SCSC Study:

Characterize the Long-term Trend and Investigate the Principal Factors Responsible for Variations in the Average TDS Concentration in Recycled Water

1) Sound water resource management will require increased reliance on recycled water:

- a) To accommodate future population growth and rising demand
- b) To meet goals of Recycled Water Policy
- c) To comply with Governor's water conservation mandates
- d) To preserve and enhance safe yield (per SGMA)

2) Increased use of recycled water depend on ability to comply w/ salinity related WDRs

- a) TDS in recycled water typically ranges between 500 - 1000 mg/L
- b) Most POTWs not designed to reduce TDS below any further
- c) Permitting options if recycled water does not meet water quality standards:
  - i. Allocate assimilative capacity to accommodate recycled water
  - ii. Authorize a "variance" for specific recycled water projects
- d) Both permitting options require discharger to demonstrate:
  - i. Best Practicable Treatment or Control (aka "Best Efforts")
  - ii. Maximum benefit to the people of the State (Justification)
- e) Regulators willingness to provide permitting flexibility depends a better understanding of factors influencing TDS concentrations in recycled water

3) Working hypotheses

- a) Modern increment of use is higher now than 40 years ago
- b) Long-term trend of rising TDS is largely due to water conservation efforts
  - i. Low flow plumbing fixtures (toilets, faucets, shower heads)
  - ii. High efficiency appliances (dishwashers and clothes washers)
- c) Cyclic fluctuations in TDS are largely explained by drought-related variations in municipal water supplies,
  - i. State Project Water (% of total supply & TDS concentration)
  - ii. Colorado River Water (% of total supply & TDS concentration)
  - iii. Groundwater Resources (% of total supply & TDS concentration)
- d) Recent spikes in TDS may be caused by short-term changes in consumer behavior required to comply with emergency conservation mandates

4) Focus of study

- a) Calculate current "increment of use"
- b) Characterize the long-term trend for TDS concentrations in recycled water
- c) Identify and quantify key factors contributing to TDS trends
- d) Assess the effect of cyclic droughts on TDS levels in recycled water
- e) Estimate the incremental increase to TDS concentrations in recycled water caused by certain wastewater treatment processes
- f) Evaluate a range of alternative averaging periods to aid in developing WDRs that continue to meet WQS while accounting for drought-related variations

Research Questions

1) How has indoor per-capita consumptive use changed over time (1977-2016)?

2) How has the volume weighed average TDS concentration changed over time (1977-2016)/

3) How has the residential/commercial per-capita "increment-of-use" changed over time? (Increment of Use = TDS in Final Effluent = TDS in Water Supply – TDS Added by Treatment)

4) What proportion of the increase in average per-capita increment of use is attributable to widespread implementation of low flow plumbing fixtures and appliances? (Engr. Est.)

5) What proportion of the increase in average per-capita increment of use is attributable to incremental installation of self-regenerating water softeners? (Engineering Estimate)

6) What affect, if any, do the following advanced waste treatment technologies have on the concentration of TDS in recycled water? (Engineering Estimates)
   a. Disinfection (using chlorination & dechlorination)
   b. Ferric chloride precipitation (metals reduction and odor control)
   c. Alum addition (to enhance flocculation and/or meet phosphorus limits)

7) To what degree are fluctuations in the volume-weighted average TDS concentration of recycled water correlated with variations in the volume-weighted average TDS concentration of the municipal water supply?

8) To what degree are fluctuations in the volume-weighted average TDS concentration of recycled water correlated with variations in the volume-weighted average TDS concentration of the wastewater influent?

9) To what degree are fluctuations in the volume-weighted average TDS concentration of the municipal water supply correlated with:
   a. Variations in the ratio of State Project Water or CRW to total water supply?
   b. Variations in the average TDS concentration of SPW and CRW?

10) To what degree are fluctuations in the ratio of SPW to total municipal water supply correlated with long-term meteorological (drought) cycles?

11) To what degree are fluctuations in the average TDS concentration of SPW and CRW correlated with long-term meteorological (drought) cycles?

12) What affect, if any, mandatory conservation measures (2015-16) have on average per capita indoor consumptive use?

13) What affect, if any, did the 2015-16 changes in average per-capita indoor consumptive use have on average TDS concentrations in wastewater influent?

14) How does the volume-weighted average TDS concentration in recycled water vary using a range of rolling averaging periods (e.g. 1-yr., 5-yr., 10-yr., 15 yr.)? Purpose: to derive compound WDRs (15 yr. rolling average <X and 1 yr. average <Y, where X>Y).

Important Considerations Affecting the Scope and Cost of the Study:

1) Our willingness to accept engineering-based estimates vs. statistical analysis to answer some of the research questions

2) The number discharger datasets to be evaluated

3) The level of effort required to acquire and pre-process the datasets

4) The number of years to evaluate (1977 – 2016 = 40 years)

5) The unit averaging period (monthly, annual)

6) The number of salt parameters to evaluate (TDS, chloride, sodium, sulfate, etc.)

7) The complexity of statistical analyses (bivariate vs. multivariate correlation)

8) The complexity and dynamism of the source water supply system

9) The complexity and dynamism of the ratio between residential and commercial users vs. industrial users

10) Complexities added by diversions to brine lines and by industrial pre-treatment programs

11) The size of the final report

12) The clarity, detail and specificity of our RFP and the resulting contract SOW

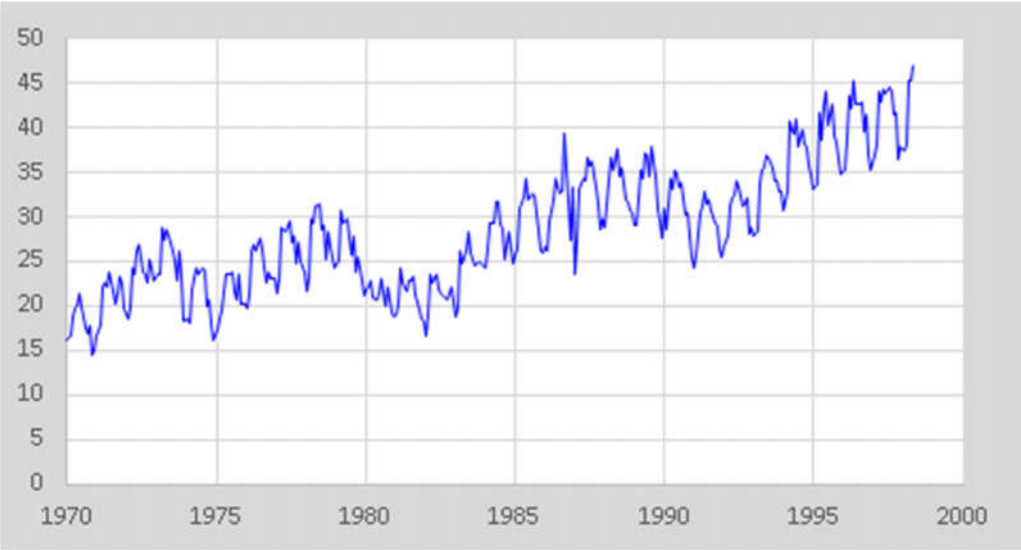
13) The number of review and revision cycles

Potential Data Sources

1) San Diego Water Authority
2) Eastern Municipal Water District
3) Inland Empire Utilities Agency
4) LACSD/LADWP
5) Metropolitan Water District (SPW & CRW data)
6) City of Riverside
7) City of San Bernardino
8) Elsinore Valley MWD (alum data)

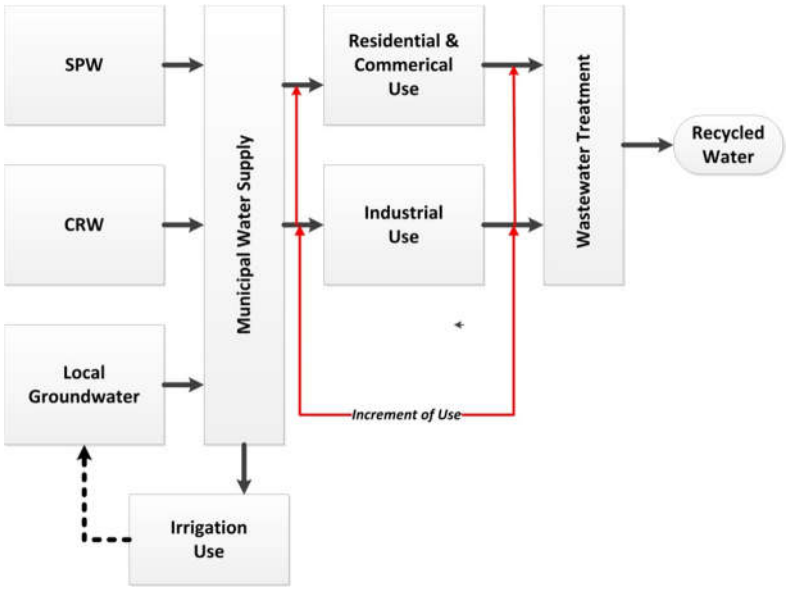
Should we focus on agencies with joint responsibility for both water and wastewater?

Fig. 1: Example of a long-term trend with cyclic fluctuations



We hypothesize that there is a baseline rising trend in TDS caused by widespread adoption of low flow plumbing fixtures and water efficient appliances, that is somewhat offset by reductions in salt load associates with less industrial manufacturing and more robust industrial pre-treatment programs in general and diversion of some industrial effluents to brine lines. The cyclic component is generally associated with the 10-15 year drought cycle in Southern California (with a longer periodicity than is shown in the graphed illustration above).

Fig. 2: Increment of Use



Increment of Use = TDS added by users of municipal water supply prior to wastewater treatment