TO: Lauren Evans, Chair, Water Quality Control Commission
Trisha Oeth, Administrator, Water Quality Control Commission

FROM: Lillian Gonzalez, Permits Section
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RE: Triennial Review Informational Hearing for Reclaimed Water Control Regulation (Regulation # 84)

DATE: April 13, 2016

Background

In accordance with the Water Quality Control Commission's (commission) triennial review cycle of regulations, a Triennial Review Informational Hearing (TRIH) is scheduled for the Reclaimed Water Control Regulation (Regulation #84) on May 9, 2016.

The last triennial review of this regulation occurred in 2013. The Water Quality Control Division (division) is requesting a rulemaking hearing in this TRIH. The division will recommend a hearing date after the evidence and the stakeholder process are further developed.

Summary of Potential Change to Regulation #84

The following areas of potential change to Regulation 84 have been discussed:

1. Addition of irrigation of crops for human consumption as an approved use;
2. Addition of indoor urinal and toilet flushing as an approved use;
3. Addition of livestock washdown as an approved use;
4. Address accumulation of total dissolved solids (TDS);
5. General clarifications and/or corrections.

The division believes that these are significant changes to the current regulation. These changes are expected to be of interest to various stakeholders including:

- Water Reuse Colorado (WRCO, reclaimed water trade group);
- Denver Water;
- Denver Parks Department;
- Denver Urban Gardens;
- Upper Black Squirrel Groundwater Management District;
- Friends and Neighbors of Washington Park;
- And other members of the public and/or the regulated community.

The division believes that changes to Regulation 84 are warranted. However, due to the scope of the potential changes and the high degree of stakeholder interest, the division cannot recommend a date for the rulemaking hearing at this time.

Discussion of Areas of Potential Change to Regulation 84

1. Crops for Human Consumption
    a. Background

    Denver Water has expressed interest in adding the irrigation of crops for human consumption as a new approved use under Regulation 84. "Crops for human consumption" includes crops that are eaten raw (unprocessed) by humans, crops that are processed prior to human ingestion, and crops which may be smoked by humans (i.e. cannabis). The proponent plans to evaluate the following: traditional commercial crops for human consumption, cannabis crops, and crops grown in community or private gardens. Currently, Regulation 84 includes the following approved uses that involve irrigation: landscape irrigation, agricultural irrigation of non food crops, and silviculture. Regulation 84 contains requirements for users to implement best management practices to minimize pathways of human exposure to reclaimed water or to restrict access to areas where reclaimed water is being used, depending on the category of reclaimed water being used. Use of reclaimed water to irrigate crops for human consumption in community or private gardens, if approved, has the potential to be the use with the most direct human contact with reclaimed water. Ingestion of produce that has been in contact with reclaimed water is a direct exposure pathway that is not anticipated with other approved uses of reclaimed water.

    According to EPA's *2012 Guidelines for Water Reuse* (EPA/600/R-12-618), other states currently allow use of reclaimed water for irrigation of crops for human consumption, including but not limited to: Arizona, California, Florida, Hawaii, Nevada, New Jersey, North Carolina, Texas, Virginia, and Washington. Reclaimed water requirements for these states can vary widely. Some of these states (Florida, Nevada, Virginia) generally only allow the use of reclaimed water if the water does not come in contact with the edible portion of the crop (for crops that are to be eaten raw). Other states (California) have more stringent treatment requirements but fewer limitations (or none) regarding reclaimed water coming in contact with crops for human consumption. The division believes it would be an efficient use of stakeholder and division resources to use the numeric limitations, treatment requirements, and/or control measures from other state(s) with strong public health record(s) as a reference point for evaluating this new use in Colorado.

    Adding irrigation of crops for human consumption as a new use will require evidence that the proposed numeric limitations, treatment requirements, and control measures proposed for addition to Regulation 84 will be protective of human health and the environment.

    b. Key Issues

    Pathogens

    Reclaimed water may contain bacterial and viral pathogens. Pathogen content may be minimized through: 1) adequate treatment and/or 2) management to control regrowth in the storage and distribution systems. Evidence to support this new use must include details of what level of treatment of reclaimed water and what type of management strategies to minimize pathogens in the storage and distribution systems are needed in order to be protective of human health and the environment.

    The division considers bacterial regrowth in storage and distribution systems to be of particular concern, since it has been shown to pose an unacceptable risk to public health. For example, in 2008 an outbreak of waterborne disease associated with *Salmonella* in drinking water struck Alamosa, Colorado. The outbreak resulted in 442 reported illnesses, 122 of which were laboratory-confirmed, and one death. Although there were several possible causes of the outbreak, CDPHE's conclusion was that an animal source of fecal contamination entered Alamosa's reservoir (likely through small

cracks and holes) and then spread throughout the entire distribution system. (Please see: *Waterborne Salmonella Outbreak in Alamosa, Colorado March and April 2008: Outbreak identification, response and investigation;* CDPHE, 2008.)

The Alamosa outbreak involved potable water not reclaimed water. However, reclaimed water, as currently regulated in Colorado under Regulation 84, has the following potential added risk factors for bacterial regrowth, which are generally not present in potable water systems:

- For reclaimed water systems, a chlorine residual or other means of preventing regrowth in the distribution system is not currently required.
- Reclaimed water is often stored in open reservoirs, ponds, or channels that are in contact with pathogen sources in the environment.
- Reclaimed water often contains carbon and nutrients, which are important food sources for bacterial growth, at level that are higher than potable water.

Another example of a pathogen concern in reclaimed water is Legionella. Legionella is a group of Gram-negative bacteria present in groundwater, drinking water systems, wastewater, and reclaimed water systems. Legionella can cause Legionnaire's disease which has an estimated mortality rate of 5-30% of those infected and is responsible for 4-5% of all cases of pneumonia within the U.S. Infection is acquired through inhalation of aerosols. Legionella is the leading cause of drinking water disease outbreaks in the U.S. Legionella can thrive in reclaimed water systems due to the warm water, high level of organic carbon, little or no disinfection residual, and little distribution system cleaning/flushing/maintenance. Recommended practices for managing Legionella risk include maintaining a chlorine residual in the distribution system and regular flushing/cleaning of the system. (Source: Development of a Risk Management Strategy for *Legionella*. LeChevallier, Mark W. 2016 Southern Regional Technology Transfer Conference, January 28, 2016.)

Antibiotic Resistant Genes/Bacteria

Stakeholders have brought forth the issue of antibiotic resistant genes and bacteria (ARGs/ARBs) in reclaimed water. ARG/ARBs are an important environmental and public health concern. ARG/ARBs are ubiquitous and can be found in reclaimed water, treated wastewater effluent, surface water, and soils.

From engineering, operational, and/or regulatory perspectives, the division is not aware of any current research that indicates a clear path forward to effectively address ARG/ARBs in reclaimed water. Several studies are underway that may inform future decisions regarding reclaimed water. For example, the National Science Foundation (NSF) is funding a study called: *Relative Abundance and Diversity of Antibiotic Resistance Genes and Pathogens in Reclaimed Versus Potable Water Distribution Systems*. The abstract for this study states:

> The approach will identify key factors, such as: level of assimilable organic carbon, presence of disinfectant, type of disinfectant, water age, and temperature that influence microbial constituents of emerging concern in reclaimed water distribution systems and thus inform future management guidelines. It has only recently been established that microbial regrowth in reclaimed water distribution systems is the primary source of waterborne disease in developed countries; however, regrowth in reclaimed water distribution systems is relatively uncharacterized, despite reasonable expectations and preliminary results that suggest even greater potential for problems due to higher levels of nutrients, source water containing microbial constituents of emerging concern, and nuances of reclaimed water distribution systems operation in water stressed regions. Left unaddressed, these concerns

will impede the direct use of reclaimed water and call into question existing reclaimed water distribution systems practices. The proposed effort will address key knowledge gaps and support rationally engineered water reuse systems that allow the benefits of reclaimed water to be fully realized, while protecting public health.

This NSF study is expected to be completed in July 2017.

Provided that the division has adequate funding, the results of the NSF study, along with similar studies, should be considered during the next triennial review of Regulation 84. During the 2016 triennial review the division recommends that this important issue be addressed, to the extent possible, through current means of reducing pathogens, such as chlorination.

Accumulation of Salt

Another key issue that has been brought forth by stakeholders is the accumulation of contaminants, such as salt due to the reuse of water. Since this new use involves irrigation with reclaimed water, the division recommends that the proponent include recommendations for the management of salt that are specific to irrigation of crops for human consumption. Please see further discussion of the issue in item #3 below.

The evidence developed by the proponent will need to address all aspects of how the use of reclaimed water for irrigation of crops for human consumption will be protective of human health and the environment. The division intends to pay special attention and has been in ongoing dialogue with the expected proponent regarding the key issues listed above: pathogenic bacteria, antibiotic resistant genes/bacteria, and accumulation of total dissolved solids.

c. Roles

The division anticipates that the following parties will take on the following roles:

Denver Water and/or WRCO will act as the proponent for this new use. The proponent will:

- draft regulation and develop and present the evidence that the use will be protective of human health and the environment;
- develop, organize and lead any stakeholder processes that may be necessary to support the adoption of the new use; and
- include recommendations regarding accumulation of total dissolved solids, salinity, and sodicity relative to the performance of crops for human consumption irrigated with reclaimed water.

The division will:

- provide input to proponent as needed;
- attend stakeholder meetings as needed;
- provide a recommendation to WQCC once all evidence has been adequately developed and presented; and
- For all services listed above, WQCD will first evaluate whether the division can administer services associated with the adoption of this new use with present resources or if the effective date of the new uses needs to be delayed until resource constraints are resolved.

All stakeholders will:

- be invited to participate in the stakeholder process.

d. Schedule Considerations
Because of the diverse stakeholder interest, it is anticipated that it will be necessary to hold multiple stakeholder meetings between the May 9, 2016 TRIH and the rulemaking hearing. It may be appropriate for the proponent to request creation of a new Colorado Water Quality Forum (forum) workgroup at the July 2016 forum retreat. The purpose of the stakeholder meetings would be for the proponent to consider input from the stakeholders at key points in the evaluation process. Since stakeholder processes can be time and resource intensive, the division will recommend a date for rulemaking hearing once the evidence and the stakeholder process are further developed.

2. Urinal and Toilet Flushing
   a. Background
   Denver Water has expressed interest in adding indoor urinal and toilet flushing as an approved use. Denver Water is expecting interest in this use to grow as commercial building managers, owners, and occupants become more interested in using, treating, and reusing water onsite and/or using reclaimed water provided by an offsite facility. Potentially, reclaimed water used for toilet flushing could be provided by onsite wastewater treatment systems dedicated to a single building or campus, or provided to multiple locations by centralized reclaimed water facilities such as the Denver Water Recycling Plant.

   Adding urinal and toilet flushing as a new use will require evidence that the proposed numeric limitations, treatment requirements, and control measures in Regulation 84 will be protective of human health and the environment.

   b. Key Issues
   Additional Risk of Human Exposure due to Indoor Use
   Most existing approved uses of reclaimed water do not involve using reclaimed water inside a residential or commercial building. Because indoor urinal and toilet flushing would require reclaimed water lines to be located in close proximity to indoor potable water lines and fixtures, this use presents additional public health risk concerning cross connections and backflow prevention. In addition, this use has the potential for human contact via aerosols generated during flushing and during maintenance (e.g., fixing the float in a toilet tank). Therefore, this use may warrant a chlorine residual maintained centrally or at point of use and/or may warrant special management strategies such as signage, dyes, or other means to alert the public and building maintenance/repair personnel that reclaimed water is in use; training for installation/maintenance/repair personnel; controlled access to reclaimed water plumbing; cross connection testing, periodic inspection requirements, and other practices. Regulation 84 may or may not be the appropriate for mechanism for management strategies such as these. Some of these management strategies may benefit from or require the involvement of the State Plumbing Board and/or local authorities.

   Antibiotic Resistant Genes/Bacteria
   Stakeholders have expressed concern about ARG/ARBs in reclaimed water in the context of toilet flushing. Please see discussion of ARG/ARBs above in *Crops for human consumption* section.

   c. Roles
   The division anticipates that the roles and responsibilities for this use will mirror those outlined in the Crops for Human Consumption section above (with the exception of the evaluation of total dissolved solids, salinity, and sodicity).

   d. Schedule Considerations
   The addition of urinal and toilet flushing as an approved use, if approved, could be on a different schedule than the other potential changes being evaluated for Regulation 84. If involvement of the State Plumbing Board or local authorities is needed, this could add

significantly to the time line. The division will recommend a date for a rulemaking hearing once the evidence and the stakeholder process are further developed.

3. Addition of Livestock Washdown as an Approved Use
    a. Background
    Denver Water has expressed interest in adding livestock washdown as an approved use for Category 3 reclaimed water. Denver Water is expecting opportunities for this use to grow with the redevelopment of the National Western Stock Show complex. Currently, regulation 84 includes another use that involves animal care: zoo operations.

    Adding livestock washdown as a new use will require evidence that the proposed numeric limitations, treatment requirements, and control measures in Regulation 84 will be protective of human health and the environment.

    b. Key Issues
    Role of Other Regulatory Agencies in Animal Management
    The division has heard stakeholder concern regarding animal welfare when reclaimed water is used in zoo operations. The US Department of Agriculture (USDA) enforces the Animal Welfare Act, which governs the humane care and treatment of warm blooded and marine animals held in zoos. The division anticipates that the USDA or other governmental agencies may have animal welfare or other animal management requirements that pertain to livestock and which may affect the use of reclaimed water. Therefore, the division recommends that the proponent verify that this use will be viable in light of animal management requirements.

    c. Roles
    The division anticipates that the roles and responsibilities for this use will mirror those outlined in the Crops for Human Consumption section above (with the exception of the evaluation of total dissolved solids, salinity, and sodicity).

    d. Schedule Considerations
    The division will recommend a date for a rulemaking hearing once the evidence and the stakeholder process are further developed. The recommended timing for a potential rulemaking involving livestock washdown may be different than the timing recommended for other changes.

4. Accumulation of Salts
    a. Background
    Elevated concentrations of certain salts may have a negative effect on water quality and its suitability for irrigating crops. Salt concentration may be expressed in the form of Total Dissolved Solids (TDS), Electrical conductivity (EC), and/or Sodium absorption ratio (SAR) TDS is an expression for the combined content of all inorganic and organic substances contained in a liquid which are present in a molecular, ionized or micro-granular (colloidal sol) suspended form. The commission regulations for groundwater contain numeric standards for Total Dissolved Solids (TDS) in Regulations 41 and 42. Electrical conductivity (EC) is an expression of salinity, or the potential of water in the root zone to result in osmotic (direct) toxicity of the plant. Sodium absorption ratio (SAR) is an expression of sodicity, or the potential of irrigation water to alter the soil properties with the outcome of reduction in the availability of water in the root zone (i.e., hard panning). The division, in Water Quality Policy 24, *Implementing Narrative Standards in Discharge Permits for the Protection of Irrigated Crops*, sets guidelines for the development of effluent limitation for discharge permits for electrical conductivity (EC) and sodium absorption ratio (SAR). Other specific dissolved substances, such as Boron, are also known to affect the performance of some crops or other vegetation. The commission regulations for groundwater and surface water contain numeric standards for Boron in Regulations 41 and 42 and Regulations 31 through 38. Reclaimed water may contain levels of dissolved substances (measured as TDS, EC, SAR, or as specific ions), that may negatively affect plants.

Currently, Regulation 84 imposes no treatment, monitoring, reporting, numeric limitations or other conditions that limit concentrations of TDS or other measures of dissolved substances in reclaimed water. Regulation 84 requires irrigators to apply reclaimed water at or below the agronomic rate. However, consistent with established scientific practice, the definition of agronomic rate in Regulation 84 addresses water and nutrient uptake, and does not address salt. Regulation 61.14(1)(a)(v) specifically exempts from groundwater permitting requirements (with the exception of phosphorus in control basins), any land application of reclaimed water that occurs in accordance with Regulation 84, including any irrigation return flow.

b. Key Issues

High Salt Levels May Damage Vegetation

Stakeholders have expressed concern about the build-up of dissolved substances in soils when plants have been irrigated with reclaimed water. For example, members of the Inter-Neighborhood Cooperation (INC) Park and Recreation Committee have expressed concern that increased sodium ion concentrations resulting from irrigation with water produced by the Denver Water Recycling Plant may have resulted in an increase in the mortality rate of mature conifers in Washington Park and other urban parks. In particular, INC asserts that: "The sodium ion concentration in the reclaimed water is the factor that seems to be the most harmful. The reclaimed water contains other substances in quantities that are elevated in comparison to Denver Water's potable product, such as boron, chloride, calcium, magnesium and others, but sodium is the ion that occurs in the water, and later in the soil, at levels that appear to be causing the principal damage."

Salt related issues such as salinity and sodicity are frequently addressed through agronomic management practices and Colorado State University published guidance to help irrigators understand and manage the risks. Management practices may vary widely according to numerous site specific factors such as: type of irrigation system, soil type (infiltration capacity, permeability, structure, texture and depth); crop/plant type; soil amendment practices; irrigation water quality; and other site specific factors. For example, best management practices to mitigate high sodium might include periodic flushing with water with lower sodium concentrations to leach accumulated salts from the root zone. Soil amendments such as gypsum, can be used to improve or reclaim soil by increasing the soils water holding content. Plant selection based on salinity tolerance aligns crops with anticipated irrigation water salinity levels.

High Salt Levels May Negatively Affect Groundwater Quality

In addition, representatives of the Upper Black Squirrel Groundwater Management District (UBSGMD), the Farmer family (users of the aquifer) and Robert Longenbaugh (private citizen), have expressed concern about the accumulation of TDS in groundwater due to irrigation of agricultural land with reclaimed water generated by Cherokee Metropolitan District (CMD) and associated irrigation return flow. During the April 2016 stakeholder meeting, Mr. Longenbaugh estimated that, in 2015, irrigation with reclaimed water generated by CMD contributed over 800,000 lbs of "total salt" over a 508 acre area, thus degrading the water quality of the Upper Black Squirrel Aquifer.

c. Scope of possible Changes

The division is not currently anticipating adding treatment requirements for salts to Regulation 84. The potential negative effects on groundwater due to irrigation with high TDS reclaimed water can vary based on climate, depth to groundwater, irrigation rate, TDS level in the irrigation water, and numerous other factors. Likewise, as discussed above, the effects of TDS on vegetation can be very site specific. As resources allow, the division will evaluate potential changes to Regulation 84 that mitigate negative effects on groundwater and/or crops due to irrigation with high TDS reclaimed water, that are protective of human health and the environment, and encourage the use of reclaimed water.

Potential changes to the regulation to address salts might include, but are not limited to:

- "report only" monitoring requirements for treaters for salt related parameters such as TDS, EC, SAR and specific ions. The intent of this potential change would be to make data publicly available for salt related parameters and to inform future reviews of reclaimed water irrigation practices and Regulation 84.
- Requirements for treaters to notify users of concentrations of salt related parameters in reclaimed water. The intent of this potential change would be to increase users' understanding of salt related concentrations and to facilitate their adoption of irrigation management practices.
- No changes to Regulation 84, if the division determines that these issues are not ripe and/or better addressed through other means such as voluntary implementation of irrigation management practices by users or changes to Regulation 61.

d. Roles

To the extent that division resources will allow, the division anticipates taking on the role of the proponent to evaluate potential changes to Regulation 84 regarding salts. For all services listed above, WQCD will first evaluate whether the division can administer services associated with the evaluation of this topic with present resources or if the evaluation needs to be delayed until resource constraints are resolved.

e. Schedule Considerations

The division will recommend a date for a rulemaking hearing once the evidence for addressing salts has been further developed. The recommended timing for a potential rulemaking involving changes to address salts will likely be combined with other changes being considered.

5. Clarifications and/or Corrections

a. Background

There are several clarifications and/or corrections to Regulation 84 that are being considered by the division, including but not limited to:

- 84.4 (Applicability): Clarify exemption for domestic wastewater used for irrigation at a domestic wastewater treatment plant.
- 84.8: Clarify that the only approved uses are those that are included in this section.
- 84.9(C)(6): Move these irrigation-specific requirements to irrigation section in 84.9(A).
- Throughout: correction of typographical errors.
- Throughout: If new uses are approved, make edits as necessary throughout Regulation 84 to fully incorporate the new use(s).

b. Key Issues

The division is not anticipating significant controversy regarding the clarifications and/or corrections currently anticipated for Regulation 84.

c. Roles
   The division anticipates taking on the role of the proponent for these changes.
d. Schedule considerations
   The division will recommend a date for a rulemaking hearing once the evidence and the stakeholder processes are further developed for the other changes being considered. The recommended timing for a potential rulemaking involving clarifications/corrections will likely be combined with other changes being considered.