphon Relief

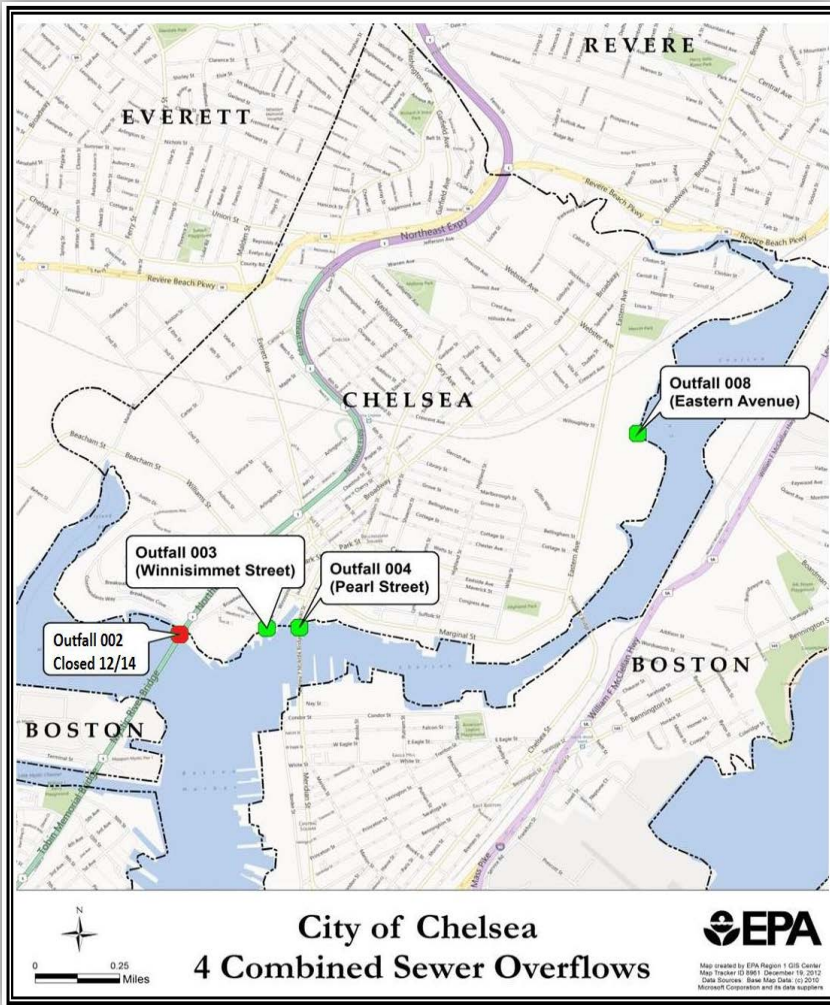


Construction is 40% complete.



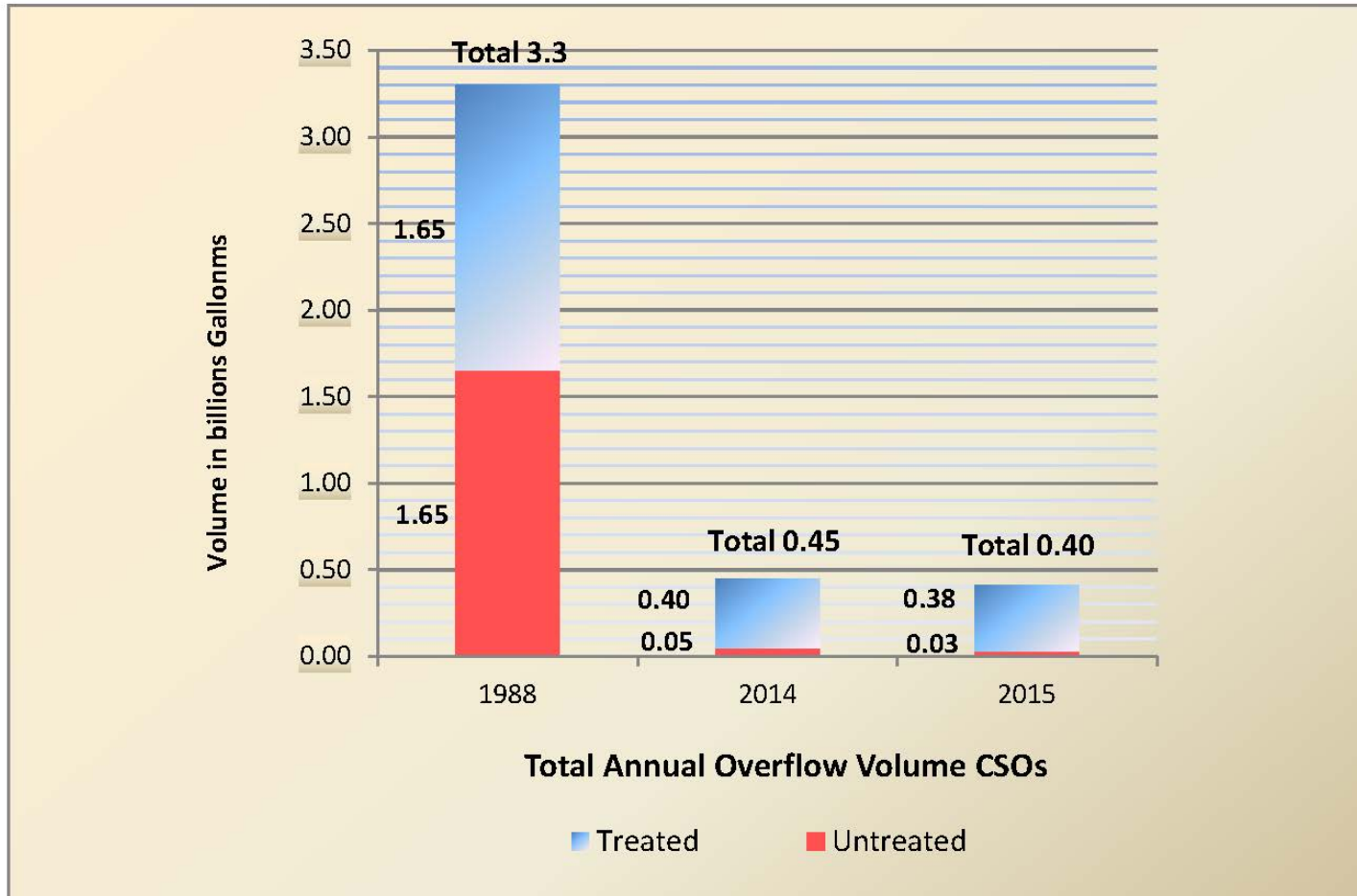


Progress in 2014: City of Chelsea Closes Outfall CHE002





Lower CSO Discharges Since 1988





CSO Program Cost and Spending

FY15 CIP: \$892.4 M
Prop. FY16 CIP: \$898.3 M

	<u>Total CSO Program</u>	<u>Community Projects</u>
Prop. FY16 CIP Budget	\$ 898.3 M	\$ 413.6 M
Spent thru Jan 2015	\$ 867.1 M	\$ 386.1 M
Remaining to be spent	\$ 31.2 M	\$ 27.5 M

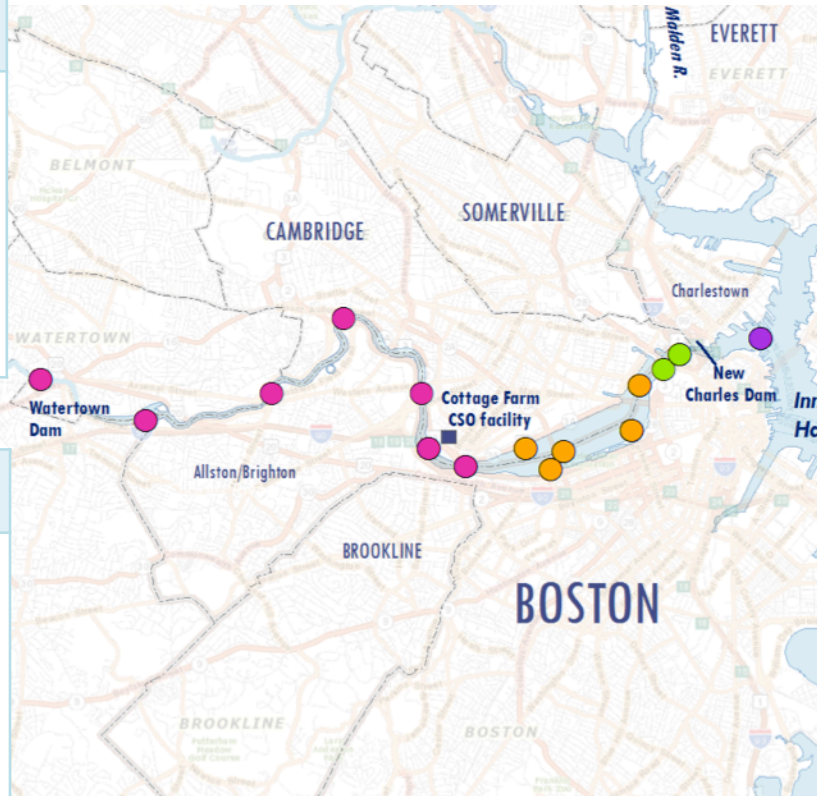
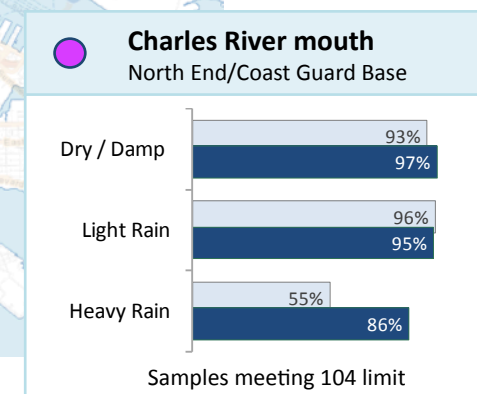
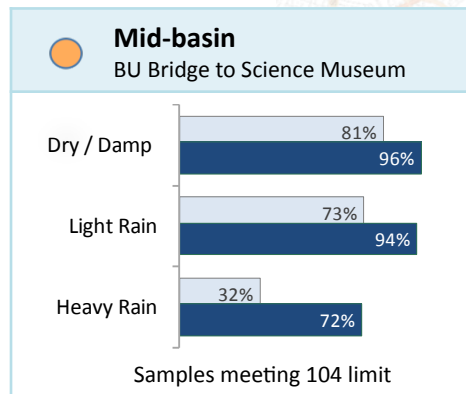
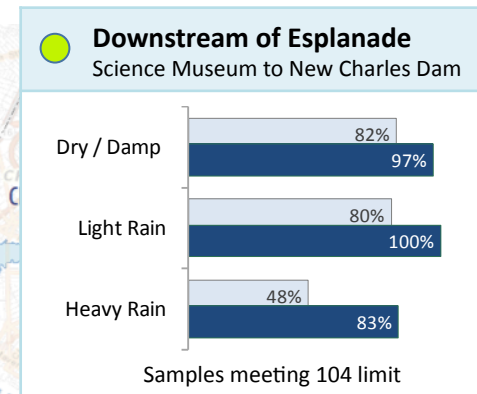
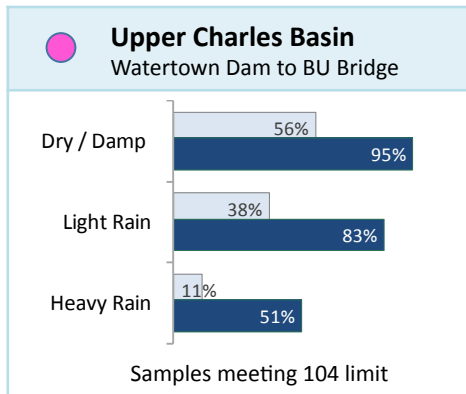
Remaining Work:

- Complete last three CSO projects in 2015.
- Close out construction contracts and perform final eligibility reviews.
- Continue to comply with Charles R. and Alewife/Upper Mystic R. CSO variances.
- Assess system performance and verify attainment of long-term levels of control by Dec 2020.



Change in Charles River Water Quality Over Time

Samples collected from: 1989-1999 2008 - 2014



Graphs show the percent of samples meeting the *Enterococcus* bacteria limit for swimming, by river reach.



Change in Mystic River Water Quality Over Time

Samples collected from: 1989-1999 2008-2014

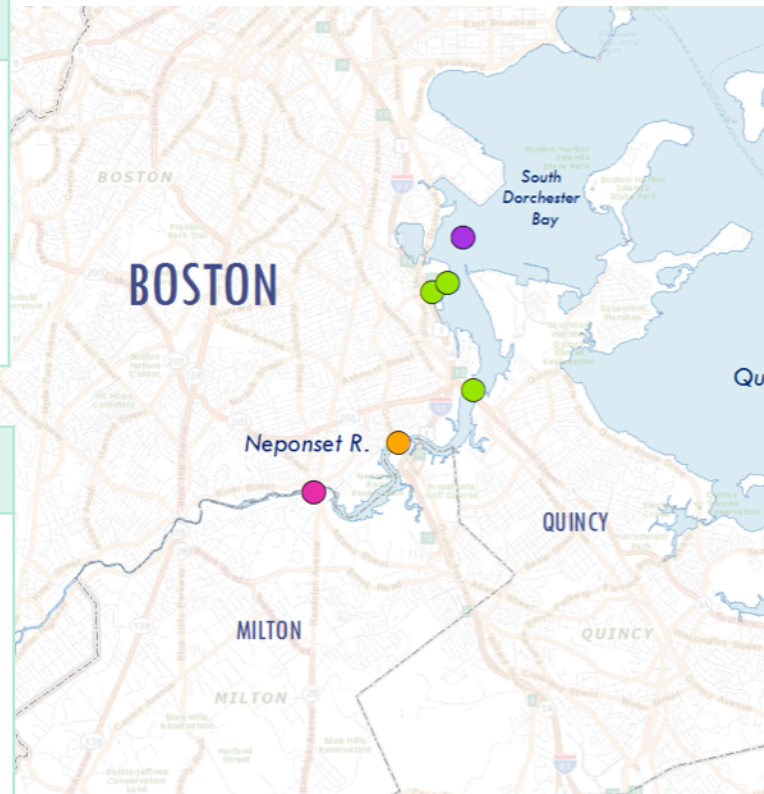
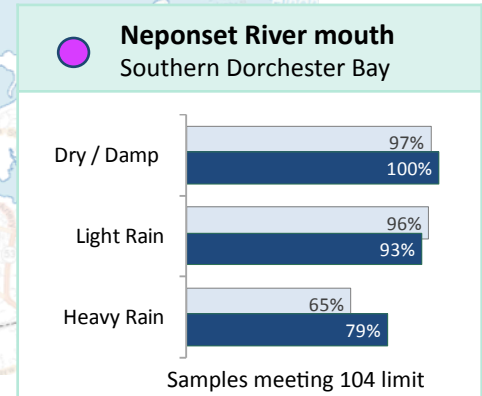
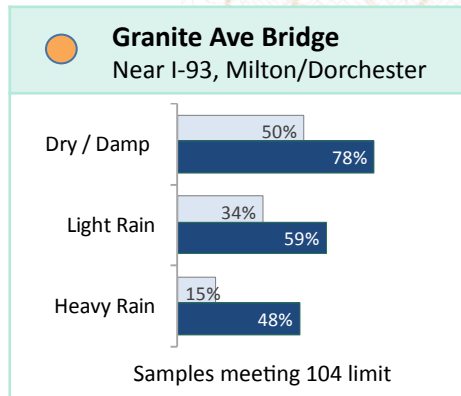
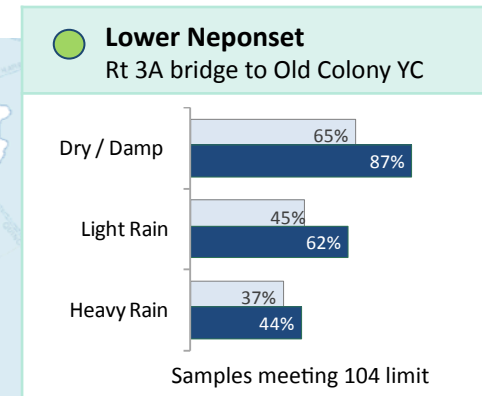
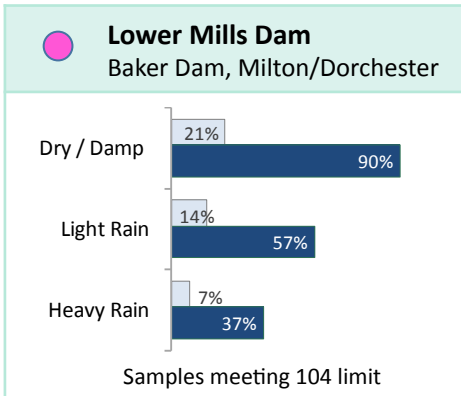


Graphs show the percent of samples meeting the *Enterococcus* bacteria limit for swimming, by river reach.



Change in Neponset River Water Quality Over Time

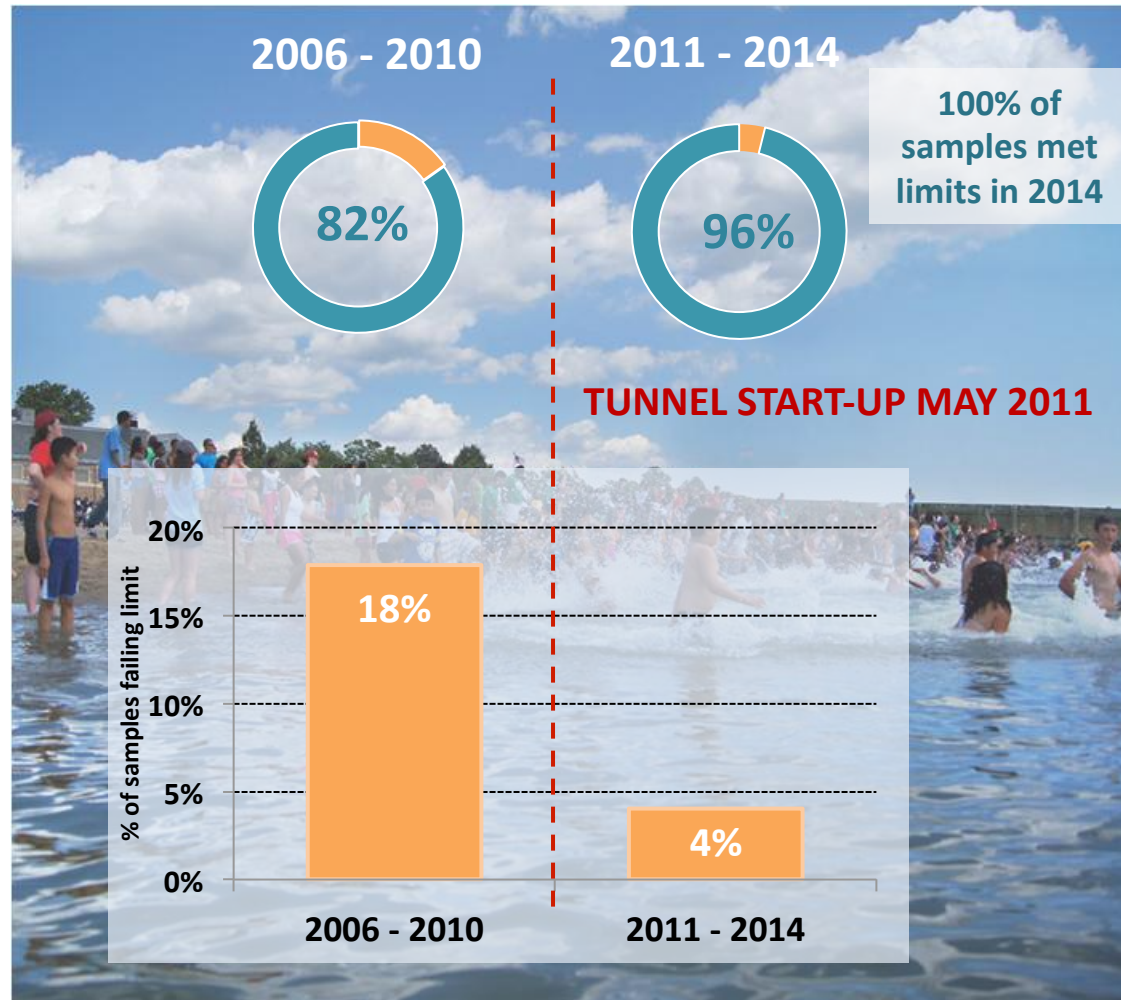
Samples collected from: 1989-1999 2008 - 2014



Graphs show the percent of samples meeting the *Enterococcus* bacteria limit for swimming, by river reach.



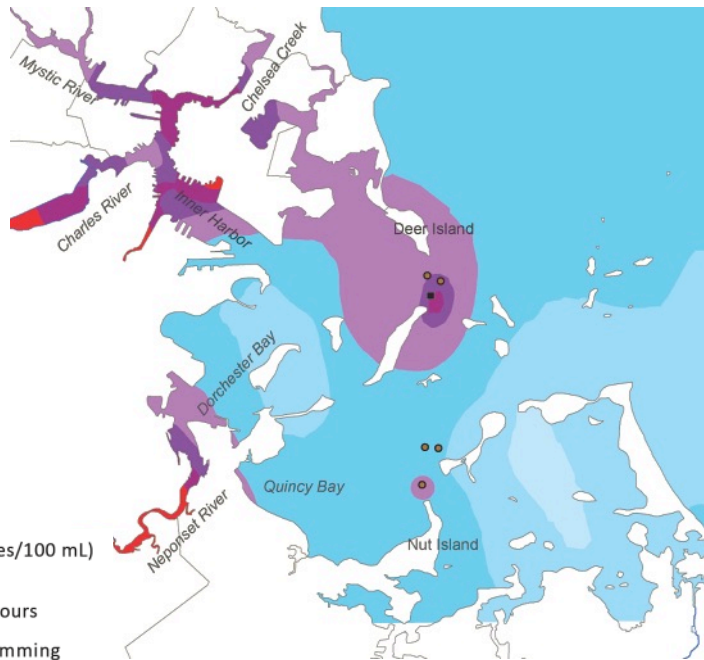
South Boston Beaches Meet Bacteria Limits on More Sampling Days



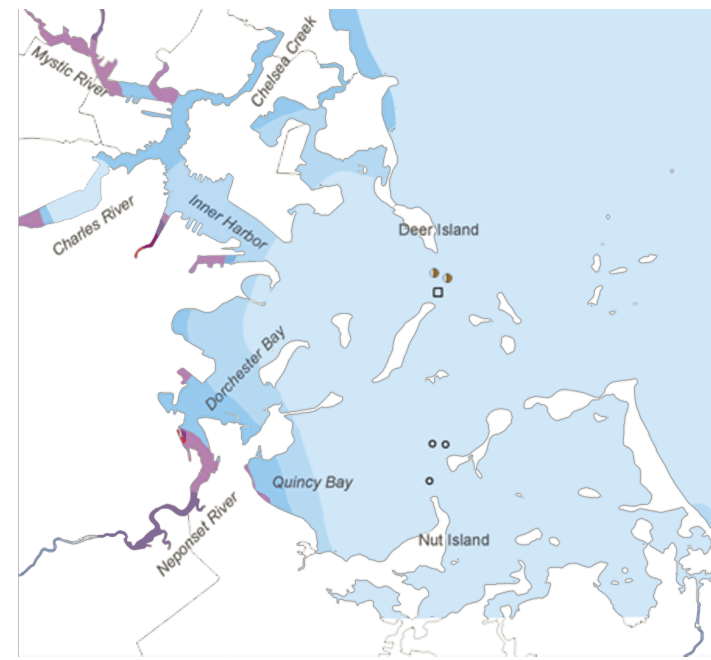


Changes in Boston Harbor Bacteria Levels in Wet Weather

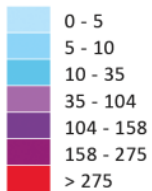
Prior to Boston Harbor projects (1989-1991)



Most Boston Harbor projects complete (post-2007)



Geometric mean (colonies/100 mL)
Sampled during rainfall
>=0.2 inches within 24 hours
Blue contours meet swimming
standard, red-purple
contours exceed swimming standard



Contours show the geometric means of *Enterococcus* data collected when more than 0.2 inches of rain fell in the previous day. Blue areas meet the EPA geometric mean swimming standard and red-purple areas exceed the standard. First panel shows data from 1989 to 1991, second panel shows data for 2008 – 2013.



Remaining Federal Court Milestones (Schedule Seven)

- October 2015: Complete construction of Gate, Siphon Relief and Floatables Control at Outfall MWR003
- December 2015: Complete construction of CAM004 Sewer Separation
- Complete construction of Reserved Channel Sewer Separation
- March 2016: Submit annual progress report (for 2015)
- January 2018: Commence 3-year performance assessment, including post-construction monitoring
- December 2020: Submit results of 3-year performance assessment to demonstrate attainment of long-term levels of CSO control





Massachusetts Water Resources Authority

Presentation to

MWRA Board of Directors

***Agreement for Operation and Maintenance of the
Fore River Pelletizing Plant with
New England Fertilizer Company***

March 11, 2015



MWRA Pellet Plant located in Quincy, MA

- **Located in Fore River Shipyard**
- **Designed, Constructed & Owned by MWRA**
 - Phase I – \$88 M
 - Phase II - \$45 M
 - **Total cost - \$133 M**
- **Since Day 1, has been a Contract Operation**
 - Contract 1: 1991 – 2001 Competitive Bid – NEFCo
 - Contract 2: 2001 – 2015 Competitive Bid - NEFCo





Pellet Plant – Contract O&M Since 1991 (cont.)

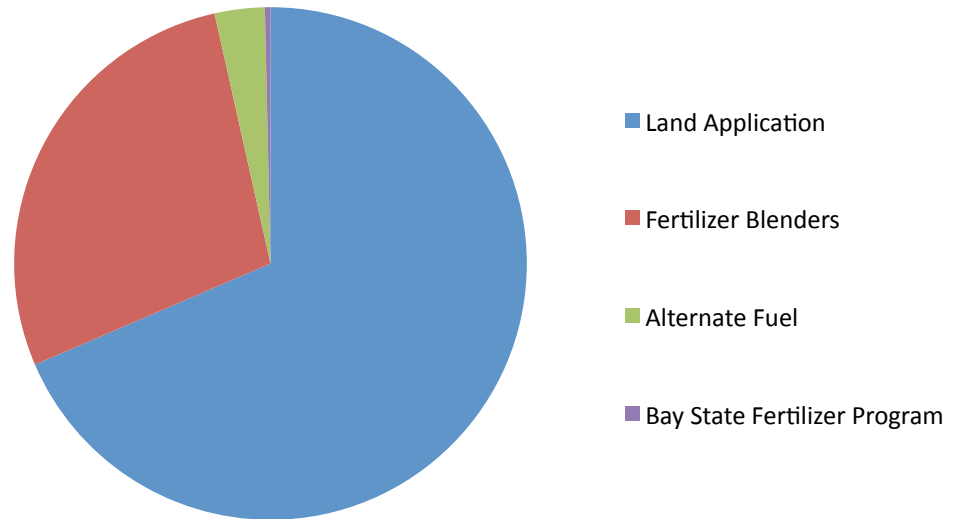
- **Current contract - S345 – 15-year (2001-2015)**
- **Process liquid sludge from DITP**
 - Receive digested sludge
 - Dewater with centrifuges
 - Dry with thermal dryers
 - Produce Class A Fertilizer Pellet
- **In CY14:**
 - Processed 100 dtpd
 - Paid NEFCo \$14.1M





Pellet Plant – Contract O&M Since 1991 (cont.)

- **Contractor is responsible for developing & maintaining Diverse Markets for beneficial reuse for all sludge sent to the Pellet Plant**
 - Land Application
 - Fertilizer Blenders
 - Alternate Fuels
 - Bay State Fertilizer Program
- **Maintain Facility & Equipment**
 - Responsible for returning a fully operable plant at the end of the contract to MWRA.





Pellet Plant – Contract Renewal Preparation

Step 1: Condition Assessment

- Facility is in excellent condition
 - 20+ year life remaining with no major capital (with continued maintenance)

Step 2: Residuals Technology Assessment

- Recommendations at DITP
 - May impact quality & quantity of sludge to FRSA
- Recommendations at Pellet Plant
 - Limited to energy efficiency gains given condition of facility





Pellet Plant – Contract Renewal Preparation Step 2 (cont.)

Technology Assessment Recommendations (cont.)

- Consider larger, more efficient Dryer Trains
 - Implemented at Philadelphia & soon Detroit
- Evaluate impacts of co-digestion programs at DITP
- Given long remaining life, any capital expense decisions must rely on payback

- **Recommend 5-year extension to quantify impacts of pilots and new dryer ops**
- Suggested next long-term contract – 15 years





Pellet Plant – Existing Contract with NEFCo

Current Contract Cost Structure

- Fixed Fee first 90 dtpd (~\$400/ton)
- Excess Quantity Fee >90 dtpd (~\$280/ton)

- Fixed yearly capital dollar value (pre-determined)
- No pass-throughs for utilities
 - Includes adjustments for inflation

- FY14 Avg - ~\$380/ton



Pellet Plant – NEFCo Contract Extension

Contract Cost Structure – Sludge Processing

	<u>Original Contract</u>	<u>Contract Extension Change</u>
• Fixed Fee	first 90 dtpd (32,850 tons/yr)	first 92.5 dtpd, same price* (33,762.5 tpy)
• Excess Quantity Fee	>90 dtpd	> 92.5 dtpd, same price
• CY2014 Total contract expenses		
\$14,090,654		
\$13,582,354 for sludge processing		\$13,334,464 if on extension
- \$12,574,468 base +		= same base +
- plus \$1,007,886 excess qty		plus \$759,996 excess qty
		Savings of \$247 K in year.
+ \$508,300 capital expenses		



Pellet Plant –NEFCo Contract Extension – Capital Program

- **Capital Program - \$7.0 Million cap**
 - \$6.087 K – project awards subject for future Board approvals
 - **NEFCo designs all capital projects – paid 15% of awarded project**
 - **NEFCo responsible for capital costs in excess of \$7.0 M cap**
 - Must return a fully operational plant at end of contract
 - Drum replacement not included in cap if completed.



Pellet Plant – NEFCo Contract Extension Summary

- **Reduced Price for Sludge Processing** (\$1.25 M savings over extension)
- **Revised Capital Program Structure**
 - Retains NEFCo liability (must return fully operating plant at end of contract)
- **Extension negotiated for 5-years**
- **Provide MWRA sufficient time to:**
 - ✓ Evaluate potential energy efficiency improvements (large dryer technology)
 - ✓ Stabilize future sludge quantities (co-digestion)
 - ✓ All for increased competition





Massachusetts Water Resources Authority

Presentation to

Board of Directors

MWRA's Dam Safety Program 2005 - 2015

March 11, 2015



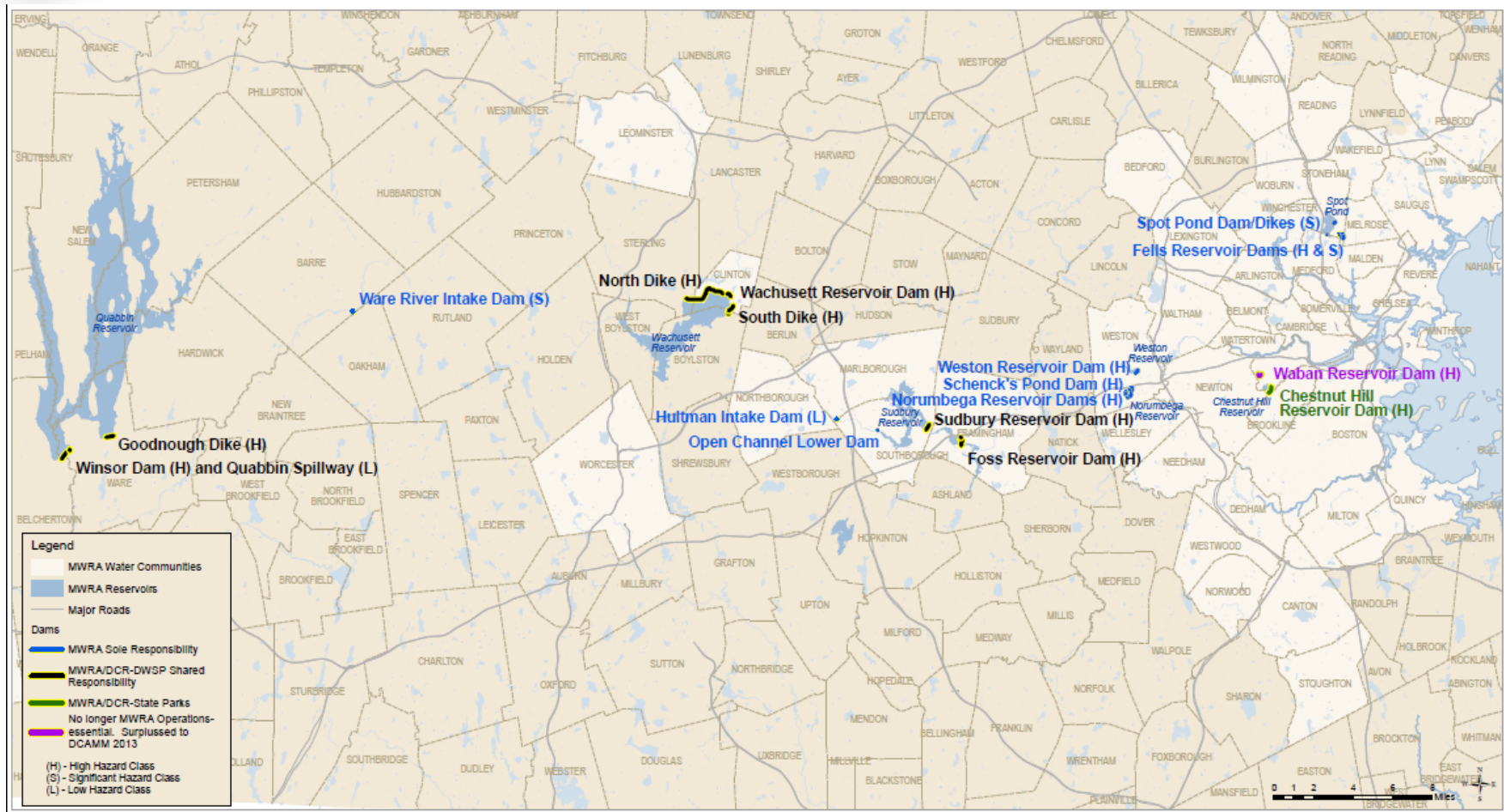
Dams and Dikes By The Numbers

27 Individual Structures

- Spread across 18 geographic locations
- Representing:
 - 17 High Hazard Class dams
 - 8 Significant Hazard Class dams
 - 2 Low Hazard Class dams
- Dams range in age (149 - 60 years old)



MWRA/DCR Dams under MA Office of Dam Safety Jurisdiction





Dam Safety Regulations

- Administered by DCR- Office of Dam Safety (ODS)
- Requires biennial inspections
- Modeled on Federal Regulations:
 - US Army Corps of Engineers
 - FEMA



MWRA-DCR MOU

- 2004 MOU - specified roles of MWRA and DCR on dams:
 - DCR Routine Maintenance and Smaller Dams
 - MWRA Capital Maintenance/Improvements Large Dams



Inspections Determine Dam Needs

Required Studies:

- Hydrology and Hydraulics (H&H)
- Seepage and Stability (S&S)
- Safety Inspections (Phase I's)
- Emergency Action Plans

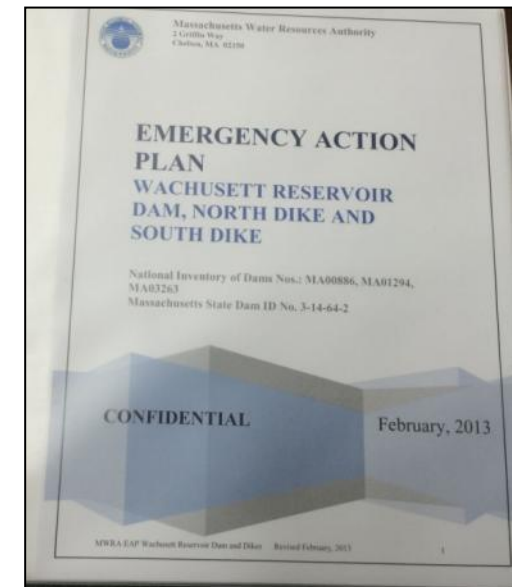
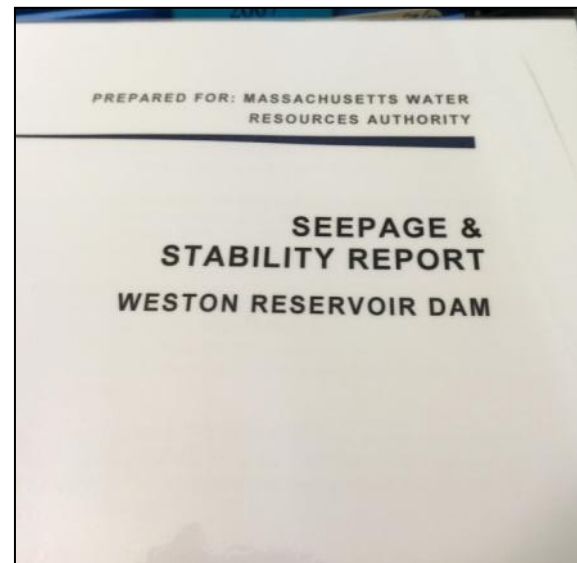
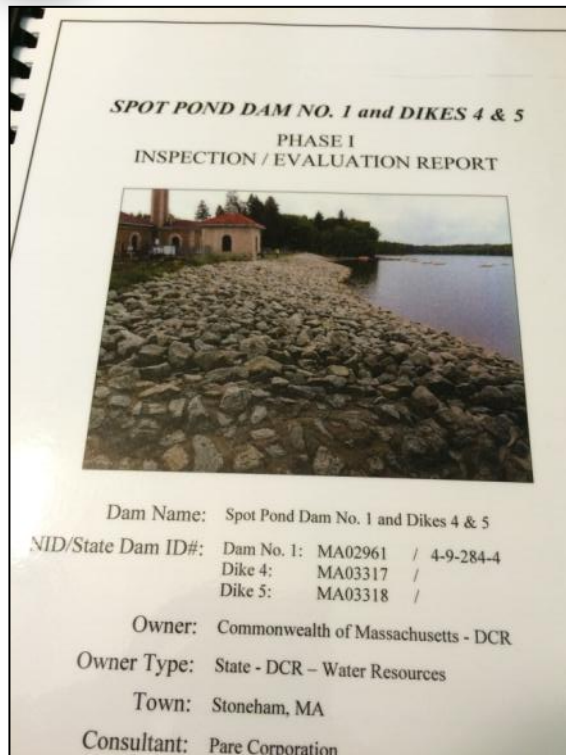
Led to Major Improvements at:

- Spillways
- Earthworks
- Masonry needs
- Tree Clearing

Dams Improvements 2005 - 2015	
Dams Capital Projects	
Crest Gate	\$ 5,400,000.00
Wachusett Dam Promenade - PCB	\$ 2,220,000.00
Wachusett Dam Face - PCB	\$ 4,300,000.00
Dam Safety Mods (5 dams):	\$ 3,443,440.00
Dams Major Maintenance Projects	
Quabbin Spillway Repointing	\$ 157,827.00
South Dike Tree Removal 1	\$ 352,950.00
South Dike Tree Removal 2	\$ 100,000.00
North Dike Tree Removal	\$ 395,000.00
Foss Dam Tree Removal 1	\$ 60,000.00
Foss Dam Tree Removal 2	\$ 70,000.00
Blue Hill Dam Repairs	\$ 88,800.00
Fells Trees 1	\$ 129,310.00
Fells Trees 2	\$ 42,173.00
Norumbega Trees	\$ 135,900.00
Goodnough Dike Tailwater Analysis	\$ 28,650.00
Quabbin Spillway Fence Rehab	\$ 400,000.00
Foss Dam Stump removal	\$ 12,531.00
Dam Safety Tech Assist Consulting	
Emergency Inspections 2005	\$ 50,000.00
T.O. Dam Safety Inspections 2006	\$ 66,135.00
T.O. for Fells Dam seeps analysis	\$ 12,955.00
H&H Analyses	\$ 60,011.00
Sudbury Spillway Insp. + weepholes	\$ 15,000.00
Dams Inundation Mapping	\$ 17,912.00
Emergency Action Plans Updates	\$ 54,000.00
OP-160 (incl inspections)	\$ 172,017.00
OP-228 (incl inspections)	\$ 166,500.00
Subtotal Dams	\$ 17,951,111.00



Inspections Identify Required Studies, Which Reveal Needs





Major Spillway Projects

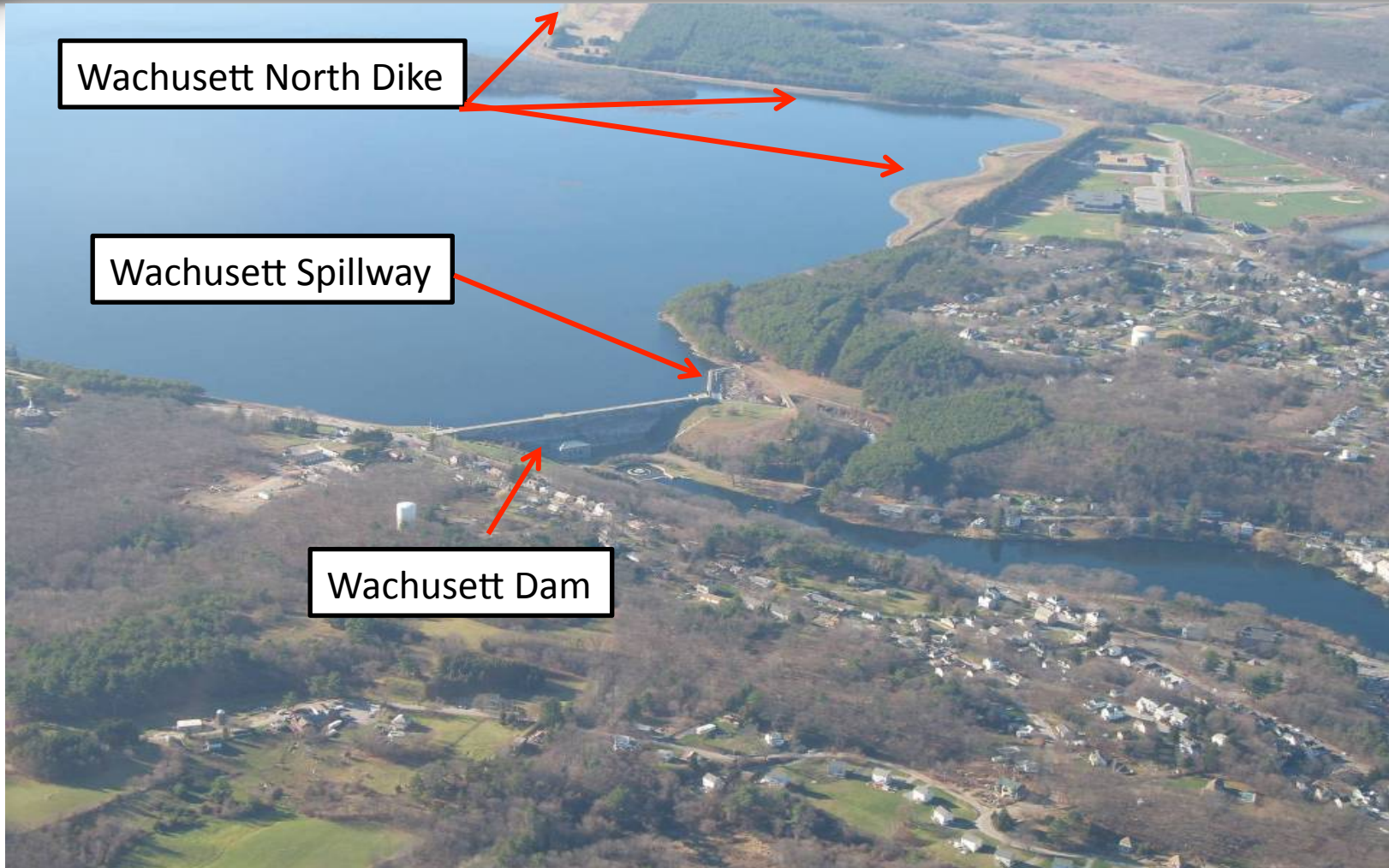


Wachusett Reservoir, Dam and Spillway

Wachusett North Dike

Wachusett Spillway

Wachusett Dam





Wachusett Dam 1908



WACHUSETT DAM, CLINTON, FROM THE WEST. MAY 27, '08.

6263

GZA
GeoEnvironmental, Inc.

Engineers and
Scientists

*Wachusett Dam & Spillway
Inspection, Design, Engineering
Services During Construction and
Resident Inspection Services
MWRA Contract No. 7019*

Hydrology & Hydraulics Evaluation
Task 2.2: Update Hydraulic
Model & Design Conditions

Updated H&H 2007



Wachusett Spillway Dismantling and New Sill





Wachusett Spillway Crest Gate Installed



Before



After





Wachusett Auxiliary spillway under construction



Before



**Spillway
Constriction**



After



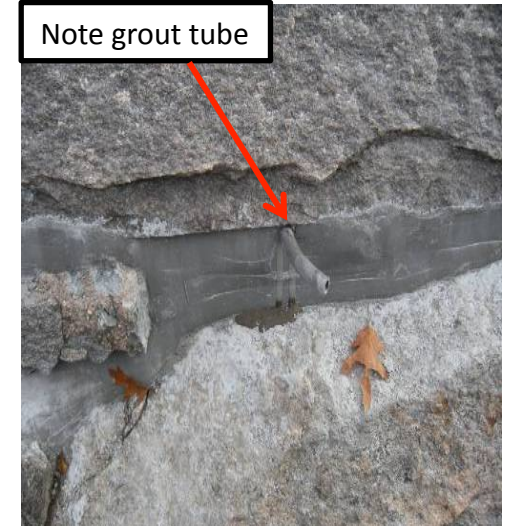
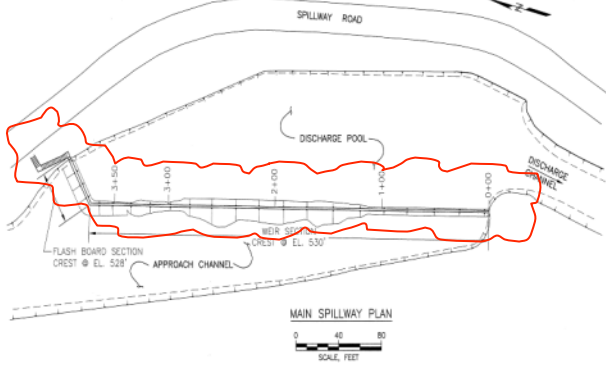
Wachusett spillway east berm construction





Quabbin Spillway Repointing and Grouting

Limits of work





Quabbin Spillway Repointing and Grouting

Downstream crest stone before



Downstream crest after





Wachusett Open Channel Lower Dam - Substantial mortar loss and offset training wall stones



Before



After





Major Earthwork Projects



North Dike Structural Stabilization of Historic Failure Zone



Before

1907 STATIC LIQUEFACTION FLOW FAILURE OF THE NORTH DIKE OF WACHUSETT DAM

By Scott M. Olson,¹ Student Member, ASCE,
Timothy D. Stark,² William H. Walton,³ Members, ASCE, and Gonzalo Castro,⁴ Fellow, ASCE

ABSTRACT: A static liquefaction flow failure occurred in the upstream slope of the North Dike of Wachusett Dam near Clinton, Massachusetts on April 11, 1907 during the first reservoir filling. The fine sands of the upstream dike shell liquefied and flowed approximately 100 m horizontally into the reservoir. This paper presents a description of the construction of the North Dike, failure of the upstream slope, and the results of stability analyses that were conducted to estimate the shear strength mobilized in the liquefied soils during failure. Analyses of the postfailure geometry, the prefailure geometry, and an analysis incorporating the kinetics of failure were conducted. The back-calculated shear strength considering the kinetics of failure is in agreement with other liquefaction flow failure case histories published in the literature. As a result, it is recommended that the kinetics of failure be considered to determine the shear strength mobilized during a liquefaction flow failure.



In process



Spot Pond Dam Armoring – in-house project





Chestnut Hill Dam Improvements

Remove old CBs, fill depressions, re-grade toe area



Hydroseed





Major Masonry Projects



Wachusett Dam Promenade PCB Demo/rebuild





Wachusett Dam PCB remediation and power washing



During



Cleaned

Uncleaned
efflorescence



After



Wachusett Dam Improvements



New drainage groins



New piezometers

Dam face cleaned and repointed



Before



After



Foss Reservoir Spillway - repointing





Foss Dam Gatehouse interior masonry grouting/repointing



Leakage through stone joints



Steel plate for protection against erosion of mortar



Repointing and Injection grouting



Weston Reservoir Dam Parapet Wall





Sudbury Dam/Spillway Masonry Repointing





Sudbury Spillway Inspection and Weep Hole Maintenance





Chestnut Hill Dam riprap improvements – left abutment



Missing riprap



Resetting riprap





Major Tree Work



ODS Policies

Office of Dam Safety

Policy on Trees on Dams

Tree and woody vegetation growth on earthen dams and in close proximity to other dams such as concrete dams is undesirable and at a minimum has some level of detrimental impact upon operation, inspection, performance, and safety of dams.

The Massachusetts Office of Dam Safety requires that earth embankment dams be maintained free of the existence of trees and woody growth. Tree roots cause serious structural damage to earth embankment and appurtenant dam features such as gate wells, spillway walls and other components.

It is recommended that earth embankment dams be maintained with a healthy uniform cover of desirable vegetation such as an appropriate variety of grasses. Dam embankment grass should be mowed periodically to promote healthy cover and prevent infestation of undesirable woody growth and weeds.

Trees and woody growth can make it difficult to conduct inspections of dams. Tree roots can cause leaks, damage concrete joints and overturn during high wind events causing large voids due to pull out of root balls and cause many other problems that will be very costly to repair. Trees and woody growth located in spillways will dramatically reduce spillway flow capacity. Trees are known to accelerate deterioration of dams and can lead to dam failure.

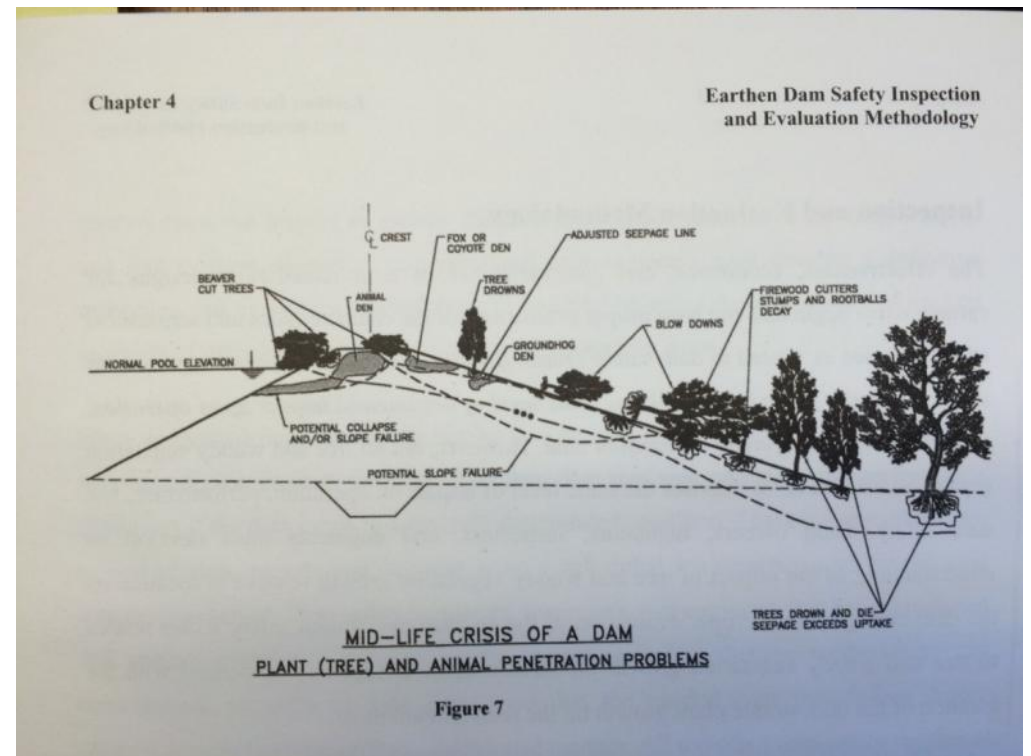
It is recommended that the area at least 20 feet downstream from the entire downstream toe of earth embankment dams be maintained free of trees and

Documents (pdf and .doc downloads)

- [Dam Safety Phase 1 Inspection Template, Form and Sample Inspection Report](#)
- [Poor and Unsafe Dam Follow-up Inspection Form](#)
- [Hazard Class Change Request Application](#)
- [Dam Construction, Repair, Alteration, Breach, Removal Permit Application. PDF or doc](#)
- [Dam Registration Form](#)
- [Dam Safety Regulations](#)



Tree Roots are bad for Earthen Dams





Proper Stumping/backfill Critical to the Integrity of the Dam





Weston Reservoir Dam





Weston Reservoir Dam

09.22.11





Weston Reservoir Dam

09.23.11





Weston Reservoir Dam

10.04.11





Weston Reservoir Dam





Fells Dams, Stoneham





Fells Reservoir Dam #8 Tree Removal





Fells Reservoir Dam #6, #7 tree and riprap work



Before



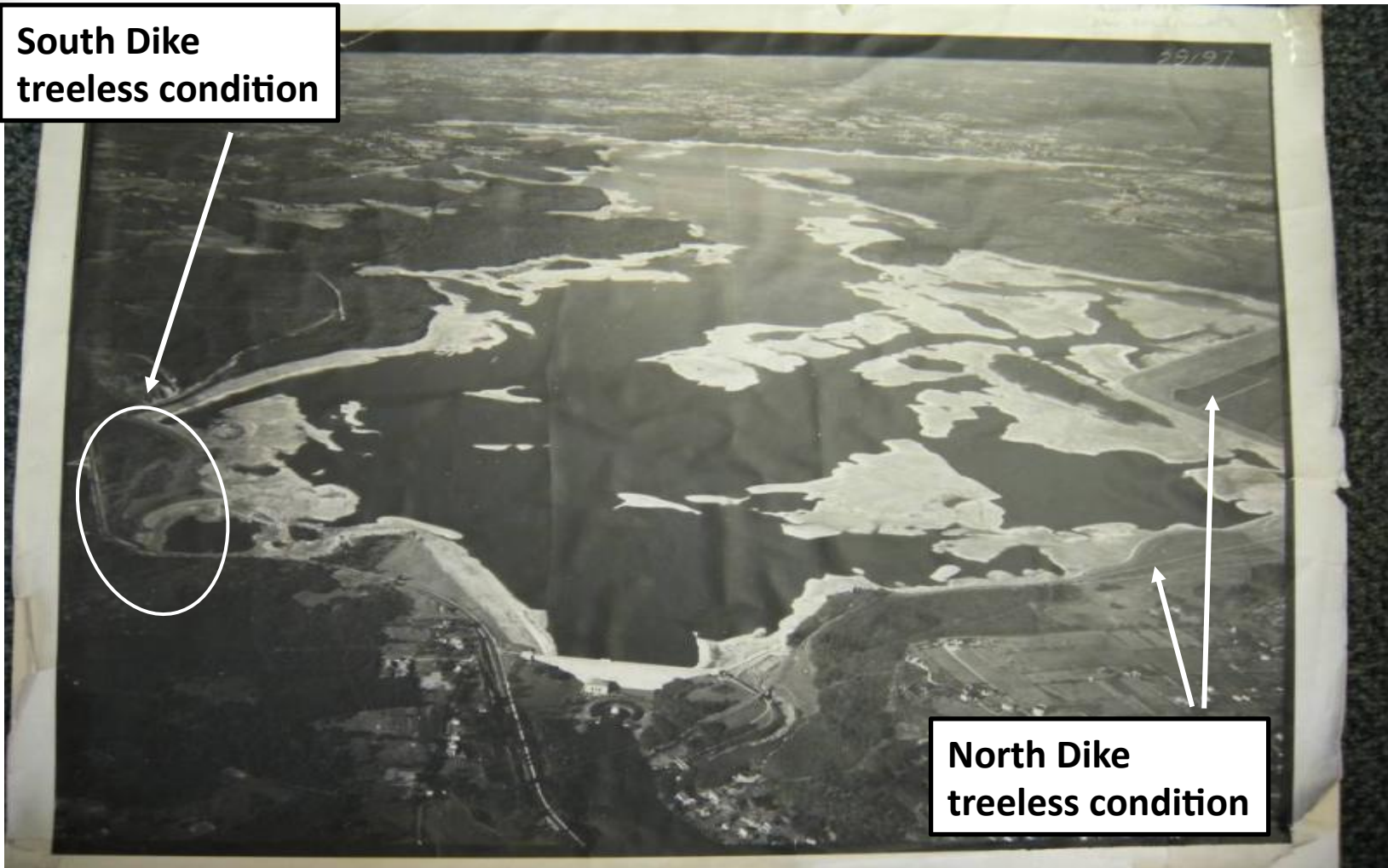
After





Wachusett Reservoir circa 1930 drought

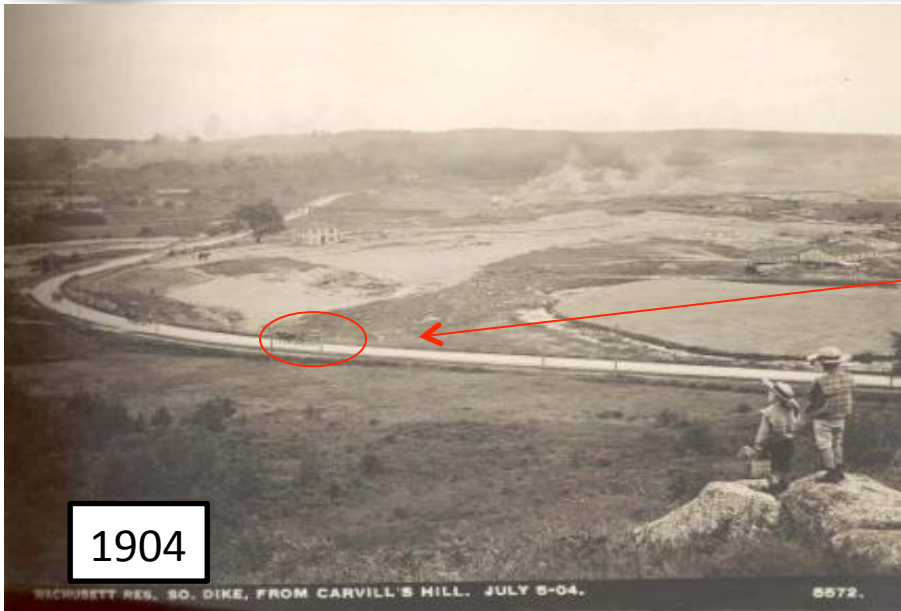
**South Dike
treeless condition**



**North Dike
treeless condition**



South Dike Comparison



Rock outcrop. Note dense tree cover





South Dike Comparison



Crest – note dense tree cover





South Dike





South Dike Crest Before and After





South Dike Final Grading and Hydroseed





North Dike Tree Removal



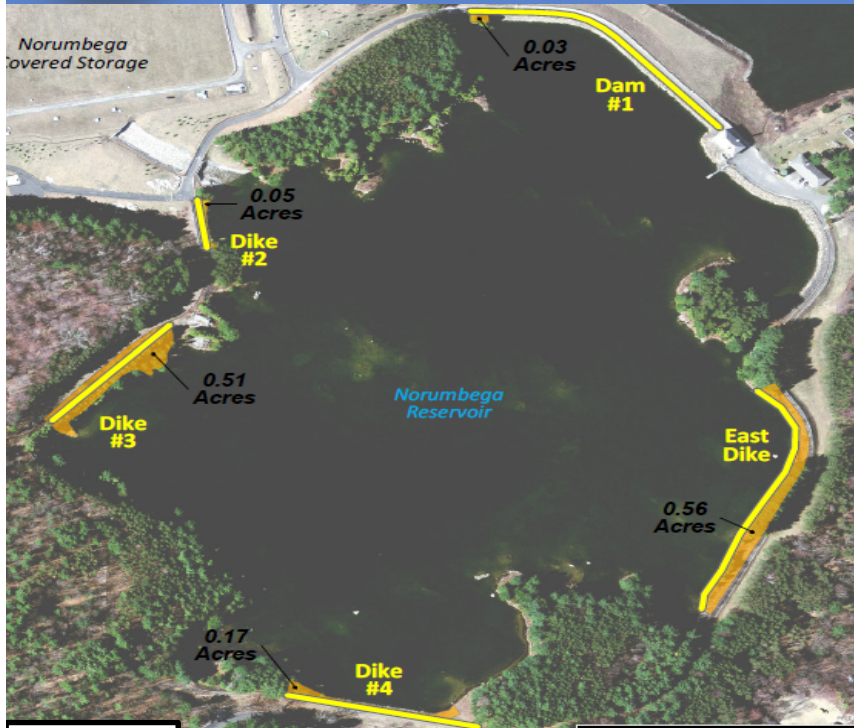


North Dike Tree Clearing

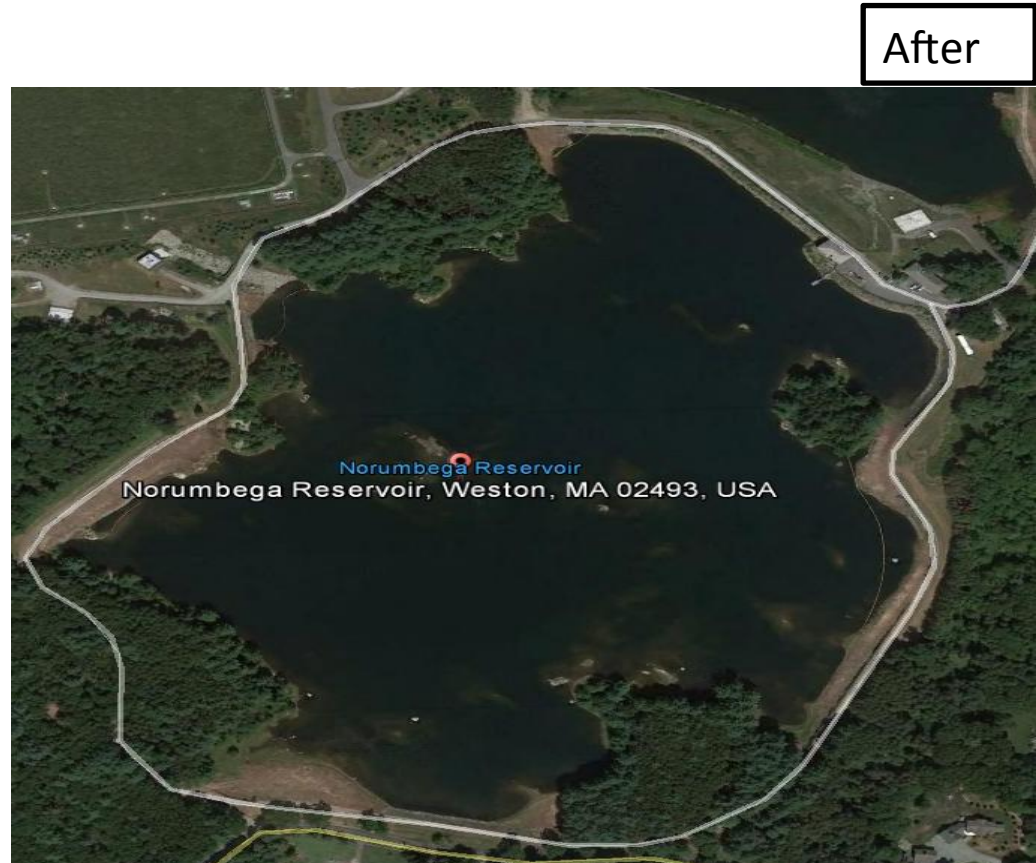




Norumbega Dam/Dikes Tree Removal



Before



After



MWRA Dam Improvements

MWRA /DCR Dam Condition Ratings

- Significant Rehabilitation/Upgrades Completed
- 2006- Dams Ranged from “Fair – Satisfactory”
- 2014, Dams upgraded. Now range from “Satisfactory – Good”



What's next on the Horizon for Dam Safety Needs

- Foss Reservoir Spillway – increase capacity and/or armor the earthen embankment. Pending ODS review on options.
- Install new piezometers at earthen dams lacking them: (North Dike and South Dike, Weston, Fells, Norumbega, Ware Diversion, Foss, Schencks, Chestnut Hill).
- Continue to meet ODS Biennial Phase I safety inspections' schedule.



Wachusett el. 396.07' on 04.01.10 @1.6 BGD





Quabbin Spilling @ 0.6 BGD on 04.05.10





Sudbury System Dams Under High Inflows



**Sudbury
in spill
03.29.10
@ 200 MGD**



**Foss
in spill
@ 250
MGD**





Thank you.



