Item #14

Town of Mountain Village

Date: 9/12/19

To: Town Council

From: Finn Kjome Public Works Director

Re: Consideration of Adding Phosphate to the Town's Drinking Water to Control Copper at the Regional Sewer Facility

Overview:

This pilot program request is a direct result of the of the combined efforts of the users of the Regional Sewer Treatment Facility's attempt to meet the copper limits required by our discharge permit with the State. The Mountain Village sewage is one of the sources of copper at the sewer treatment plant therefore the Town has been tasked with being to be part of the solution. Several engineering firms have looked at removing copper at the sewer plant but have determined that it is best to treat for copper before it gets to the plant.

Finn Kjome

PLUMMER

TECHNICAL MEMORANDUM

Mountain Village
Water Treatment Facilities
Phosphate Addition
Human Health and Environmental Information Regarding Phosphate Addition for Corrosion Control

Project No.:	4106-001-02
Date:	September 11, 2019
Prepared For:	Finn Kjome - Mountain Village
Prepared By:	Julian Paiz, EIT; Mark Dahm, P.E.
CC:	William Frownfelter - Short Elliott Hendrickson Inc.

1 INTRODUCTION

1.1 PHOSPHORUS AND ORTHOPHOSPHATE

Phosphorus is an element that is most commonly found to chemically bound to oxygen to form a class of compounds collectively called phosphates. Phosphates are naturally occurring minerals that are mined to support multiple biological functions. Phosphates are essential nutrients that aid in human, animal, & plant development. Additionally, phosphates are used synthetically to build man made products such as fertilizers, cleaners, and water treatment chemicals. Phosphates can be further broken down into the following 3 forms: orthophosphates, condensed phosphates (meta, pyro, polyphosphates) and organic phosphates. Each has different phosphorous containing molecules and a different chemical arrangement. Orthophosphate is the smallest molecule containing only one phosphorus element. Readily available and reactive, orthophosphate, can be produced by natural processes. This is the form most readily utilized by plants and animals. Condensed phosphates are generally larger molecules and are widely used in industry to make detergents, fertilizers and food additives. These condensed phosphates can be transformed back to orthophosphate when added in water. Organic phosphates are orthophosphates or polyphosphates that are bound or tied up in plant tissue, solid waste, or other organic material (carbon containing). After decomposition, this form can be converted to orthophosphate.

2 CORROSION CONTROL TREATMENT

2.1 NEED FOR CORROSION CONTROL TREATMENT (CCT)

Mountain Village Utilities would like to add orthophosphate to the drinking water supply to reduce the level of copper in the water. The need for the copper reduction is due to State controlled limits imposed on water leaving the Town of Telluride Wastewater Treatment Facility (WWTF). Drinking water from Mountain Village, and the copper in it, ends up in the Telluride wastewater facility. The facility has a very limited capacity to remove copper as part of the treatment process and upgrading the facility to do so would be very expensive. The proposed solution is to reduce the amount of copper coming into the facility by adding orthophosphate in Mountain Village. The new chemical will form a natural protective barrier on copper pipes and fixtures in the drinking water system and limit the transfer of copper to the water. The reduction in copper will help Telluride's WWTF in meeting the copper limits.

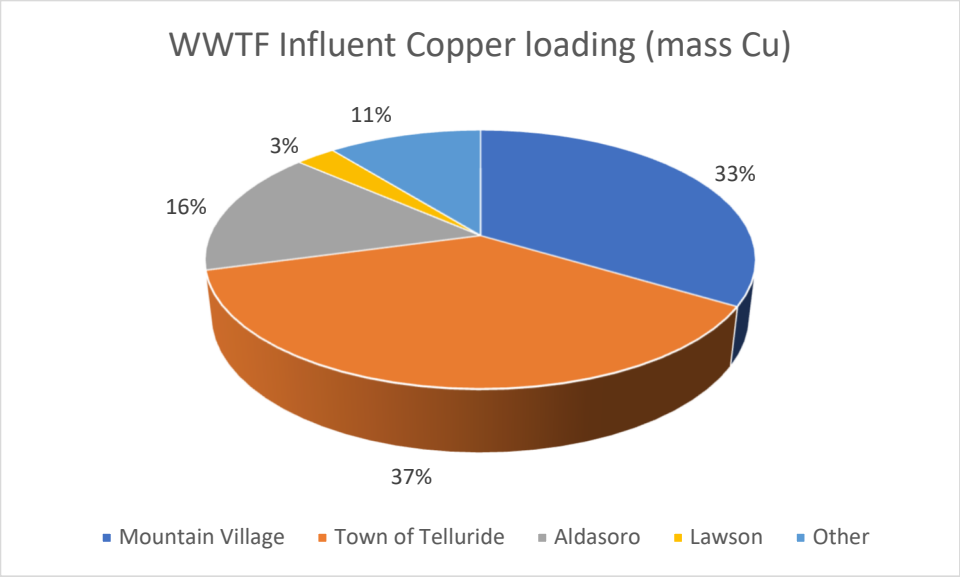
As the water leaves the WWTF, it travels directly to the San Miguel River and the copper can be harmful to fish such as the cold-water Sculpin and Cutthroat Trout, thus, the State has imposed limits on the

facility. The State imposes a set of limits on every facility in Colorado and each set is site specific. The new permit for the facility in Telluride sets the limit for copper at 10 micrograms per liter of water. The facility has until 2022 to comply but the copper must be measured as a 2-year rolling average. This means data collected starting in 2020 will affect the facilities ability to comply.

2.2 SOURCE OF THE COPPER

Mountain Village is not the only source of copper that ends up in the San Miquel. Figure 1 illustrates recent data collected by the Town of Telluride. Mountain Village is shown to be the second largest contributor of copper coming into to the Town WWTF.

Figure 1 – Copper Loading



While the exact copper concentration in the Mountain Village sewer collections system is variable; data collected shows both Mountain Village and the Town have had similar concentration coming into the treatment facility. Relevant copper concentrations are presented in Table 1.

Table 1 – Copper Concentrations

	Copper Concentration (ug/l*)
Mountain Village Combined Influent	6**
Town Combined Influent	6
Pre CCT plan WWTF Effluent	18
Maximum Allowable WWTF Effluent Permitted Limit	10

*Micrograms per liter of water
**Average from limited and preliminary data set, value subject to seasonal variability

2.3 TOWN OF TELLURIDE PLAN

The Town of Telluride has recently implemented a Corrosion Control Treatment (CCT) plan to address the copper issue in the Town's drinking water system. The Town is pH adjusting the drinking water after it is produced and before it enters the distribution system. The Town introduces sodium hydroxide into the

water at both of its water treatment facilities to achieve the desired effect. To date, Telluride has seen recordable improvements in copper levels leaving the wastewater treatment facility resulting from the action taken at its drinking water facilities. The Town has requested Mountain Village also research and pilot a CCT plan with the aim of achieving further reductions in the copper concentrations.

2.4 OPTIONS FOR CORROSION CONTROL

Corrosion control in municipal water treatment is a complex and highly site-specific issue. The combination of local water chemistry, distribution system makeup, and water treatment facility operational practices requires unique approaches to corrosion control. To address the complexity of the issue, significant research has been applied to identify pathways for the most successful treatment outcomes. An EPA guidance document has been created from this information and allows the engineer to follow one of several flow charts for specific criteria which is unique to the community of interest. Treatment recommendations at the conclusion of the flowcharts are varied and simplified by filtering economic constraints that often apply within the municipal sector. The two most common approaches to corrosion control treatment used by municipalities are: pH adjustment, as used by the Town of Telluride, and phosphate addition as is proposed here.

2.5 ORTHOPHOSPHATE SELECTION

The unique water chemistry of the source water treated by Mountain Village is the driver for proposing orthophosphate for CCT. The same treatment plan utilized by the Town, pH adjustment, was extensively studied for its application in Mountain Village. The results revealed a high probability of the formation of carbonate minerals onto the distribution system piping and fixtures. This would be an undesired consequence associated with pH adjustment and leave the potential of creating a larger problem than the copper issue. The EPA flow chart identified the addition of orthophosphates to be the alternative with the greatest potential for success in reducing copper in Mountain Village water.

The use of orthophosphate is a fully approved EPA treatment process and is utilized by multiple municipalities within the State. Based on current Colorado Department of Public Health (CDPHE) data, of the approximately 2,000 public water systems in Colorado, 89 have been approved to use phosphate treatment for drinking water. Table 2 presents a list of some of these communities.

Table 2 – Communities Using Orthophosphates

Community	Population	Phosphate Dose used (mg/l)
Silverthorne	5,000	0.6
Vail	29,000	0.4
Edwards	32,000	0.4
Estes Park	16,000	1.0
Eldora	3,000	0.5
Parker	52,000	0.4
Brighton	36,000	0.4

Mountain Village proposes to test the effectiveness of the orthophosphate addition for a temporary 1-year pilot period. If the pilot testing results are not satisfactory, Mountain Village Public Works staff would discontinue its use.

3 HUMAN HEALTH IMPACTS

3.1 BIOLOGICAL ROLE OF PHOSPHORUS

Phosphorus is needed as part of normal human metabolism to build healthy bones and it provides an essential role in keeping other parts of the body and immune system healthy. Phosphorus is found in a large variety of foods, either occurring naturally or added through the food manufacturing process. Commonly consumed items and their phosphorus content are described in Table 3.

Table 3 – Phosphorus Content

	Phosphorus Content (milligrams)
Average can of soda	50
1 cup of milk	250
2.5oz of cooked trout	200
½ cup quinoa	150
¼ sunflower seeds	400

The average daily intake of phosphorus in the United States is 1,400 milligrams according to data published in 2014 by the National Center for Biotechnical Information.

3.2 PROPOSED ADDITION OF ORTHOPHOSPHATE AT MOUNTAIN VILLAGE

The proposed dose of chemical to be used at Mountain Village is 1.5 milligrams per liter of water. Every milligram of orthophosphate is approximately 1/3 phosphorus; therefore, the proposed dose will add 0.5 milligrams of phosphorus per liter of water. With a conservative daily intake of 10 liters of water per day, a person's total phosphorus intake from water consumed would be 5 milligrams per day. At the average daily intake of 1,400 milligrams, the additional contribution from the drinking water consumed would amount to 0.36 %. The Food and Drug Administration has listed orthophosphate as a food additive to be safe for human consumption, therefore, the additional 0.36% will not have a significant effect on human health in Mountain Village.

4 ENVIRONMENTAL IMPACTS

Phosphorus is also an essential nutrient for plant cellular growth and its effects are commonly seen in fertilization of crops or gardens. The primary concern with phosphorus in the natural environment is that too much can lead to problems with excessive plant growth, including algae. When this algae dies in the fall/winter, oxygen in the rivers is consumed, potentially leaving a minimal amount for the fish to breathe. With river health vital to the local economy, care must be taken to not introduce too much phosphorus to the river system.

Winter low flow in the San Miguel River can be approximated conservatively at 21.5 Million Gallons per Day (MGD). Recently, water quality monitoring of the river upstream of the Town WWTF show average levels of phosphorus around the 0.08 milligrams per liter. Discharge from the WWTF adds an additional 1.0 MGD of flow to the San Miguel. With Mountain Village contributing 35 % of this flow, the additional 0.5 milligrams per liter phosphorus added by the proposed CCT plan would result in a very small increase of total phosphorus to the river. Calculations show this value to be less than 4%. This estimate assumes no additional reduction from the treatment process for the added phosphorus contribution from Mountain Village and a worst-case scenario using the lowest natural flow in the river. Realistically, the contribution is likely to amount to a less than 2% increase.

Mountain Village Corrosion Control Pilot Study

Orthophosphate Addition to Drinking Water Source

PLUMMER

September 19th, 2019

Phosphate Addition Overview

- Human Health Impacts
- Environmental Impacts

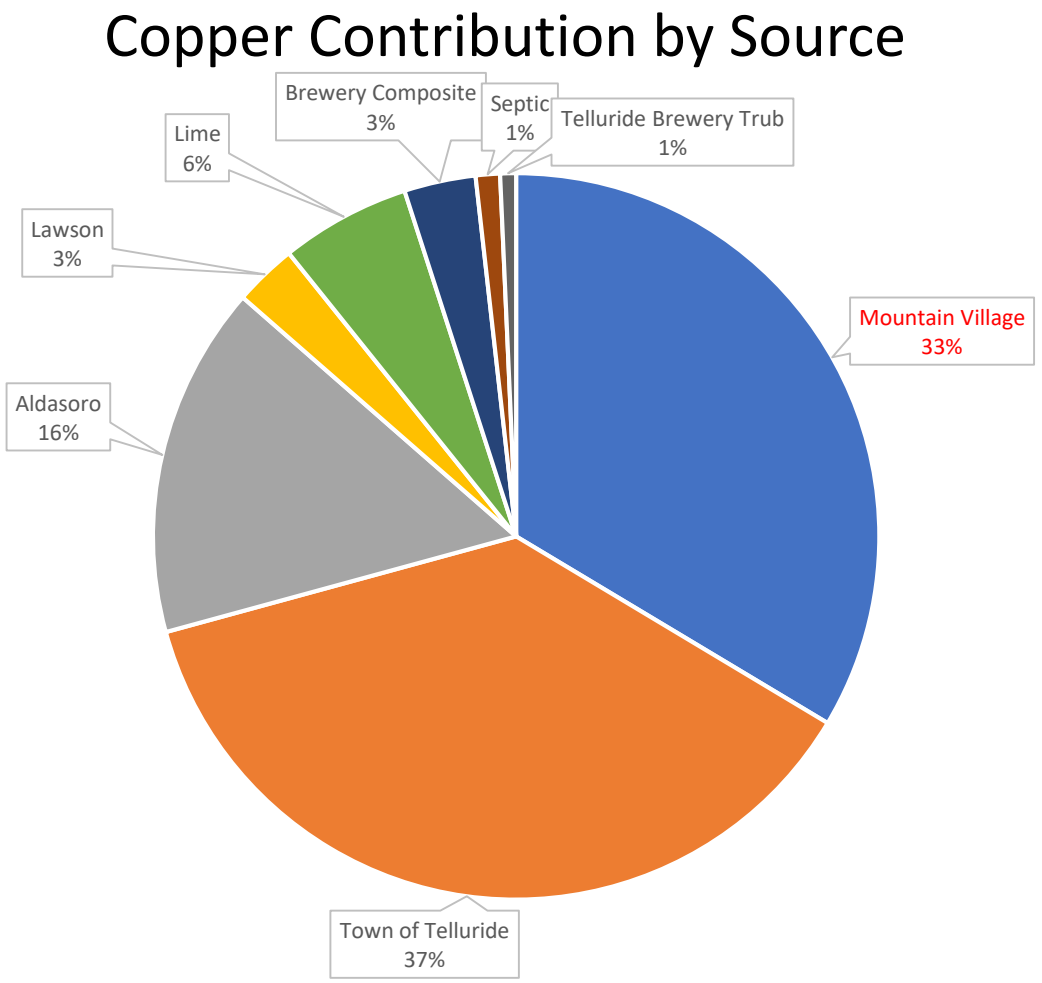
Why Not Sodium Hydroxide (pH Adjustment)

- Water chemistry model results
- High dissolved inorganic carbon (DIC)
- Deposition of calcium carbonate in distribution system

Why Orthophosphate

- Current Town of Telluride permit requires Copper concentration be reduced to 10 µg/l by 2022
  - 2 year rolling average
  - Copper concentrations measured in *Jan. 2020* will affect ability to comply.
- Town of Telluride already using Sodium Hydoxide (pH adjustment) at both WTP's.
  - Improvements in effluent Copper levels seen

Mountain Village Copper Contribution



Phosphorus - Human Health Impacts

- Average daily intake in the US is *1400 mg*
- Phosphorus contributions from common foods
  - Can of Soda - *50mg*
  - 1 cup of Milk - *250mg*
  - 2.5 oz. of Cooked Trout - *200mg*
  - ½ cup Quinoa - *150mg*
  - ¼ Sunflower Seeds - *400mg*

Human Health Impacts – Example

- Phosphate (PO4) - 96g/mol
- Phosphorus (P) - 31g/mol
  - Phosphorus in phosphate ~1/3
  - We are proposing to dose ~1.5 mg/l as (PO4) or *0.5mg/l* as (P)
- Recommended daily water consumption
  - 4 liters, say 10 liters to be conservative

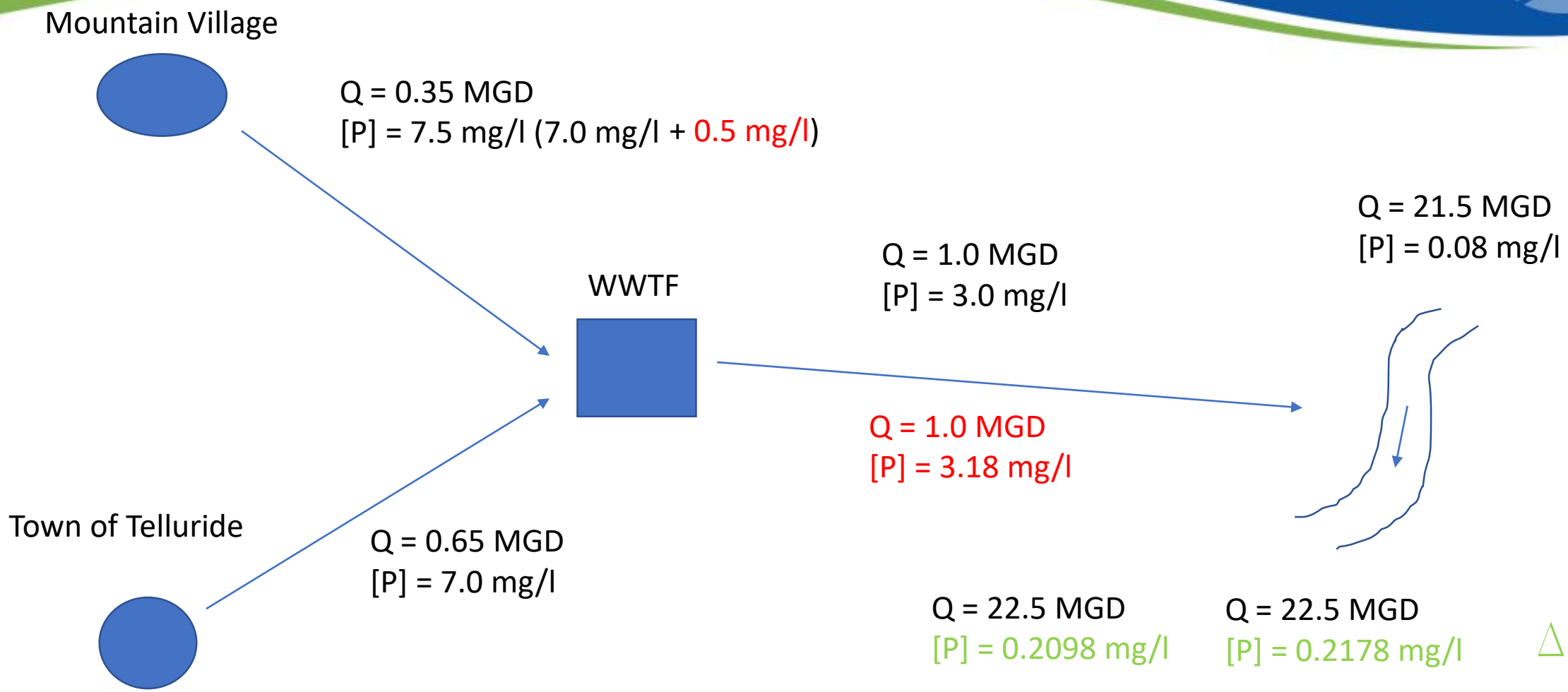
5mg per day from Drinking Water
or 0.4% Daily recommended value
assuming 100% bioavailability

Other Colorado Communities Using Orthophosphate for Corrosion Control

89 total Communities in the State using PO4, some of the larger ones:

Community	Population	Phosphate Dose Used (mg/l)
Silverthorne	5000	0.6
Vail	29000	0.4
Edwards	32000	0.4
Estes Park	16000	1.0
Eldora	3000	0.5
Parker	52000	0.4
Brighton	36000	0.4
Mountain Village	**1,400**	**0.5**

Phosphorus - Environmental Impacts



QUESTIONS?

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