C I T Y O F B O U L D E R
WATER RESOURCES ADVISORY BOARD
INFORMATION ITEM

MEETING DATE: January 25, 2016

AGENDA TITLE: Informational Item – Betasso Water Treatment Facility Design Improvements Update

PRESENTERS:
Jeff Arthur, Director of Public Works for Utilities
Douglas Sullivan, Acting Principal Engineer for Water, Wastewater and Stormwater
Tom Settle, Water Treatment Manager
Steve Buckbee, Engineering Project Manager

EXECUTIVE SUMMARY

This agenda item is intended to provide an update on the upcoming Betasso Water Treatment Facility improvements project. City staff and its engineering consultant, HDR Engineers, are in the process of completing design improvements for a major facility upgrade. The Betasso facility was originally constructed in 1964 and has a number of aging treatment process facilities. The Betasso facility requires significant treatment process upgrades to ensure that it can continue to meet current and future drinking water regulations.

The current design project has progressed past the 60 percent design milestone. Final design drawings and bid documents are scheduled for an April 2016 completion. City staff will bid the project's construction phase at that time. The design engineer's 60 percent construction cost estimate is approximately $28 million. An estimated $3 million will be required in addition to the bid amount to fund the project's construction phase services component. This project will involve relatively complex construction phasing to ensure that the treatment processes continue to operate and effectively meet the city's daily water demand and associated treatment regulations throughout the project's construction. The project's construction phase is estimated at a 27-month duration.

The City of Boulder will fund this project through a Water Utility bond in the second quarter of 2016. The current bond amount is estimated at $35 million. The bond's final amount will be set in the second quarter of 2016 after city staff has received the project's 90 percent design construction cost estimate. At that time, City staff will decide if any other Water Utility projects will be included in the bond.

The December 15, 2014 WRAB meeting was conducted at Betasso, which included a tour, and a presentation on the upcoming improvements project. The Betasso project was also identified in the 2016 CIP overview which was presented to the WRAB at the April 27, 2015 meeting. The purpose of this information item is to provide the WRAB a project design update.

BACKGROUND

The City's treated water system is served by two water treatment facilities – the Betasso Water Treatment Facility and the Boulder Reservoir Water Treatment Facility. The Betasso facility and is located several miles up Boulder Canyon west of the City limits. The Boulder Reservoir facility is located in northeast Boulder on 63rd Street immediately north of the Diagonal Highway. This WRAB Information Item focuses on the Betasso facility improvements project. The Betasso facility receives raw water from the City's two primary watersheds – North Boulder Creek and Middle Boulder Creek. These watersheds utilize a network of raw water reservoirs, raw water pipelines, and raw water hydroelectric facilities to convey water to the Betasso facility.

Over the past five years, the City's annual water system demand has averaged approximately six billion gallons. The Betasso facility operates year-round while the Boulder Reservoir facility typically operates seven months a year – between April and October, depending on the City's water demands. Approximately 2/3 of the annual water supply is provided by the Betasso facility and the remaining 1/3 of the water supply is provided by the Boulder Reservoir facility.

The two facilities supplement each other to provide greater redundancy during the higher demand periods. The Boulder Reservoir facility was upgraded years ago with increased capacity to provide greater resiliency to allow the Betasso facility to be taken off-line for maintenance during winter months if necessary. The City's water demand varies significantly from month to month with a baseline water use during the winter months and a much higher water use to address irrigation needs during the summer months. Water production at the two facilities varies from year to year and during the year based on water resource needs, operational requirements and improvement projects.

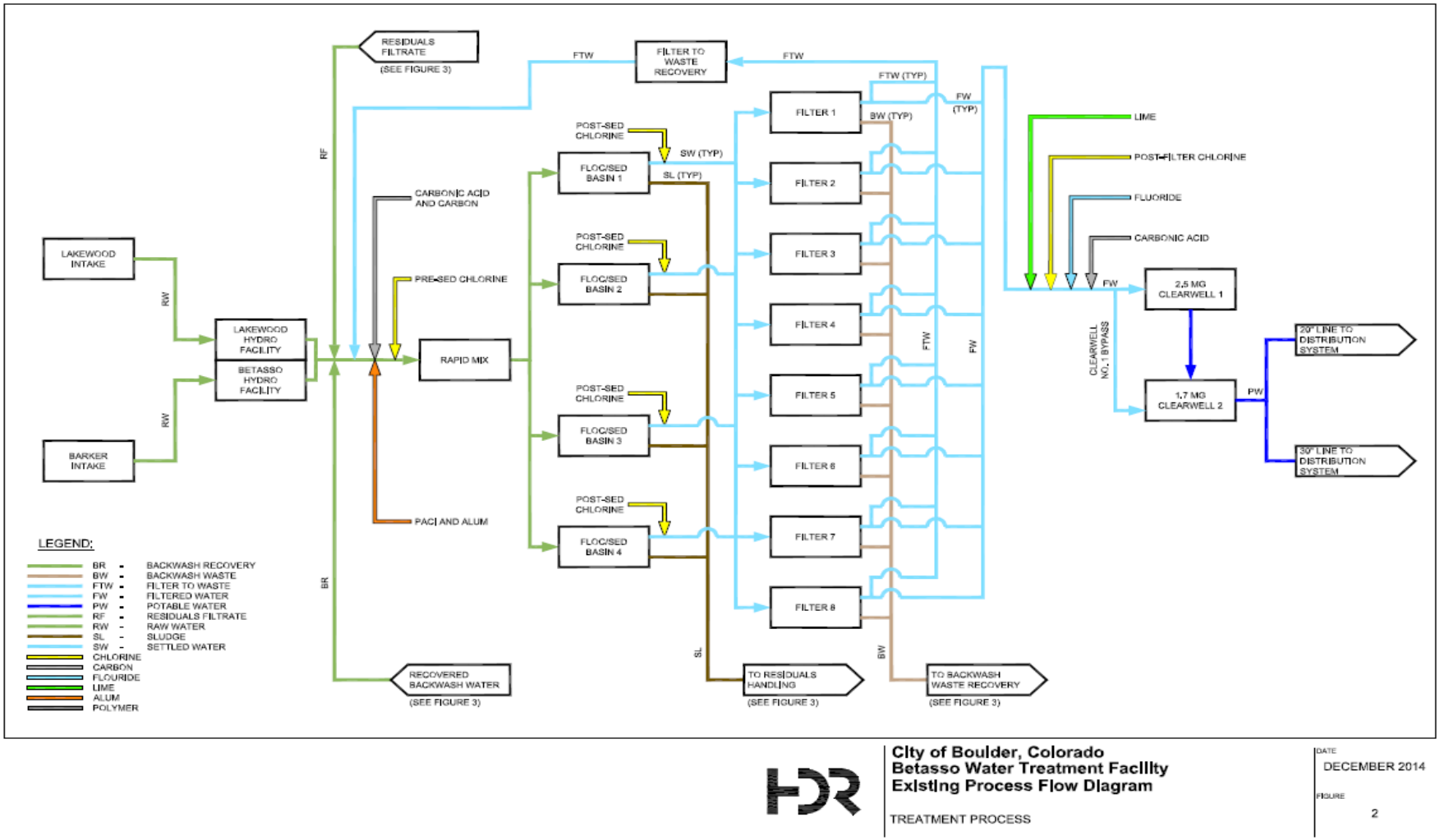
The Betasso facility has a rated capacity of 40 million gallons per day (mgd). However, the facility's reliable treatment capacity is closer to 32 mgd. There are significant operational issues associated with the pre-treatment and residuals handling processes that limit the capacity of downstream treatment processes. The primary purpose of this project is to upgrade the pre-treatment processes, replace equipment at the end of its useful service life, and add a new residuals handling building to ensure the facility has a firm capacity of 40 mgd.

Treatment Process

The Betasso Water Treatment Facility was originally constructed in 1964. A significant facility expansion was completed in 1976 to increase the rated capacity. There have been numerous modifications to the facility throughout the years. The treatment process includes the following key components: chemical addition, rapid mix, flocculation, sedimentation, filtration, and disinfection. Powdered activated carbon can be added upstream for taste and odor control.

Figure 1 provides a flow diagram of the Betasso Water Treatment Facility.

Figure 1 - Betasso Water Treatment Facility – Flow Diagram



HDR

City of Boulder, Colorado
Betasso Water Treatment Facility
Existing Process Flow Diagram

TREATMENT PROCESS

DATE
DECEMBER 2014

FIGURE
2

ANALYSIS

City staff selected HDR Engineers as the design consultant in 2014 for the Betasso improvements project. To date HDR has completed a plant-wide assessment, an alternatives analysis, and a long-term capital improvements plan. HDR is currently working on the project design and is developing updated cost estimates at major project milestones. The 60 percent construction cost estimate is approximately $28 million. **Attachment A** provides the HDR 60% Design Review package highlights (pages 1-6) which includes the current cost estimate and associated schedule.

The current project scope and associated cost estimate are significantly greater than the original project estimated in 2011. There are several reasons for the scope and cost increase. The primary reason for the increase is that last year's 20-year Water Utility CIP identified two Betasso projects instead of one. The first project was scheduled in 2016 and the second project was scheduled in 2026. In 2015, these two projects were combined into a single project which now represents the current design approach. Other factors impacting the cost increase include a scope increase which was based on greater facility needs following the completion of the facility assessment.

The City's approach will utilize a base bid with a few bid alternatives to provide the city flexibility in awarding the contract. Based on the bid price and the city's budget, the bid alternatives could be removed from the bid in the event the bids are higher than expected. Recent Front Range construction bids along with recent City of Boulder construction bids have come in significantly higher than their corresponding engineer's estimated construction cost.

Preliminary design for the Betasso facility improvements project began in September 2014. Major issues identified in the facility assessment and alternatives phases include the following:

- Pretreatment is inadequate to sustain effective treatment at flows in excess of 32 mgd
- During periods of high concentrations of color and total organic carbon in the source water, the filters have limited run time due to turbidity breakthrough
- Residuals thickening, dewatering, and drying processes are insufficient to treat the volume of solids generated
- Replacement of many assets at the end or beyond useful life
- A new backup generator and increased fuel storage

Based on the facility assessment findings, the current project goals include the following:

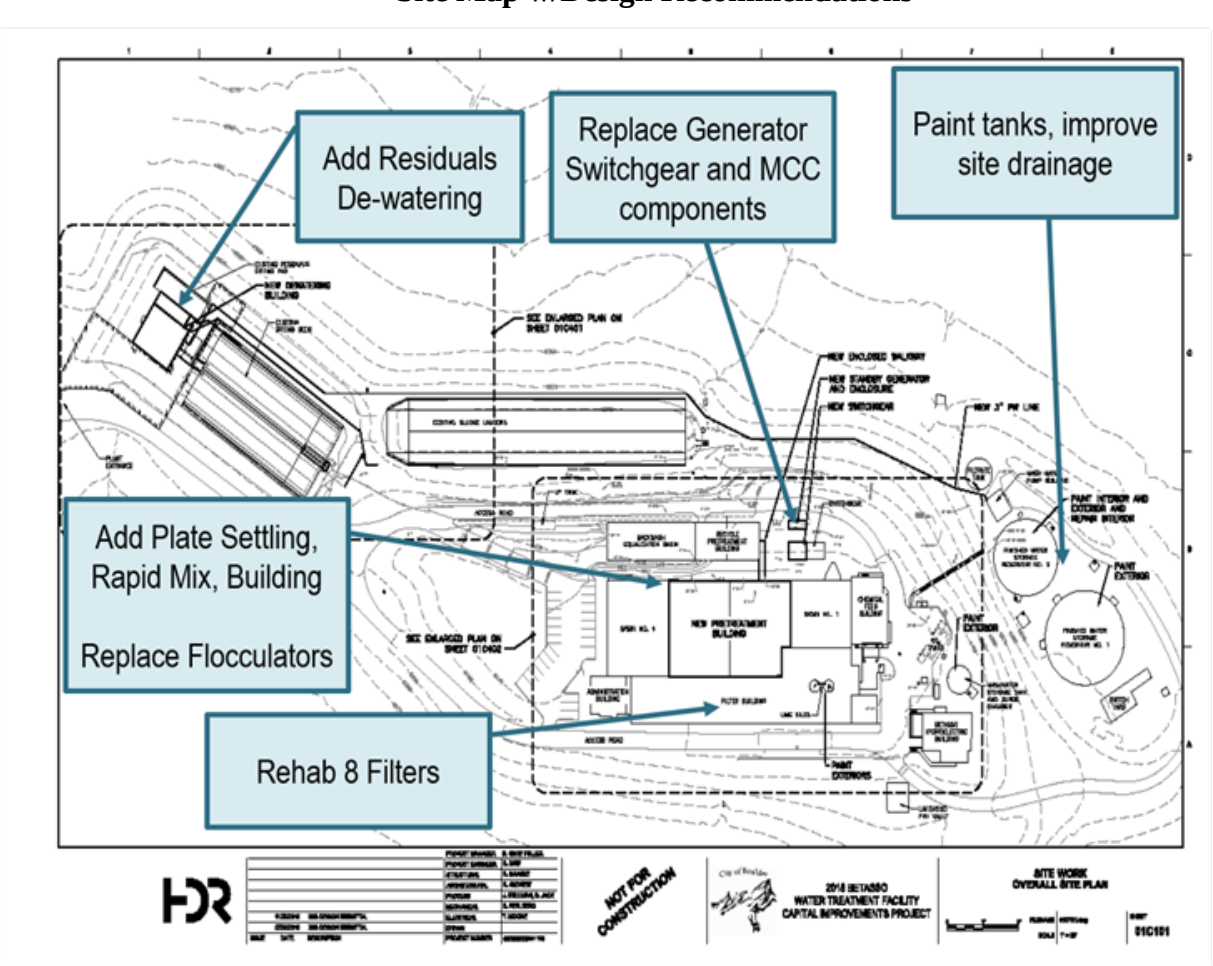
- Provide a sustainable capacity of 40 mgd at all times of the year
- Only haul solid (dry) residuals from the facility
- Replace all equipment at the end of its useful life
- Provide robust pre-treatment
- Retain operational simplicity and gravity flow when possible
- Provide a long term strategic plan for replacing and maintaining assets
- Reuse, repair and repurpose facility infrastructure when possible

Seven major CIP improvements were selected for inclusion in the 2016 design project to address the project goals. These improvements are listed below. **Attachment B** provides the HDR CIP memo highlights (pages 1-8) which includes a description of the seven major process improvements.

- Pretreatment Improvements
- Pretreatment Building Addition
- Filter Improvements
- Filter Valve Replacement
- Residuals Handling Improvements
- Power Reconfiguration and Backup Power Improvements
- Outdoor Tank Improvements

Figure 2 provides a site map of the Betasso Water Treatment Facility with the design recommendations identified.

Figure 2 – Betasso Water Treatment Facility
Site Map w/Design Recommendations



Project Schedule:

- Contractor Prequalification – 1st quarter 2016
- County Special Use Permit Approval – 2nd quarter 2016
- Project Bid – 2nd quarter 2016
- Bond Issuance – June 2016
- Contractor Mobilization – 3rd quarter 2016
- Project Closeout – 4th quarter 2018

NEXT STEPS

WRAB Mid-Project Construction Tour – 3rd quarter 2017

ATTACHMENTS

A – HDR 60% Design Review package (pages 1-6) – Jan 12, 2016
B – HDR CIP Memo (pages 1-8) – September 30, 2015

1. Scope of Work:

This Basis of Estimate (BOE) summarizes the opinion of probable construction costs (OPCC) for the 2016 Betasso Water Treatment Facility Capital Improvements Project (the Project) based on the 60-percent design progress package submitted to the City. The Project's scope has evolved to reflect an estimated $27.4 million construction project incorporating major improvements addressing several key treatment and equipment issues. The major improvements cover a range of facility performance and operational concerns including:

- Pretreatment Basin Improvements
- Filter Improvements
- Filter Valve Replacement Improvements
- Residuals Handling Improvements
- Dewatering Building
- Power Reconfiguration Improvements
- Outdoor Tanks Improvements

The Project facilities to be designed include the following:

- Pretreatment Improvements including two (2) new rapid mix chambers; four (4) new flocculation/sedimentation treatment trains using horizontal paddles, plate settlers and vacuum sludge collection equipment to be located in existing Basins No. 2 and 3, with a new Pretreatment Building covering the treatment trains.
- Filter Improvements consisting of removing existing filter media; repairing filter box wall and floor surfaces; replacing surface wash piping and arms; adding weir plates to backwash troughs; and, installing new filter media.
- Filter Valve Replacement consisting of new filter influent valves, backwash supply valves, backwash drain valves, and surface wash supply valves; new pneumatic valve actuators; new electric actuators on each filter's effluent and filter-to-waste valves, the filter influent header isolation valve and the master backwash valve; and installing new air compressors and compressed air piping.
- Residuals Handling Improvements providing mechanical dewatering using a belt filter press; residuals equalization tank(s); ancillary equipment; located in a new Dewatering Building.
- Power Reconfiguration improvements consisting of new primary service switchgear equipment; new motor control centers (MCC); and, a new standby power generator designed to provide emergency service for operating the entire plant.
- Outdoor Tank improvements consisting of the recoating of Clearwell 1 & 2, the Backwash Water Supply tank, Lime Silo exteriors, and structural repairs to Clearwell 1.
- Balance of C3 Projects consisting of miscellaneous civil, architectural, structural, process, mechanical, electrical, and instrumentation improvements.

2. Method of Accomplishment:

The General Contractor will self perform the earthwork, concrete and all site demolition. All other work including plumbing, process mechanical piping, installation of the process mechanical equipment, HVAC, and electrical and instrumentation will be subcontracted. The GC will staff the project with a full time Construction Manager, Project Superintendent, Project Engineer, Site Safety Manager, and a part time Quality Control Manager. A full time Project Manager will manage the project from the contractor's home office with support as necessary. The GC's site staff will coordinate with the appropriate plant personnel for all onsite construction traffic and construction activities. The General Contractor will monitor both its own forces and all subcontractor craft employees at all times. All work within the existing facility will be done in a manner as to minimize the impact to plant operations. Anticipated major subcontractor packages may include the following:

- Site Development: To include, site grading, site paving, site utilities.
- Building Erection: To include supply and erection of precast concrete.
- Roofing: To include insulation, roof membrane, sheet metal trim and parapet caps.
- HVAC: To include exhaust fans, ductwork, and controls.
- Plumbing: To include above and below grade supply & DWV piping, equipment and fixtures.
- Mechanical: To include setting of equipment and associated piping, supports and hangers.
- Electrical: To include primary electrical service, power distribution, lighting, fire alarm and lightning protection.

3. Estimate Methodology/Type:

This OPCC is based on the 60% design review package "2016 Betasso WTF Capital Improvements Project" dated November 20, 2015 issued by HDR. Detailed quantity takeoffs were developed based on the available documents and the assumptions/exclusions stated above using Bluebeam and estimating software. Costs from similar projects were utilized in conjunction with local subcontractor and vendor budgetary pricing. RS Means and historical data were also used where applicable. Standard productivity rates from similar projects were used for all activities related to the building, site work.

4. Cost Estimate:

The estimate summary below outlines the direct, indirect field costs and other estimate factors used to develop the overall cost estimate for the project. This estimate utilized the following data for the Direct Cost and Indirect cost percentages based on current market conditions, historical data and project estimating experience. Escalation costs are calculated using Bureau of Labor Statistics (2015).

Estimate Totals					
Description	***% of Total***		***Amount***		***Totals***
Labor		$	1,182,241		
Material		$	8,576,603		
Equipment		$	311,363		
Subcontract		$	8,759,321		
Subtotal Const Direct Costs				**$**	**18,829,528**
Contractor's Mob & Demob	4.0%	$	753,181		
Contractor's Field Overhead	7.0%	$	1,318,067		
Contractor's General Condition	3.5%	$	659,033		
Sales Tax Estimate (Exempt)	0.0%	$	-		
Subtotal Field Const Indirect Costs				**$**	**2,730,281**
Contractor's Fee	8.00%	$	1,724,785		
Construction Contingency	10.00%	$	2,328,459		
Escalation Project (2018)	5.41%	$	1,386,691		
Contractor's Bonds & Insurance	1.50%	$	404,996		
Subtotal Other Const Indirect Costs				**$**	**5,844,931**
Total				**$**	**27,404,740**

5. Cost Basis:

- Allowances –
  - Filtrate Discharge Piping - $25,000
  - Sludge Transfer Piping - $25,000
  - Chlorine Scrubber (Demo) - $60,000
  - Overhaul IT closet - $30,000
  - Pretreatment Chemical Feed Improvements - $60,000
  - Compressed Air System - $71,716
  - HVAC - $140,184

- Estimate includes all new motor control centers, disconnects, variable frequency drives (VFD's), low voltage panels and transformers.

- Balance of electrical estimate includes takeoff estimates for grounding, lighting fixtures and switches. The balance is of the estimate is based on a cost per square foot basis.

- Instrumentation estimate is based on takeoffs of devices with ancillary support work quantified and an average cost per device used to cover the conduit, cable and connections required for a complete and operating system.

6. Escalation:

Single Weighted Avg Escalation

Data						
Base Project Cost	% Complete by End of Year	Year	Escalation			
$ 25,613,001.00	10%	2016	1.45%	$	37,209.56	
$ 25,613,001.00	50%	2017	4.47%	$	572,739.90	
$ 25,613,001.00	40%	2018	7.58%	$	776,752.75	
$ 25,613,001.00						
$ 25,613,001.00						
	100%			$	1,386,702.21	5.414%

Escalation estimate based on the Bureau of Labor Statistics

7. Assumptions/Exclusions:

The estimate assumes the following:

- Multiple mobilization / demobilization activities or the general contractor.
- Assumes location provides for sufficient lay-down and staging area.
- All procurements by the general contractor and its subcontractor's.
- All media removal and replacement can be accomplished through existing doorways adjacent to the filter.
- Estimate includes vendor provided budgets for process equipment costs.
- Shutdowns will be limited to occasional 5-day duration during low demand periods (typically Oct 15 to Mar 15). One-day shutdowns may be allowed during specific periods coordinated with the City. Shutdowns will not be allowed from May 15 through August 15.
- Silt fencing assumed to be 3,000 LF. Budget for development of a SWPPP included in the Indirect Cost factor for GC mobilization.
- Asphalt paving pricing based on quantity of 15,000 SF assuming 6" gravel base, 3" base course, and 1" surface course.
- Enclosed walkway slab assumed to be a slab on grade w/o deep foundations.
- Precast concrete budget pricing as provided by Stresscon.

- Interior masonry walls at the Dewatering Building are standard 8" CMU and are painted.
- Floor grating priced as 1 ¾" x 3/16" aluminum
- Elevated walkway handrail priced as 1 ½" diameter aluminum two (2) rail system 3'-6" high with posts at 5' O.C.
- Recessed wheel guides at the Dewatering Building priced as C8x11.5 "C" channel members.
- Building flashings priced as aluminum.
- Roofing assumed to be fully adhered TPO.
- Doors and frames priced as standard gauge hollow metal.
- Door hardware is priced as basic code compliant hardware sets for each opening.
- Insulated rolling overhead doors are priced as standard metal, manual operation doors w/ electric door openers.
- Preparation and coating of piping in existing pipe gallery is an allowance
- Clearwell's 1 & 2, Washwater Tank, and lime silo restoration costs are included.
- Enclosed walkway is priced as a pre-engineered metal building style enclosure. Metal wall panels and metal roof and windows.
- The electrical and instrumentation estimates are based upon the scope illustrated in the drawings and coordinated with respective discipline engineers.
- Training and testing will be coordinated by the GC with the City in advance of startup and commissioning phase activities.

The estimate excludes the following:

- All permits, regulatory fees, environmental fees or requirements and acquisition of such.
- Any work related to hazardous materials or waste.
- Any rock excavation or excavation of unforeseen underground obstacles.
- Dewatering for underground work.
- *Force Majeure*, or schedule delay based on weather related events.
- Bypass pumping
- Security systems.
- Painting, tagging, labeling of any exposed conduit.
- Site security measures.
- Any overtime or holiday work.
- The estimate does not include costs associated with an extended work week.
- The estimate does not include any extended warranty costs.
- Lead paint and asbestos abatement

8. Project Schedule:

The estimated costs are based on a 27 month construction schedule with notice to proceed approximately received in September of 2016 and final completion approximately November 2018.

Construction Phase	Start Date	Finish Date
Contract Award	Jul 2016	Aug 2016
Notice to Proceed	--	Sep 2016
Mobilization	Sep 2016	Sep 2016
Construction	Oct 2016	Aug 2018
Substantial Completion	Aug 2018	Oct 2018
Project Closeout	Oct 2018	Nov 2018

9. Level of Confidence:

Many factors determine the level of confidence for an estimate based on preliminary design documents. Those factors can include but are not limited to the following: local subcontractor and vendor budgetary pricing, the level of design defined for developing the OPCC and the undefined scope of work. The logistics for accessing, maneuvering within and storing equipment/materials at the proposed construction site as it relates to the surrounding area is also taken into consideration. Major equipment pricing is based on budgetary quotes provided by various equipment manufactures. The project site is located in a remote area with limited access to construction vehicles and oversize transport deliveries. Based on the information above and AACE guidelines, this OPCC was developed as a Class II Plus estimate with a 10% construction contingency. The margin of error for this estimate is L: -15% H: +25%.

10. Reconciliation:

Direct Costs

30% vs. 60% Update

Description	30% Design August 11 2015	60% Update January 12 2016	Difference	Percentage Plus or Minus	Comments
Labor	$ 1,399,876	$ 1,182,241	$ (217,635)	-16%	Decrease in Electrical labor allowance vs actual
Material	$ 7,871,923	$ 8,576,603	$ 704,680	9%	Prior Electrical was an allowance vs actual pricing
Equipment	$ 307,389	$ 311,363	$ 3,974	1%	
Subcontract	$ 6,894,460	$ 8,759,321	$ 1,864,861	27%	More defined scope/quantities for demolition, precast erection and sequencing of basin construction
Totals	$ 16,473,648	$ 18,829,528	$ 2,355,880	14%	

Indirect Costs

30% vs. 60% Update

Description	30% Design August 11 2015	60% Update January 12 2016	Difference	Percentage Plus or Minus	Comments
Contractor Mobilization	$ 658,946	$ 753,181	$ 94,235	14%	Increase in Directs raises Indirects
Contractor Field Overhead	$ 1,153,155	$ 1,318,067	$ 164,912	14%	Increase in Directs raises Indirects
Contractor Field General Conditions	$ 576,578	$ 659,033	$ 82,455	14%	Increase in Directs raises Indirects
Tax	$ -	$ -	$ -		Exempt
Contractor Fee	$ 1,508,986	$ 1,724,785	$ 215,799	14%	Increase in Directs raises Indirects
Construction Contingency	$ 4,074,263	$ 2,328,459	$ (1,745,804)	-43%	Lowered from 20% to 15%
Escalation	$ 1,557,183	$ 1,386,691	$ (170,492)	-11%	Update figures raised to 5.414%
Contractor Bonds & Insurance	$ 390,041	$ 404,996	$ 14,955	4%	
Totals	$ 9,919,152	$ 8,575,212	$ (1,343,940)	-14%	

Total Costs

30% vs. 60% Update

Description	30% Design August 11 2015	60% Update January 12 2016	Difference	Percentage Plus or Minus	Comments
Direct Costs	$ 16,473,648	$ 18,829,528	$ 2,355,880	14%	More well-defined scope
Indirect Costs	$ 9,919,152	$ 8,575,212	$ (1,343,940)	-14%	Lower contingency and updated escalation rate
Totals	$ 26,392,800	$ 27,404,740	$ 1,011,940	4%	

11. Reconciliation Summary:

The increase in the direct costs can be attributed to the following:

- The costs for the additional electrical equipment, materials and added scope changes increased adding up to an additional amount of $629,299 for the electrical and an additional $75,000 for the instrumentation
    - 600kW emergency generator to be reduced in size
    - Added Heat trace panel and wiring in the Dewatering Building
    - Add 5 sections of MCC's in Dewatering Building
    - Added two 10HP VFD's to the Dewatering Building
    - Added new work in the filter area not previously defined
    - Switchgear 1 revised with numerous additions and deletions
    - Switchgear 2 is new with numerous additions and costs shifted from Switchgear 1
    - Pretreatment Basins
    - Multi-Source ATO System
    - Multi-Source ground fault system
- The vendor pricing received from engineering for the cost of materials and equipment for major components.
    - MRI Inclined Plate Settlers - $1,900,000
    - MRI Sludge Collectors - $360,000
    - MRI Filter Weir Plates - $95,325
    - Horizontal Paddlewheel Flocculator - $375,000
    - Screw Conveyors - $175,000
    - Pretreatment Vertical Rapid Mixers - $286,000
    - Vertical Dewatering EQ Tank Mixers - $48,800

1 Introduction

The Betasso Water Treatment Facility (BWTF) is the primary treatment facility in the City of Boulder's (City) potable water system. The BWTF was constructed in 1964 as a conventional surface water treatment plant that receives its raw water supply by gravity from Barker Reservoir and Silver Lake. Treated water is delivered from the BWTF to the distribution system via two gravity transmission lines. Although the BWTF is designed for 50 million gallons per day (mgd), it can only reliably produce about 28 mgd on a consistent basis.

The BWTF site is located west of the City at approximately 6,400 feet of elevation, with limited unused land area due to the topography of the site. Figure 1 illustrates the overall layout of the BWTF with the major elements of the facility highlighted to indicate their primary function. Figure 2 and Figure 3 provide a general process flow diagram for the BWTF representing the primary treatment system and the residuals handling system, respectively.

The City's most recent master planning effort for the BWTF was completed in 2011 (Treated Water Master Plan, MWH). Since that time, the City has completed several other studies for the BWTF including the 2014 Residuals Study (Brown and Caldwell) and the 2014 Filter Study (Arcadis). In September 2014, the City's Utilities Division launched the Betasso Water Treatment Facility Capital Improvements Project (project) with HDR. The primary objectives of the project include:

- Provide a 20-year Capital Improvements Plan (CIP) for the BWTF
- Identify improvements for implementation in 2016-2018 and complete preliminary design of the improvements
- Prioritize BWTF asset replacement
- Identify the improvements required to achieve a 40 million gallon per day (mgd) capacity at the BWTF

The project is divided into the major tasks outlined below.

Summary of Project Tasks	
Task 100	Project Coordination
Task 200	Data Collection & Review
Task 300	Facility Assessment
Task 400	Alternatives Analysis
Task 500	Capital Improvement & Implementation Plan
Task 600	Preliminary Design of Phase 1 Improvements

This CIP Memo represents the culmination of Task 500 Capital Improvement & Implementation Plan. Prior to this memo, the terminology “Phase 1” was used to refer to the large CIP project that the City will implement in 2016-2018. Additional phases have not been identified. Therefore, the term “Phase 1” has been replaced in this memo by “2016 Capital Improvements Project” or “2016 Project”.

The objectives of Task 500 were to establish the scope of improvements for the 2016 Project, develop conceptual designs for the 2016 Project improvements, and develop a 20-year CIP for the BWTF. This memo addresses the following topics:

- Background information used to develop the recommended improvements
- Descriptions and conceptual designs for the Major CIP improvements recommended for the BWTF
- Miscellaneous plant improvements recommended for the BWTF
- A proposed scope of work and engineering opinions of probable construction costs for the 2016 Project
- Descriptions and planning budgets for long-term CIP projects, maintenance projects, and future studies
- Implementation schedules for the 2016 Project and the 20-year BWTF CIP

2 Background

The Facility Assessment was completed in January 2015 and consisted of a series of site visits, staff interviews, and a multi-discipline condition assessment of the BWTF. The assessments identified 183 items related to various operational, maintenance and performance issues at the BWTF (Appendix D, Facility Assessment Memo, January 6, 2015). The issues were categorized into CIP ("C") or maintenance projects ("M") and were assigned a criticality rating on a scale of 0 to 6. Issues with a criticality rating of 3 or less require attention in the next 5 years, while issues with a criticality rating of 4 through 6 require attention in the next 5 to 20 years.

Following the Facility Assessment, several key issues were evaluated during the Alternatives Analysis including pretreatment improvements, residuals handling, standby power and valve actuators (Alternatives Analysis Memo, March 13, 2015). This analysis resulted in the following recommendations:

- **Pretreatment** – Plate settlers are the preferred pretreatment technology for installation in the existing floc/sed basins.
- **Residuals Handling** – A belt filter press is the preferred option for dewatering residuals, with a new Dewatering Building.
- **Standby Power** – A new diesel generator is the preferred standby power option to be integrated into the power reconfiguration strategy for the BWTF and to provide standby power to the entire facility.
- **Valve Replacement** – Pneumatic actuators for open/close service and electric actuators for modulating service are the preferred types for the filter valve actuators that will be replaced in the Pipe Gallery.

Development of the CIP and Implementation Plan was initiated to summarize formal recommendations for CIP projects, maintenance projects and those issues requiring further evaluation. To begin, all of the CIP issues identified with a criticality rating of 3 or less were consolidated into a short-term CIP projects list. (See Appendix A.) These issues were then reviewed in conjunction with the recommended alternatives identified during the Facility Assessment and used to prepare a draft list of Major CIP improvements for the BWTF. The following section addresses the recommended Major CIP improvements.

3 Major CIP Improvements

A workshop was conducted with City staff on March 31, 2015 to review the draft list of Major CIP improvements. (A copy of the workshop notes is provided in Appendix B.) Based on the results of the discussions during the workshop, the following seven Major CIP improvements were selected for further consideration for the 2016 Project:

- Pretreatment Improvements
- Pretreatment Building Addition
- Filter Improvements
- Filter Valve Replacement
- Residuals Handling Improvements
- Power Reconfiguration Improvements
- Outdoor Tank Improvements

Figure 4 provides a site plan of the BWTF showing the location of the improvements listed above. Figure 5 and Figure 6 illustrate the process flow diagrams with the improvements incorporated into the main treatment process and the residuals handling system, respectively. The following project descriptions highlight the concepts used to develop each Major CIP improvement.

3.1 Pretreatment Improvements

The pretreatment system at the BWTF consists of rapid mix, flocculation, and sedimentation. The entire pretreatment process will be upgraded to enhance the BWTF's treatment capacity and performance. This will be accomplished by converting existing Basins No. 2 and 3 into four (4) new pretreatment trains, with Basins No. 1 and 4 removed from service. New concrete structures will be constructed inside the existing basins, with the basin roof/topsoil and intermediate floor slab removed. The four new pretreatment trains will provide a total treatment capacity of 40 mgd and a total hydraulic capacity of 50 mgd. Figure 7 through Figure 11 illustrate the conceptual design. The key elements of the pretreatment improvements are:

- Raw water flow control/metering using magnetic flow meters and flow control valves
- Two (2) concrete dual-chamber rapid mix basins for each set of new pretreatment trains, complete with two (2) vertical mixers each, flow splitting weirs, and influent piping connections to the existing raw water piping

- Chemical feed piping for aluminum sulfate, polyaluminum chloride, coagulant polymer, powder activated carbon, and lime
- Three-stage baffled flocculation using horizontal paddle flocculators
- Stainless steel plate settler modules with integral settled water launders
- Effluent channel and piping connecting to existing filter influent piping in the Pipe Gallery
- Low profile hoseless vacuum sludge collector systems with transfer piping
- Basin drain piping and valves

3.2 Pretreatment Building Addition

A new Pretreatment Building will be constructed over existing Basins No. 2 and 3 to enclose the four (4) new pretreatment trains. The building enclosure will prevent the formation of ice on the surface of the water in the vicinity of the plate settlers and it will also provide safe access to the pretreatment process. The building will include the following features:

- Textured precast concrete panels
- Concrete double-tee roof
- Exterior windows
- Internal lighting
- Internal concrete walkways
- Access doors to the existing Filter Building
- Enclosed walkway access to the DAF Building

3.3 Filter Improvements

During the Facility Assessment, the existing clay tile underdrain in Filter No. 6 was determined to be in good condition. Consequently, the filter improvements that are planned for the 2016 Project are based on the premise that the existing clay tile underdrains will remain in place in all eight filters. Key elements of the filter improvements are as follows:

- Removal of the filter media and support gravel
- Cleaning and grout repair of the underdrains
- High-pressure washing of the concrete surfaces in the filter box above the underdrains, including the backwash troughs
- Applying waterproof coatings to submerged concrete surfaces

- Replacing surface wash arms and supply piping
- Installing leveling weir plates on the concrete backwash troughs
- Installing 12 inches of new support gravel, 14 inches of new silica sand, and 18 inches of new anthracite

The City will complete the rehabilitation of Filter No. 6 prior to the 2016 Project to maintain filter capacity entering the high demand season. Consequently, the filter improvements to be included in the 2016 Project will be performed in seven (7) of the eight (8) existing filters. Figure 12 and Figure 13 provide a typical filter plan view and section illustrating the filter improvements, respectively.

In the event that the underdrains in Filters No. 1-4 need to be replaced in the 2016 Project, these four filters will undergo a complete renovation including the key elements listed above plus the following:

- Removing the existing clay tile underdrains
- Removing the existing concrete backwash troughs
- Installing new gravel-less air scour underdrain laterals and air supply piping from the Pipe Gallery
- Installing new fiberglass backwash troughs at a higher elevation than the original troughs

3.4 Filter Valve Replacement

The BWTF filter valves consist of a combination of open/close pneumatic butterfly valves and modulating electric butterfly valves. During the Facility Assessment, the electric valves were determined to be in good condition while the pneumatic valves were determined to be in poor condition. With regards to actuators, both the pneumatic and electric actuator types were determined to be in poor condition. Consequently, the filter valve replacement for the 2016 Project will replace the following for each of the eight filters:

- 6-inch surface wash – pneumatic valve and actuator
- 30-inch filter influent – pneumatic valve and actuator
- 30-inch backwash supply – pneumatic valve and actuator
- 36-inch backwash waste – pneumatic valve and actuator
- 12-inch filter to waste – electric actuator only
- 14-inch filter effluent – electric actuator only

The new butterfly valves will either be flanged or wafer style. The existing piston-type pneumatic actuators will be replaced with vane-type pneumatic actuators. In addition to the valve/actuator replacements listed above, the entire compressed air system will be replaced with two (2) new air compressors, receiving tanks, air dryers, and compressed air piping. Figure 13 illustrates the valve and actuator replacements on a typical filter section view.

3.5 Residuals Handling Improvements

The residuals handling strategy at the BWTF has evolved over the course of the project from the initial objective of thickening residuals (sludge) to an emphasis on dewatering residuals for hauling and disposal. The major CIP improvements include a new Dewatering Building with a gravity belt thickener (GBT) / belt filter press (BFP). The building will be located between the existing residuals drying beds and the residuals drying pad. Figure 14 through Figure 16 illustrate the general site plan and equipment arrangement for the facility. Other key elements of the improvements include:

- Partially-buried concrete residuals equalization tanks with vertical mixers located adjacent to the Dewatering Building
- A combined GBT/BFP dewatering unit with ancillary equipment including feed pumps and polymer feed system
- Screw conveyors for transferring dewatered sludge to containers or an exterior dewatering pad
- An interior bay for two (2) roll-off containers or trailers
- Transfer piping to the existing drying beds and lagoons to provide a backup discharge location for sludge
- Associated transfer, drain and washdown service piping
- Access roads for truck loading/unloading of the roll-off bins from the facility entrance road

3.6 Power Reconfiguration Improvements

The primary objective of the power reconfiguration improvements is to replace and relocate equipment past the end of its useful life and to increase the reliability of the facility's electrical distribution system. The power reconfiguration improvements will consist of the following key elements:

- Remove electrical equipment that is at the end of its service life

- Modify, expand, or mirror the existing DAF switchgear to serve as the primary plant electrical distribution point, with radial feeder circuits to motor control centers (MCCs) distributed throughout the facility
- Modify feeder circuits to some MCCs to reduce “daisy-chain” power feeds and improve reliability and maintainability
- Provide a new diesel generator with capacity to power the entire facility
- Provide for a future means to deliver power from the hydropower plant into the BWTF electrical distribution system

Figure 17 illustrates the recommended power reconfiguration improvements.

3.7 Outdoor Tank Improvements

The BWTF site has a number of large outdoor above-grade steel tanks. Three of the tanks are in need of repairs including the two clearwells and the Wash Water Tank. The key elements of the outdoor tank improvements consist of the following:

- Sand blast and paint exterior of Clearwell No. 1
- Sand blast and paint interior and exterior of Clearwell No. 2
- Sand blast and paint exterior of Wash Water Tank
- Replace up to 20 percent of the steel roof rafters in Clearwell No. 2

The improvements listed above are noted on Figure 4.

4 Miscellaneous Plant Improvements

The majority of the CIP issues with a criticality rating of 3 or less are addressed by the seven Major CIP improvements outlined in the previous section. The remaining CIP issues with a criticality rating of 3 or less are referred to as “miscellaneous plant improvements” and are summarized in Table 1. Detailed descriptions and cost estimates associated with each of these improvements are included in Appendix B.