Engineers...Working Wonders With Water®

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April 5, 2018

Abigail Antolovich
Denver Water
3412 1600 W 12th Avenue
Denver, CO 80204

Subject: 50 Percent Progress Report PureWater Colorado Demonstration Project

Dear Abigail:

This letter includes attachments and schedule updates regarding the PureWater Colorado Demonstration Project. It is anticipated that the project is at fifty percent completion, with the major milestone being delivery of the water tanker to the brewing beverage partner. A breakdown by task of completed goals, obstacles encountered, associated deliverables included as attachments, and need for revision of scope of work and timelines is included in the following Table 1. Dates highlighted in Table 1 indicate a proposed schedule change with reasoning described in the milestones column.

Please let me know if you need additional information and if the proposed schedule and scope/deliverable changes and updates are acceptable.

Sincerely,

CAROLLO ENGINEERS, INC.

Austa M. Parker, PhD
Water Reuse Technologist

Author Initials: amp

Attachments: Commissioning and Test Plan Report
Batch 1 Water Quality Report to CDPHE
Batch 2 (Beverage Production) Water Quality Report to CDPHE
Confirmation of Delivery/Chain of Custody for Water Delivery to Beverage Manufacturer

cc: Damian Higham, Denver Water
John Rehring, Carollo Engineers

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Table 1. Project Progress, Deliverables, Milestones, and Schedule Updates by Task.

Task	Description	Task Status	Deliverables	Deliverables Status	Milestones	Project Timeline (12/28/20174)	Current or Expected Timeline
1	Equipment Installation and Project Kickoff	Complete	Commissioning and Test Plan Report	Complete (Attached)	• Equipment commissioned, delivered and successfully put into operation. • Equipment commissioning was delayed by one week due to additional plumbing and electrical needs during setup. • Test plan written with input and guidance from CDPHE and Carollo.	1/22/2018 - 1/26/2018	1/22/2018 - 2/2/2018
2	Pure Water Production and Pilot Operation	Ongoing	Pilot operation report/water quality summary	Batch 1 and 2 Water Reports (Attached)	• Pilot operation task delayed by one week as carry over from commissioning delay. • Denver Water operations staff provided training by manufacturers and Carollo. • Pilot plant successfully operated overnight and over the weekend. • Demonstration facility operation ongoing.	1/29/2018 - 4/6/2018	2/5/2018 - 4/13/2018
3	Facility Tours with Target Stakeholders and Policy Makers	Ongoing	Summary report of attendees/feedback	To be Completed	• Outreach stakeholder group determined it was better to provide tours to the target audiences when water was available for consumption, following operation and extensive analytical testing. Therefore tours with target stakeholders were delayed by ~2 weeks. • Tours with target stakeholders have begun and are ongoing for one additional week than originally planned.	2/26/2018 - 4/6/2018	3/16/2018 - 4/13/2018
4	Outreach	Complete	Outreach materials completed	Complete (Available with final report)	• Outreach materials were completed one month ahead of schedule and before target audience tours began. • All outreach materials for demonstration project have been designed and produced for outreach.	1/22/2018 - 4/30/2018	1/22/2018 - 3/15/2018
5	Beverage Production	Delivery Complete/Production Ongoing	Documentation showing completion of beverage production – requesting change to water delivery confirmation	Batch 2 CDPHE water quality report (Attached) and Chain of Custody Documents (Attached)	• Beverage production will continue into June 2018. It is requested that the deliverable for this task be changed to pure water delivery to beverage manufacturer to comply with project schedule. • A sterilized tanker was filled with ~4500 gallons of purified water on March 14 and March 15, 2018. • Analytical testing on the pure water was completed (March 16 – April 4, 2018). • Purified water tanker was successfully delivered to beverage partner (April 5, 2018).	2/26/2018 - 4/30/2018	3/14/2018 - 4/5/2018
6	Decommission Pilot Equipment	No Work Complete	Decommissioning document	To be Completed	• No work completed. • Decommissioning is expected to take place one week later than originally planned to provide more time for target audience outreach.	4/9/2018 - 4/16/2018	4/16/2018 - 4/20/2018
7	Project Management and Final Report	Ongoing	Final project report	To be Completed	• Project management including collecting materials and writing reports ongoing. • Final report anticipated to be delivered by May 31, 2018.	1/22/2018 - 5/31/2018	1/22/2018 - 5/31/2018

carollo
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January 27, 2018

Abigail Antolovich
Denver Water
3412 1600 W 12th Avenue
Denver, CO 80204

Subject: Commissioning and Test Plan Report

Dear Abigail:

This letter includes an attachment of the Commissioning and Test Plan for the PureWater Colorado Demonstration Project that details all activities planned for commissioning. Commissioning was scheduled to be complete by January 19, 2018, but with delays pertaining to equipment shipping with winter storms and plumbing requirements, commissioning was completed on January 26, 2018 – as detailed in Table 1. All equipment has now been delivered to the site and is in intermittent operation.

Table 1. Commissioning Week Schedule – Updated January 18, 2018.

Day	Time	Activity	Who
Monday 1/22/18	6:30 AM – 1 PM (TBD)	Assemble BAF Filter Tower	Austa (Carollo) with help from plant staff
	1 PM – 2 PM	Xylem Arrives for safety training	David Foster from Xylem (704) 409 9867
	2 PM – 4 PM	Xylem repairs broken BAF plumbing	David Foster
Tuesday 1/23/18	6 AM – 1 PM	Xylem commissions ozone, UV AOP, and BAF	David Foster
		PALL arrives to fill out paperwork, do safety training and start commissioning	Scott Toomey from PALL (213) 598 0290
	1 PM – 4 PM	Leopold representative arrives, completes safety training and paperwork, and will load carbon into BAF and test backwash sequencing	Kyle, Leah, and David from Xylem/Leopold, Austa/Tasie (Carollo)
Wednesday 1/24/18	6 AM - 12 PM	Start flowing water through all system processes	Xylem, Leopold, PALL, Carollo, with plant staff plumbing assistance if needed
	12 PM – 4 PM	Work through operational parameters and sequences, clearly define all alarm setpoints	Xylem, Leopold, PALL, Carollo

Thursday 1/25/18	8 AM – 12 PM	Operations training on all equipment –complete ½ with PALL ½ with Xylem and switch if needed	David Foster, Scott Toomey, Carollo, and all Operations Staff. If filming, production staff
	12 PM – 4 PM	Final commissioning activities; plant staff takes over pilot operation	Xylem, Leopold, PALL, Carollo
Friday 1/26/18	8 AM – 4 PM	Plant staff completed first operations checks	Carollo assistance as needed

Please let us know if you have any questions or comments on the commissioning process.

Sincerely,

CAROLLO ENGINEERS, INC.

Austa M. Parker, PhD
Water Reuse Technologist

Author Initials: amp

Attachments: Commissioning and Test Plan Report

cc: Damian Higham, Denver Water
John Rehring, Carollo Engineers

PureWater Colorado

Commissioning and Test Plan Report

January 2, 2018

Contents

1.1 Overview

With the population of Colorado expected to double by 2050 and water demands predicted to outpace supply by up to 560,000 acre-feet, according to the Colorado Water Plan, new supplies and efficiency strategies will be needed to secure Colorado's water future. Direct potable reuse (DPR) is an option that is becoming more prominent in the united states and worldwide, with regulatory development efforts in full swing in California, countless pilots throughout the country and full-scale implementation projects in Texas. The technical, financial and public acceptance hurdles associated with DPR are still significant, but Colorado needs to position itself to take advantage of this new water supply strategy. As such, WateReuse Colorado (WRCO) has, over the couple years, endeavored to lay the groundwork for eventual regulations, planning tools and education and outreach materials. As demonstrated throughout the country, a demonstration facility can serve to educate key decision-makers and influencers, while advancing public acceptance of DPR.

As such, Denver Water is partnering with Carollo and WRCO on a pilot facility to demonstrate the efficacy of DPR in general and a non-reverse (RO) osmosis treatment train. This particular treatment train has proven to produce safe, reliable water without the brine disposal issues associated with RO-based treatment. Having this pilot operated locally shows that the treatment is compatible with Colorado wastewater, but is also something regulators find valuable in securing funding for burgeoning regulatory work. This pilot will undergo commissioning in early January and is expected to run through March, producing water at approximately 20 gpm.

This water will be used in water tastings, brewing and wine-making to be utilized in conjunction with activities associated with Denver Water's centennial celebration. It will showcase the leadership, innovation and passion of not only Denver Water, but the Colorado water community as a whole.

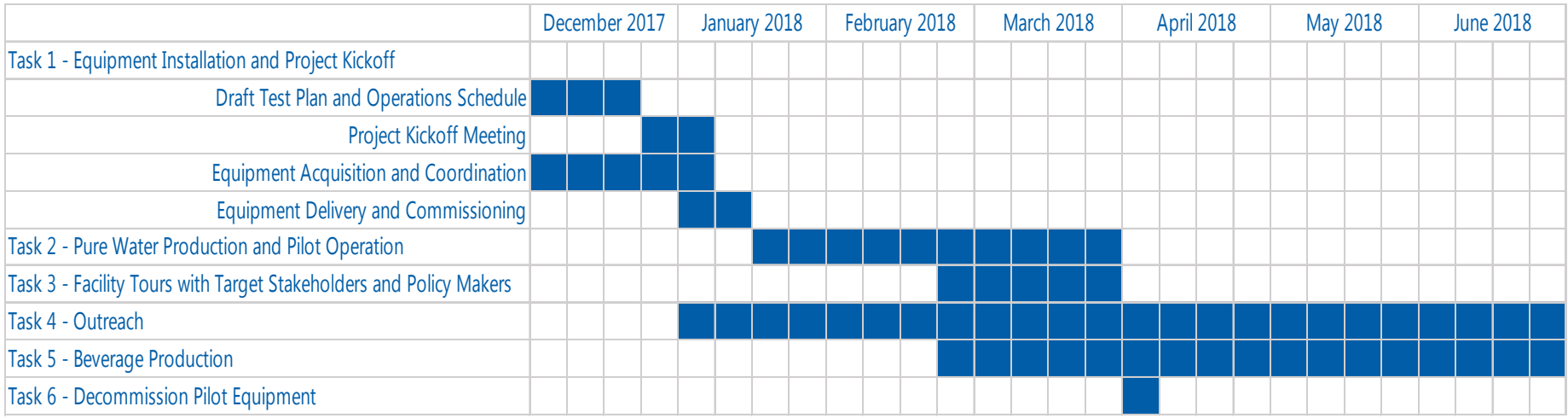
1.2 Project Schedule

The demonstration project is planned to take approximately 3 months from commissioning to decommissioning, while producing purified water for about 1 month of this time period. Purified water can be produced once the biofilter has fully acclimated (weeks 1-5), and analytical results verify the purified batched water is safe for consumption. Table 1 provides an overview of the demonstration facility task schedule, and Table 2 provides a detailed overview of the project plan.

Table 1. PureWater Colorado Weekly Schedule

Week starting 1/8	Task
1	Commissioning - BAF startup
2	BAF Acclimation O_3 Dose and UV Dose Verification
3	Biofilter Acclimation
4	Biofilter Acclimation
5	Biofilter Acclimation, If biofilter is at steady-state, sample finished water
6	Standard Operation, waiting for data results
7	Standard Operation, waiting for data results
8	Pure Water Operation
9	Pure Water Operation
10	Pure Water Operation
11	Pure Water Operation
12	Decommissioning

Table 2. PureWater Colorado Weekly Schedule



1.3 Water Treatment Train

The purpose of the PureWater Colorado DPR Demonstration project is to demonstrate to the public the ability of advanced treatment to provide safe drinking water protective of public health to supporAt Direct Potable Reuse (DPR) development in Colorado.

Due to Colorado's geographic location, including reverse osmosis (RO) in a treatment train is not advantageous. Therefore, the treatment process will be designed without an RO process. The treatment train will include ozone, biologically active filtration (BAF), microfiltration (MF), granular activated carbon filtration (GAC), and ultraviolet light advanced oxidation (UV AOP) processes, shown as Figure 1.

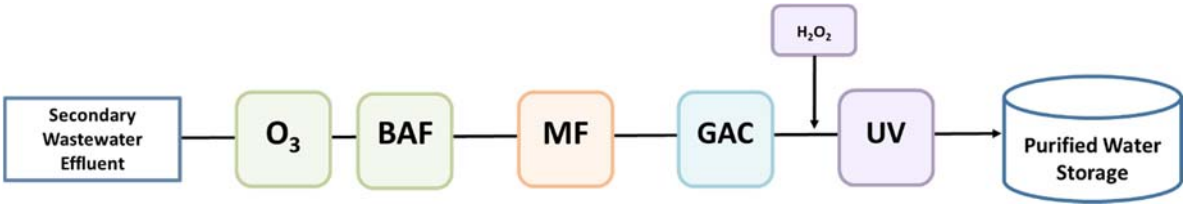


Figure 1. Pure Water Colorado DPR Treatment Train

Equipment will be supplied by several manufacturing partners including:

- Xylem: Ozone, BAF, and UV AOP
- PALL: MF
- Calgon Carbon: GAC

Anticipated log removal credits for virus and protozoa (*Giardia and Crytposporidium*) and processes anticipating chemical contaminant removal are summarized in Table 3.The proposed treatment train will meet or exceed all potable water quality goals.

Table 3. Purified Water Demonstration Facility Schedule

Process	Virus	*Giardia*	*Cryptosporidium*	Contaminant Removal
Ozone	5-log	--	--	✓
BAF	--	--	--	✓
MF	--	4-log	4-log	
GAC	--	--	--	✓
UV AOP (high dose)	6-log	6-log	6-log	✓
Total	**11-log**	**10-log**	**10-log**	**Meets MCLs and CEC Goals[1]**
Potable Goals	9-log	9.1-log	7.4-log	Meet MCLs

-- No removal credit is expected

[1]CEC Goals Defined in Appendix B

1.3.1 Xylem MiPRO Advanced Oxidation Pilot System

The Xylem MiPRO Advanced Oxidation system features ozone and ultraviolet advanced oxidation process. The pilot system features a fully automated ozone and ultraviolet (UV) disinfection unit which can be operated as an AOP process or as a conventional ozone or UV process individually. The pilot features a pressure swing adsorption (PSA) oxygen generator provided with the MiPRO pilot, as well as a connection for gaseous oxygen (GOX) in the event that GOX is required.

All of the pilot equipment is installed in a climate controlled trailer with lighting, and is suitable for outdoor use. The system includes remote monitoring capability via cellular modem.

1.3.1.1 General Operation

The Xylem MiPRO Advanced Oxidation system influent pump will feed secondary effluent water directly to the ozone from Denver Water' Recycle Plant influent line.

1.3.1.2 Installation Requirements

Installation requirements for the advanced oxidation system is found in Table 4.

Table 4. Ozone and Ultraviolet Advanced Oxidation System Specifications

Xylem MiPRO Advanced Oxidation Pilot System			
Equipment			
Length	Width	Height	Weight
40′	8′	8′-6″	20,000 lbs

Plumbing Requirements

Description	Size	Type	Material
Influent (Low Pressure)	1.5″	ANSI 150′ Flange	SCH 80 PVC
Influent (High Pressure)	1.5″	ANSI 150′ Flange	Sch 80 PVC
Treated Water Outlet	1.5″	ANSI 150′ Flange	Sch 80 PVC
Off Gas Vent	½″	NPT	
UV/AOP Treated Water Outlet	1.5″	ANSI 150′ Flange	Sch 80 PVC
Potable Water Inlet	¾″	NPT	Sch 80 PVC
Sink Drain	2″	ANSI 150′ Flange	Sch 80 PVC
Process Drain	1″	NPT	Sch 80 PVC
Electrical Requirements			
Reference	Voltage	Phase	Amps
Power Input	480	3	60
Remote Start	Dry contact, 2 Amp, 24 V – close to start		
Ethernet	Standard Industrial Ethernet – Allen Bradley TCPIP		
Recirculation Mode	Dry contact, 2 Amp, 24 V – close to start		

1.3.1.3 Xylem Equipment Contact Information

- Company: Xylem (contact)
- Contact: David Foster
- Phone: 704.430.8688
- Email: David.Foster@xyleminc.com

1.3.2 Leopold Biological Active Filter (BAF)

The biologically active filter is provided by Leopold (owned by Xylem). The system is designed to test the reduction of biological oxygen demand (BOD), ammonia, total organic carbon (TOC), trace organic compounds and total suspended solids (TSS). The system includes all necessary process equipment, pumps, valves, instruments and ancillary equipment, etc. to function as a stand-alone testing unit. The pilot requires a warm climate and will need protection from freezing in cold weather studies.

1.3.2.1 General Operation

Leopold's R-BAF Pilot Plant will accept effluent from the ozone treated water outlet. Influent will fill a storage reservoir, which is then pumped to the top of the filter. Treated effluent flows to the PALL Ultrafiltration unit.

The included backwash system is filled with potable water it has connection to provide up-flow from the bottom of the filter to the top, as well as down-flow from the top of the filter to the bottom. The tank also has an overflow connection that drains into the waste stream.

The pilot requires a visit from site staff at least once per day when operational to make daily checks, replenish chemicals, to make process adjustments and to report operational problems.

1.3.2.2 Installation Requirements

Leopold supplies 50 feet of each size hose for site connections, as well as 100 feet of 4-wire outdoor grade electric cable connected to the pilot's main electrical panel. Installation requirements for the biological active filter is found in Table 5.

Table 5. Biological Active Filtration Specifications

Leopold R-BAF Pilot Unit			
Filter Skid Equipment			
Length	Length	Length	Length
10'-2"	**10'-2"**	**10'-2"**	**10'-2"**
Backwash Tank Equipment			
Length	Diameter	Height	Weight
-	5'	8'	10,000 lbs
Plumbing Requirements			
Description	Size	Type	Material
Filter Feed Connection	2"	Cam Lock	
Filter Waste Connection	3"	Cam Lock	
Electrical Requirements			
Reference	Voltage	Phase	Amps
Main Electrical Panel	240	Single	60
	4 wire feed (2 hot, neutral and ground)		

1.3.2.3 BAF Equipment Contact Information

- Company: Leopold (equipment), Xylem (contact)
- Contact: David Foster
- Phone: 704.430.8688
- Email: David.Foster@xyleminc.com

1.3.3 PALL 6” Microfiltration Membrane Module

1.3.3.1 General Operation

The PALL 6’’ Microfiltration module is a ski mounted unit that will take effluent from the Leopold BAF unit and will feed MF treated effluent to the Calgon GAC units.

1.3.3.2 Installation Requirements

Installation requirements for the microfiltration system is found in Table 6.

Table 6. Ultrafiltration Specifications

PALL 6” MF Membrane Module			
Filter Skid Equipment			
Length	Width	Height	Weight
19’-10”	8’	8’-4”	10,700 lbs
Plumbing Requirements			
Description	Size	Type	Material
Feed	1.5”	FNPT	
Filtrate	1.5”	FNPT	
Drain	2”	FNPT	
Optional Drain for Chemical Cleaning Waste	2”	FNPT	
Electrical Requirements			
Reference	Voltage	Phase	Amps
Power Input	240	Single	100

1.3.3.3 PALL Microfiltration Equipment Contact Information

- Company: PALL
- Contact: Rick Moro
- Phone: 516.924.2054
- Email: rick_moro@pall.com

1.3.4 Calgon Carbon DISPOSORB Granular Activated Carbon (GAC)

The DISPOSORB canisters are designed for rapid deployment of GAC adsorption. The canisters contain all of the features of a full-scale adsorber, but are easily transportable and are intended to be disposed of properly after use. For the purpose of this project, the small (55 gallon) canisters will be used.

1.3.4.1 General Operation

The GAC adsorption canisters receive the effluent of the ultrafiltration system through the feed pump. The inlet must have a flexible connection to allow minor deflection in the piping to vessel connection or the vessel top

head. The discharge must have an elevated pipe loop to ensure the canister remains flooded with water at all times.

1.3.4.2 Installation Requirements

Installation requirements for the granular activated carbon adsorber is found in Table 7.

Table 7. Granular Activated Carbon Specifications

Calgon Carbon DISPOSORB GAC Adsorber			
Equipment			
Length	Diameter	Height	Weight
-	1'-11"	3'	350 lbs
Plumbing Requirements			
Description	Size	Type	Material
Inlet	¾"	FPT Coupling	Threaded PVC
Outlet	1"	FPT Coupling	Threaded PVC
Drain			
Electrical Requirements – for pump (https://www.pumpcatalog.com/goulds/npe-npe-f-316l-ss-stainless-steel-pump-series/1st2d1a4/**)**			
Reference	Voltage	Phase	Amps
Feed Pump	60	Single	

1.3.4.3 GAC Equipment Contact Information

- Company: Calgon Carbon
- Contact: Ben Goecke
- Phone: 425.286.0754
- Email: bgoecke@calgoncarbon.com

1.3.5 Finished Water Storage

An intermediate bulk container will be used for storage of finished water. The use of a water tanker as well as 275 gallon totes will allow for the transport of finished water to subsequent use locations. The totes feature a chemical-resistant HDPE tank surrounded by a galvanized steel cage. The steel frame is mounted on a pallet for easy transport with fork lift. Totes are BPA-free, are made of UV inhibiting material, FDA compliant and approved for the storage of drinking water. The water tanker will meet requirements for potable water storage and transport. The purified water will be stored after chloramination, targeting a chloramine concentration of 2.5 – 3.0 mg/L.

1.3.6 General Equipment Considerations

Due to freezing and other operational concerns, the systems will likely need to be protected from the elements. This will be accomplished by locating units within the recycling plant or heating inside of the pilot skids treatment system.

1.4 Monitoring and Operations

1.4.1 Daily Monitoring and Data Collection

Staff training will be provided by the vendors and/or Carollo at plant startup. Each day, operations should complete the table as a checklist provided in Appendix C. Each pilot unit is equipped with online monitoring capabilities, but not all pilot units provide remote access to the SCADA center. The main purpose of the daily monitoring is the check for leaks, alarms, and process abnormalities.

1.4.2 Water Quality Analysis

For this batch testing demonstration project, analytical analysis will only need to be run for the purpose of verifying online monitors and then to verify the final product water meets potable water quality requirements, as defined by Regulation 11 and the Surface Water Treatment Rule (SWTR). Analytical monitoring, including all pathogen, contaminant, and water quality parameters, needed to monitor the advanced treatment process and calibrate online meters are included in Table 8. Each batch of water will be collected and stored away from potential contamination until all analytical tests on the batch of water are verified. During conditioning of BAF unit, disinfectant byproduct precursors will be analyzed to better determine needs associated with storage of disinfected water.

Table 8. Pilot Monitoring Parameters and Sampling Locations

Sampling Parameter	Sampling Location						
	Secondary Filtered Effluent	Ozone Effluent	Biofiltration Effluent	Ultrafiltration Effluent	GAC Filtration	UV AOP Effluent	Batch Finished Water
Chemical Primary MCLs[1]							●
Microbial Primary MCLs[2]							●
CECs[3]							●
NDMA			●				●
Total and Free Chlorine	●						●
TOC (grab)	●	●	●	●	●	●	●
UVA (grab)						●	●
Ozone (online)		●					
TOC (online)		●					
UVT (online)		●	●	●		●	
Turbidity (online)	●		●				
UV Dose (online)					●		
UV Sensor Intensity (online)					●		

[1]Chemical constituents listed in Surface Water Treatment Rule

[2]Microbial constituents listed in Surface Water Treatment Rule

[3]CEC list included as Appendix B

1.4.3 Finished Water Results and Reporting

The results from each of five batch testing events will be analyzed to verify all drinking water treatment goals (per the SWTR) are met and reported for each event, as detailed in Appendix A. All microorganism and chemical contaminant MCLs will be met prior to each batch of water to be consumed. Results will be verified by Carollo Engineers and Denver Water, and sent to CDPHE prior to water being consumed or shipped for brewing purposes.

1.5 Regulatory Considerations

1.5.1 Definition of Public Water system

The outreach associated with the pilot will not have an average of >25 people consuming the water during the 60 busiest days of outreach and operations. This will ensure that our system does not meet the definition of a public water system and therefore be subject to the primary drinking water regulations. Beverages produced with the water from this project will be regulated as food and will be subject to local, state and federal regulations.

1.5.2 Storage Tank Rule

The storage tank rule ensures that finished potable water being stored continues to meet standards through planning of delivery, storage infrastructure and use and regular inspections to ensure the plan is carried out. While this only applies to official public water systems, the goals of providing safe water align with our project goals, so analogous planning and inspecting activities surrounding storage of treated water will be performed.

1.5.3 Cross Connections Rule

Similar to the storage tank rule, the cross connection rule only applies to public water systems, but its goals are identical to the project goals and so the concepts and considerations of the rule will be applied to the project. Denver Water's cross connection group will be involved in design and implementation to ensure that finished water is free from contamination and the integrity of the pilot system is maintained.

1.6 Primary and Secondary Responsible Parties

A list of responsible parties for each of the major tasks defined in this project are listed in Table 9.

Table 9. Project Roles and Responsibilities by Task

Task	Sub-task	Primary group	Secondary group	Start	Completion
Treatment system design	Scope out/design electrical needs associated with treatment, heating and lighting	Electrical engineering	Water treatment engineering	12/1/2017	12/29/2017
	Site/equipment layout	Recycling Plant	Water resources planning	12/1/2017	12/15/2017
	Select and procure shelter for outdoor equipment	Water resources planning		12/1/2017	1/9/2017
	Coordinate with vendors on equipment procurement	Carollo Engineers		12/1/2017	1/9/2017
	Gather vendor equipment specs	Carollo Engineers	Equipment vendors	12/1/2017	12/8/2017
System installation	Install electrical equipment	Electrical shop		1/4/2017	1/10/2017
	Install insulation, heat tape as necessary	Water resources planning	Carollo Engineers	1/8/2017	1/12/2017
	Placement of Xylem Mi-Pro container	Equipment vendors	Carollo Engineers	1/10/2017	1/10/2017
	Placement of Pall MF skid	Equipment vendors	Carollo Engineers	1/9/2017	1/9/2017
	Placement of GAC barells	Equipment vendors	Carollo Engineers	1/9/2017	1/9/2017
	Placement and assembly of BAF unit	Equipment vendors	Carollo Engineers	1/9/2017	1/9/2017
	Make water connections	Mechanical shop	Carollo Engineers	1/8/2017	1/11/2017
	Make electrical connections	Electrical shop	Equipment vendors	1/8/2017	1/11/2017
	Make alterations to plant to accommodate equipment	Recycling Plant	Water resources planning	1/8/2017	1/11/2017
	Secure crane services for Xylem container placement	Water resources planning	Carollo Engineers	12/1/2017	1/9/2017
	Erect shelter	Water resources planning	Vendor	1/8/2017	1/11/2017
	Filling BAF with spent carbon	Vendor	Carollo Engineers	1/8/2017	1/13/2017
	Secure finished water containers - tanker, totes	Water resources planning	Carollo Engineers	12/1/2017	1/17/2017
System Commissioning	Integrate controls and monitoring	Equipment vendors	Recycling Plant	1/8/2017	1/17/2017
	Condition BAF	Equipment vendors	Carollo Engineers	1/17/2017	2/15/2017
	DDBP precursor sampling	Water quality lab	Carollo Engineers	1/17/2017	1/17/2017
	Monitoring for conditioning of BAF	Water quality lab	Carollo Engineers	1/17/2017	2/15/2017
System Decommissioning	Shipping arrangements	Carollo Engineers, Inc.	Water resources planning	3/1/2018	4/6/2018
	Crank/forklift rental needs	Water resources planning	Carollo Engineers	3/1/2018	4/6/2018
	Disconnect plumbing, electrical	Electrical and plant staff		4/2/2018	4/5/2018
	Clean site location	Plant staff		4/9/2018	4/13/2018
Stakeholder tours	Coordinate tour dates/times	Public affairs	Water resources planning	12/15/2017	1/15/2017
	Develop tour invite list	Public affairs	Water resources planning	12/15/2017	1/15/2017
	Accompany tours	Recycling Plant	Water resources planning	2/1/2017	3/30/2017
	Develop any marketing materials - handouts, pamphlets, videos	Public affairs	Water resources planning	12/15/2017	2/1/2017
Operations	Generate operations checklist	Carollo Engineers	Water resources planning	12/1/2017	1/10/2018

	Daily treatment system checks	Recycling plant	Carollo Engineers	1/11/2018	3/30/2018
	Generating operations/WQ reports	Water resources planning		1/9/2018	3/30/2018
	Finished water sampling & testing	Water quality lab		2/1/2018	3/30/2018
	Ship water to beverage companies	Water resources planning	Carollo Engineers	2/15/2018	3/30/2018
Regulatory	Initial conversations with CDPHE drinking water	Carollo Engineers	Water resources planning	11/1/2017	12/15/2017
	Follow up conversations with CDPHE drinking water	Carollo Engineers	Water resources planning	12/15/2017	3/30/2018
	Conversations with CDPHE food safety	Water resources planning	Carollo Engineers	12/15/2017	3/30/2018
	Commerce City permitting process	Water resources planning		12/1/2017	1/9/2018
Administrative	Track expenditures	Water resources planning		11/1/2017	4/30/2018
	Grant reporting	Water resources planning		11/1/2017	4/30/2018
	Coordinate with Declaration brewing	Water resources planning	Public affairs	11/1/2017	9/1/2018
	Coordinate with Invintion winery	Water resources planning	Public affairs	11/1/2017	9/1/2018
	Coordinate with additional beverages manufacturers	Water resources planning	Public affairs	11/1/2017	9/1/2018

Appendix A

Contaminant	EPA[3]		Pure Water Colorado Pilot				
	MCLG[1]	MCL or TT[1]	Batch Finished Water Results (mg/L)				
	(mg/L)	(mg/L)	Batch A Week 5	Batch B Week 8	Batch C Week 9	Batch D Week 10	Batch E Week 11
Microorganisms							
Cryptosporidium	0	TT[2]					
Giardia lamblia	0	TT[2]					
Heterotrophic plate count	--	TT[2]					
Legionella	0	TT[2]					
Total Coliforms	0	≤ 5.0%					
Turbidity	--	TT[2]					
Viruses (enteric)	0	TT[2]					
Disinfection Byproducts							
Bromate	0	0.01					
Chlorite	0.8	1					
Haloacetic acids (HAA5)	--	0.06					
Total trihalomethanes (TTHMs)	--	0.08					
Chloramines (as Cl_2)	4	4					
Chlorine (as Cl_2)	4	4					

Chlorines Dioxide (as Cl_2)	0.8	0.8
Volatile Organic (VOCs)		
Benzene	0	0.005
Carbon Tetrachloride	0	0.005
Dichloroethane (1,2-)	0	0.005
Dichloroethylene (1,1-)	0.007	0.007
Dichloroethylene (cis-1,2-)	0.07	0.07
Dichloroethylene (trans-1,2-)	0.1	0.1
Dichloromethane	0	0.005
Dichloropropane (1,2-)	0	0.005
Ethylbenzene	0.7	0.7
Monochlorobenzene	0.1	0.1
o-Dichlorobenzene	0.6	0.6
p-Dichlorobenzene	0.075	0.075
Styrene	0.1	0.1
Tetrachloroethylene (PCE)	0	0.005
Toluene	1	1
Trichlorobenzene (1,2,4-)	0.07	0.07
Trichloroethane (1,1,2-)	0.003	0.005
Trichloroethane (1,1,1-)	0.2	0.2
Trichloroethylene (TCE)	0	0.005
Vinyl Chloride	0	0.002
Xylenes (Total)	10	10
Synthetic Organic Compounds (SOCs)		
2,3,7,8-TCDD (Dioxin)	0	$3x10^{-8}$
2,4,5-TP (Silvex)	0.05	0.05
2,4-D	0.07	0.07

Acrylamide	0	TT
Adipates	0.4	0.4
Alachlor (Lasso)	0	0.002
Atrazine (Atranex, Crisazina)	0.003	0.003
Benzo(a)pyrene (PAH)	0	0.0002
Carbofuran (Furadan 4F)	0.04	0.04
Chlordane	0	0.002
Dalapon	0.2	0.2
Dibromochloropropane (DBCP)	0	0.0002
Diethylhexyl Phthalate (DEHP)	0	0.006
Dinoseb	0.007	0.007
Diquat	0.02	0.02
Endothall	0.1	0.1
Endrin	0.002	0.002
Epichlorohydrin	0	TT
Ethylene Dibromide	0	0.00005
Glyphosate	0.7	0.7
Heptachlor Epoxide	0	0.0002
Heptachlor (H-34, Heptox)	0	0.0004
Hexachlorobenzene	0	0.001
Hexachlorocyclopentadiene	0.05	0.05
Lindane	0.0002	0.0002
Methoxychlor (Marlate)	0.04	0.04
Oxyamyl (Vydate)	0.2	0.2
Pentachlorophenol	0	0.001
Picloram	0.5	0.5
Polychlorinated Biphenyls	0	0.005
Simazine	0.004	0.004

Toxaphene	0	0.003
Inorganic Chemicals (IOCs)		
Antimony	0.006	0.006
Arsenic	0	0.01
Asbestos (fibers > 10µm)	7 million fiber/liter (MFL)	7 (MFL)
Barium	2	2
Beryllium	0.004	0.004
Cadmium	0.005	0.005
Chromium	0.1	0.1
Copper	1.3	TT, Action Level 1.3
Cyanide	0.2	0.2
Fluoride	4	4
Lead	0	TT, Action Level 0.015
Mercury	0.002	0.002
Nitrate (as N)	10	10
Nitrite (as N)	1	1
Selenium	0.05	0.05
Thallium	0.0005	0.002
Radionuclides		
Combined Radium (226/228)	0	5 pCi/L
Gross Alpha	0	15 pCi/L
Beta particles and Emitters	0	4 mrems/ year
Uranium	0	0.03

Notes:

(1) MCLG = Maximum Contaminant Level Goal
MCL = Maximum Contaminant Level
TT = Treatment Technique

(2) The EPA's SWTRs require DLTWTF to:

a. Disinfect their water, and

b. Filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

Cryptosporidium: 3-log removal.
Giardia lamblia: 3-log removal.
Viruses: 4-log removal.
Legionella: No limit, but EPA believes that if Giardia and viruses are removed/inactivated, Legionella will also be controlled.
Turbidity: ≤ 0.3 NTU 95 percent of the time, never to exceed 1 NTU.
HPC: No more than 500 bacterial colonies/mL.

(3) Regulatory levels detailed in:
SWTR = Surface Water Treatment Rule
IESWTR = Interim Enhanced Surface Water Treatment Rule
LT1 = Long-Term 1 Enhanced Surface Water Treatment Rule
LT2 = Long-Term 2 Enhanced Surface Water Treatment Rule
TCR = Total Coliform Rule
D/DBPR = Disinfectants/Disinfection By-Products Rule
SDWA = Safe Drinking Water Act and Amendments
Arsenic Rule
Radionuclide Rule

Appendix B

Contaminant	Health Based Criteria	Pure Water Colorado Pilot				
		Batch A	Batch B	Batch C	Batch D	Batch E
Gen X						
1,4-Dioxane						
PFOA						
PFOS						
LIST OF PFCs						
Bromate						
NDMA						
DBP Precursor Sampling						

Appendix C

			Xylem MiPro Unit											Leopold Biofiltration Unit								PALL Microfiltration Unit					Calgon GAC Disposorb Unit	
			Ozone						UV AOP																			
Date	Time	Name	Influent Flow (GPM)	Influent Pressure (PSI)	Influent UVT (%)	Effluent UVT (%)	Vent O3 Concentration (ppm)	Dissolved O3 Concentration (ppm)	Flow (GPM)	Influent Pressure (PSI)	UV Sensor Intensity (UVI) mW/cm^2	Influent UVT (%)	UV Dose (mJ/cm^2)	Influent Turbidity (NTU)	Effluent Turbidity (NTU)	Influent DO (mg/L O2)	Effluent DO (mg/L O2)	Temperature (°F)	Influent Flow (MGD)	Effluent Flow (MGD)	Media Headloss	Influent Flow (GPM)	Influent Pressure (PSI)	Effluent Pressure (PSI)	Influent Turbidity (NTU)	Effluent Turbidity (NTU)	Influent Pressure Gague (PSI)	Effluent Pressure Gague (PSI)

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March 29, 2018

Tyson Ingels and Ron Falco
Colorado Department of Public Health and Environment
4300 Cherry Creek S Drive
Denver, CO 80246

Subject: PureWater Colorado Demonstration Project Drinking Water Quality Results

Dear Ron and Tyson:

This letter is intended to provide the finished water quality results from the finished water quality sampling event conducted on March 7, 2018 at the PureWater Colorado Demonstration Project hosted at the Denver Water Recycling Facility (5650 York Street Commerce City, CO 80022). The project demonstrates the ability to purify secondary treated wastewater effluent from the Metro Wastewater Reclamation District's Robert W. Hite Treatment Facility to drinking water quality using ozone, biofiltration (BAF), microfiltration (MF), granular activated carbon (GAC), and UV Advanced Oxidation (UV AOP) in series (Figure 1). The demonstration project will serve batch tested water to a select group of tour attendees for outreach purposes for a period of four weeks.

Finished water quality results demonstrate the robust performance of the treatment processes and the ability to meet all regulated contaminant levels (MCLs) and water quality goals for a dedicated list of contaminants of emerging concern (CECs). Virus, Giardia, and Cryptosporidium log removal credits for each treatment processes were anticipated as shown in Table 1.

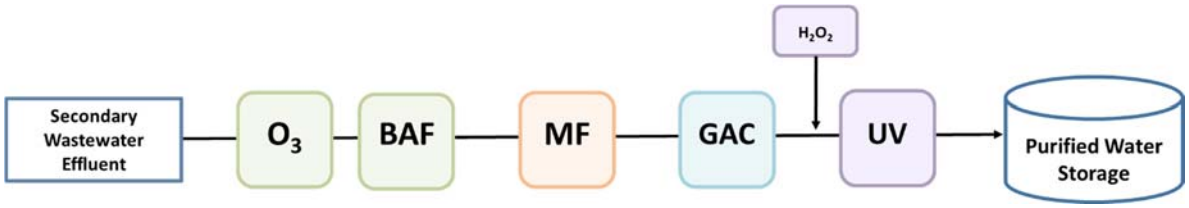

Figure 1. PureWater Colorado DPR Demonstration Project Treatment Train

Table 1. Anticipated Log Removal Credits Based on Previous Research and Process Operation.

Process	Virus	*Giardia*	*Cryptosporidium*
Ozone	5-log	--	--
BAF	--	--	--
MF	--	4-log	4-log
GAC	--	--	--
UV AOP (high dose)	6-log	6-log	6-log
Total	**11-log**	**10-log**	**10-log**
Potable Water Goals[(1)]	9-log	9.1-log	7.4-log

Notes:

-- Pathogen removal credit is not expected.

1) As determined by EPA SDWA

Process Operation and Performance Monitoring

Process performance parameters were documented at the start time of collection and were monitored online for the duration of batch sample collection by Carollo (Table 2).

Table 2. Online Process Performance Parameters During Batch Collection

Parameter	BATCH #1	Units
Sample Date	3/7/2018	
Time (Start)	2:30 PM	
Time (Stop)	3:13 PM	
Ozone Dose	5.21	mg/L
Ozone Flow	15.1	GPM
Biofiltration Empty Bed Contact Time (EBCT)	18.4	MIN
Microfiltration Trans Membrane Pressure (TMP)	4.1	PSI
UV Flow	5.7	GPM
UV Transmittance (UVT) - Influent to UV AOP	97.4	%
UVT - Finished Water	98.4	%
UV Dose	2307	mJ/cm^2

Finished Water Collection and Storage

Finished water was collected in a 275 gallon chemical storage tote by Denver Water operations staff and Carollo (Figure 2) on March 7, 2018. The tote was disinfected and rinsed with free chlorine and potable water prior to being filled with purified finished water. Purified water was collected and subsequently dosed with free chlorine to first quench the hydrogen peroxide residual, and then for disinfection using ammonium sulfate to create chloramines for storage. All batch finished water totes are being stored in a secure environment at the Denver Water Recycling Facility, with access to the totes only by Carollo and Denver Water operations staff.

Figure 2. Purified Finished Water Collection and Storage Tote

Lab Sampling and Water Quality Analysis

Sampling for chemical and microbial contaminants was conducted by Denver Water laboratory staff on March 8, 2017. Samples were taken to the Denver Water lab for analysis or sent to the contract lab (Eurofins) via overnight delivery for analysis. All regulated contaminant results, MCLs, and responsible laboratories are shown in Table 3. Results for CEC sampling are shown in Table 4 with associated water quality goals and references, where available.

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Table 3. Regulated Contaminant Purified Finished Water Batch 1 Water Quality Results

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results
				MCLG[1]	MCL or TT[1]	Batch 1 (3/7/2018)
Microorganisms						
Cryptosporidium	cysts/L	Eurofins	0.093	0	TT[2]	<0.093
Giardia lamblia	cysts/L	Eurofins	0.093	0	TT[2]	<0.093
Heterotrophic plate count	CFU/mL	DW Lab	0.01	--	TT[2]	<0.01
Total Coliforms	P-A/100 mL	DW Lab	1	0	≤ 5.0%	Absent
Turbidity	NTU	DW Lab	0.05	--	TT[2]	0.4
Disinfection Byproducts						
Bromate	ug/L	Eurofins	1	0	10	2.6
Chlorite	mg/L	Eurofins	0.01	0.8	1	ND
Haloacetic acids (HAA5)	ug/L	Eurofins	2	--	0.06	ND
Total trihalomethanes (TTHMs)	ug/L	Eurofins	2	--	0.08	ND
Chloramines (as Cl_2)	mg/L	Carollo - On Site	0.2	4	4	2.5
Total Chlorine (as Cl_2)	mg/L	Carollo - On Site	0.2	4	4	2.7
Chlorines Dioxide (as Cl_2)	mg/L	Eurofins	0.24	0.8	0.8	ND
Volatile Organic (VOCs)						
Benzene	ug/L	Eurofins	0.5	0	5	ND
Carbon Tetrachloride	ug/L	Eurofins	0.5	0	5	ND
Dichloroethane (1,2-)	ug/L	Eurofins	0.5	0	5	ND
Dichloroethylene (1,1-)	ug/L	Eurofins	0.5	0	5	ND
Dichloroethylene (cis-1,2-)	ug/L	Eurofins	0.5	0.07	70	ND

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results
				MCLG[1]	MCL or TT[1]	Batch 1 (3/7/2018)
Dichloroethylene (trans-1,2-)	ug/L	Eurofins	0.5	0.1	100	ND
Dichloromethane	ug/L	Eurofins	0.5	0	5	ND
Dichloropropane (1,2-)	ug/L	Eurofins	0.5	0	5	ND
Ethylbenzene	ug/L	Eurofins	0.5	0.7	700	ND
Monochlorobenzene	ug/L	Eurofins	0.5	0.1	100	ND
o-Dichlorobenzene	ug/L	Eurofins	0.5	0.6	600	ND
p-Dichlorobenzene	ug/L	Eurofins	0.5	0.075	75	ND
Styrene	ug/L	Eurofins	0.5	0.1	100	ND
Tetrachloroethylene (PCE)	ug/L	Eurofins	0.5	0	5	ND
Toluene	ug/L	Eurofins	0.5	1	1000	ND
Trichlorobenzene (1,2,4-)	ug/L	Eurofins	0.5	0.07	70	ND
Trichloroethane (1,1,2-)	ug/L	Eurofins	0.5	0.003	5	ND
Trichloroethane (1,1,1-)	ug/L	Eurofins	0.5	0.2	200	ND
Trichloroethylene (TCE)	ug/L	Eurofins	0.5	0	5	ND
Vinyl Chloride	ug/L	Eurofins	0.3	0	2	ND
Xylenes (Total)	ug/L	Eurofins	0.5	10	10,000	ND
Synthetic Organic Compounds (SOCs)						
2,3,7,8-TCDD (Dioxin)	pg/L	Eurofins	5	0	30	ND
2,4,5-TP (Silvex)	ug/L	Eurofins	0.2	0.05	50	ND
2,4-D	ug/L	Eurofins	0.1	0.07	70	ND
Acrylamide	ug/L	Eurofins	0.1	0	TT	ND

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results
				MCLG[1]	MCL or TT[1]	Batch 1 (3/7/2018)
Adipates	ug/L	Eurofins	0.6	0.4	400	ND
Alachlor (Lasso)	ug/L	Eurofins	0.05	0	2	ND
Atrazine (Atranex, Crisazina)	ng/L	Eurofins	5	0.003	3000	ND
Benzo(a)pyrene (PAH)	ug/L	Eurofins	0.02	0	0.2	ND
Carbofuran (Furadan 4F)	ug/L	Eurofins	0.5	0.04	40	ND
Chlordane	ug/L	Eurofins	0.1	0	2	ND
Dalapon	ug/L	Eurofins	1	0.2	200	ND
Dibromochloropropane (DBCP)	ug/L	Eurofins	0.01	0	0.2	ND
Diethylhexyl Phthalate (DEHP)	ug/L	Eurofins	0.6	0	6	ND
Dinoseb	ug/L	Eurofins	0.2	0.007	7	ND
Diquat	ug/L	Eurofins	0.4	0.02	20	ND
Endothall	ug/L	Eurofins	5	0.1	100	ND
Endrin	ug/L	Eurofins	0.01	0.002	2	ND
Epichlorohydrin	ug/L	Eurofins	0.4	0	TT	ND
Ethylene Dibromide	ug/L	Eurofins	0.01	0	0.05	ND
Glyphosate	ug/L	Eurofins	6	0.7	700	ND
Heptachlor Epoxide	ug/L	Eurofins	0.01	0	0.2	ND
Heptachlor (H-34, Heptox)	ug/L	Eurofins	0.01	0	0.4	ND
Hexachlorobenzene	ug/L	Eurofins	0.05	0	1	ND
Hexachlorocyclopentadiene	ug/L	Eurofins	0.05	0.05	50	ND
Lindane	ug/L	Eurofins	0.04	0.0002	0.2	ND

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results
				MCLG[1]	MCL or TT[1]	Batch 1 (3/7/2018)
Methoxychlor (Marlate)	ug/L	Eurofins	0.05	0.04	40	ND
Oxyamyl (Vydate)	ug/L	Eurofins	0.5	0.2	200	ND
Pentachlorophenol	ug/L	Eurofins	0.04	0	1	ND
Picloram	ug/L	Eurofins	0.1	0.5	500	ND
Polychlorinated Biphenyls						
PCB 1016 Aroclor	ug/L	Eurofins	0.08	0	5	ND
PCB 1221 Aroclor	ug/L	Eurofins	0.1	0	5	ND
PCB 1232 Aroclor	ug/L	Eurofins	0.1	0	5	ND
PCB 1242 Aroclor	ug/L	Eurofins	0.1	0	5	ND
PCB 1248 Aroclor	ug/L	Eurofins	0.1	0	5	ND
PCB 1254 Aroclor	ug/L	Eurofins	0.1	0	5	ND
PCB 1260 Aroclor	ug/L	Eurofins	0.1	0	5	ND
Simazine	ng/L	Eurofins	5	0.004	4000	ND
Toxaphene	ug/L	Eurofins	0.5	0	3	ND
Inorganic Chemicals (IOCs)						
Antimony	ug/L	DW Lab	1	0.006	6	0.52
Arsenic	ug/L	DW Lab	1	0	10	1
Asbestos (fibers > 10µm)	MFL	Eurofins	0.2	7	7	ND
Barium	ug/L	DW Lab	5	2	2000	47.6
Beryllium	ug/L	DW Lab	1	0.004	4	<0.05
Cadmium	ug/L	DW Lab	0.2	0.005	5	<0.05

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results
				MCLG[1]	MCL or TT[1]	Batch 1 (3/7/2018)
Hexavalent Chromium	ug/L	DW Lab	1	0.1	100	2.9
Copper	ug/L	DW Lab	0.5	1.3	TT, Action Level 1300	5.4
Cyanide	mg/L	Eurofins	0.025	0.2	0.2	ND
Fluoride	mg/L	DW Lab	0.05	4	4	0.82
Lead	ug/L	DW Lab	0.5	0	TT, Action Level 15	<1
Mercury	ug/L	DW Lab	1	0.002	2	<0.05
Nitrate (as N)	mg/L	DW Lab	0.05	10	10	2.58
Nitrite (as N)	mg/L	DW Lab	0.05	1	1	<0.10
Selenium	ug/L	DW Lab	5	0.05	50	2.4
Thallium	ug/L	DW Lab	1	0.0005	2	<0.05
Radionuclides						
Combined Radium (226/228)	pCi/L	Eurofins	0.49	0	5	0.88
Gross Alpha	pCi/L	Eurofins	3	0	15	ND
Beta particles and Emitters	pCi/L	Eurofins	3	0	50	12
Uranium	ug/L	DW Lab	1	0	30	0.3

Notes:
MCLG = Maximum Contaminant Level Goal
MCL = Maximum Contaminant Level
MRL = Maximum Reporting Limit
TT = Treatment Technique

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results
				MCLG[1]	MCL or TT[1]	Batch 1 (3/7/2018)

The EPA's SWTRs require Water Treatment Facilities to:

a. Disinfect their water, and

b. Filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

Cryptosporidium: 3-log removal.
Giardia lamblia: 3-log removal.
Viruses: 4-log removal.
Legionella: No limit, but EPA believes that if Giardia and viruses are removed/inactivated, Legionella will also be controlled.
Turbidity: ≤ 0.3 NTU 95 percent of the time, never to exceed 1 NTU.
HPC: No more than 500 bacterial colonies/mL.

Regulatory levels detailed in:
SWTR = Surface Water Treatment Rule
IESWTR = Interim Enhanced Surface Water Treatment Rule
LT1 = Long-Term 1 Enhanced Surface Water Treatment Rule
LT2 = Long-Term 2 Enhanced Surface Water Treatment Rule
TCR = Total Coliform Rule
D/DBPR = Disinfectants/Disinfection By-Products Rule
SDWA = Safe Drinking Water Act and Amendments
Arsenic Rule
Radionuclide Rule

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Table 4. CECs Purified Finish Water Batch 1 Water Quality Results

Contaminant	Units	Laboratory	MRL	Water Quality Goals	PureWater Colorado Batch Finished Water Results Batch 1 (3/7/2018)
CECs					
1,4-dioxane	ug/L	Eurofins	0.07	1[(1)]	ND
NDMA	ng/L	Eurofins	2	10[(1)]	ND
PFOA/PFOS/PFC Suite					
Perfluorobutanesulfonic acid (PFBS)	ng/L	Eurofins	2	--	ND
Perfluorodecanoic acid (PFDA)	ng/L	Eurofins	2	--	ND
Perfluorododecanoic acid (PFDoA)	ng/L	Eurofins	2	--	ND
Perfluoroheptanoic acid (PFHpA)	ng/L	Eurofins	2	--	ND
Perfluorohexanesulfonic acid (PFHxS)	ng/L	Eurofins	2	--	ND
Perfluorohexanoic acid (PFHxA)	ng/L	Eurofins	2	--	ND
Perfluorononanoic acid (PFNA)	ng/L	Eurofins	2	--	ND
Perfluorononanoic acid (PFOS)	ng/L	Eurofins	2	200[(5)]	ND
Perfluorooctanoic acid (PFOA)	ng/L	Eurofins	2	400[(5)]	ND
Perfluorotridecanoic acid (PFTrDA)	ng/L	Eurofins	2	--	ND
Perfluoroundecanoic acid (PFUnA)	ng/L	Eurofins	2	--	ND
Pertluorotetradecanoic acid (PFTeDA)	ng/L	Eurofins	2	--	ND
Gen X	ng/L	Eurofins	5	--	ND
4-nonylphenol	ng/L	Eurofins	100	500000[(2)]	ND
Atenolol	ng/L	Eurofins	5	70000[(3)]	ND
Caffeine[(6)]	ng/L	Eurofins	5	350[(3)]	10

Contaminant	Units	Laboratory	MRL	Water Quality Goals	PureWater Colorado Batch Finished Water Results
					Batch 1 (3/7/2018)
Carbamazepine	ng/L	Eurofins	5	1000[3]	ND
Cotinine	ng/L	Eurofins	10	10000[3]	ND
DEET	ng/L	Eurofins	10	2500[3]	ND
Dilantin	ng/L	Eurofins	20	1000[3]	ND
Estradiol	ng/L	Eurofins	5	1[3]	ND
Estrone	ng/L	Eurofins	5	350[3]	ND
Ethinyl Estradiol	ng/L	Eurofins	5	280[3]	ND
Geosmin	ng/L	DW Lab	1	5[7]	<1
Ibuprofen	ng/L	Eurofins	10	40000[3]	ND
Meprobamate	ng/L	Eurofins	5	260000[3]	ND
(MIB) 2-methylisoborneol	ng/L	DW Lab	1	5[7]	<1
Primidone	ng/L	Eurofins	20	840[4]	ND
Sucralose[6]	ug/L	Eurofins	0.1	150000[8]	ND
TCEP	ng/L	Eurofins	10	2500[3]	ND
Triclosan	ng/L	Eurofins	10	350[3]	ND

Contaminant	Units	Laboratory	MRL	Water Quality Goals	PureWater Colorado Batch Finished Water Results
					Batch 1 (3/7/2018)

Notes:
-- = None Available
MRL = Method Reporting Limit
ND = Non-Detect

1) No EPA criteria for NDMA. CA DDW lists a notification level.
2) 2008 Australian Water Recycling Guidelines.
3) Additional health-based screening levels from 2010 SWRCB Recylced Water CEC Scientific Advisory Panel Final Report.
4) Drinking Water Equivalent Level (DWEL) developed by Intertox, Inc. (2009) for Orange County Water District.
5) NRC 2012 Report.
6) Caffeine and sucralose are surrogates for water-soluble uncharged chemicals of moderate molectular weight and not a CEC for its own health impacts, but rather for occurence.
7) No MCL exists for MIB or geosmin and they are considered CECs in this study due to public perception and taste and odor concerns. A threshold of 5 ng/L is listed based on WRF 3032 2013.
8) FDA threshold idefintifed as a health screening level in WE&RF project 11-02. FDA threshold of 5 mg/kg was converted to a drinking water concentration based on 60-kg and 2 L/day in the WE&RF project 11-02.

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This letter reflects results from the first Batch of water taken (Batch #1). Subsequent water quality results will be sent to CDPHE for four additional sampling events in the following four weeks, with the next results to report being for a water tanker that was filled with purified finished water to send to a beverage manufacturer. Before the water is released to a beverage manufacturer or served to the public from any batch, we will provide the water quality results to CDPHE.

Thank you for your continued support and review of the demonstration project results. Please let us know if you have any questions or comments. Further details are available at any time upon CDPHE request.

Sincerely,

CAROLLO ENGINEERS, INC.

Austa M. Parker, PhD
Technologist
PureWater Colorado Project Manager

Author Initials: amp

cc: Damian Higham, Denver Water
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April 5, 2018

Tyson Ingels and Ron Falco
Colorado Department of Public Health and Environment
4300 Cherry Creek S Drive
Denver, CO 80246

Subject: Batch 2 Update - PureWater Colorado Demonstration Project Drinking Water Quality Results

Dear Ron and Tyson:

This letter provides process performance parameters and water quality results for the second batch of water collected on March 14th and March 15th as part of the PureWater Colorado Demonstration hosted at the Denver Water Recycling Facility (5650 York Street Commerce City, CO 80022). A 275 gallon batch of purified water was stored for outreach purposes and 4600 gallons of purified water were placed in a sterilized water tanker for transport to Declaration Brewing Company to produce beer in collaboration with Denver Water's 100th anniversary celebration, further details are provided in this letter.

Water quality results indicate excellent performance by the treatment process, meeting all regulated contaminant levels (MCLs) and health goals for contaminants of emerging concern (CECs).

Project Overview

The project demonstrates the ability to purify secondary treated wastewater effluent from the Metro Wastewater Reclamation District's Robert W. Hite Treatment Facility to drinking water quality using ozone, biofiltration (BAF), microfiltration (MF), granular activated carbon (GAC), and UV Advanced Oxidation (UV AOP) in series (Figure 1). The demonstration project will serve batch tested water to a select group of tour attendees for outreach purposes for a period of four weeks, and purified water will be provided to a beverage distributor.

Finished water quality results demonstrate the robust performance of the treatment processes and the ability to meet all MCLs and water quality goals for a dedicated list of CECs. Virus, Giardia, and Cryptosporidium log removal credits for each treatment processes were anticipated as shown in Table 1.

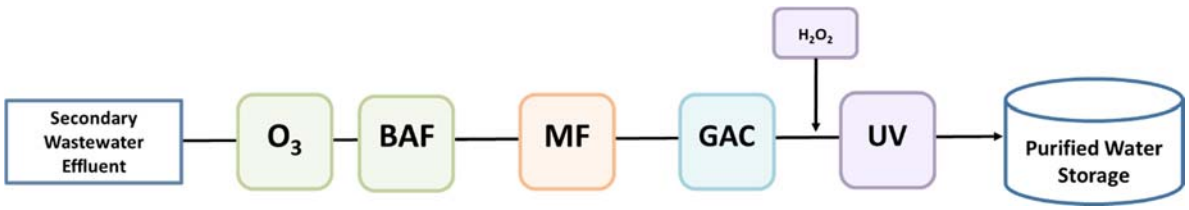

Figure 1. PureWater Colorado DPR Demonstration Project Treatment Train

Table 1. Anticipated Log Removal Credits Based on Previous Research and Process Operation.

Process	Virus	*Giardia*	*Cryptosporidium*
Ozone	5-log	--	--
BAF	--	--	--
MF	--	4-log	4-log
GAC	--	--	--
UV AOP (high dose)	6-log	6-log	6-log
Total	**11-log**	**10-log**	**10-log**
Potable Water Goals[(1)]	9-log	9.1-log	7.4-log

Notes:

-- Pathogen removal credit is not expected.

1) As determined by EPA SDWA

Process Operation and Performance Monitoring

Process performance parameters were documented at the start time of collection and were monitored online for the duration of batch and tanker sample collection by Carollo (Table 2).

Table 2. Online Process Performance Parameters During Batch 2 Tanker Collection (Additional Process Performance Data in Attachment Appendix A)

Parameter	BATCH #2	Units
Sample Date	3/15/2018	
Time (Start)	2:02 PM	
Time (Stop)	2:45 PM	
Ozone Dose	5.03	mg/L
Ozone Flow	15.1	GPM
Biofiltration Empty Bed Contact Time (EBCT)	18.2	MIN
Microfiltration Trans Membrane Pressure (TMP)	5.20	PSI
UV Flow	5.45	GPM
UV Transmittance (UVT) - Influent to UV AOP	97.9	%
UVT - Finished Water	99.0	%
UV Dose	2463	mJ/cm^2

Finished Water Collection for Beverage Production and Storage

Finished water was first collected in 275 gallon chemical storage totes by Denver Water operations staff and Carollo on both March 14 and March 15, 2018. The totes were disinfected and rinsed with free chlorine and potable water prior to being filled with purified finished water. Purified water was collected and subsequently dosed with free chlorine to first quench the hydrogen peroxide residual, and then for disinfection using ammonium sulfate to create chloramines for storage. Sixteen 275 gallon batches of purified water were collected and disinfected over the two day period. After storage tote collection, water was allowed to flow by gravity into a water storage tanker that arrived to the site sealed and sterilized by the food transport company. Fifteen batches of disinfected purified water were flowed by gravity into the chemical storage tanker for a final storage tanker volume of 4125 gallons of purified water to deliver to Declaration, the project brewing partner. The last 275 gallon batch of water collected was disinfected and stored in a secure environment at the Denver Water Recycling Facility, with access to the totes only by Carollo and Denver Water operations staff.

The purified water tanker will be transported to Declaration Brewing on the afternoon of April 5th with the water quality results presented in this letter and a signed chain of custody for subsequent beverage production to take place in April and May 2018.

Figure 2. Purified Finished Water Collection and Tanker Filling

Lab Sampling and Water Quality Analysis

Sampling for chemical and microbial contaminants was conducted by Denver Water laboratory staff on March 15, 2017 from a batch of water collected in the middle of sample filling. Samples were taken to the Denver Water lab for analysis or sent to the contract lab (Eurofins) via overnight delivery for analysis. All regulated contaminant results, MCLs, and responsible laboratories are shown in Table 3. Results for CEC sampling are shown in Table 4 with associated water quality goals and references, where available.

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Table 3. Regulated Contaminant Purified Finished Water Batch 2 Water Quality Results

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results
				MCLG[1]	MCL or TT[1]	Batch 2 (3/15/2018)
Microorganisms						
Cryptosporidium	cysts/L	Eurofins	0.093	0	TT[2]	<0.093
Giardia lamblia	cysts/L	Eurofins	0.093	0	TT[2]	<0.093
Heterotrophic plate count	CFU/mL	DW Lab	0.01	--	TT[2]	<0.01
Total Coliforms	P-A/100 mL	DW Lab	1	0	≤ 5.0%	Absent
Turbidity	NTU	DW Lab	0.05	--	TT[2]	0.33
Disinfection Byproducts						
Bromate	ug/L	Eurofins	1	0	10	1.3
Chlorite	mg/L	Eurofins	0.01	0.8	1	ND
Haloacetic acids (HAA5)	ug/L	Eurofins	2	--	60	ND
Total trihalomethanes (TTHMs)	ug/L	Eurofins	2	--	80	ND
Chloramines (as Cl_2)	mg/L	Carollo - On Site	0.2	4	4	2.8
Total Chlorine (as Cl_2)	mg/L	Carollo - On Site	0.2	4	4	3.1
Chlorines Dioxide (as Cl_2)	mg/L	Eurofins	0.24	0.8	0.8	ND
Volatile Organic (VOCs)						
Benzene	ug/L	Eurofins	0.5	0	5	ND
Carbon Tetrachloride	ug/L	Eurofins	0.5	0	5	ND
Dichloroethane (1,2-)	ug/L	Eurofins	0.5	0	5	ND
Dichloroethylene (1,1-)	ug/L	Eurofins	0.5	0	5	ND
Dichloroethylene (cis-1,2-)	ug/L	Eurofins	0.5	0.07	70	ND

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results
				MCLG[1]	MCL or TT[1]	Batch 2 (3/15/2018)
Dichloroethylene (trans-1,2-)	ug/L	Eurofins	0.5	0.1	100	ND
Dichloromethane	ug/L	Eurofins	0.5	0	5	ND
Dichloropropane (1,2-)	ug/L	Eurofins	0.5	0	5	ND
Ethylbenzene	ug/L	Eurofins	0.5	0.7	700	ND
Monochlorobenzene	ug/L	Eurofins	0.5	0.1	100	ND
o-Dichlorobenzene	ug/L	Eurofins	0.5	0.6	600	ND
p-Dichlorobenzene	ug/L	Eurofins	0.5	0.075	75	ND
Styrene	ug/L	Eurofins	0.5	0.1	100	ND
Tetrachloroethylene (PCE)	ug/L	Eurofins	0.5	0	5	ND
Toluene	ug/L	Eurofins	0.5	1	1000	ND
Trichlorobenzene (1,2,4-)	ug/L	Eurofins	0.5	0.07	70	ND
Trichloroethane (1,1,2-)	ug/L	Eurofins	0.5	0.003	5	ND
Trichloroethane (1,1,1-)	ug/L	Eurofins	0.5	0.2	200	ND
Trichloroethylene (TCE)	ug/L	Eurofins	0.5	0	5	ND
Vinyl Chloride	ug/L	Eurofins	0.3	0	2	ND
Xylenes (Total)	ug/L	Eurofins	0.5	10	10,000	ND
Synthetic Organic Compounds (SOCs)						
2,3,7,8-TCDD (Dioxin)	pg/L	Eurofins	5	0	30	ND
2,4,5-TP (Silvex)	ug/L	Eurofins	0.2	0.05	50	ND
2,4-D	ug/L	Eurofins	0.1	0.07	70	ND
Acrylamide	ug/L	Eurofins	0.1	0	TT	ND

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results
				MCLG[1]	MCL or TT[1]	Batch 2 (3/15/2018)
Adipates	ug/L	Eurofins	0.6	0.4	400	ND
Alachlor (Lasso)	ug/L	Eurofins	0.05	0	2	ND
Atrazine (Atranex, Crisazina)	ng/L	Eurofins	5	0.003	3000	ND
Benzo(a)pyrene (PAH)	ug/L	Eurofins	0.02	0	0.2	ND
Carbofuran (Furadan 4F)	ug/L	Eurofins	0.5	0.04	40	ND
Chlordane	ug/L	Eurofins	0.1	0	2	ND
Dalapon	ug/L	Eurofins	1	0.2	200	ND
Dibromochloropropane (DBCP)	ug/L	Eurofins	0.01	0	0.2	ND
Diethylhexyl Phthalate (DEHP)	ug/L	Eurofins	0.6	0	6	ND
Dinoseb	ug/L	Eurofins	0.2	0.007	7	ND
Diquat	ug/L	Eurofins	0.4	0.02	20	ND
Endothall	ug/L	Eurofins	5	0.1	100	ND
Endrin	ug/L	Eurofins	0.01	0.002	2	ND
Epichlorohydrin	ug/L	Eurofins	0.4	0	TT	ND
Ethylene Dibromide	ug/L	Eurofins	0.01	0	0.05	ND
Glyphosate	ug/L	Eurofins	6	0.7	700	ND
Heptachlor Epoxide	ug/L	Eurofins	0.01	0	0.2	ND
Heptachlor (H-34, Heptox)	ug/L	Eurofins	0.01	0	0.4	ND
Hexachlorobenzene	ug/L	Eurofins	0.05	0	1	ND
Hexachlorocyclopentadiene	ug/L	Eurofins	0.05	0.05	50	ND
Lindane	ug/L	Eurofins	0.04	0.0002	0.2	ND

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results
				MCLG[1]	MCL or TT[1]	Batch 2 (3/15/2018)
Methoxychlor (Marlate)	ug/L	Eurofins	0.05	0.04	40	ND
Oxyamyl (Vydate)	ug/L	Eurofins	0.5	0.2	200	ND
Pentachlorophenol	ug/L	Eurofins	0.04	0	1	ND
Picloram	ug/L	Eurofins	0.1	0.5	500	ND
Polychlorinated Biphenyls						
PCB 1016 Aroclor	ug/L	Eurofins	0.08	0	5	ND
PCB 1221 Aroclor	ug/L	Eurofins	0.1	0	5	ND
PCB 1232 Aroclor	ug/L	Eurofins	0.1	0	5	ND
PCB 1242 Aroclor	ug/L	Eurofins	0.1	0	5	ND
PCB 1248 Aroclor	ug/L	Eurofins	0.1	0	5	ND
PCB 1254 Aroclor	ug/L	Eurofins	0.1	0	5	ND
PCB 1260 Aroclor	ug/L	Eurofins	0.1	0	5	ND
Simazine	ng/L	Eurofins	5	0.004	4000	ND
Toxaphene	ug/L	Eurofins	0.5	0	3	ND
Inorganic Chemicals (IOCs)						
Antimony	ug/L	DW Lab	1	0.006	6	0.54
Arsenic	ug/L	DW Lab	1	0	10	<0.5
Asbestos (fibers > 10µm)	MFL	Eurofins	0.2	7	7	ND
Barium	ug/L	DW Lab	5	2	2000	34.3
Beryllium	ug/L	DW Lab	1	0.004	4	<0.05
Cadmium	ug/L	DW Lab	0.2	0.005	5	<0.05

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results
				MCLG[1]	MCL or TT[1]	Batch 2 (3/15/2018)
Chromium	ug/L	DW Lab	1	0.1	100	2.3
Copper	ug/L	DW Lab	0.5	1300	TT, Action Level 1300	3.6
Cyanide	mg/L	Eurofins	0.025	0.2	0.2	ND
Fluoride	mg/L	DW Lab	0.05	4	4	1.02
Lead	ug/L	DW Lab	0.5	0	TT, Action Level 15	<1
Mercury	ug/L	DW Lab	1	0.002	2	<0.05
Nitrate (as N)	mg/L	DW Lab	0.05	10	10	3.06
Nitrite (as N)	mg/L	DW Lab	0.05	1	1	<0.10
Selenium	ug/L	DW Lab	5	0.05	50	<0.5
Thallium	ug/L	DW Lab	1	0.0005	2	<0.05
Radionuclides						
Combined Radium (226/228)	pCi/L	Eurofins	0.49	0	5	0.37
Gross Alpha	pCi/L	Eurofins	3	0	15	ND
Beta particles and Emitters	pCi/L	Eurofins	3	0	50	10.3
Uranium	ug/L	DW Lab	1	0	30	0.1

Notes:
MCLG = Maximum Contaminant Level Goal
MCL = Maximum Contaminant Level
MRL = Maximum Reporting Limit
TT = Treatment Technique

Contaminant	Units	Laboratory	MRL	EPA[3]		PureWater Colorado Batch Finished Water Results
				MCLG[1]	MCL or TT[1]	Batch 2 (3/15/2018)

The EPA's SWTRs require Water Treatment Facilities to:

a. Disinfect their water, and

b. Filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

Cryptosporidium: 3-log removal.
Giardia lamblia: 3-log removal.
Viruses: 4-log removal.
Legionella: No limit, but EPA believes that if Giardia and viruses are removed/inactivated, Legionella will also be controlled.
Turbidity: ≤ 0.3 NTU 95 percent of the time, never to exceed 1 NTU.
HPC: No more than 500 bacterial colonies/mL.

Regulatory levels detailed in:
SWTR = Surface Water Treatment Rule
IESWTR = Interim Enhanced Surface Water Treatment Rule
LT1 = Long-Term 1 Enhanced Surface Water Treatment Rule
LT2 = Long-Term 2 Enhanced Surface Water Treatment Rule
TCR = Total Coliform Rule
D/DBPR = Disinfectants/Disinfection By-Products Rule
SDWA = Safe Drinking Water Act and Amendments
Arsenic Rule
Radionuclide Rule

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Table 4. CECs Purified Finish Water Batch 1 Water Quality Results

Contaminant	Units	Laboratory	MRL	Water Quality Goals	PureWater Colorado Batch Finished Water Results Batch 2 (3/15/2018)
CECs					
1,4-dioxane	ug/L	Eurofins	0.07	1[(1)]	ND
NDMA	ng/L	Eurofins	2	10[(1)]	3.1
PFOA/PFOS/PFC Suite					
Perfluorobutanesulfonic acid (PFBS)	ng/L	Eurofins	2	--	ND
Perfluorodecanoic acid (PFDA)	ng/L	Eurofins	2	--	ND
Perfluorododecanoic acid (PFDoA)	ng/L	Eurofins	2	--	ND
Perfluoroheptanoic acid (PFHpA)	ng/L	Eurofins	2	70 (total)[(5)]	ND
Perfluorohexanesulfonic acid (PFHxS)	ng/L	Eurofins	2	--	ND
Perfluorohexanoic acid (PFHxA)	ng/L	Eurofins	2	--	ND
Perfluorononanoic acid (PFNA)	ng/L	Eurofins	2	--	ND
Perfluorononanoic acid (PFOS)	ng/L	Eurofins	2	70 (total)[(5)]	ND
Perfluorooctanoic acid (PFOA)	ng/L	Eurofins	2	70 (total)[(5)]	ND
Perfluorotridecanoic acid (PFTrDA)	ng/L	Eurofins	2	--	ND
Perfluoroundecanoic acid (PFUnA)	ng/L	Eurofins	2	--	ND
Pertluorotetradecanoic acid (PFTeDA)	ng/L	Eurofins	2	--	ND
Gen X	ng/L	Eurofins	5	--	ND
4-nonylphenol	ng/L	Eurofins	100	500000[(2)]	610
Atenolol	ng/L	Eurofins	5	70000[(3)]	ND
Caffeine[(6)]	ng/L	Eurofins	5	350[(3)]	9

Contaminant	Units	Laboratory	MRL	Water Quality Goals	PureWater Colorado Batch Finished Water Results
					Batch 2 (3/15/2018)
Carbamazepine	ng/L	Eurofins	5	1000[3]	13
Cotinine	ng/L	Eurofins	10	10000[3]	ND
DEET	ng/L	Eurofins	10	2500[3]	ND
Dilantin	ng/L	Eurofins	20	1000[3]	ND
Estradiol	ng/L	Eurofins	5	1[3]	ND
Estrone	ng/L	Eurofins	5	350[3]	ND
Ethinyl Estradiol	ng/L	Eurofins	5	280[3]	ND
Geosmin	ng/L	DW Lab	1	5[7]	<1
Ibuprofen	ng/L	Eurofins	10	40000[3]	ND
Meprobamate	ng/L	Eurofins	5	260000[3]	ND
(MIB) 2-methylisoborneol	ng/L	DW Lab	1	5[7]	<1
Primidone	ng/L	Eurofins	20	840[4]	ND
Sucralose[6]	ug/L	Eurofins	0.1	150000[8]	ND
TCEP	ng/L	Eurofins	10	2500[3]	ND
Triclosan	ng/L	Eurofins	10	350[3]	ND

Contaminant	Units	Laboratory	MRL	Water Quality Goals	PureWater Colorado Batch Finished Water Results
					Batch 2 (3/15/2018)

Notes:
-- = None Available
MRL = Method Reporting Limit
ND = Non-Detect

1) No EPA criteria for NDMA. CA DDW lists a notification level.
2) 2008 Australian Water Recycling Guidelines.
3) Additional health-based screening levels from 2010 SWRCB Recylced Water CEC Scientific Advisory Panel Final Report.
4) Drinking Water Equivalent Level (DWEL) developed by Intertox, Inc. (2009) for Orange County Water District.
5) Colorado Health Advisory of 70 ng/L for the total concentration of PFOA, PFOS, and PFHPA.
6) Caffeine and sucralose are surrogates for water-soluble uncharged chemicals of moderate molectular weight and not a CEC for its own health impacts, but rather for occurence.
7) No MCL exists for MIB or geosmin and they are considered CECs in this study due to public perception and taste and odor concerns. A threshold of 5 ng/L is listed based on WRF 3032 2013.
8) FDA threshold idefintifed as a health screening level in WE&RF project 11-02. FDA threshold of 5 mg/kg was converted to a drinking water concentration based on 60-kg and 2 L/day in the WE&RF project 11-02.

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This letter reflects results from the second Batch of water taken and water tank filling (Batch #2). Subsequent water quality results will be sent to CDPHE for three additional sampling events in the following weeks.

Thank you for your continued support and review of the demonstration project results. Please let us know if you have any questions or comments. Further details are available at any time upon CDPHE request.

Sincerely,

CAROLLO ENGINEERS, INC.

Austa M. Parker, PhD
Technologist
PureWater Colorado Project Manager

Author Initials: amp

Attachments: Appendix A – Process Performance Monitoring for Purified Water Tanker Filling

cc: Brett Icenogle, CDPHE
Brandi Honeycutt, CDPHE
David Kurz, CDPHE
Damian Higham, Denver Water
Abigail Antolovich, Denver Water
Russell Plakke, Denver Water
David Brancio, Denver Water
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John Rehring, Carollo Engineers

carollo
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Appendix A – Process Performance Monitoring for Purified Water Tanker Filling

Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Units
Sample Date	3/14/2018	3/14/2018	3/14/2018	3/14/2018	3/14/2018	3/14/2018	3/14/2018	3/14/2018	3/15/2018	3/15/2018	3/15/2018	3/15/2018	3/15/2018	3/15/2018	3/15/2018	
Time (Start)	10:23	11:05	11:45	12:28	13:09	13:51	14:33	15:15	8:34	9:17	9:58	10:41	11:52	12:35	13:17	
Time (Stop)	11:05	11:44	12:27	13:08	13:50	14:31	15:13	15:50	9:15	9:56	10:38	11:30	12:34	13:16	13:59	
Ozone Dose	4.84	5.11	5.05	5.08	4.71	4.88	5.01	4.97	5.33	4.84	5.07	4.91	4.82	5.03	4.81	mg/L
Ozone Flow	15.1	15.1	14.8	15.0	15.1	15.1	15.1	15.2	12.8	11.8	15.1	15.0	14.9	15.1	15	GPM
Biofiltration Empty Bed Contact Time (EBCT)	17.4	19.2	17.2	19.6	17.6	16.6	17.1	20.2	17.3	19.0	18.8	15.3	18.1	17.4	17.2	MIN
Microfiltration Trans Membrane Pressure (TMP)	4.41	4.466	4.365	4.497	4.747	4.816	4.872	4.891	4.99	5.30	5.17	5.27	5.422	5.421	5.797	PSI
UV Flow	4.5	5.2	5.7	5.1	5.6	4.6	5.6	5.2	6.0	5.8	5.6	5.1	5.7	5.7	5.7	GPM
UV Transmittance (UVT) - Influent to UV AOP	100	98.2	96.3	96.6	97.9	98.8	99.4	97.5	97.7	97.9	97.8	97.1	98.1	97.4	97.8	%
UVT - Finished Water	98.4	99.1	98.4	98.1	98.9	99.1	99.3	99.4	99.4	99.1	99.8	99.5	99.4	98.9	98.3	%
UV Dose	2277.6	2860.2	2366.2	2545.5	2338.7	2750.1	2366.2	2328	2246.8	2360.6	2364.3	2395.6	2334.1	2328.2	2328.2	mJ/cm^2

DENVER WATER

CHAIN OF CUSTODY

Receiving Laboratory: WQ Laboratory, 6100 w Quincy Ave, Denver CO 80235, Tel 303-628-5940

All fields must be filled out.

Customer Name: Denver Water

Address: 5650 York st | City and State: Commerce City

Phone Number: | Fax Number:

Sampled By: (*Please print clearly*)

Sampler's Signature:

Location of Sample	Date Collected	Time Collected	Sample/Facility Point ID	Grab or Composite (G/C)	Entry Point Sample (DW)	Distribution Point Sample (DW)	Surface Raw Water (SW)	Ground Water (GW)	Wastewater (WW)	Watershed (WS)	Other	NUMBER OF CONTAINERS	Preservative	Container Type and Volume	Analysis Requested (EPA XXX.X)	Reg Compliance Y/N	Receipt Temperature (deg C)	Received in ice (Y/N)	Additional Information
PureWater CO Batch #2 Water for Brewing ~4000 gallons																			

SPECIAL INSTRUCTIONS/COMMENTS

Custody transfer for transport between recycling plant & declaration brewing.

RELINQUISHED BY (Printed Name, Signature, Date and Time):

Damian Higham 4/5/18 11:40

Stanley J Shutt

Comments

RECEIVED BY (Printed Name, Signature, Date and Time):

Stanley J Shutt 4-5-18 11:40 AM

Gregory Schlichting 2:08 PM

Comments

PureWater Colorado Demonstration Facility Finished Water Storage Checklist

Item		Initials	
Sample Container Received Date:	3/13/18	DH	Notes:
Type of Container:	☐ Tote ☒ Tanker	DH	Notes:
Volume of Container, gallons:	4600	DH	Notes:
Container Arrived Empty and Undamaged:	☒ Yes ☐ No	DH	Notes:
Number of Inlets, Outlets, Overflows, Hatches and Vents:	2	DH	Notes:
Container Arrived Sealed:	☒ Yes ☐ No	DH	Notes: Seals #: 5765733, 5765738, 5765736
Container Label:	None	DH	Notes:
Container Fill Date:	3/14-15/18	DH	Notes:
Filling Method:	☐ Direct ☒ Transfer	DH	Notes:
Appurtenances Open to Atmosphere Sealed or Valved off During Storage:	☒ Yes ☐ No	DH	Notes: Hatch closed & outlet compartment closed. Tanker parked just SW of demo
Filled Container Storage Location: Access to Storage Location Limited to Authorized Personnel Only:	☒ Yes ☐ No	DH	Notes:
Container Inspection Date:	3/27/18	DH	Notes: Inspected after move.
Container Condition:	☒ Intact ☐ Damaged	DH	Notes: No changes
Container Inspection Date:	4/5/18	DH	Notes: Inspected prior to delivery
Container Condition:	☒ Intact ☐ Damaged	DH	Notes: No changes
Container Inspection Date:			Notes:
Container Condition:	☐ Intact ☐ Damaged		Notes:
Container Draining Date:	4/5/18	DH	Notes: Water delivered and transferred to Declaration Brewing via Bulk Transporters.

DEL CAMINO SERVICE PLAZA
10763 TURNER BLVD.
LONGMONT, CO 80504

303-678-0443
FAX 303-682-9990

-INVOICE- NO: 485492
Date: 03/12/18

Page: 1

Sold To: Bulk Transporters Inc
P O Box 127
Gilcrest, CO 80623

Customer No: 21
Phone No: 970-737-2474

Contact Contact Alexander Davis

Cust. Order #:

Cashier:KRISTINA
Service Person:KRISTINA

Product Code	Item Description	Qty	Unit Price	Amount
3	TANKER W/O-SPINNER-FOOD	1	245.00	245.00
	KOSHER			
	SEAL #S			
	5765803,5765733,5765734,5765735			
	5765736,5765737,5765738			
3	TANKER W/O - HOSES EACH	2	10.00	20.00
3	TANKER W/O - PUMP EACH	1	20.00	20.00

I acknowledge receipt of the goods and service listed on this invoice and state I am authorized to charge to the above account.

Tractor# 153
Trailer# 920
Mileage:
Driver In:
03/12/18 9:55a
Driver Out:

Sub-Total:	285.00
Shipping:	0.00
Tax [2.9]:	0.00 *
Total:	285.00
DUE UPON RECEIPT:	285.00
Amount Paid:	0.00
Amount Due:	285.00
Change:	0.00

970 415 2496
Proudly Serving you for over 25 Years!

Del Camino Service Plaza & Truck Wash LLC

10763 Turner Blvd. Longmont, Co. 80504
Interstate 25 * Exit # 240
303-678-0443 303-682-9990

Date: 3/12/18	Arrival Time:	Start Time:	Finish Time:
Customer Name: Bulk Transporters		Customer # 21	Bay # 4
Cleaning Procedure: Hot	Tractor # 153		Trailer # 920
Invoice # 485492	PO #		DOT Class:

Last Product: Corn syrup	**Chemical Tank**
Last Product:	**Sanitary Food Grade** X
Last Product:	**Sanitary Non-Certify**
Last Product:	**Kosher Washout** X
Last Product:	**Dry Bulk**

	SERVICE	EMPLOYEE #	SUPERVISOR #
X	Hot Flush	221	110
	Cold Flush		
X	Hoses / 2	221	110
X	Pump	221	110
	Dry		
X	Kosher	221	110
	Caustic		
X	Detergent	221	110
	Steam		
	Valves		

Pre-Cleaning	Auth to Clean By: M C	Inspection List R.E.	Seal Numbers
EMP#	Hot Water: ✓	Tank Interior ✓	5765803, 5765733, 5765734, 5765735
Pass:	Steam: ✓	Hot Water Rinse ✓	5765736, 5765737, 5765738
Fail:	Detergent: HD#5 ✓	Caps & Gaskets ✓	
Restricted	Caustic: CIP-1	Valve ✓	
Heel:	Wash Temp: 200	Pump ✓	
Product:	Rinse Temp: 180	Dome Lid & Covers ✓	
Color:	Cold Rinse: 160	Dry	
Class:	Vessel Temp:	Hoses & Hose Tubes ✓	
Other:	RLU Result:	Tank Exterior	

Remarks:

Cleaned By: Marcelo Castillo	**Inspected By:** Rodrigo E.

DEL CAMINO SERVICE PLAZA AND TRUCK WASH LLC MAKES NO GUARANTEE WITH RESPECT TO THE COMPLETENESS OF THE WASHING PROCESS OR THE COMPLETE ELIMINATION OF ALL RESIDUE AND MOISTURE. INSPECTION OF THE EQUIPMENT IS AGREED TO REMAIN THE RESPONSIBILTY OF THE CUSTOMER AND THE HERBY RELIEVE AND DISCHARGE DEL CAMINO SERVICE PLAZA AND TRUCK WASH OF ANY RESPONSIBILTY. CLAIMS AND DEMANDS OF ANY KIND WHAT SO EVER BY ANY PERSONS FOR DAMAGES AS A RESULT OF ALLEGED IMPROPER OR INCOMPLETE CLEANING OF EQUIPMENT. I HAVE READ AND UNDERSTAND THE TERMS AND CONDITIONS LISTED ABOVE AND LISTED ON THIS ORDER.

Pick Up and Acceptance From Driver on Date: 3-12-18

Signature: [signature]

Print Name: Alex Davis

Del Camino Service Plaza and Truck Wash LLC
10763 Turner Blvd. Longmont, CO 80504
Phone 303-678-0443 Fax 303-682-9990

Certification of Kosher Wash Out

Customer Name Bulk Transporters

Invoice Number 485492

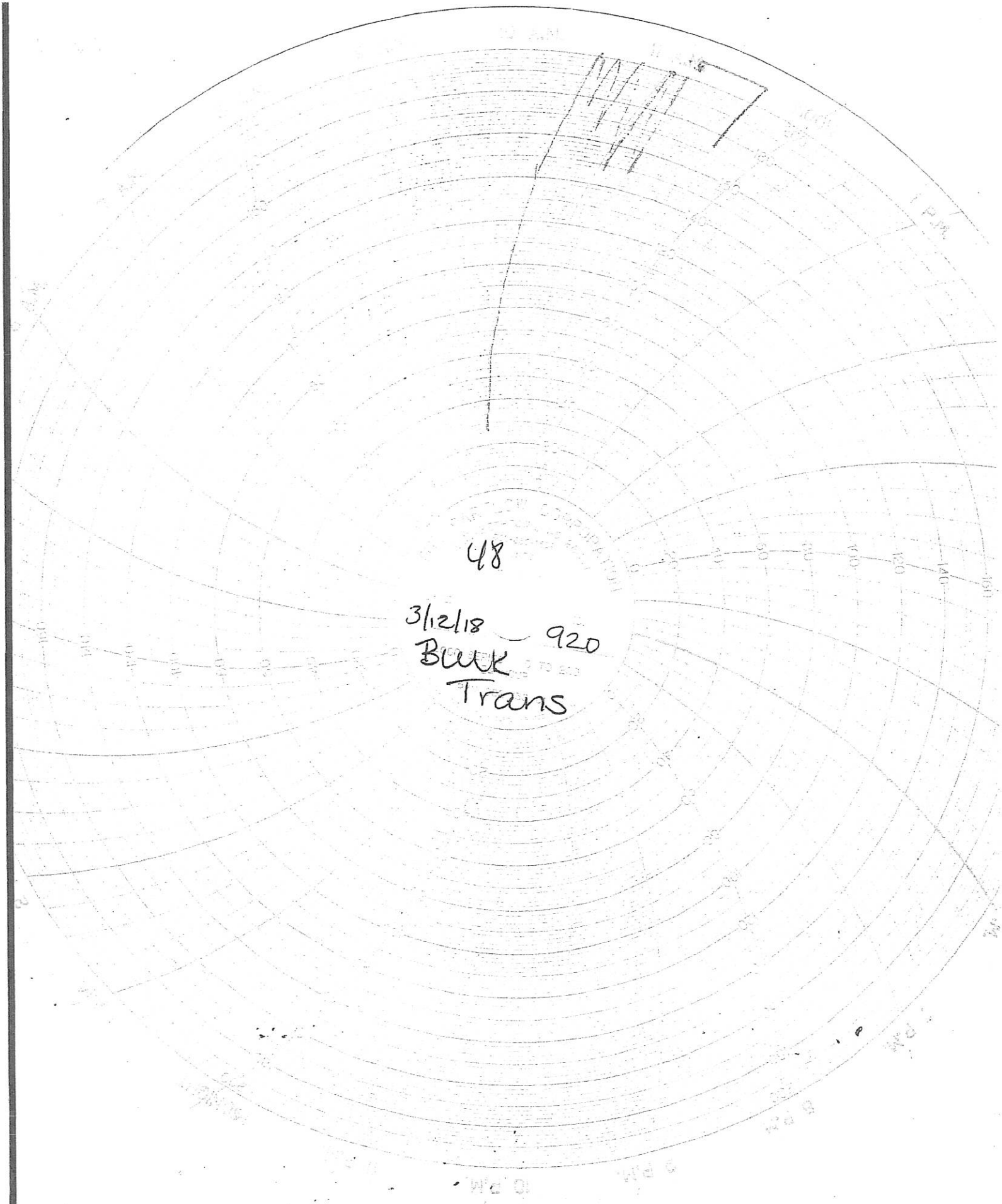
This certificate is to declare that tank number 920 was washed out on 3/12/18 by qualified technicians using Kosher Wash Procedures.

Del Camino Service Plaza and Truck Wash LLC has been certified by:

The Scroll K / Vaad Hakashrus of Denver.

Should you have any questions please call Brian Pearce at 303-678-0443.

Thank you for your business.


48
3/12/18 — 920
Bulk
Trans