# Total Dissolved Solids and Groundwater Quality Protection

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In May 1994 the State Water Resources Control Board approved a proposed amendment to the San Diego Regional Water Quality Control Board's Comprehensive Water Quality Control Plan allowing a revision of the groundwater quality objectives for total dissolved solids (TDS) for two areas of the San Diego region of southern California. The TDS limit in the current Plan is 500 mg/L. The approved amended Plan would allow the TDS to increase to 750 mg/L. The amendments of this Plan would allow the discharge (recharge) of reclaimed wastewaters to the groundwater of the area. The reclaimed wastewaters have a TDS of about 665 mg/L. Since the TDS was above the water quality objective, the reclaimed wastewaters could not be recharged to the groundwater without constituting pollution of the groundwater in accord with California groundwater quality protection regulations. In support of this position, the State Board staff with the approval of the Board stated,

*"This amendment will allow* [wastewater reclamation] *project proponents to avoid costly and unnecessary demineralization processes to achieve compliance."*

This action by the State Board raises a number of questions about the appropriateness of changing the groundwater quality protection standards in order to facilitate a less expensive groundwater recharge. First is the question of cost. While the State Board approved the staff's analysis of the situation of achieving a 500 mg/L TDS in the reclaimed wastewater as being too costly, as discussed below, these costs if properly evaluated are relatively small and must certainly be balanced against the cost of deteriorated groundwater quality that will occur if the TDS is allowed to increase to 750 mg/L.

## Costs of TDS Removal

No economic analysis was presented in support of this amendment to the Comprehensive Water Quality Control Plan. Therefore, it is not known whether the staff actually performed a proper economic analysis of the situation as is required by the Porter-Cologne Water Quality Control Act (WRCB, 1989). An indication of the potential cost of reducing the TDS of the reclaimed wastewater from 665 mg/L to less than 500 mg/L can be gained from the experience of the Orange County Sanitation District. This District is in the process of recharging reclaimed wastewater in which they are treating the wastewater to remove TDS using reverse osmosis (R/O). At a meeting last year representatives of the District reported the R/O costs to be about $300/ac ft. This cost is less than the cost of imported water from the Sacramento/San Joaquin River Delta system. If it is assumed that those responsible for production of the reclaimed water had to pay $500/ac ft. for removal of TDS, it is found that the cost to those who generate the wastewaters with the excessive TDS would be about 10 cents/person/day. The actual cost would likely be less than this. Is this really too costly? Should not those who generate the wastewaters that are to be reclaimed by groundwater recharge pay an additional 10 cents/person/day to remove TDS so that this generation, as well as future generations in the area of the recharge project, experience the benefits and do not have to pay the cost of the adverse impacts of the higher TDS waters when the enhanced recharged groundwaters are recovered for domestic use?

**Benefits of Lower TDS Waters**

While the State Board staff with the approval of the State Board stated that it was "unnecessary" to keep the TDS below 750 mg/L, a critical review of the impact of TDS on domestic water supply water quality shows that allowing the TDS to increase to 750 mg/L represents a significant adverse impact on the use of this water for domestic purposes. It is well-known in the domestic water supply water quality field, as well as in the general water quality literature (McKee and Wolf, 1963; NAS NAE, 1973; US EPA, 1987), that increasing the TDS of a domestic water supply,

- increases taste of the water
- increases corrosion of distribution system, household plumbing, appliances, etc.
- increases scaling of appliances and deterioration of cloth-clothes -- reduce service life
- sodium - adverse to public health
- sodium - adverse to plants through increase in sodium adsorption ratio

It appears that those on the State Board staff that developed the statement that is "unnecessary" to maintain the TDS objective at 500 mg/L are not familiar with the historical basis for the development of this standard. This standard evolved out of a review and has been maintained at its current value because of the adverse impacts of the type listed above of elevated TDS above 500 mg/L. While increasing the TDS above a couple of hundred mg/L starts to become detrimental to a domestic water supply water quality, at above about 500 mg/L the adverse impacts become particularly significant.

It is also important to note that the saline water conversion program (sea water desalinization) that was originally developed by the US Public Health Service in the late 1950's selected 500 mg/L as the target for desalinization of waters that were to be used for domestic water supply purposes. Since removal of salts from sea water requires large amounts of energy, there would have been significant economic advantages in the development of the desalinization of sea water program to only reducing TDS to 1000 or so mg/L. While waters with a TDS of 1,000 to 1,500 mg/L are drinkable and otherwise useable for domestic purposes, such waters are highly undesirable because of the wide variety of adverse impacts of the types listed above. Therefore, the long-standing 500 mg/L TDS limit for domestic water supplies is not an arbitrarily developed value and cannot be raised without significant adverse impacts on the consumers of the water with the elevated TDS.

While to the knowledge of the authors the costs of the above listed adverse impacts have not been quantified, they are certainly not *de minimus*. Further, a proper economic analysis of the cost of reducing the TDS of reclaimed wastewater should include the cost to the consumers/users of the reclaimed recovered wastewater. It is concluded that it was inappropriate for the State

Board staff and the State Board to approve a statement that it is "unnecessary" to maintain the TDS in the reclaimed wastewater to less than 500 mg/L.

**Additional Benefits of R/O Treated Domestic Wastewater**

Lee and Jones-Lee (1993 and 1994) have discussed the potential impacts of using reclaimed domestic wastewaters in enhanced groundwater recharge projects. They point out that even with the advanced treatment of the reclaimed wastewaters, such wastewaters contain conventional and non-conventional contaminants and some Priority Pollutants. The non-conventional contaminants are principally composed of those organic chemicals that are present in a wastewater whose composition is unknown. Their presence is known based on total organic carbon analyses of the wastewater compared to the analytical results for specific organics. Only a small fraction of the TOC present in domestic wastewaters is characterized in water pollution evaluations. Normally about 95% of the organics in domestic wastewaters (the non-conventional contaminants) are of unknown character and, therefore, unknown hazard to public health and the domestic water supply water quality.

As discussed by Lee and Jones-Lee (1993 and 1994), every few years a new highly hazardous chemical that has been associated with wastewater discharges, such as PCB's, dioxin, etc., is found in the environment. Those chemicals, until they were specifically identified, were part of the non-conventional contaminants. At this time even the most comprehensive wastewater pollution evaluation considers no more than about 200 selected chemicals. The GAO (1994) has recently reported that there are about 65,000 chemicals in commerce in the US today. The GAO also reported that about 1,000 new chemicals are introduced into commerce each year. With regulatory agencies only addressing a maximum of about 200 of these chemicals, many of the tens of thousands of chemicals that are in commerce today could be present in the non-conventional contaminant fraction of domestic wastewaters. It is highly inappropriate to assume that a domestic water supply that has received domestic wastewaters independent of the degree of treatment of the types practiced today and meets all drinking water MCL's is "safe" to consume. It is prudent public health policy to assume that any domestic water supply that has received domestic wastewaters, and therefore contains residual non-conventional contaminants, is potentially hazardous to public health and/or is otherwise detrimental to the use of the water for domestic purposes.

One of the significant added benefits of R/O treatment of domestic wastewaters that are to be reclaimed for domestic water supply use through enhanced groundwater recharge is the removal of a substantial part of the non-conventional contaminants. This is certainly in the direction of improving public health protection and the service life of plumbing, fixtures, appliances, etc.

As discussed by Lee and Jones-Lee (1994), many of the reclaimed wastewater recharge projects that are being implemented today rely on the aquifer (soil aquifer treatment) to remove many of the residual chemicals present in the wastewaters. Soil aquifer treatment systems for many types of chemicals have finite capacities to provide for contaminant removal. Lee and Jones-Lee (1994) express concern that inadequate consideration is being given in the use of soil aquifer treatment to the long-term liabilities that could develop when the soil aquifer treatment system capacity to treat becomes exhausted. Unless great care is taken in the development and operation of the reclaimed wastewater enhanced groundwater recharge project, the owners/operators of such projects could become responsible parties for "Superfund"-like clean-up programs which would be needed in order to prevent continued contamination of the groundwaters by the non-conventional as well as conventional contaminants and Priority Pollutants present in the wastewater. The R/O treatment of the reclaimed wastewater before recharge to the groundwater could significantly reduce the potential for liabilities of this type to develop.

**Conclusions**

The statement developed by the State Board staff and approved by the Water Resources Control Board that it is "unnecessary" to remove TDS from reclaimed wastewaters that are being recharged to an aquifer is not in accord with what is known about the potential impacts of the conventional, non-conventional and Priority Pollutants present in reclaimed domestic wastewaters. In addition to controlling some of the adverse impacts of the TDS that will arise by allowing the reclaimed wastewater with an elevated TDS above the current standard of 500 mg/L to be recharged to the groundwater, the removal of the TDS by R/O treatment will result in a concomitant improvement in the character of the recharged reclaimed wastewater by reducing the public health and water quality hazard that the residual contaminants in the wastewater represent to the use of this reclaimed wastewater for domestic purposes. The cost of the R/O treatment of the reclaimed wastewater will be compensated for to some extent, which at this time is undefined, by reduction of the magnitude of the adverse impacts of the conventional, non-conventional and Priority Pollutants present in the reclaimed wastewater. Further, even if the non-conventional contaminants' impacts were zero, which is not likely to be the case, the cost/benefits of TDS control are strongly in favor of removal of TDS. Following this approach, future generations would be able to enjoy the same groundwater quality as is being experienced by this generation. The practice of changing the groundwater quality protection standard to allow the introduction of reclaimed wastewater into the aquifer at reduced cost represents a short-term economic gain for those who produce the wastewaters with excessive TDS at the expense of future generations' health, economic and social welfare. Rather than changing the water quality protection objective, as was recently done by the State Board for several groundwater basins in the San Diego area, the State Board should have required that the reclaimed waters be treated to protect existing groundwater quality. This is in the best interest of the protection of future generations' groundwater resources and does not represent a significant economic hardship to the public who generate the wastewaters that are proposed for reclamation and groundwater recharge and recovery.

**References**

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