

Date: 8/24/2020

To: Walt Schwarz, PE

From: Jason Schaefer, PE

Subject: Bell Mountain Ranch Water Treatment Study: 1.3 MGD

The Town of Castle Rock (Town) contracted Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) to develop a planning-level design for the expansion of the existing Bell Mountain Ranch Water Treatment Plant (WTP), solids handling system, and transmission/distribution system to the Bell Mountain Ranch (BMR) development. This memorandum summarizes the various design aspects of the proposed expansion and includes conceptual cost estimates for each aspect of the design.

Background

The current WTP is capable of treating 504 gallons per minute (roughly 0.75 MGD) via eight (8) parallel ion exchange units to remove iron and manganese. The water treated by ion exchange is dosed with sodium hypochlorite and caustic soda prior to entering the unbaffled clearwell. Four (4) existing high service pumps deliver water to the two BMR's two (2) storage tanks. The waste from the ion exchange, which is high in salt and contains radium, is currently discharged directly to the Glade Gulch.

In order to develop a planning-level design for the expansion of the WTP, Burns & McDonnell reviewed existing documentation provided by the Town – including previous studies, property information, and water quality data. A tour of the existing facility was conducted on May 14 with Burns & McDonnell and Town staff. Additionally, a kick-off meeting was held on May 21 that established a target finished water flowrate of 4 MGD for the WTP expansion. However, the scope of an expansion of this size did not correspond with current goals for the Town. Therefore, on August 7 the Town established a goal of 1.3 MGD from the WTP. This target flowrate was chosen based on the maximum flowrate achievable without significant expansion, and the ability to use the existing high service pump station without alterations.

Raw Water Sources

Currently, the WTP is served by two existing wells, each capable of providing 500 gpm (0.72 MGD). In order to expand finished water treatment to 1.3 MGD, the Town will need to expand the raw water sources by 480 gpm (0.7 MGD). Burns & McDonnell suggests expanding the raw water supply to have redundant sources, but expansion of the raw water supply is not included in this report.

Treatment Options

The existing ion exchange treatment process is proposed to be replaced with pressurized greensand filtration vessels. The proposed treatment train is shown in the Process Flow Diagram

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in Figure 1 and generally consists of pressurized greensand filtration vessels in a pre-engineered metal building addition. Sodium hypochlorite and sodium permanganate are proposed as pre-oxidants to aid the greensand filters in the removal of iron, manganese, and radium from the raw water. Sodium hypochlorite will also be used as the primary disinfectant, with caustic soda for pH adjustment and a liquid ammonium sulfate (LAS) system to produce chloramine residuals in the distribution system. A backwash waste tank is proposed as a part of the new solids handling process. The Design Criteria in Figure 2 provides detail on the quantities and capacities associated with the proposed expansion.

The existing WTP's clearwell and high service pump station will be reused without alteration, and the existing building will house the air compressors, receive and the expanded chemical systems. The existing clearwell, a 30,000-gallon, unbaffled steel tank, was built with the original plant. Colorado Department of Public Health and Environment (CDPHE) requires groundwater systems to maintain a 0.2 mg/L residual, measurable at the entrance and furthest extent of a distribution system. Due to the existing clearwell's lack of baffles and potential to short circuit, it will not provide 4-log virus inactivation.

If there is measurable microbial activity, the groundwater system must be taken offline until the issues have been corrected and the system can be put back online. As the BMR distribution system will be connected to the Town's system, if there are any issues in the BMR WTP or distribution system and the WTP must be shut off, water can be delivered to the BMR area from the Town via the new pump station and pipeline discussed below.

Backwash Residuals System

A backwash residual system is proposed in addition to the pressurized greensand vessels. Backwash waste from the greensand filters will be dosed with alum to thicken solids prior to entering the backwash waste tank. The backwash waste tank will provide settling and thickening for solids before the solids are pumped to a tanker truck for hauling to the Town's Plum Creek Water Purification Facility (PCWPF) for processing. To decrease water waste, the backwash waste tank will also include a pumped backwash recover line to recycle decanted backwash waste to the greensand filters vessels.

Distribution

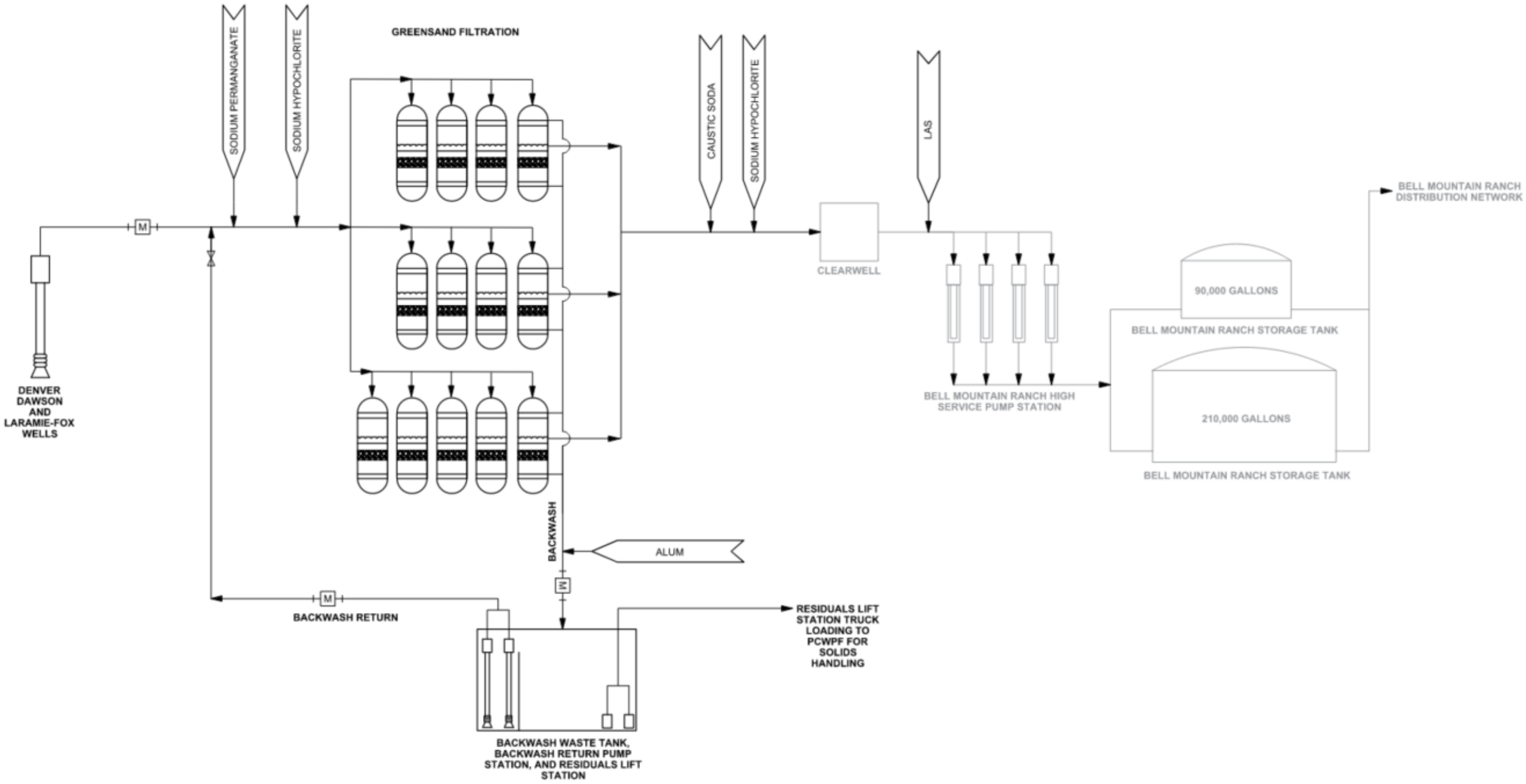
The high service pump station (HSPS) consists of two (2) 475 gpm pumps, and two (2) 180 gpm pumps, for a total installed capacity of 1.88 MGD (1,310 gpm) with no redundancy. The HSPS pumps finished water from the clearwell to the two BMR storage tanks. The water then flows by gravity into BMR's high-pressure zone via a network of 8- and 12-inch pipes. The water will move by gravity from the BMR (HGL 6940) area to the Town's Green Zone (HGL 6805).

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The 8-inch connection piping as designed by Wright Water Engineers will have a maximum delivery capacity of 1 MGD. This piping will need to be increased to 10-inches if the Town would like to receive 1.3 MGD from the BMR WTP.

Burns & McDonnell included a pump station and 10-inch pipe that can deliver water from the Town into the BMR high-pressure zone. This connection allows the Town to provide water to the BMR area in the event that the BMR WTP is temporarily taken offline. See Figure 4 for a proposed location of the pump station and 10-inch pipe from the Town to BMR.

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	BELL MOUNTAIN RANCH PROCESS FLOW DIAGRAM		project
			contract
	FIGURE 1		-
	date 8/14/2020 designed B. YAFFE		SK -

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BELL MOUNTAIN RANCH WATER TREATMENT PLANT EXPANSION					
Raw Water		Chemical Feed System		Clearwell (Existing)	
Maximum Capacity (MGD)	1.3	Sodium Hypochlorite	Preoxidant & Disinfection	Volume (gal)	30,000
		Solution Concentration (%)	12.5		
Greensand Filter		Storage Weight (gal)	900	High Service Pump Station (Existing)	
Maximum Capacity (MGD)	1.3	Number of Feed Pumps	2+1	Pumps	3+1
Loading Rate (gpm/ft2)	5	Maximum Dosage Preoxidant (mg/L)	2.5	Type	Vertical Turbine Pump
Backwash Rate (gpm/ft2)	12	Maximum Dosage Disinfection (mg/L)	2.5	Capacity (gpm/pump)	475 (2), 180 (2)
Number of Filter Units	12+1			Installed Capacity (gpm/MGD)	1,310 / 1.88
		Sodium Permanganate	Preoxidant		
		Solution Concentration (%)	20	Backwash Waste Water Tank	
		Storage Volume (gal)	55	Volume (gal)	30,000
		Number of Feed Pumps	1	Residuals Pumps	2
		Maximum Dosage (mg/L)	0.15	Residuals Pumps Capacity (gpm/pump)	50
				Backwash Return Pumps	2
		Alum	Water Treatment Residuals	Backwash Return Pumps Capacity (gpm/pump)	100
		Solution Concentration (%)	48.5		
		Storage Volume (gal)	110		
		Number of Feed Pumps	2		
		Maximum Dosage (mg/L)	2		
		Caustic Soda	pH Adjustment		
		Solution Concentration (%)	50		
		Storage Volume (gal)	900		
		Number of Feed Pumps	2		
		Maximum Dosage (mg/L)	30		
		Liquid Ammonium Sulfate	Chloramine Residual		
		Solution Concentration (%)	38		
		Storage Volume (gal)	300		
		Number of Feed Pumps	2		
		Maximum Dosage (mg/L)	2		



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BELL MOUNTAIN RANCH
DESIGN CRITERIA

FIGURE 5

project

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date 8/13/2020
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TOWN OF CASTLE ROCK
MODIFIED BELL MOUNTAIN RANCH
WATER TREATMENT PLANT

project	125295
contract	
SK -	202

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LINEAR FEET OF 10-INCH PVC = 8,000

BURNS MCDONNELL date 8/14/2020 designed B. YAFFE	BELL MOUNTAIN RANCH DISTRIBUTION PIPING	project
		contract
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Cost Estimate

Table 1 summarizes the estimated total project construction costs with a detailed estimate attached to this memorandum. These costs include contractor general conditions, contractor overhead and profit, contingency, and engineering costs. This cost estimate is in line with Association for the Advancement of Cost Engineering (AACE) Class 4, which have an expected accuracy range of -15% to -30% on the low side and +20% to +50% on the high side. Projected project costs assume an escalation rate of 3.5%.

Table 1: Estimated project cost summary

Project Component	Total Cost
WTP Expansion (Including Solids Handling)	\$4,164,000
Distribution Pipeline and Pump Station	\$5,25,000
Total 2020 Project Cost:	\$9,689,000
Total 2021 Project Cost:	\$10,028,000
Total 2022 Project Cost:	\$10,379,000
Total 2023 Project Cost:	\$10,742,000
Total 2024 Project Cost:	\$11,118,000
Total 2025 Project Cost:	\$11,507,000

These conceptual opinions of probable construction costs rely primarily on Burns & McDonnell's experience and judgements as professional consultants combined with information from past experience, vendors, and published sources.

The construction industry has experienced dramatic cost changes in materials in the past decade. Material costs for concrete, steel, copper, and other metals continue to fluctuate. Recent government and banking industry issues have contributed to even more overall economic uncertainty. The instability of fuel prices affects nearly all material costs. Many other items can also influence the local bidding environment. Burns & McDonnell has no control over weather, cost and availability of labor, material and equipment, labor productivity, construction contractor's procedures and methods, unavoidable delays, construction contractor's methods of determining prices, economic conditions, government regulations and laws (including the interpretation thereof), competitive bidding or market conditions and other factors affecting such opinions or projections; consequently, the final costs may vary from the opinions of costs presented here. Moreover, the cost opinions presented here are only conceptual in nature and can vary significantly as design and detail is added to the project. Project budgets should continue to be carefully reviewed at regular intervals to assist in the decision-making process.

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Conclusion

In order to address treatment goals and allow for planned future water supply expansion near the BMR development, Burns & McDonnell proposes the following project components to expand the WTP:

- Expansion of the WTP to include greensand filtration
- Backwash recovery system
- Residuals tank and lift station for trucking thickened solids to Plum Creek Water Purification Facility for solids handling
- 10-inch distribution pipeline to connect the BMR distribution network to the Town's network
- Pump Station to deliver water from the Town to the BMR distribution network

The estimated cost for this project in 2020 dollars is \$9.7 million.

JJS/bgmy

Attachment:
Conceptual Design Cost Estimate

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OPINION OF PROBABLE CONSTRUCTION COST Bell Mountain Ranch Expansion Town of Castle Rock, CO

BMCD - 125295

Treatment Plant Expansion

Description	Unit	Quantity	Unit Cost	Total Cost
Site/Facility Work				
Demolition	LS	1	\$50,000	\$50,000
Backwash Recovery Tank (30,000 gallons)	LS	1	\$400,000	\$400,000
Treatment Building	SF	900	\$500	\$450,000
Electrical	LS	1	\$284,000	\$284,000
Sitework	LS	1	\$400,000	\$400,000
Equipment				
Greensand Filtration	LS	1	\$285,000	\$285,000
Sodium Hypochlorite System (Feed Equipment and Containment)	LS	1	\$35,000	\$35,000
Alum System (Feed Equipment and Containment)	LS	1	\$20,000	\$20,000
Caustic Soda System (Feed Equipment and Containment)	LS	1	\$20,000	\$20,000
Ammonia System (Feed Equipment and Containment)	LS	1	\$20,000	\$20,000
Solids Lift Station Pumps	EA	2	\$35,000	\$70,000
Backwash Water Decant Pumps	EA	2	\$35,000	\$70,000
Sub Total Equipment			\$450,000	
Pipe & Valves		20%		\$90,000
Installation		40%		\$180,000
Material and Labor Subtotal				\$2,374,000
Contractor's General Conditions (12%)				\$285,000
Material and Labor plus General Conditions				\$2,659,000
Contractor Overhead and Profit (15%)				\$399,000
Contingency (20%)				\$532,000
Engineering (16%)				\$574,000
			Total Cost	\$4,164,000

Distribution Pipeline and Pump Station

Description	Unit	Quantity	Unit Cost	Total Cost
Packaged Pump Station	LS	1	\$1,250,000	\$1,250,000
Electrical	LS	1	\$525,000	\$525,000
Site Improvements	LS	1	\$175,000	\$175,000
Distribution 10" PVC Pipe	LF	8,000	\$150	\$1,200,000
Material and Labor Subtotal				\$3,150,000
Contractor's General Conditions (12%)				\$378,000
Subtotal				\$3,528,000
Contractor Overhead and Profit (15%)				\$529,000
Contingency (20%)				\$706,000
Engineering (16%)				\$762,000
			Total Cost	\$5,525,000

Overall Project Costs*

Total Project Cost 2020				\$9,689,000
Total Project Cost 2021				\$10,028,000
Total Project Cost 2022				\$10,379,000
Total Project Cost 2023				\$10,742,000
Total Project Cost 2024				\$11,118,000
Total Project Cost 2025				\$11,507,000
*Assumes 3.5% escalation in cost per year				