STAFF SUMMARY

TO: Board of Directors
FROM: Frederick A. Laskey, Executive Director
DATE: March 8, 2006
SUBJECT: Update on New EPA Drinking Water Regulations

COMMITTEE: Water Policy & Oversight

__X__ INFORMATION
_____ VOTE

Michael J. Hornbrook
Chief Operating Officer

Betsy Reilley-Matthews, Sr. Program Mgr, QA
Jae R. Kim, Director, Water Engineering
Stephen Estes-Smargiassi. Director, Planning
Preparer/Title

Marian A. Orfeo
Director, Planning and Coordination

RECOMMENDATION:

For information only. No action required.

In January 2006, EPA finally released the long awaited Long Term 2 Surface Water Treatment Rule and the Stage 2 Disinfectants and Disinfection Byproducts Rule. MWRA staff have been active in the formulation and revision of these rules since 1997, and have briefed the Board a number of times during their evolution. The new rules will require additional monitoring for pathogens in source water, and more comprehensive testing and a more stringent standard for disinfection byproducts throughout the distribution system. As anticipated, planned and budgeted for, the rules will also require that MWRA add another primary disinfectant (currently proposed by staff to be Ultraviolet (UV) light treatment for both the metropolitan Boston system and the CVA system).

Staff will return to the Board later this spring prior to beginning the procurement process for treatment designers with a comprehensive review of all the treatment options that have been considered for meeting the new rules, the costs and benefits of each approach, and the justification for our recommendation of UV. Based on staff's analysis of new federal regulations and the progress made to date in watershed protection and pipeline rehabilitation, staff see no reason at this time to recommend to the Board any modifications to the original 1998 treatment technology decision to remain an unfiltered water system.

This staff summary reviews the requirements of the new rules; discusses what impact they will have on MWRA operations, facilities and finances; and reviews the important changes in the final rules from the previously discussed versions. No surprises involving increased expenditures are

anticipated, and some potential monitoring costs seem likely to be avoided in the short term. The staff summary also describes the key issues facing MWRA and our community partners in upcoming rules, and previews the Master Plan discussion on water quality and treatment issues.

DISCUSSION:

On January 4 and 5, 2006, EPA finally issued their long anticipated new microbial and disinfectant byproducts rules. The 1996 Amendments to the Safe Drinking Water Act called for EPA to issue the two new regulations by May 2002. The most important impacts of these new regulations are the requirements for inactivation of *Cryptosporidium* and a second means of primary disinfection in all unfiltered systems, and higher than anticipated "CT" requirements that would translate into higher ozone doses[1]. Combined, these standards will require the addition of a second disinfection process at both the John J. Carroll and Ware Water Treatment Plants by 2014. Staff propose to meet the requirements by adding ultraviolet light (UV) disinfection at both plants.

MWRA staff have been following the development of these rules since 1997 and been active in efforts to influence them. The pair of rules, the Long Term 2 Enhanced Surface Water Treatment Rule (LT2, for short) and the Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 D/DBP or Stage 2), focus on the control of *Cryptosporidium* and on further reducing the amounts of chlorine disinfectant byproducts to which consumers are exposed. The rules are the latest in a series of rules focusing on these issues. The LT2 Rule brings to closure EPA's efforts since the Milwaukee *Cryptosporidium* outbreak in March 1993 to tighten drinking water treatment to protect against that pathogen. It is also the first microbial treatment rule to consider source water quality in mandating treatment levels, moving away from EPA's former "one-size-fits-all" approach. The Stage 2 Rule marks a shift in EPA's focus on disinfection byproducts from only looking at long-term cancer health outcomes of DBPs to the possibility that they might also have shorter term developmental or reproductive effects (low birth weight, birth defects or miscarriages).

The two rules were developed in tandem because of the recognition that there is a strong potential for what is called a risk-risk trade-off: improvements to inactivate more pathogens may cause utilities to take actions that increase disinfection byproducts or improvements to reduce disinfection byproducts may actually reduce the effectiveness of treatment against pathogens.

The rules were developed using a regulatory negotiation process under the Federal Advisory Committee Act (FACA), which allows the creation of stakeholder committees (called FACAs) to agree upon and recommend approaches to complex regulatory issues. The interests of unfiltered water systems were provided a specific representative on the panel, and MWRA was an active caucus member and commented on pre-proposal and official drafts throughout the process. The FACA process culminated in September 2000 with an Agreement in Principle (AIP) which represented the compromise position of all the stakeholders. As reported to the Board at that

1 "CT" stands for the concentration of disinfectant multiplied by the time it is in contact with the water and is a way of measuring disinfection effectiveness.

time, notable in the agreement was the "deal" that there would remain an unfiltered option, but that unfiltered systems would use two primary disinfectants as a "multiple barrier" and provide at least 99% *Cryptosporidium* inactivation. EPA developed the draft and final rules based on the compromises reached in the AIP. Staff have previously provided updates to the Board on the evolving regulations in September 2000, August 2001, and March and December 2003.

The Long Term 2 Enhanced Surface Water Treatment Rule will require that MWRA add an additional disinfectant at both the Carroll Water Treatment Plant (CWTP) and at the Ware Disinfection Facility serving the CVA communities. Under the new rule all unfiltered systems must have two primary disinfection systems[2], one capable of achieving stated levels of *Giardia* and *Cryptosporidium* inactivation, the other capable of virus inactivation[3]. The new rule also mandates *Cryptosporidium* testing, with the level of treatment required being based on the results. Based on the results of pilot testing and other research, ultraviolet (UV) light disinfection appears to be MWRA's most cost effective solution at both locations. A more detailed discussion of the rule requirements and MWRA's efforts to influence them is in Attachment A. As discussed above, staff will return to the Board this spring prior to beginning the procurement process for treatment designers with a comprehensive review of all the options that have been considered for meeting the new rules, the costs and benefits of each approach, and the justification for our recommendation of UV.

The Stage 2 Disinfectants and Disinfection Byproducts Rule revises how water systems sample for and report on disinfection byproducts. The Stage 2 Rule is an attempt to reduce the variability of DBP levels across the distribution system. The rule will require that systems undertake an effort to locate areas of higher DBPs and then to conduct their regulatory monitoring at those locations. Rather than the current system of averaging all DBP results across all sample locations and four quarters, annual averages will be required at each sampling location, with the highest result determining compliance with standards. The effect will be to reduce the average exposure and to eliminate locations with significantly higher levels. Because the new ozone disinfection at the CWTP has greatly reduced levels of the two primary groups of chlorine disinfection byproducts, THMs and HAAs, staff believe MWRA will have little difficulty complying with the new standards. At Quabbin, natural organic carbon levels are low enough that DBP levels at most locations in the CVA system should be below the new standards, although results at the new targeted sampling locations will need to be considered. No new facilities specifically connected to the Stage 2 DBP rule are anticipated at the CWTP, however depending on sampling results over the next several years, the use of chloramination in place of free chlorine for residual disinfection may be recommended for the CVA system. The current conceptual design for the UV facility at the Ware disinfection facility includes provisions to add chloramination.

---

2 Primary disinfection inactivates any pathogens (harmful germs) in the source water. Residual disinfection is used to maintain the quality of the water as it passes through the distribution system.

3 The rule will require 2-log (99%) inactivation of *Cryptosporidium*, 3-log (99.9%) inactivation of Giardia, and 4-log (99.99%) inactivation of viruses. Using the required compliance calculations, MWRA now would be credited with around 1 log *Cryptosporidium* inactivation, but substantially more than the required 3-log for *Giardia* and 4-log for viruses.

As discussed in more detail in Attachment B, there will be a substantial effort to identify the new sampling locations, and the partial communities and the CVA communities will need to undertake a 12 month intensive sampling effort beginning in October 2007. Due to efforts by MWRA and others to convince EPA to acknowledge the effects of recent treatment investments (and subsequent reduction in DBP levels) by systems such as MWRA, it is expected that the fully supplied communities served by the CWTP will not need to undertake the sampling effort at an expected savings of over $500,000 in MWRA laboratory costs alone.

Compliance Schedule and Costs. The new rules will come into effect in April 2006. There are a number of MWRA and community efforts necessary for compliance beginning this spring, but the major deadlines are to have any new facilities on line by March 2014. This timeline will require design efforts to begin in about 18 months to 2 years from now, with procurement efforts beginning late this year. Funds for both design and construction are already programmed into the current CIP, with a total investment of around $49 million.

Review and Comment Process. MWRA staff have been active participants in EPA's development process for these new rules since the fall of 1997, and have briefed the Board several times on key issues we were trying to affect. In several areas our efforts were successful, but in several others they were only partially realized. Of prime importance, the new LT2 rule abandons the "one-size-fits-all" approach and tailors treatment requirements for both filtered and unfiltered systems to the quality of their source waters. This was a central theme in MWRA's treatment technology decision making process, and in our subsequent defense of that process in Federal Court.

Equally important is the fact that the new rule continues to allow for an unfiltered option: at a number of times during the rule development process that option seemed in jeopardy. Due to efforts by MWRA and the other major unfiltered systems, the option was not only preserved, but remained reasonably attainable. The ability to use evidence of significantly lower DBP levels to avoid unnecessary sampling, while not quite as flexible as hoped, is also a significant victory between the draft and final rules.

A significant effort was made by MWRA, AWWA and AMWA (the national industry associations) to reduce the degree of conservatism that EPA applied in determining how stringent the disinfection requirement to inactivate *Cryptosporidium* would be. Many reviewers felt that EPA had erred in applying several, essentially duplicative layers of safety factors into the calculations of the required "CT" for a given level of inactivation. In response to comments on the pre-publication draft, EPA did somewhat reduce the excessive safety factors, but no further changes were made between the draft and final rule. This means that while MWRA's own site specific research indicates that the CWTP can and does achieve 99% (2-log) *Cryptosporidium* inactivation utilizing ozone, MWRA cannot receive full credit for that under the new rule[4]. Staff

4 The design was based on site-specific inactivation studies, which were based on current engineering practice and found to be adequate by Judge Stern to inactivate 99% of any *Cryptosporidium* potentially present. EPA in essence changed the rules mid-construction.

propose that MWRA meet the necessary *Cryptosporidium* inactivation with the addition of UV, using ozone as the second primary disinfectant, and as well as for taste and odor control. Even if MWRA could meet the more stringent *Cryptosporidium* CT requirements of the new rule with ozone, a second primary disinfectant such as UV would still be required to comply with the new rule.

Assisting Communities. MWRA staff have begun the effort to work with MWRA communities in interpreting the new rules, educating community staff on what efforts they will need to undertake, and assuring that there is a clear understanding of roles and responsibilities. An initial training session was conducted in December 2005 jointly with NEWWA and EPA at MWRA's Chelsea facility. Staff have coordinated with EPA and DEP on community requirements and plan to release a detailed memorandum to communities on the two rules in March. Staff will also use appropriate Advisory Board forums to communicate the requirements to communities and conduct both group training and one-on-one discussions as required.

MWRA expects to take the lead in a number of the early requirements to facilitate a consistent approach and to reduce the total efforts of community and MWA staff. Existing laboratory agreements will be continued – any required source water testing will be done by MWRA, as will DBP testing for the fully supplied communities in the MetroBoston area. Partially supplied communities and the CVA communities will continue to use their own laboratories or MWRA's on a fee for service basis.

Remaining Unfiltered. Under the new LT2 rule, MWRA must continue to comply with the Surface Water Treatment Rule filtration avoidance criteria to provide public health protection from source water to tap. The eleven criteria are broken down into three separate sections: Source Water Quality Criteria, Disinfection Criteria, and Site Specific Criteria. MWRA meets and betters all regulatory standards for all source water and site-specific criteria, although the source water quality criteria requires continued vigilance with bird harassment each winter.

Based on staff's analysis of new federal regulations and the progress made to date in watershed protection and pipeline rehabilitation, staff see no reason at this time to recommend to the Board any modifications to the original 1998 treatment technology decision to remain an unfiltered water system.

Attachment C provides a brief overview of how the other major unfiltered systems plan on complying with the new rules. MWRA's approach is similar to most other systems. Most notably, Portland Oregon is expected to sue EPA in an attempt to avoid constructing new treatment and covered storage facilities. Attachment D provides additional background on treatment and water quality regulatory and research issues that staff are following.

Budget Impacts:

The approved FY06-08 CIP includes $43.5 million for design and construction of the addition of UV disinfection to the CWTP. The CIP also includes $5.5 million for the addition of UV

disinfection to the Ware Disinfection Facility. The cost of operating the UV facilities at CWTP is expected to be mostly offset by savings in liquid oxygen (LOX) and electricity from lower ozone doses. Additional operating costs of UV for the CVA system are preliminarily estimated to be approximately $100,000/year. The exact impact of the UV patent fee or if it will be upheld are still unknown, although the cost could be considerable.

Both the LT2 and Stage 2 rules mandate additional sampling. MWRA already conducts *Cryptosporidium* testing equivalent to that required, so no additional sampling cost is anticipated for the LT2 rule. Increased costs for long term monitoring of DBPs after 2012 are expected to be approximately $20,000 per year. This is still subject to the negotiation of our consecutive system sampling agreement with DEP and EPA, and could be higher if the MWRA fully supplied communities are not treated as a single combined distribution system. There is also a risk that MWRA could be required to conduct the "standard monitoring plan" for establishing new sample locations between October 2007 and October 2008 at a cost of approximately $500,000 if DBP levels from the CWTP rise unexpectedly.

Attachment A – Long Term 2 Enhanced Surface Water Treatment Rule
Attachment B - Stage 2 Disinfectants and Disinfection Byproducts Rule
Attachment C - What are other the unfiltered systems doing?
Attachment D - Longer Term Regulatory Issues

Attachment A – Long Term 2 Enhanced Surface Water Treatment Rule

The Long Term 2 Enhanced Surface Water Treatment Rule (LT2, for short) focuses on the control of *Cryptosporidium*. It represents the latest step in controlling waterborne disease from surface water supplies begun in 1989 with the original Surface Water Treatment Rule, and continued with the Interim Enhanced Surface Water Treatment Rule in 1998 and the Long Term 1 Surface Water Treatment Rule in 2002. The focus of the rules since 1993 has been on understanding and controlling the potential risk due to *Cryptosporidium*. In March 1993, over 400, 000 thousand people became sick and as many as 100 died in Milwaukee due to an outbreak of Cryptosporidiosis caused by inadequate treatment of polluted source water. Research since then has shown that *Cryptosporidium* can be very infectious, with as few as one oocyst needed to infect an individual, that many source waters contain the organism, and that some infectious oocysts can and do breach even well run conventional filtration plants. It is clear that nationwide some systems are at risk.

Concurrent with the attention on *Cryptosporidium*, EPA was under increasing pressure to recognize that the format of its earlier rules presented essentially a "one-size-fits-all" approach to a more complex nationwide situation. EPA's own research agenda clearly pointed out the fallacy of that approach, showing that some locations had too little protection, while others may have been forced into over investing on unneeded protection. Thus the big push in the development of the LT2 rule was to develop a risk based regulation, with treatment tailored to the degree of risk. Board members may recall that this was a principle theme for MWRA during the treatment technology trial against EPA Region 1, even as EPA national was pushing a more risk based agenda.

As discussed above, the new rule was developed (simultaneously with the Stage 2 D/DBP rule) using a stakeholder negotiation process under the Federal Advisory Committee Act. MWRA was involved during the entire process, actively working on technical issues and participating in both the unfiltered caucus and the larger water utility caucus. The end result of the several year negotiation process was an Agreement in Principle, signed by all participants in September 2000. The document called for tiered treatment by both filtered and unfiltered water systems based on *Cryptosporidium* testing of source water, retained an option for unfiltered systems and mandated changes in existing uncovered distribution storage reservoirs. The retention of the unfiltered option was a significant victory, as the additional requirements for remaining unfiltered – 99% *Cryptosporidium* inactivation and use of a second primary disinfectant – were reasonably achievable and less costly than filtration.

However, in regulations the original intent may be acceptable, but the final regulatory language may not be, so staff have stayed involved throughout the rest of the process. We have reviewed pre-proposal drafts and the official draft (August 2003), and worked with the unfiltered utilities, AWWA and AMWA on technical review, comments and lobbying EPA staff. The next few paragraphs discuss some of the issues MWRA tracked and attempted to influence as the regulation was being finalized.

Maintaining the Unfiltered Option: MWRA's principle concern during the stakeholder process and as the regulations were developed was maintaining a practical unfiltered option. The agreement in principle called for retaining the unfiltered option, but EPA posed a number of critical questions about the nature of the option when it published the draft rule. While the draft called for retaining the existing 11 waiver requirements, the potential that they could be made substantially more stringent was raised by EPA in a specific request for comments. The final rule retains the existing criteria. The eleven criteria are broken down into three separate sections: Source Water Quality Criteria, Disinfection Criteria, and Site Specific Criteria. *Unfiltered supplies will be required to add Cryptosporidium control to their watershed protection plans: the MWRA/DCR plans already do so. MWRA meets and betters all regulatory standards for all eleven criteria, although the source water quality criteria requires continued vigilance with bird harassment each winter.*

Tiered Treatment Requirements: The Agreement in Principle and the draft and final rule called for tiered treatment requirements based on health risk as measured by source water quality. This important step away from the "one-size-fits-all" approach will require that every water system conduct 24 months of source water quality monitoring – generally for *Cryptosporidium*. Based on the results of that testing, filtered systems will be placed into one of four "bins" of increasing levels of *Cryptosporidium* reduction requiring some action, ranging from improving source water quality, to improving the operation of existing treatment, to adding additional inactivation.

Unfiltered systems will require either 99% or 99.9% (2-log or 3-log) inactivation depending on source water *Cryptosporidium* levels and must use chlorine dioxide, ozone, or UV to meet the *Cryptosporidium* inactivation requirements. *As discussed below, MWRA proposes to use ultraviolet (UV) light disinfection to achieve the Cryptosporidium inactivation requirement at both the Quabbin and Wachusett sources.*

Two Primary Disinfectants Required: Unfiltered supplies will be required to use at least 2 primary disinfectants, with the second one achieving at least 4-log virus inactivation.[5] The justification for its inclusion in the agreement in principle and the rule was the feeling among some stakeholders that systems which did not provide the added protection of filtration needed the redundancy and robustness of using two different strong disinfectants. EPA had asked in the draft rule whether an even stricter interpretation was needed, but choose not to do so in the final rule, based on comments from the unfiltered systems that it was not justified, as it added little to microbial control and would potentially increase disinfection byproduct (DBP) levels. *Ozone at Wachusett and free chlorine at Quabbin can easily meet the requirement for a second primary disinfectant (along with UV as the other primary disinfectant).*

Cryptosporidium Monitoring: Under the LT2 rule, MWRA will be required to conduct 2 years of source water monitoring at both Quabbin and Wachusett reservoirs. All the results will be

5 Primary disinfection is used to inactivate or kill pathogens in source water. Residual disinfection maintains the quality of the water as it passes through the distribution system. MWRA currently uses ozone for primary disinfection, and chloramines for residual disinfection in the metroBoston area, and chlorine for both primary and residual disinfection for the CVA system.

averaged and if the mean *Cryptosporidium* level is 0.01 oocysts/L or less, MWRA will be required to provide at least 2-log *Cryptosporidium* inactivation. If the mean *Cryptosporidium* level is greater than 0.01 oocysts/L then at least 3-log *Cryptosporidium* inactivation will be required. *Data collected over past several years indicates that MWRA's results will most likely be less than 0.01 oocysts/L.*

MWRA must submit a sampling plan by July 2006, and the 24 months of sampling will begin in October 2006. *MWRA is currently doing essentially what will be required, so there will be no budget impact for increased monitoring.*

Some stakeholders felt that any unfiltered system with higher *Cryptosporidium* levels should be required to add filtration, and in the draft rule EPA called for comments on the concept. MWRA and others argued that the states had existing authority under the watershed protection waiver criterion to mandate filtration if a system had inadequate control of pathogen sources and EPA adopted our position in the final rule. This would allow a system to work with their state to attempt to fix the watershed problem rather than simply being mandated to filter. In essence this was the result of MWRA's Federal Court battle with EPA.

Required Ozone CT: A more important issue had to do with how EPA statistically manipulated the available data on the inactivation of *Cryptosporidium* by ozone to develop tables of the required level of disinfection at different water temperatures (the so-called CT tables). In developing the tables, EPA chose a significantly more conservative method than used in the original SWTR and by designers or state regulatory agencies in developing site-specific design criteria. The effect of EPA's conservatism is to require much higher ozone doses to comply with any particular level of inactivation. While the CWTP, as designed and constructed, would likely be able to physically achieve those CT values, it would be much more costly to operate, and the concern about ozone creating bacterial "food" and increasing the potential for bacterial regrowth within the distribution system would be heightened. The required doses would be higher than any evaluated in the "Task 8" research efforts, and thus it is not clear that those conclusions could be applied to this mode of operation.

As described in the March and December 2003 staff summaries, MWRA worked with American Water Works Association (AWWA) technical staff and a diverse group of utilities to convince EPA to change its approach. While EPA did moderate its approach in the draft regulations, they still require higher doses than MWRA originally anticipated[6]. As the approach finally accepted by EPA was based on the technical analysis done by AWWA, it was unlikely to be moderated further; nonetheless, MWRA and others commented on its conservatism. The final rule retains the excessive conservatism.

While we are meeting our site specific target of at least 99% inactivation of Cryptosporidium at CWTP, we would only be credited with somewhat over 90% under the new rule. The addition of

6 The design was based on site-specific inactivation studies, which were based on current engineering practice and found to be adequate by Judge Stern to inactivate 99% of any *Cryptosporidium* potentially present. EPA in essence changed the rules mid-construction.

UV will easily achieve the required Cryptosporidium inactivation target, and we will be able to lower the ozone dose, and reduce electricity and liquid oxygen (LOX) costs, while still achieving the taste and odor control benefits of ozonation.

Potential for a Variance of Inactivation Requirements: In response to some comments requesting the possibility that very high quality source water not be required to add *Cryptosporidium* inactivation, in the preamble to the final rule, EPA discusses how they would interpret the variance provision of the SDWA. EPA indicated that if a system could reliably demonstrate 1000 times less *Cryptosporidium* (essentially the 3 log reduction attributed to standard filtration facilities) than the lowest bin for filtered systems, then disinfection for *Cryptosporidium* may not be needed[7]. EPA indicates that it does not think that it is possible to actually prove the very low pathogen level given the state of current methods, but leaves open the possibility that a water system might develop the tools to do so.

A review of the most sensitive *Cryptosporidium* testing underway on MWRA water as part of the on-going research with Tufts University indicates that metro-Boston levels are around 5 times higher than the variance target, and that a substantially more sensitive and repeatable method would be needed to meet the requirement to reliably demonstrate the low levels. No high volume testing has been conducted on Quabbin water. *The variance does not appear to be a fruitful path for further review.*

Uncovered distribution reservoirs: The final rule is much more stringent than draft. In 1998, in the Interim Enhanced Surface Water Treatment Rule, EPA outlawed the construction of new uncovered distribution reservoirs, but indicated that it needed to consider costs and benefits before requiring the elimination of existing ones. The draft LT2 rule allowed three ways of complying: cover the open reservoir, provide disinfection capable of 4-log virus inactivation (a relatively mild level), or implement a risk mitigation plan with state approval. The final rule only allows covering or treatment, and requires 2-log *Cryptosporidium*, 3-log *Giardia*, and 4-log virus inactivation – essentially what an unfiltered system needs for its source water. *This aspect of the rule no longer affects MWRA, indicating the wisdom of eliminating all of our uncovered reservoirs, but several large systems elsewhere face substantial unexpected investments.*

New Facilities Required by LT2 Rule -- Carroll Water Treatment Plant - UV Addition

UV disinfection is prosposed be added to the CWTP for two reasons:

- The LT2ESWTR requires unfiltered systems to have two primary disinfectants, and
- The new *Cryptosporidium* inactivation requirements for Concentration and Time (CT) are more stringent than the site-specific CT data on which the CWTP was designed.

7 Some reviewers believe that EPA included this discussion as a legal defense against an anticipated lawsuit against the new rule by Portland Oregon. Portland has indicated that they believe that the rule is arbitrary and that they should not be required to cover their open distribution reservoirs nor add any additional treatment to deal with *Cryptosporidium*.

Complying with the new *Cryptosporidium* CT criteria with ozone would be difficult, and require doses beyond those evaluated for distribution system impacts.

Retrofitting into an existing plant is always difficult, even a brand new one such as CWTP. Staff identified a series of objectives or constraints for the concept design team to ensure MWRA's long-term treatment flexibility. These included:

- Not precluding the ability to later add filtration;
- Minimizing the value of facilities which would be rendered obsolete if filtration were later added;
- Maximizing the effectiveness of the ozone treatment during construction; and
- Minimizing the reduction in storage within the clearwell storage tank.

While these objectives did exclude some options that may have had a lower initial capital cost, they prevented MWRA from building itself into a corner, precluding the possibility of adding filtration or other treatment facilities if ever needed. If filtration were ever added to the CWTP, UV disinfection would play a useful role in plant operation. The use of UV would obviate the need for additional free chlorine disinfection after filtration to control for filter sloughing, and provide additional inactivation of pathogens.

A UV Disinfection Treatment Feasibility Study was completed in March 2004. This report examined alternative UV technologies and presented conceptual layouts for a UV system at the Carroll WTP, recommending that the new facilities be built within the portion of the storage tank now used for additional ozone contact time. Additional testing will likely be required before proceeding with design as well as deciding on the lamp type (medium vs. low pressure) and reactor design. Our research on the interaction of ozone and UV indicates that there is synergy that will result in a smaller UV facility and lower UV doses[8]. The use of UV for *Cryptosporidium* inactivation will also allow MWRA to lower the ozone dose reducing costs for liquid oxygen (LOX) and electricity. Ozone would continue to increase the clarity of the water, to remove certain algae related tastes and odors, and would also provide the required second primary disinfectant.

UV units must be tested to demonstrate that the flow path and UV intensity meets the reactor design requirements. New York City recently completed this validation process for their Catskill/Delaware water supply, which is also unfiltered. Units from multiple manufacturers were validated and subsequently bid for construction. A similar process is anticipated for the Carroll WTP UV units.

The design will consist of modifications to the plant to incorporate UV without interfering with its operation. The design will include preparation of the equipment area, piping, installation of

8 This research was conducted as part of a tailored collaboration with funding from several other utilities and the AWWA Research Foundation.

the UV units, electrical wiring, HVAC and instrumentation. Testing and design will take approximately 28 months.

Construction must be carefully sequenced to avoid interruption of the existing plant operation. It is anticipated that some plant components will be shut down to allow these modifications, similar to, but with more activity and a longer duration than the winter shutdowns of half the plant expected for maintenance each year or the recently completed half plant operation this winter for modifications. Construction is expected to take 30 months and would occur over two winter seasons.

The estimated cost to add UV units to the Carroll WTP is $43.5 million. This includes the cost for testing, design, construction and engineering during construction. Funds are included in the current CIP. Based on the final regulations, facilities must be in operation no later than March 2014[9]. The anticipated adjusted schedule below will be reflected in the Final FY 2007-09 CIP.

Design Notice To Proceed	1/2008
Biddable Documents	4/2010
Construction Notice To Proceed	1/11
Substantial Completion	6/13

The next significant milestone will be issuing the Request for Proposals for design services in early 2007.

New Facilities Required by LT2 Rule -- Ware Disinfection Facility – UV Addition

The original design for the Ware Disinfection Facility (WDF) serving the three CVA communities allowed for expansion with ozone, so current plans assume the addition of UV facilities in essentially the same location. When the WDF was in planning and design, it was expected that *Cryptosporidium* inactivation would eventually be needed but there was still substantial uncertainty about when and what exactly would be required. Based on a Life Cycle Cost Analysis, in 1995 MWRA delayed a decision on adding ozone at a cost of $15 million until the new rules were issued. At that time, the LCCA analysis indicated that the delay in investment and operating costs would be worthwhile if ozone construction was delayed even a few years. However, now that UV is available as a less expensive option, that decision will result in even greater savings for the CVA system.

A one-year UV pilot test facility was operated at the Winsor Dam Power Station from January to December 2004. Both Medium Pressure (MP) and Low-Pressure High-Output (LPHO)

9 This date assumes that as expected, MWRA requests and DEP grants the 2 one –year extensions of the March 2012 deadline allowable for system needing capital construction to comply with the rule.

lamps (essentially fluorescent bulbs) were evaluated. The project results indicated that:

- Either MP or LPHO UV technology may be used successfully with Quabbin Reservoir water.
- The UV lamps used in the MP system have a useful life which substantially exceeds that expected or advertised by the supplier.
- There is no tendency for increased algae growth downstream of the UV reactors.
- Due to the potential for iron fouling, UV equipment should be installed upstream of chlorine injection if possible.
- The power supply to the area is reasonably stable.
- A UV system with a high degree of power turndown should be installed to facilitate operation at the desired dose over varying flows.

A study was also conducted which evaluated three alternative locations for the UV facility. The results indicated that the permanent UV facility should be located adjacent to the existing Ware Disinfection Facility. A conceptual design report was completed in November of 2005. The design allows for the inclusion of either MP or LPHO reactors. The preliminary design also includes the option to add ammonia if chloramination is desired as the residual disinfectant in the future. (See discussion under the Stage 2 D/DBP Rule in Attachment B)

The estimated construction cost for the facility is approximately $4,500,000. The chloramination option would add approximately $350,000. Funds are included in the current CIP. It is anticipated that bids for both MP and LPHO reactors would be solicited during the design of the Quabbin UV facility and the most cost efficient alternative would be selected.

The design and construction schedule for this project shown below will be reflected in the Final FY07-09 CIP.

Design Notice To Proceed	7/2007
Biddable Documents	1/2009
Construction Notice To Proceed	9/2009
Substantial Completion	3/2011

Attachment B - Stage 2 Disinfectants and Disinfection Byproducts Rule

Some disinfection byproducts (DBPs) have been regulated since 1979. DBPs form when disinfectants react with the natural organic matter in the water. Original concerns were long term health impacts ("endpoints") such as cancer. More recently concerns have been raised by research of shorter term developmental or reproductive impacts (low birth weight, birth defects, and miscarriages). While still in the hypothesis stage with mixed study results still coming in every few months, these issues raised enough concern to be the principle focus of the regulatory negotiation.

Essentially the new rule requires that water systems look for DBPs where they are most likely to be high, and then adjusts the compliance calculation to focus on an annual average at each of these locations. Currently high and low locations are averaged together. This locational running annual average (LRAA) has the effect of reducing the chance of higher exposures.

Maximum Contaminant Levels (MCLs): The average trihalomethane (THM) maximum contaminant level (MCL) of 80 parts per billion (ppb) and average haloacetic acid (HAA) MCL of 60 ppb will remain unchanged; however, for both of these, an important change will be made in the method of measurement: sampling must include those locations most likely to have high levels and each location will be averaged separately. This Locational Running Annual Average has the effect of reducing allowable levels by about half for systems that use free chlorine for their residual disinfectant. Since the Carroll WTP has come on line, substituting ozone for free chlorine as MWRA's primary disinfectant, chlorine DBPs (trihalomethanes-THMs and Haloacetic acids - HAAs) have decreased dramatically. *Current levels are generally in the 4 to 12 ppb range, easily meeting the new requirements.* [10]

Bromate: The average bromate (a byproduct of ozonation) MCL of 10 ppb will remain unchanged. *Testing thus far at the plant indicates that the ozone process contributes little bromate to finished water*[11]*. No problems meeting the requirement are anticipated.*

Selecting New Sampling Locations: The Stage 2 rule requires a first step of monitoring to identify the highest DBP locations. This effort is called an Initial Distribution System Evaluation (IDSE). There are a few options allowed to substitute for a full scale expensive IDSE sampling program, although some are costly in their own rights. One option allows communities with consistently very low THM and HAA levels (no samples with over 40 ppb THMs or 30 ppb

10 Current results in the CVA system appear to pass the new requirements, but once new sampling locations in higher risk locations are tested, these new sites may be close to or above the LRAA limits. Because chlorine is used for both primary and residual disinfection in the CVA system it is not clear that the addition of UV will reduce levels to comfortably pass. This issue will be investigated further over the next several years.

11 Samples during the fall of 2005 indicated a short term problem with the supply of sodium hypochlorite contributing several parts per billion of bromate, well below the regulatory standard. This is not uncommon nationally, but should have been prevented by our product specifications. Staff have reinforced the importance of the constituents analysis requirements to our supplier, and no recurrence has been seen since then.

HAAs) to opt out of IDSE sampling and simply select new compliance sampling sites based on existing data. With the start-up of the CWTP and ozonation, MWRA's levels have generally been in the single digits. Unfortunately as developed in the draft rule, this provision completely excluded systems which had made recent investments in treatment by requiring that the data be 2 years of historical data before the promulgation of the rule. MWRA would have missed those dates. MWRA staff worked with AWWA to identify a number of systems around the country which would be required to waste money with unnecessary sampling due to the restrictive language, and EPA revised the language in the final rule.

For MWRA and its fully supplied communities, the IDSE sampling would have required identifying over 300 sites in 30 communities, planning for the sampling, training community samplers, and doing the lab analysis on over 2,000 samples. Lab costs alone would have been over $500,000 from October 07 to September 08, and there would have been a substantial drain on MWRA and community staff time. While the IDSE sampling itself will not be required, MWRA and the communities unfortunately will still need to do a planning process as if it will be required as there will not be enough calendar quarters of DBP data in time to avoid the requirement to submit the sampling plan. MWRA staff plan to take the lead in developing the sampling plans using existing data, review the plans with each individual community, and submit them as a package on behalf of the communities. *There is a small risk of having to execute the IDSE sampling at the cost of around $500,000 if for some wholly unexpected reason MWRA experiences much higher DBP levels between now and October 2007 (or even a single result over the 40/30 levels for THMs or HAAs), but staff believe it to be highly unlikely.*

Most partially served and the CVA communities will still need to do some local monitoring. MWRA will provide technical assistance, and some communities may be able to avoid the cost of the sampling if their local DBP levels are very low.

Significant Excursions: Another area which MWRA staff worked with AWWA and AMWA on was a provision to deal with individual high sampling results. While compliance is based on the LRAA, and a single high sample would generally not be a compliance issue as it would be averaged with 3 other quarterly results, some of the stakeholders and EPA were concerned that these individual high results might still be of health concern. Given the uncertain state of the health research, regulating on a single sample basis could not be supported, and the compromise was a requirement that systems work with their states to identify if there were simple voluntary operational changes which could reduce these higher results (changing storage tank cycling to reduce residence time, for example). As with all regulatory language, there was a tendency during drafting for it to become more and more restrictive – essentially gutting the compromise. Due to the strong resistance on the part of the utility community, the final rule reflects the spirit of the compromise. *No anticipated issues for MWRA or communities.*

Review of Treatment Changes: The new rule continues requirements that systems look carefully at any changes made to treatment so that inadvertent risk trading does not occur. That is, as the system is trying to reduce DBP levels, it does not inadvertently and unnecessarily increase the microbial risk. *This adds an additional step in facility design and permitting.*

Consecutive System Sampling: An area where efforts to revise the draft rule where unsuccessful was in how consecutive systems would be treated. A consecutive system is a system like MWRA which supplies water to other systems. Most regulations allow the state primacy agency considerable latitude in developing a commonsense sampling plan to account for the local circumstances. For several rules, DEP has treated MWRA and all the fully supplied communities essentially like a single system, greatly reducing the sampling and analysis burden.

In the final rule EPA acknowledged that a system like MWRA's would end up sampling far more intensively than a similar system which physically was identical, but was under one agency. The sampling required will not be as intensive as if each community were regulated separately, but is still more than twice what we had hoped for. Under our current consecutive system agreement with DEP, MWRA currently is required to collect 16 quarterly samples (vs. 114 if each fully supplied community was treated separately and 4 if we were simply a single system). Under the new rule, each community will be required to have at least a single sampling site, with a total of at least 32 (vs. 16 if the system was treated as a single system). New compliance monitoring locations will need to be identified by January 2009, and the new sampling and compliance calculations would begin in April 2012. *Assuming that approximately 32 sites must be sampled, the additional laboratory cost will be around $20,000 per year. Until sites are identified, the impact on sampling crews cannot be determined.*

Staff recently met with EPA and DEP to discuss the timing of the 40/30 certification and sample site selection, and will continue to work to extract the maximum sampling flexibility from the new rule as possible.

EPA Oversight: Of potentially important interest is the fact that due to the regulatory schedule the initial activities under this rule will be overseen by EPA directly, rather than DEP. It normally takes around 2 years for each state to adopt new EPA rules as their own, and for most rules this is not an issue as there are no immediate compliance activities. These two rules have substantial activities that must be completed prior to the states taking primacy. All the other New England states have indicated that they will take an active informal partnership role during the critical early years. *At this time, DEP has indicated that they do not have the staff resources to do so, and thus MWRA will be dealing directly with EPA Region 1 staff on all early issues.*

New Facilities Required by Stage 2 Rule – Carroll Water Treatment Plant

Based on current data and staff review of the new Stage 2 Rule, there does not appear to be any need to make capital investments in the CWTP beyond those identified in the discussion of the LT2 Rule above.

New Facilities Required by Stage 2 Rule - Ware Disinfection Facility – Chloramination

Based on a preliminary review of the available data on DBP levels within the CVA systems, staff believe that the continued use of free chlorine for residual disinfection presents a risk of failing to

comply with the LRAA requirements at every location. Anticipating this possibility the conceptual design of the UV addition to the Ware Disinfection Facility included the option to include chloramination as a replacement for free chlorine as the residual disinfectant if desired. A recommendation to add chloramination has not yet been presented to the CVA community water department staff, but will be shortly.

The necessary facilities include storage tanks for ammonia, feed pumps and a carrier pipe to inject the ammonia some distance downstream on the CVA pipe. This would provide for the use of the CVA pipe for sufficient contact time between the free chlorine and the water to satisfy virus inactivation CT requirements (similar to how residual disinfection was done at the old Norumbega facility from 1997 to 2004.)

The construction cost of the necessary facilities is approximately $350,000 and the debt service and operating costs would be included in the CVA rates.

Attachment C - What are other the unfiltered systems doing?

New York City: NYC is in the design process for the addition of UV to their Catskill and Delaware system. NYC has a dual track process similar to the one MWRA had from 1993 to 1998. They have an agreement not to filter, but had to site and design a filtration plant. The addition of UV had been agreed upon prior to the new LT2 Rule in exchange for not having to produce the final filtration plant design. The 2.2 billion gallon per day plant is expected to cost about $600 million. They are also in the process of building filtration for their smaller Croton system whose watersheds are in the more urbanized Westchester County just north of NYC. A significant issue is their very large uncovered Hillview Reservoir with capacity of 900 million gallons. The estimated cost for covering the entire volume is $640 million, but no firm decision has been made on how to respond to the LT2 requirements. NYC is also concerned that they might have difficulty complying with the Stage 2 DBP requirements given certain operational restrictions posed by the portions of their new Third City Water Tunnel now in operation. Chloramination is being considered among other options.

Portland Maine: Portland currently ozonates the water they draw from Lake Sebago. Similar to MWRA, they anticipate adding UV disinfection and reducing their current ozone dose.

San Francisco: San Francisco is still studying multiple treatment options, including UV, ozone and a chlorine dioxide, with an estimated cost of over $100 million. They recently switched to chloramines for residual disinfection to comply with the Stage 1 DBP Rule, and do not anticipate additional changes for the Stage 2 Rule. They have no remaining open distribution reservoirs.

Seattle: Seattle has two sources, the Cedar and the Tolt. The Tolt historically had seasonal turbidity problems and Seattle added filtration in 2000 using a design - build - operate contract. The Cedar River supply remains unfiltered, and Seattle build an ozone and UV disinfection facility in 2004, again using a DBO contract. Both systems now meet the new LT2 requirements for treatment. Seattle has five remaining uncovered storage reservoirs, and plans on covering them and creating open space above by 2013 at a cost of $123 million.

Auburn Maine: Auburn anticipates adding UV disinfection to their current chlorine primary disinfection system at a cost of $3 to $4 million. They switched to chloramines for residual disinfection in 2003 and do not anticipate any additional changes for compliance with Stage 2.

Tacoma Washington: Tacoma currently has an ozone disinfection plant under construction, and will follow that with the construction of UV as a second primary disinfectant by the compliance date of 2014. Total costs of the two stages of treatment construction are estimated to be $40 million. Tacoma has one last uncovered distribution reservoir with a capacity of 100 million gallons. Covering it is expected to cost $55 million.

Portland Oregon: Portland has indicated that it will sue EPA to overturn certain aspects of the new LT2 rule as arbitrary and capricious. The city has hired the law firm of Foley Hoag who represented MWRA in our treatment technology case. Portland currently provides no

inactivation for *Cryptosporidium* and states that no treatment should be mandated. Portland also has several uncovered distribution system reservoirs which they do not want to cover.

Attachment D - Longer Term Regulatory Issues

MWRA is tracking a series of proposed and potential regulatory changes which may have impacts on MWRA or its member communities. Staff will continue to be involved in research, regulatory development and review processes to attempt to influence rules as early in the process as possible.

Issues currently being tracked include:

Ground Water Rule – EPA is substantially behind its congressionally mandated dates for issuing this rule, but indicates that it should be issued in 2006. The rule is expected to require increased monitoring of source water quality for ground water and depending on the results, additional action, including increased treatment for some local sources. The Ground Water Rule will have no direct impact on MWRA, but could increase costs of local sources or encourage communities using less protected groundwater sources to turn to MWRA water temporarily or longer term.

Distribution System Rule – This rule would update or replace the Total Coliform Rule. At this point EPA is only at the identification of issues stage, issuing white papers for discussion. It is clear that as treatment has improved nationwide, that there are still potentially important risks to water quality and public health after the water leaves the treatment plant. This is to a large extent in alignment with MWRA's approach to investment over the past decade with a focus on water quality all the way to the tap and substantial investments in distribution system storage and pipeline rehabilitation. Looking at the range of issues in the white papers prepared to date, it is clear the EPA will likely take a more careful look at storage tank maintenance and operation, internal condition of pipes, the possibility of contamination getting in through small holes in pipes and aging infrastructure and corrosion. MWRA already has adopted many of the best practices being discussed, so the impact on us may be more limited, but there is a potential for increased attention and investments by communities in their own distribution systems. As EPA has only begun the process of regulatory development, an actual rule is still years away. Because of the wide ranging potential for required changes in operations and facilities, MWRA staff will carefully track this new rule.

Disinfection Byproducts of ozone, chloramine or UV – EPA continues to review the toxicological and epidemiological data associated with any potential health risk associated with disinfection byproducts. In the past several years, their attention has moved beyond just the byproducts of chlorine to those of other disinfectants. Some of the byproducts of chloramine are already regulated, as is one ozone byproduct. To date no potential byproducts of UV have been identified. The Unregulated Contaminants Monitoring Rule requires that water systems provide data to EPA on certain unregulated contaminants so that EPA can determine how widespread their occurrence is. There are a number of byproducts of chloramine which are being examined – it is likely that the MWRA system will have them at some level, but it remains to be seen what the level of health concern will be. Individual byproducts could be regulated as soon as several years from now, but it is more likely that new EPA rules would be later than that. DEP

is also examining certain byproducts, and has already issued a health advisory for NDMA which is both a source water contaminant from certain industrial processes and potentially a byproduct of chloramination. MWRA and our fully and partially supplied communities could all be affected by new byproduct regulations.

Simultaneous Compliance – An emerging issue of concern is the interaction of various rules. The interaction of disinfection to kill germs and the creation of undesirable byproducts of disinfection has been recognized for some time, but more recently it has become clear that almost all stages of treatment can potentially affect other compliance goals. The lead in drinking water debacle in Washington DC in early 2004 now seems to have been definitely related to inadequately considered changes in disinfection practice which dramatically and unexpectedly increased lead levels. Similar lead corrosion problems have been identified as potentially related to changes in coagulation chemicals in filtration plants, and one cause of the cryptosporidiosis outbreak in Milwaukee may have been a change in the type of coagulant. EPA and treatment researchers are now looking carefully at a wide range of chances for improvements in one aspect of treatment or system operation to adversely affect other important goals.

In addition, subtle seasonal or longer term changes in source water quality may have unexpected effects on treatment effectiveness. For example, in the MWRA system, levels of certain more reactive natural organic matter (as measured by UV 254 absorbance) appear to affect the amount of lead leaching from home plumbing, even if all other aspects of treatment are unchanged. These changes can occur, not because of changes in watershed activities, but due to the relative contribution of "younger" Wachusett or "older" Quabbin reservoir water being delivered in wetter or dryer years. It is not yet clear if there are simple changes in corrosion control which could be used to adjust for these types of source water quality shifts or if a change in the type of corrosion control may be needed.

Lower detection levels/ more chemicals detected - Another area which may have profound effects on how water systems operate is the continued trend toward lower detection levels for all sorts of natural and human-made environmental contaminants. Concurrent with the increased ability to find ever smaller amounts of chemicals in water is the science of evaluating their health effects. While the science of detection is always necessarily ahead of the science of understanding the health implications, researchers regularly publish epidemiological or toxicological findings which cast doubt on the safety of chemicals which may be found in water. These may or may not eventually be determined to be of sufficient concern to be regulated, but their presence does raise concerns among consumers.

Changes in Acceptable Levels - The levels of health concern for already regulated contaminants may also change over time, almost always downward. For example, the amount of lead in children's blood which is considered safe has steadily decreased over time. As fewer cases of outright lead poisoning occur nationwide, due to the reduction in lead from gasoline, paint and water, more subtle effects on brain development are able to be seen. This has resulted lower health safety guidelines and thus places continued pressure to reduce lead exposure from all sources. Many health professionals argue that no lead exposure is acceptable,