Regulatory Options for Membrane Treatment and Residuals Management

Background

Over a period of several years, Colorado’s Water Quality Control Division (Division) received requests for discharge permits from several existing and potential dischargers of brine from membrane treatment systems. At least one of these requests was for permit effluent limits based on assimilative capacity of the receiving stream during times where flows were greater than low flow conditions as defined in Section 31.9(1) of Colorado’s Basic Standards and Methodologies for Surface Water. When this issue was raised before the Water Quality Control Commission (Commission) during its May 2005 meeting, a determination was made to establish a workgroup to evaluate potential regulatory changes that would be necessary to accommodate such requests by dischargers. This workgroup was named the Assimilative Capacity at Flows Greater Than Low Flow Workgroup. The Commission scheduled a rulemaking hearing for July of 2006 to consider any proposal that the workgroup developed.

The threshold question for the workgroup was the following: “Should flow conditions that are higher than critical (regulatory) low flow levels be used for discharge permitting and if so, what criteria should govern their use?” The workgroup determined, at the outset, that it would be appropriate to prepare a set of “white papers” to elucidate the many complex issues embedded in this question. Altogether, eight white papers were developed, which are available at http://www.coloradowaterquality.com/ro/index.htm.

Many significant issues and concerns were raised in these papers about the prospect of allocating assimilative capacity at flows greater than regulatory low flows. By December of 2005, the general consensus of the workgroup was that the Division did not have the resources to develop permits and oversee their compliance under this type of permitting approach. Furthermore, the group agreed that implementing such a system could result in significant or unknown negative impacts to beneficial uses of state waters. However, without further study, the magnitude of these impacts could not be quantified. In consideration of these obstacles, the group recommended that there be no further effort at that time to develop a proposal to revise existing regulations to provide for permits that would allocate assimilative capacity at flows above low flow. The possibility of developing a pilot study to address the identified concerns was left open.

R.O. Roundtable – An Introduction

In July 2005, a group of interested stakeholders was organized to examine issues specifically related to managing reject streams from membrane treatment facilities, including reverse osmosis (R.O.). Eventually, this R.O. Roundtable became a formal workgroup under the Colorado Water Quality Forum, in recognition of the fact that an increasing number of water providers are considering the use of membrane water treatment technology in order to deliver high quality drinking water to their customers. The Commission has expressed a concern that if membrane technology is to be viable, it must be implemented responsibly, with residual disposal options...
that do not adversely impact the environment or beneficial uses of water. In response, the workgroup has established the following strategic objectives:

- Evaluate membrane water treatment technologies including disposal of membrane treatment wastes;
- Develop recommendations to the Division for residual disposal options that are cost effective and address environmental impacts; and
- Provide recommendations to the Commission for regulatory strategies that meet the needs of drinking water providers and wastewater treatment agencies, while addressing the concerns of downstream water users and the general public.


**Regulatory Committee Activities**

In March, 2006, the workgroup established a committee to evaluate regulatory options to address potential environmental impacts and to assure the protection of beneficial uses of water through the management and proper disposal of brine residuals from reverse osmosis and other membrane treatment systems. The approach taken by the committee has involved a review of regulations within the Commission’s existing framework that were determined to be potentially relevant to concerns related to membrane treatment and brine disposal or could be used as a model for future regulation. These regulations were grouped into three categories: 1) controls on receiving water quality; 2) controls on effluent quality; and, 3) treatment technology requirements.

While more than a dozen regulations were evaluated after the initial screening process, there did not appear to be a single existing regulation that could, without significant modification, address all of the issues and opportunities associated with membrane treatment, brine management, and disposal. Therefore, the committee determined that a new, integrated approach was needed. This could be accomplished for a site-specific area of interest through a watershed protection control regulation that combines elements of existing water quality regulations. The committee decided that several alternative regulatory approaches may be needed to address the full range of membrane treatment and residual disposal issues found throughout the state.

**Receiving Water Quality-Based Requirements**

There does appear to be a need for some underlying control on receiving water quality to serve as the basis for any proposed control on effluent quality or treatment technology. Typically, water quality standards are adopted to assure the protection of receiving water quality. Once adopted for a particular water body or segment, water quality standards are applicable to all dischargers to that receiving water. In the context of a watershed protection control regulation, it may be possible to establish numerical or narrative standards for receiving waters that are applicable only to a certain class of discharges, e.g., membrane treatment facilities. Concerns about discharges of salinity and other parameters of concern may vary from one area to another around the state. Protection of different beneficial uses of water will also need to be considered.
There is not an existing criterion for total dissolved solids (TDS) to protect aquatic life, water supply, agricultural, or recreational uses in the Basic Standards. While there is a secondary Maximum Contaminant Level (MCL) under the federal Safe Drinking Water Act for salinity of 500 mg/l, it is not enforceable in finished drinking water, nor has it been implemented as a permit limit. It would be costly and technically challenging for the state, working on its own, to embark upon a process of establishing a table value criterion for TDS. Moreover, such an approach potentially could result in the creation of an indiscriminant regulatory burden for all dischargers. Similarly, there are no existing criteria for some of the key macro-constituents of salinity, including carbonate, potassium, magnesium, and sodium. Each of these substances can be of concern in high concentrations, which may be present in some brine waste streams.

While there is no recommendation to forever “close the door” on the development of criteria or standards for salinity or its individual constituents, it is not a promising solution for addressing existing concerns about brine discharges in the near term. However, the development of surface water quality standards may be necessary in the future. For example, it can be extremely expensive for municipal drinking water systems to remove TDS as part of the treatment process. In addition, high levels in irrigation waters can have negative impacts on crops. [Need to include agricultural use discussion here? – also, can CSU give a talk to the workgroup on their study on LSP salinity issues?] With our scarce water resources, it is important to take all reasonable efforts to ensure water uses are protected.

**Technology-Based Requirements**

While a generalized technology-based approach of establishing minimum effluent limitations or treatment requirements could establish a “floor” for performance expectations related to brine management and disposal, it is possible that in some instances this approach would not assure site-specific protection of the environment and existing beneficial uses of water. The workgroup has established a separate committee to examine various technical approaches for the management, disposal, and recovery/reuse of the minerals contained in such brine streams. It is expected that the work products from that committee will provide substantive information for the regulatory options committee to consider when technology-based requirements are evaluated. There is recognition that individual water utilities may be able to manage brine wastes only to a certain degree and there may also be a need for regional approaches for enhanced brine dewatering and ultimate disposal of residual solids.

**Watershed-based Requirements**

A watershed-based control regulation could be established by the Commission at any desired watershed scale and be tailored to address specific water quality concerns, e.g., beneficial uses of water and existing or proposed types of discharges. Receiving water quality requirements could be imposed at the point of use rather than in the entire stream segment. This could be structured in a manner that would support a system for pollutant trading.

It could be possible to establish a narrative or numerical protection level in the context of a watershed-based control regulation that would have only site-specific and facility-specific applicability. The effective protection level could be based upon preserving existing ambient...
water quality to protect aquatic life uses, agricultural, or drinking water supply uses. It might also be possible, albeit somewhat complicated, to specify effluent limitations, waste load allocations and/or treatment requirements in a control regulation focused on a specific water body.

There was a consensus among the committee members that different regulatory options may be appropriate depending on the number and scale of specific facilities relying upon membrane treatment in a watershed. This may lend further support to the concept of water body-specific control regulations where there are multiple potential brine sources and indicate a need for discharger-specific regulatory solutions in isolated cases. A number of different regulatory options may accommodate small individual sources of brine wastewater, including those governing indirect discharges to publicly owned treatment works (POTWs), where POTWs allow such activities.

**Regulatory-Technical Framework**

A generic framework is needed to accurately assess potential water quality impacts at a watershed level associated with membrane treatment (as opposed to conventional treatment), or where large numbers of point-of-use membrane devices are used in combination with conventional treatment. Under such a framework, various scenarios for brine discharges should be evaluated: direct surface discharge of brine concentrates; discharge in accordance with tiered effluent limits (based on the actual discharge capacity of the facility and perhaps the seasonal flow conditions in the receiving stream); discharge to alluvial ground water; or deep aquifer injection and disposal of residual solids in a regional monofill. Where appropriate, the evaluation should focus on real time changes in water quality associated with discharges, as opposed to generalized loading comparisons under different scenarios. Such an assessment is needed to provide the technical underpinnings for any new regulatory development efforts in this arena.

**REGULATORY OPTIONS**

The Regulatory Committee examined a number of existing regulations to see which section(s) of them would be appropriate for management of membrane treatment residuals. These regulations and other possible approaches were captured in an outline of Regulatory Options that is attached as Appendix A. Based upon the preceding discussion, the Committee reduced this information to the following three options that it believes should be further explored:

**Watershed Approach Option:**

This option, likely in the form of a control regulation, would be the most complex to develop and implement. However, it would be more flexible in terms of providing the necessary protection at the point of use. Features/benefits of this approach could include:

- Close linkage of water quality uses with water quality impacts
- Focus on specific pollutants of concern for the watershed
- Identification of sources to be regulated
• Point of compliance for various uses could be identified
• Facilitation of development and implementation of a pollutant trading program
• Enhanced linkage to source water protection efforts
• Inclusion of water quality and technology-based elements
• Robust system for protection of beneficial uses at reasonable cost

Adoption of Water Quality Standards Option

This option would track most closely with the existing regulatory scheme. Features/benefits would include:

• Addressing one or two major pollutants associated with reject streams
• Protection of uses at all points in the receiving water
• Less costly to develop and implement as it would presumably be applied to large basins
• Requirement of Use Attainability Analysis for segment-specific standards
• Existing system of standards development and permitting would be used for implementation

Technology –Based Approach Option

• Addresses pollutants associated with reject streams
• Heavily research-dependent
• May not be protective of uses, particularly where dilution is low
• Likely outcome would be “zero” discharge of membrane treatment residuals
Appendix A

Outline of Regulatory Options

1. Controls on Stream Quality
   - Encompasses all inputs, including wastewater treatment plants, drinking water treatment plant discharges, non-point source discharges, and background
   - Ensures stream is protected

1a. Watershed Protection Control Regulations (e.g., Dillon Reservoir Control Regulation)
   - Contains water quality standards, TMDL/WLAs, watershed goal
   - Used now for reservoirs; may be harder to apply to streams?
   - Trading may be allowed
   - Would need to define compliance point(s)
   - Can be used to clearly protect the environment or to maintain existing water quality
   - Could include both water quality numeric values as well as best management practices (e.g. Cherry Creek Reservoir Control Regulation.)?
   - Would affect all dischargers of TDS

1b. New Regulation Similar to Colorado River Salinity Control Regulation (Regulation 39)
   - Approaches the problem at a basin-wide level
   - Has implementation scheme to make it workable for dischargers (municipal, industrial, etc.)
   - Establishes preliminary standards and compliance points
   - Goal of zero discharge

1c. Site-Specific Water Quality Standards for TDS/Other Parameters
   - Apply throughout stream at all locations
   - Affects all dischargers, not just those discharging WTP residuals
   - Broad-brush approach
   - Needs UAA for ambient standards
   - Ambient standards can be used to protect existing quality
   - May work in conjunction with control regs.
   - Still need TMDL/WLA approach for certain segments
   - May require that Reg. 61 is updated to implement

1d. Regulation 93 – 303(d)/TMDL/WLA process
   - Would only be triggered if a standard was violated or a use was impacted.
   - Can be a driver for remediation or for the development of a watershed control regulation.

1e. Basic Standards Regulation (Regulation 31)
   - (See comments above under 1c.)
   - Defining ambient quality may be another approach
2. Controls on Effluent Quality
   More specific to individual types of dischargers (e.g., RO brine)

2a. New Regulation Similar to Colorado River Salinity Control Regulation (Reg. 39)
   (See comments above under 1b.)

2b. Effluent Limitations Regulation ((Reg. 62)
   o Blending may be O.K. if pollutant not specifically regulated under Regulation 62 or
   the discharge falls under a federal effluent guideline

2c. Watershed Protection Control Regulations (e.g., Dillon Reservoir Control Regulation)
   (See comments above under 1a.)

2d. Permit Regulations (Reg. 61)
   o Will look to effluent-limits, WQS or Control regulations
   o ACALF: further evaluation is needed, especially as an option for certain locations,
       etc.
   o Could possibly pair ACALF with site-specific control regulation

2e. EPA’s UIC Regulations
   o Which class applies? (Class I, II, or V)
   o Potential geologic issues for some locations (can’t qualify under regs)
   o May also need State Groundwater discharge permit, in addition to UIC permit

2f. Pollutant Trading Program
   o Pollutant-dependent (Is the pollutant amenable to trading?)
   o Framework (Pollutant Trading Policy) already in place
   o Is flexible for non-304(a)-based criteria
   o May be able to apply TDS criteria at point of DW intake and have some flexibility
     with where apply MCL-based water quality standards; will need to apply aquatic life
     standards throughout segment

2g. Pretreatment Regulations (local limits; sewer use ordinance)
   o To control/limit what may be discharged to sewers/WWTPs
   o Scale issues (may work for smaller WWTPs)
   o Site-specific solution for certain facilities
   o Dependent on receiving stream water quality standards (in part) for calculation of
     local limits
   o Essentially can become a prohibition on this disposal option (to sewer/WWTP) for
     some individual entities, but doesn’t solve overall problem

2h. Effluent Limitation guidelines
   o EPA is currently examining the promulgation of ELGs for drinking water residuals
Would establish BATs applicable to all
Look at what environmental effects from specific industrial discharge would be
(more discharge-specific)

3. Regulatory Requirements on Treatment Technology

Treatment technologies could include: desalination; concentrating solar collectors;
cogeneration with nearby power plant facilities; regional disposal or treatment facility

3a. Site Location Approval-Type Process for new or modified Drinking Water Plants

Currently, domestic wastewater treatment works must obtain approval from the Division
with respect to certain site location and design review requirements when a new facility is
proposed or when a previously-approved facility is expanded. The purposes of this process
include a number of factors, such as:

- Feasibility of the facility to treat proposed waste streams
- Effects on long-range comprehensive planning for an area as it affects water
  quality
- Ability to meet existing effluent limitations or PELs
- Foreseeable potential adverse impacts on public health
- Opportunity for public notice and comment.

This process also helps both the state and the proposing entity to examine, in detail, how the
wastewater facility will impact human health and the environment by requiring both a
thorough analysis of potential impacts on downstream beneficial uses and approval by the
appropriate 208 management agency that the facility meets requirements of the local water
quality management plan.

A similar or modified approach for water treatment facilities that are considering membrane
treatment technologies would help ensure that they can realistically implement their
proposed residual disposal strategy, taking into consideration potential impacts to the
environment and to other water and wastewater treatment facilities in the watershed.

3b. Design Criteria for Potable Water Systems

- Are existing criteria in place regarding discharges? Being reworked now?
- Will add stronger requirements re: facility needs to have viable residual disposal
  option before WTP is approved

3c. Drinking Water Regulations for Treatment Techniques

3d. Pretreatment Regulations (local limits; sewer use ordinance)

- (See comments above under 2g.)

3e. New Consolidation of Facilities Policy (for disposal of brine or solid waste)
o Similar to existing Consolidation of WWTPs Policy; would require analysis to see if economies of scale, etc., exist

4. No Need for Any Requirements (“I’m only putting back what I’m taking out”)
   - Augmentation return flow requirements do require water to be put back
   - Timing of return flows
   - Basin-wide calculations
   - Individual household water softeners vs. treatment at a central facility (and discharge to sewer vs. discharge from central facility to either sewer or stream)