CITY OF BOULDER
WATER RESOURCES ADVISORY BOARD
AGENDA ITEM
MEETING DATE: March 19, 2007

AGENDA TITLE: Update on the Integrated Evaluation of Boulder Reservoir Water Treatment Plant (BRWTP) Source Water Protection and Treatment Improvements

PREPARING DEPARTMENT:
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BOARD ACTION REQUESTED: None at this time

FISCAL IMPACT: The 2007-2012 CIP includes $250,000 in 2007 to evaluate, $500,000 in 2008 to design and $25,000,000 to construct a pipeline from Carter Lake to the BRWTP and/or provide long term treatment facility improvements.

Also included in the six-year CIP is funding to evaluate, design and construct ($100,000 in 2007, $300,000 in 2008 and $3,000,000 in 2009) mid-term treatment plant improvements. In 2007, $250,000 was budgeted to provide source water protection improvements along the Boulder Feeder Canal.

PURPOSE: This memorandum provides information to the Water Resources Advisory Board (WRAB) on the status of source water protection and treatment improvements for the BRWTP. A previous update was provided on October 17, 2005 (**Attachment A**) with an information item provided about the Carter Lake Pipeline Feasibility Study done by the Northern Colorado Water Conservancy District (NCWCD) on February 27, 2006 (**Attachment B**).

EXECUTIVE SUMMARY:
City staff has worked with Black & Veatch Consulting Engineers (B&V) to develop a draft report on the Integrated Evaluation of Boulder Reservoir Water Treatment Plant (BRWTP) Source Water Protection and Treatment Improvements (see **Attachment C**). This study evaluates recommendations from two previous reports, the Source Water Quality Planning Study

– Phase I dated 2003 and the Pre-design Report for Near Term Improvements for the Boulder Reservoir Water Treatment Plant dated 2003. The study develops and evaluates alternatives for source water protection and treatment and proposes a long term capital improvement plan for the BRWTP.

Seven alternatives were identified for detailed evaluation. All of the alternatives assumed construction of the mid-term improvements recommended in the 2003 Pre-design Report. A baseline alternative, which included no additional treatment improvements, was evaluated. Five of the alternatives included long-term treatment plant improvements and one alternative included the construction of a pipeline from Carter Lake to the Boulder Reservoir Water Treatment Plant. Each alternative was evaluated based on performance, as well as total present worth cost. The expected performance of each alternative was ranked based on a set of criteria. Performance of each alternative was also evaluated based on the number of barriers it would provide for six key groups of contaminants. Based on consideration of both long term performance and cost, construction of the Carter Lake Pipeline is being recommended as the preferred alternative. Although the capital cost of constructing a pipeline is relatively high, the total present worth cost is comparable to other alternatives.

BACKGROUND:
On October 17, 2005 staff presented an update on the status of two studies (**Attachment A**), the Source Water Quality Planning Study – Phase I Report dated 2003 and the Pre-design Report for Near Term Improvements for the Boulder Reservoir Water Treatment Plant dated 2003. Background information was provided on the quality of the source water and the history of the facility. Source water protection and treatment plant improvement recommendations were made.

The primary long-term recommendation of the Source Water Study was the construction of a pipeline from Carter Lake to the Boulder Reservoir Water Treatment Plant. The 2003 Pre-design Report listed costs for near-term, mid-term and long term improvements at the treatment plant, but made no long-term recommendations. Membranes, ultraviolet (UV) disinfection and ozone were proposed as possible long-term treatment improvements. During this same time period, the city of Boulder participated in a feasibility study performed by the NCWCD to evaluate a pipeline from Carter Lake to the BRWTP. Information on the status of the Carter Lake Pipeline was provided in the October 27, 2005 memo and a subsequent update was presented to WRAB on February 27, 2006 (**Attachment B**).

Information was presented in the October 27, 2005 memo on the status of drinking water regulations. At that time the Long-term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) had not yet been promulgated. This regulation has since been put into effect. Based on current source water quality data, it appears that the Boulder Reservoir WTP source water falls into a Bin 1 category, indicating that no further treatment is required from a regulatory perspective. However, on-going monitoring has indicated both acute and chronic degradation of the BFC and Boulder Reservoir water supplies. Given the increased reliance on this facility and the concern that the current treatment processes may not adequately address the potential contaminant loading, further evaluation was given to long-term capital improvements for the Boulder Reservoir Water Treatment facility that included both source water protection and treatment.

While the city is currently meeting all regulatory requirements, the water quality in areas served by the Boulder Reservoir Water Treatment Plant is vulnerable to degradation as a result of seasonal variation of the water quality in the Boulder Reservoir and acute contamination episodes in the BFC and the reservoir. Of particular concern are microbial contamination, disinfection by-product (DBP) formation, contamination by organic micro-pollutants, manganese, taste and odor concerns and high total dissolved solids and sulfate concentrations. Because these factors pose a potential threat to drinking water quality, the city has established drinking water quality goals that are in some instances more stringent than regulatory requirements. These goals are outlined in Chapter 3 of the attached draft report.

ANALYSIS

In May 2006, the city contracted with B&V to complete the second phase of the source water planning study in which long-term improvements to the treatment process were evaluated in conjunction with the construction of a pipeline in order to develop a long term capital improvement plan for the Boulder Reservoir Water Treatment facility. Alternatives were developed assuming three source water options: seasonal use of the BFC with the Boulder Reservoir utilized during the winter; year-round use of the Boulder Reservoir, eliminating the use of the BFC; and the Carter Lake pipeline. Treatment processes were paired with each source water option based on the water quality limitations of each source. The following seven alternatives were evaluated:

- Alternative 1A: Continue to utilize both the Boulder Feeder Canal and Boulder Reservoir with no additional long term treatment plant improvements.
- Alternative 1B: Continue to utilize both the Boulder Feeder Canal and Boulder Reservoir with UV disinfection.
- Alternative 1C: Continue to utilize both the Boulder Feeder Canal and Boulder Reservoir with UV disinfection and Granular Activated Carbon (GAC) adsorption.
- Alternative 2A: Year-round use of the Boulder Reservoir, eliminating the use of the BFC with no additional long term treatment plant improvements.
- Alternative 2B: Year-round use of the Boulder Reservoir, eliminating the use of the BFC with UV disinfection.
- Alternative 2C: Year-round use of the Boulder Reservoir, eliminating the use of the BFC with ozone.
- Alternative 3: Carter Lake Pipeline.

All of these alternatives assume the construction of the proposed mid-term improvements recommended in the 2003 Pre-design Report.

Process Selection

The proposed treatment processes were selected based on several factors including: integration with the existing treatment process, expected performance and cost. During the evaluation, water contaminants were grouped into seven categories as follows: microbial pathogens; disinfection byproducts; organic micro-pollutants; manganese; taste & odor and total dissolved solids & sulfate. Potential improvements were evaluated based on their ability to address one or more of these seven categories of contaminants. The alternatives were screened to give greater

consideration to those that addressed more than one contaminant, thereby reducing the number and complexity of the treatment process. The Carter Lake Pipeline was the only source water protection improvement considered. Source protection strategies for Boulder Reservoir and the BFC would never achieve the level of protection and security of the Carter Lake Pipeline.

Treatment processes that provide low inactivation/removal of Cryptosporidium were not considered. Filtration technologies including membrane filtration, second stage granular media filtration, and slow sand filtration were not evaluated in this study as they generally only provide inactivation/removal of Cryptosporidium, and provide little in the way of additional barriers for other contaminant categories. Chemical oxidation can potentially provide additional barriers for microbial pathogens, DBPs, organic micro-pollutants, manganese, and objectionable tastes and odors, depending on the oxidant used and its point of application. Addition of chlorine dioxide for DBP, manganese, and taste and odor control is included in the city's mid-term improvements plan, and is therefore assumed as part of the baseline treatment for the long-term improvements evaluated. Ozone was also evaluated in this study because of its superior performance for taste and odor control, ability to oxidize many organic micro-pollutants, and additional pathogen inactivation. UV disinfection was also evaluated due to its superior disinfection performance for bacteria, viruses, and protozoan pathogens. GAC was evaluated in this study based on additional barriers for DBPs, organic micro-pollutants, and objectionable tastes and odors that it may provide.

Performance Evaluation

A decision process for evaluating the alternatives was developed that utilized a performance ranking as well as a net present cost. Criteria were developed to rank each of these alternatives. Each criterion was weighted based on the consensus of its relative importance. The seven alternatives were then numerically rated based on their ability to meet each criterion. The criteria, relative weighting and performance score for each alternative are shown in Table 6.1 of the draft report. Each of the alternatives was also evaluated for the number of barriers it would provide against the seven water quality contaminant categories.

The first three alternatives would not meet the city's water quality goals with respect to TDS and sulfates when raw water is provided from the reservoir. Alternative 1A, the baseline alternative, would not meet the city's water quality goals with respect to pathogens and does not provide an effective organic micro-pollutant barrier. With the addition of UV disinfection, Alternative 1B provides adequate pathogen inactivation, but this alternative would not provide an effective barrier for organic micro-pollutants. With the addition of GAC the concern of organic micro-pollutants would be addressed. Alternatives 1A, 1B and 1C ranked 0.51, 0.56 and 0.61 respectively.

Alternatives 2A, 2B and 2C propose eliminating the use of the BFC. These alternatives provide some potential settling of Cryptosporidium. However, water quality data from the reservoir indicates similar, if not higher, levels of bacteria in the reservoir as the BFC. Aside from the potential of settling Cryptosporidium, these alternatives have the same advantages and limitations as Alternatives 1A, 1B and 1C respectively. Alternatives 2A, 2B and 2C ranked 0.51, 0.57 and 0.61 respectively. Alternative 3, the Carter Lake Pipeline meets all of the city's water

quality goals and provides at least one barrier for each contaminant category evaluated. It ranked 0.94.

A net present cost was calculated for each alternative, taking into account both capital and operations and maintenance costs. A 30 year life cycle was assumed for treatment plant processes, with a 70 year life cycle for the pipeline. The remaining value of the pipeline was credited back in the net present cost evaluation. Operations and maintenance costs included power, chemicals and consumables. The cost of staffing the facility was not included as it was assumed to be constant for all of the alternatives. Capital costs were not included for the mid-term treatment plant improvements. However, maintenance costs for the mid-term improvements were included in all of the alternatives. The present worth cost, capital cost and operations and maintenance (O&M) costs (in $million) are described in chapter 7 of the draft report and are shown below:

Alternative	Description	Present Worth Cost	Capital Cost	O&M Costs
1A	BFC	$5.2	$0	$0.17
2A	BFC & UV	$9.3	$2.4	$0.21
3A	BFC & UV & GAC	$53.4	$21.9	$0.86
2A	BR	$5.5	$0	$0.18
2B	BR & UV	$9.6	$2.4	$0.22
2C	BR & Ozone	$26.9	$13.6	$0.33
3	Carter Lake Pipeline	$16.6	$20	$0.19

While the capital cost of the Carter Lake Pipe line is relatively high, the net present cost is not significantly higher than installing UV and it is significantly less expensive than adding GAC or Ozone.

The 2007-2012 CIP included $36,000,000 for bonded projects. These projects are as follows:

2009 - $25,000,000	Carter Lake Pipeline
2009 - $3,000,000	BRWTP Improvements
2009 - $3,000,000	Barker Dam
2012 - $5,000,000	Betasso Improvements

The 2007 annual average water bill for a single family home was estimated to be $345.10. The city Utilities Division has projected a need for a 3 percent increase in water rates due to inflation. Based on the 2007-2012 CIP bonded projects, the required rate increases (including 3 percent for inflation) and the associated annual average water bill was projected as follows:

Inflationary Increase		Annual bill	Bond Rate Increase	Annual bill
2008	3%	$355.45	10%	$379.61
2009	3%	$366.11	10%	$417.57
2010	3%	$377.09	6%	$442.62
2011	3%	$388.40	4%	$460.32

Based on these assumptions, the average annual single family water bill in 2011 would increase $71.92 in order to fund all of these projects.

There are several reasons to consider improvements to the Boulder Reservoir Water Treatment facility (BRWTP), and specifically the protection of its source water, that will provide long-term benefits to the city. The city is placing a greater reliance on this facility than in the past due to continued planned growth in the city's water service area. Even though currently regulatory requirements are being met, the risk of contaminants entering the source water and passing through the treatment process still exists. The Silver Lake Watershed land was acquired beginning in 1096 and has been protected from public access since 1921. As a result, it consistently and reliably provides high-quality source water for the Betasso WTP. Investing in a pipeline that will protect the source water for the BRWTP far into the future is a worthwhile investment similar to that undertaken by prior generations with the Silver Lake Watershed. The cost of this investment is somewhat reduced because there is currently an opportunity to share costs in constructing the Carter Lake pipeline with other communities.

The BRWTP was originally operated as a summer peaking plant. For the first 10 years of its existence, the treatment plant relied entirely on water taken directly from the Boulder Feeder Canal which only operates in the non-winter months. The ability to pump water from Boulder Reservoir in the winter, when the canal is not in operation, was added later and improvements were made to the treatment plant process in 1993 to allow year-round operation. The BRWTP can be operated year-round, 24 hours a day and has a nominal capacity of 16 MGD. Currently, the plant typically operates during 10 to 11 months of the year with about 3 of those months operating for only 12 hours per day. The amount of time that the plant is operated will increase in the future because the water supplies planned for meeting Boulder's future growth will be delivered through the CBT system. The capacity of this facility was increased in 2005 from 8 to 16 MGD in order to meet the essential indoor demand level of the city, thereby providing redundancy to the Betasso WTP for that portion of the city's water supply that can't be foregone without dire consequences. The BRWTP production has increased from treating 10 percent of the city's total water demand in 1991 to approximately 30 percent in 2005 and is anticipated to provide 40 percent of the total supply on average in the future.

Monitoring beginning in 1997 and continuing until the present has demonstrated an increased level (chronic) of bacteriological contamination in both the canal and the reservoir (Chapter 2). Spiking events have also been observed. 24 hour e-coli monitoring at the BFC facility intake showed spiking events sometimes greater than 2000 colony forming units (cfu's) per 100 mls. E-coli is the best indicator available for the presence of disease causing organisms (pathogens). Spiking events on the canal are probably not limited to microbiological. There are many unmonitored contaminant possibilities from activity and land use along the canal.

A Source Water Assessment and Protection Plan (SWAP) was developed by city staff in conjunction with the Colorado Department of Public Health and Environment as part of the city's regulatory requirements. A SWAP delineates the watershed for each source water and identifies potential sources of contamination. This is followed by an assessment of vulnerability for each potential contaminant. Protection procedures and protocols are then developed. The SWAP assessment of the BFC indicated that the BFC is susceptible to all categories of contaminants. A vulnerability Study was also completed in 2003 by Brown and Caldwell and Versar Inc. This study also documented the BFC as the city's most vulnerable supply.

In the early 1890's, the city of Boulder recognized water quality concerns associated with taking water directly from Boulder Creek near the mouth of Boulder Canyon. Through City Council's direction, a pipeline was built which moved the point of diversion further upstream to an un-impacted watershed above Nederland. In 1906 the city made its first purchase of land and water storage reserviors in the Silver Lake Watershed. City ownership in this area was later expanded and public access was closed. Because the Silver Lake Watershed is protected, the quality of the water is very high and the vulnerability to degradation is low.

The quality of water in Carter Lake is also excellent. It is a deep reservoir with a small natural runoff area and is filled mostly with high quality water imported from the Western Slope. However, as a result of surface runoff into the Boulder Feeder Canal, degradation of the water occurs as it is conveyed from Carter Lake to Boulder Reservoir. Boulder Reservoir is a shallow, low volume reservoir, which is used for recreation and storage for later irrigation use, as well as a water supply. Water that is stored in Boulder Reservoir is further susceptible to increases in TDS including sodium, sulfate, hardness, turbidity and manganese, as well as recreational impacts. The conveyance of Carter Lake water in a pipeline directly into Boulder Reservoir WTP would prevent water quality degradation.

The city of Boulder is currently participating in the development of right-of-way acquisition plans and permit applications for the Southern Water Supply Project II (Carter Lake Pipeline). Other participants include Little Thompson Water District, the town of Frederick and Left Hand Water. The pipeline is estimated to cost $33 million. Depending upon the number of participants, the city of Boulder's share of the cost can range from $20 to $25 million. A previous pipeline project was completed in 1997 and supplied water to the cities of Broomfield, Louisville, Longmont, Superior and eight other water providers.

While the city is currently meeting the LT2ESWTR, an important aspect of the regulation is the recognition of the importance of a multi-barrier approach for treating drinking water. A multi-barrier treatment process provides a number of protective "layers" against contamination by using more than one method of prevention and treatment to remove/inactivate pathogens and minimize disinfection byproducts (DBPs). Cryptosporidium are of particular concern because they are resistant to conventional disinfection methods. TheLT2 acknowledges source water protection as important component to providing safe drinking water. The Carter Lake Pipeline will address both the near-term and potential increase in degradation to water quality of the BRWTP. Although water treatment technology has advanced, treatment processes do fail. Preventing source water contamination provides a more robust barrier than subsequent treatment. The Carter Lake Pipeline would also provide a much more uniform water quality, substantially simplifying the treatment optimization and increasing treatment process reliability.

PUBLIC COMMENT AND PROCESS:
The public process has not been initiated.

NEXT STEPS:
Staff will respond to WRAB questions and comments regarding the draft report. It is anticipated the final report will be presented to the WRAB in May along with other information as part of the city's

Community and Environmental Assessment Process (CEAP).

The report recommendations for the Carter Lake Pipeline will be incorporated in the city's six-year Capital Improvement Program (CIP). It is anticipated that design of the Carter Lake pipeline will begin in 2008 and construction in 2009, although the schedule is subject to approval by not only the city but also other participating water providers and permit review agencies.

The NCWCD should complete right-of-way acquisition plans and permit applications for the pipeline by the end of 2007. This will include an application to Boulder County for 1041J – Matters of State Interest review.

ATTACHMENTS:

Attachment A:	WRAB Information Item - Update on Boulder Reservoir Source Water Protection and Facility Improvements for the Boulder Reservoir Water Treatment Plant dated October 17, 2005
Attachment B:	WRAB Agenda Item – Update on Carter Lake Pipeline Feasibility Study dated February 27, 2006
Attachment C:	Integrated Evaluation of Boulder Reservoir Water Treatment Plant (BRWTP) Source Water Protection and Treatment Improvements Draft Report