Multi-State Salinity Coalition

Evaluation of Long-Term Trends and Variations in the Average Total Dissolved Solids Concentrations in Wastewater and Recycled Water

February 8, 2018

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  - San Diego County Water Authority
  - Metropolitan Water District of Southern California
- Technical Direction - Risk Sciences

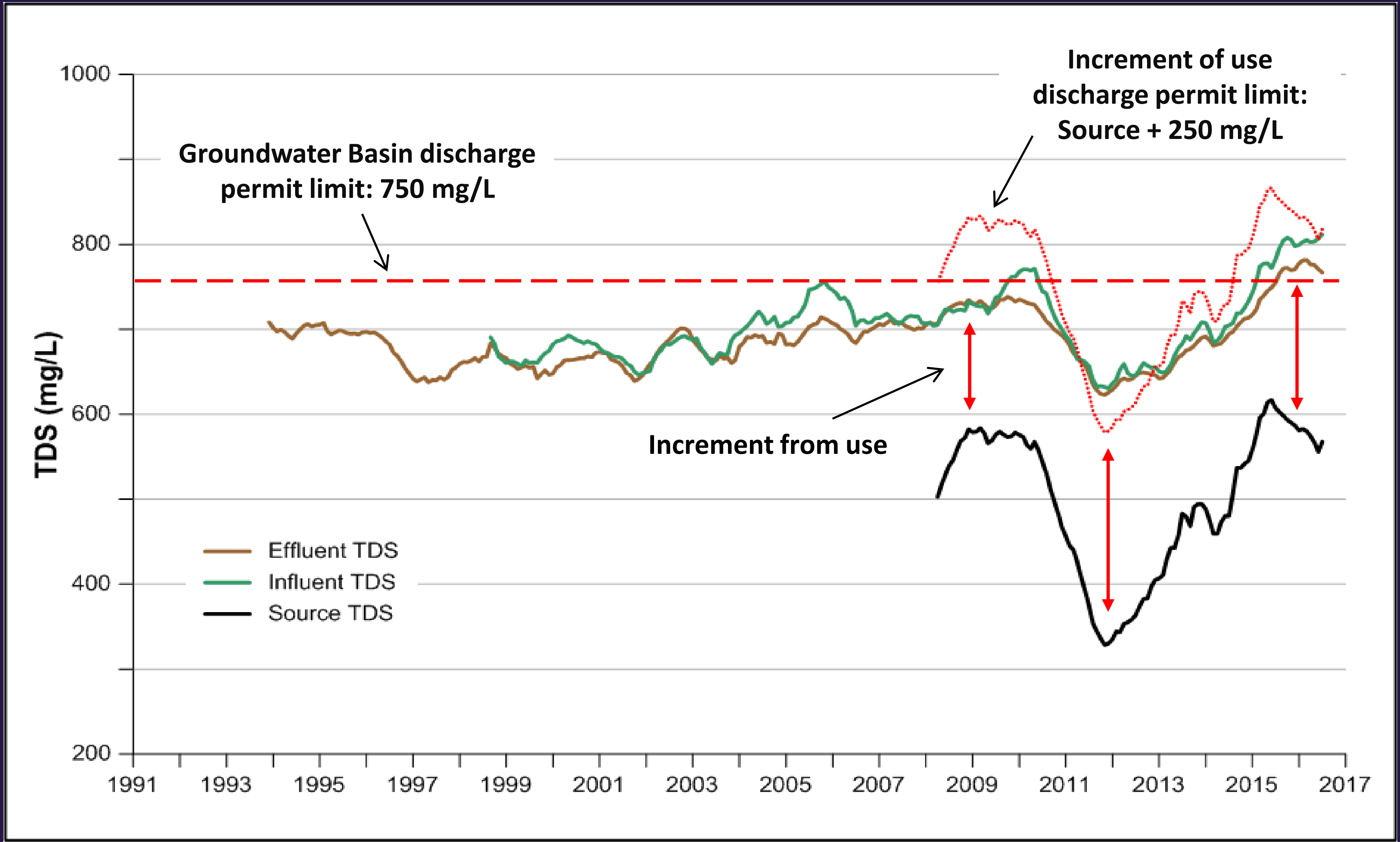
TDS Trends Study - Synopsis

- Identify the effects of drought and water conservation measures on the long-term TDS trends in wastewater and recycled water
- Drought, water conservation measures, and other explanatory variables are intertwined (auto-correlated) to some degree
- Study analyzed both deterministic models and statistical models (multiple linear regression) to predict TDS in wastewater and recycled water
- Provide the science and statistical analysis to provide a framework for policy discussions

TDS Trends Example - Temecula Valley WRF

Considerations:

- 12-mo average period
- Influent ~ Effluent
- Discharge limit based on IFU limit and absolute limits.



Multiple Linear Regression: Influent TDS

$$y_i = b_0 + \sum_{j=1}^{n} b_j x_{ij} + e_i$$

where

y_i = the predicted value of the response variable y for data point i

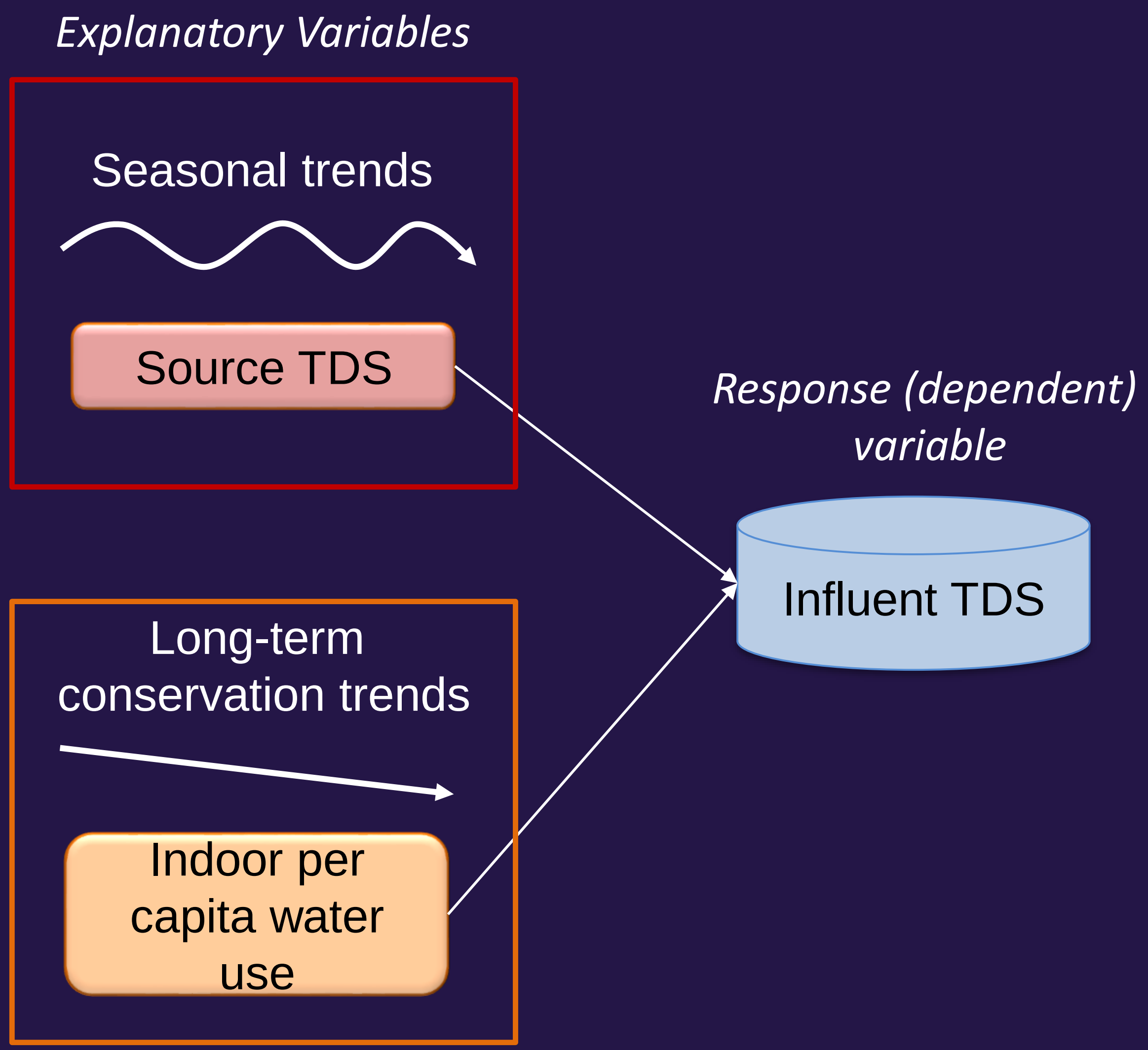
b_0 = the model intercept coefficient

b_j = the model slope coefficient for explanatory variable j

n = the total number of explanatory variables in the model

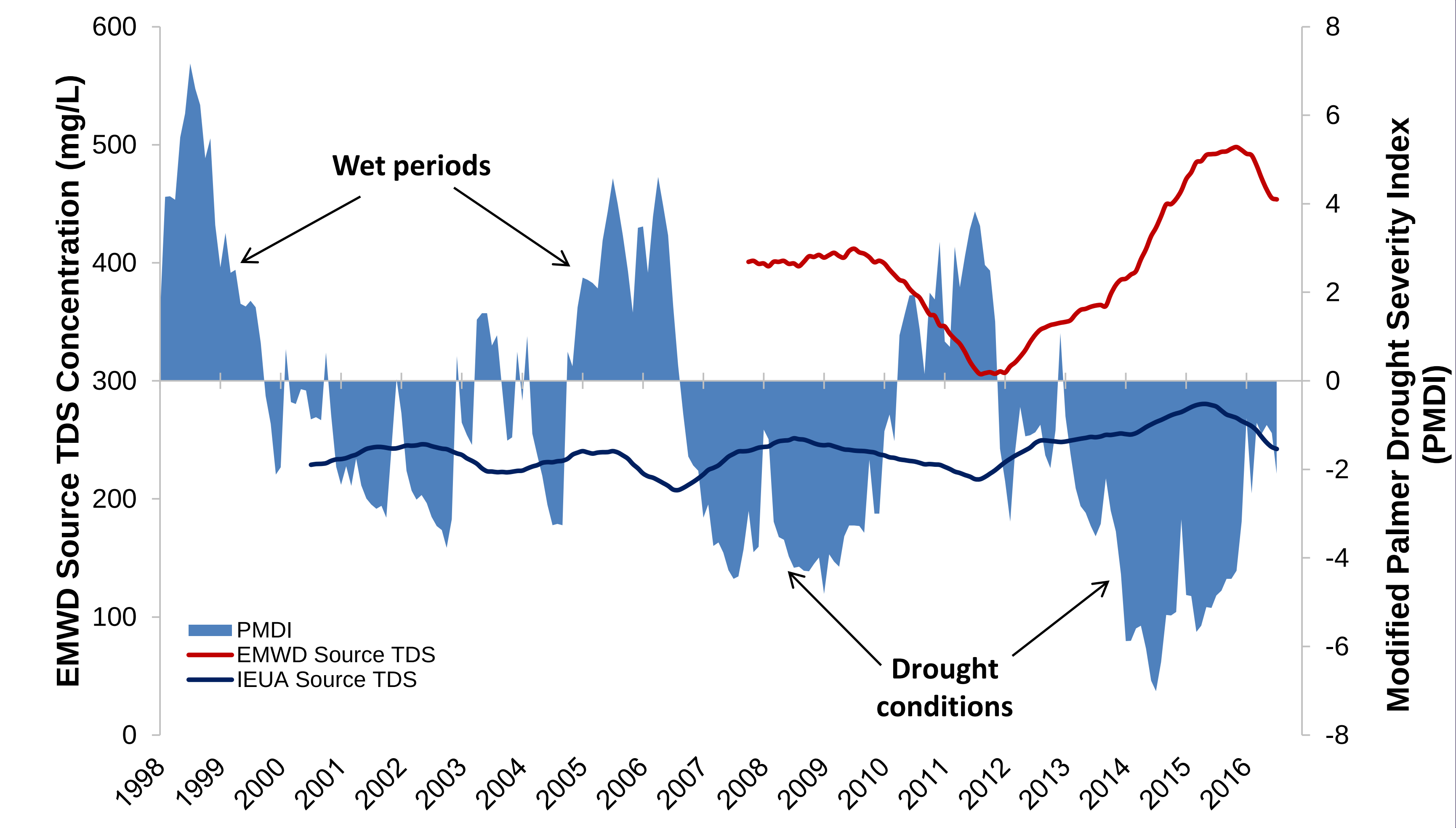
x_{ij} = the known value x of explanatory variable j for data point i

e_i = the residual error of data point i from the fitted model

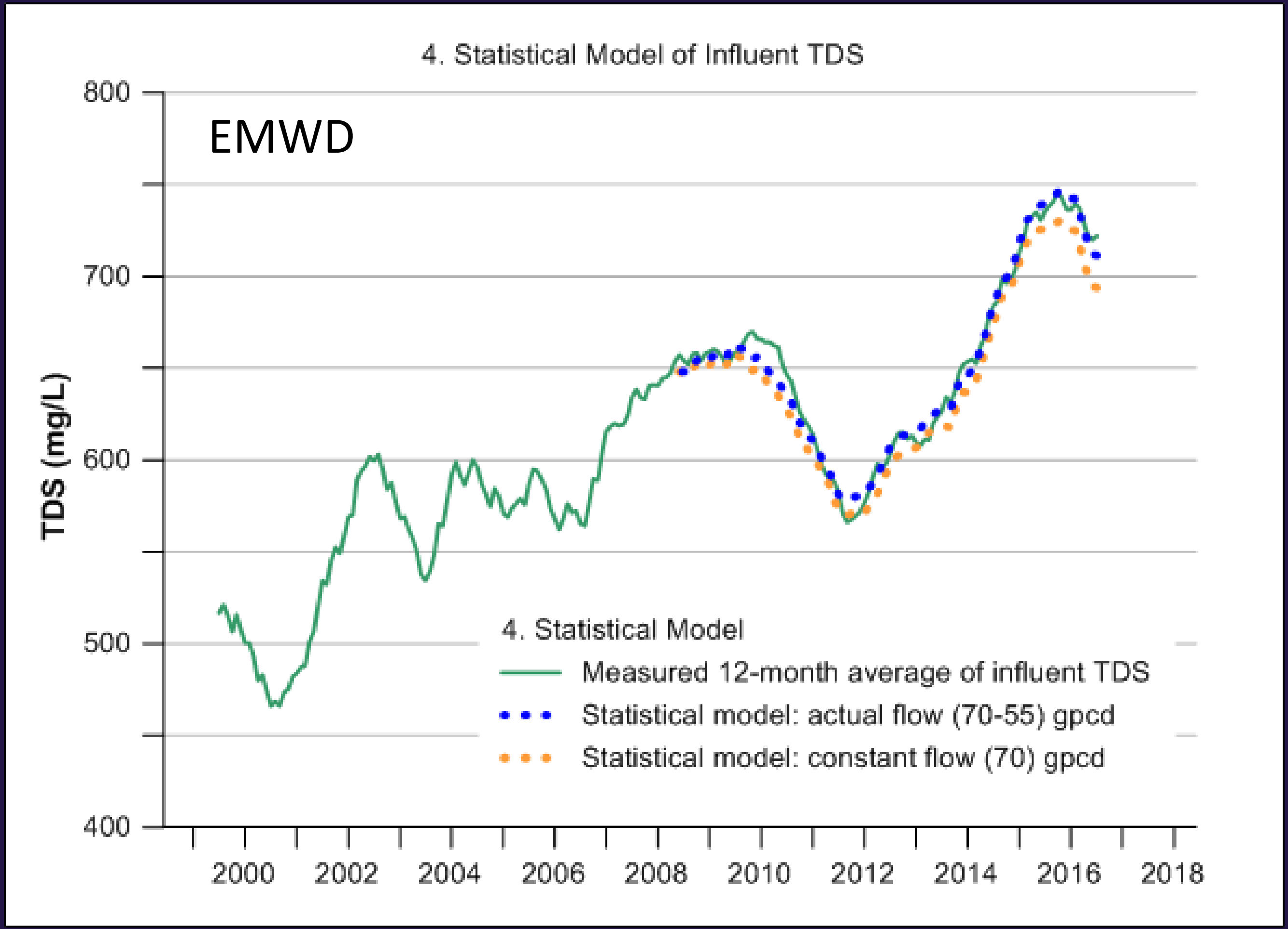


Source Supply TDS Concentrations and Drought

- Higher TDS concentration with drought periods
- EMWD greater reliance on imported water
- IEUA greater reliance on groundwater and local water supply

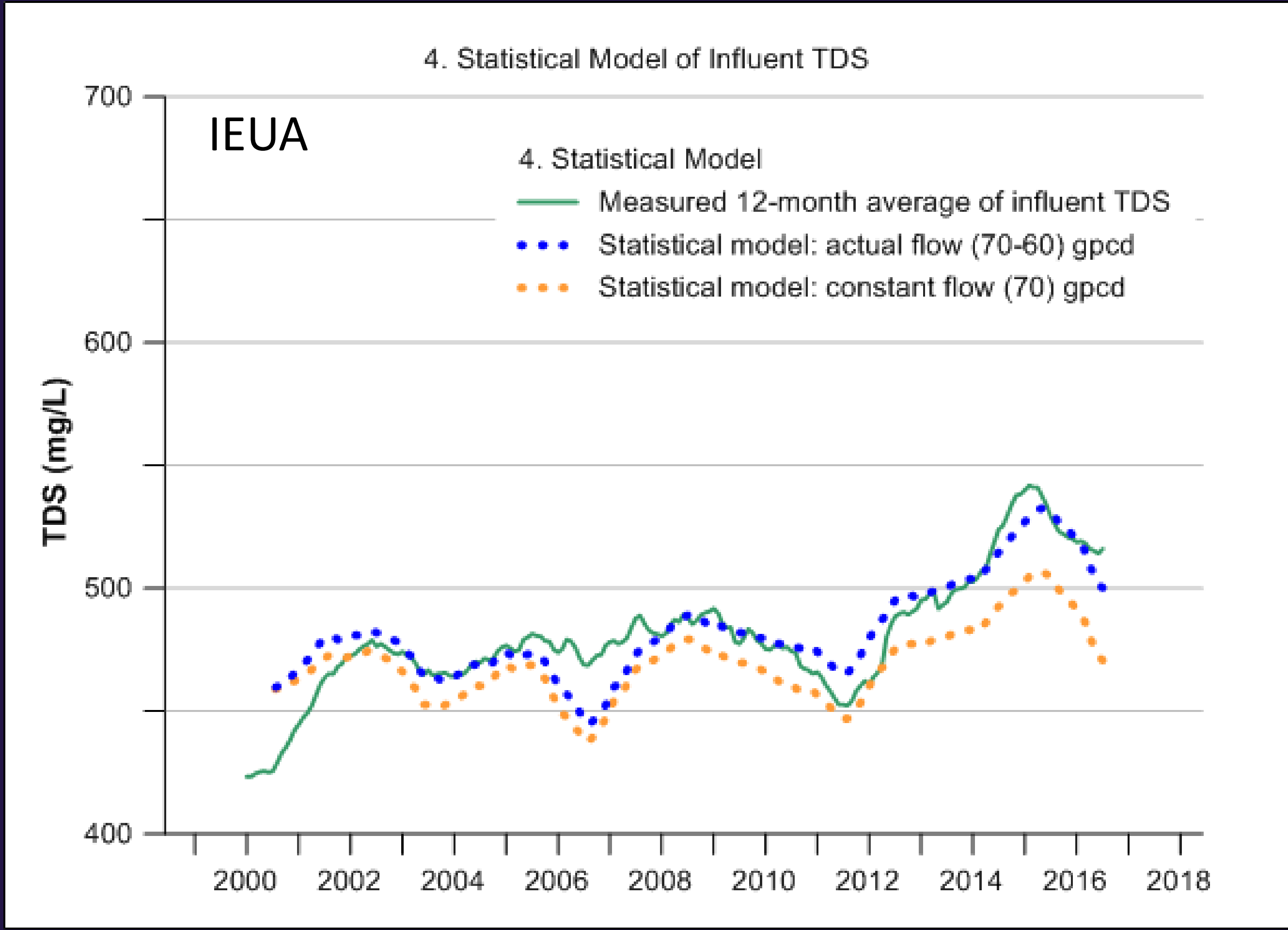


Multiple Linear Regression: Influent TDS



- Variables:
  - STDS: Source TDS
  - IGPCD: Influent per capita water use
- R -squared = 0.98
- Relative Importance (%)
  - STDS: 88.2
  - IGPCD: 11.8

Multiple Linear Regression: Influent TDS



- Variables:
  - STDS: Source TDS
  - IGPCD: Influent per capita water use
- R -squared = 0.75
- Relative Importance (%)
  - STDS: 67.2
  - IGPCD: 32.8

TDS Statistical Model Matrix

- Using the statistical models, matrices were developed to predict the effects of conservation and changes in source water TDS. Much of this variation was due to climatic factors such as drought.

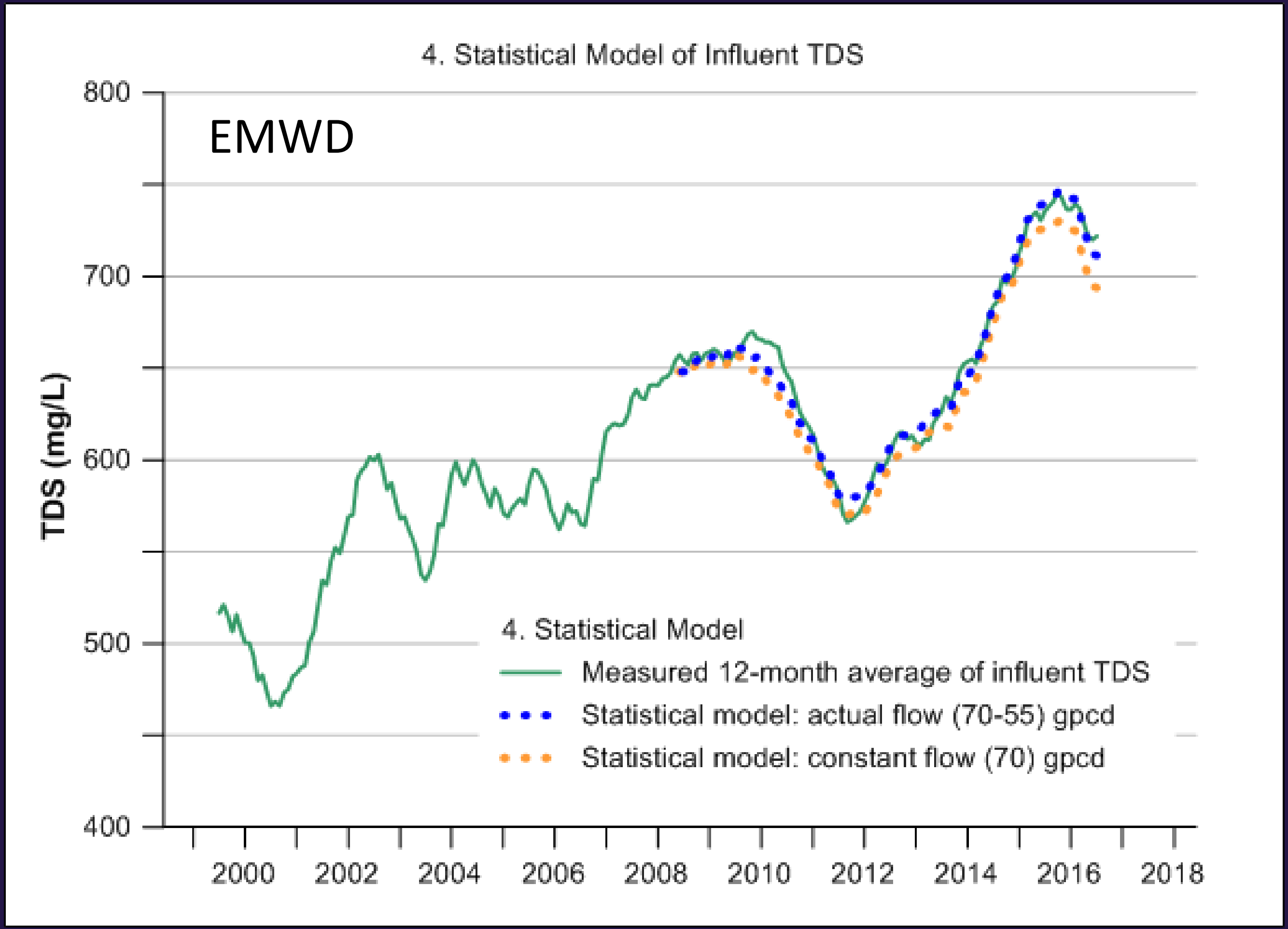
- EMWD Example: During the peak of the drought, source water quality was approximately 500 mg/L and indoor per capita water use was 55 gpcd. The estimated water quality entering a WWTP would be approximately 750 mg/L.

EMWD Statistical Model Matrix for Influent TDS

Indoor Water Use (gpcd)	Source TDS (mg/L) 300	325	350	375	400	425	450	475	500	525	550	575	600
40	608	629	650	671	692	713	733	754	775	796	817	838	859
42	605	626	646	667	688	709	730	751	772	793	814	835	856
44	601	622	643	664	685	706	727	748	769	790	810	831	852
46	598	619	640	661	682	703	724	744	765	786	807	828	849
48	595	616	637	657	678	699	720	741	762	783	804	825	846
50	591	612	633	654	675	696	717	738	759	780	801	821	842
52	588	609	630	651	672	693	714	735	755	776	797	818	839
54	585	606	627	648	668	689	710	731	752	773	794	815	836
56	581	602	623	644	665	686	707	728	749	770	791	812	832
58	578	599	620	641	662	683	704	725	746	766	787	808	829
60	575	596	617	638	659	679	700	721	742	763	784	805	826
62	572	592	613	634	655	676	697	718	739	760	781	802	823
64	568	589	610	631	652	673	694	715	736	756	777	798	819
66	565	586	607	628	649	670	690	711	732	753	774	795	816
68	562	583	603	624	645	666	687	708	729	750	771	792	813
70	558	579	600	621	642	663	684	705	726	747	767	788	809

Every 1 gpcd decrease amounts to 1.7 mg/L increase in TDS

Multiple Linear Regression: Influent TDS



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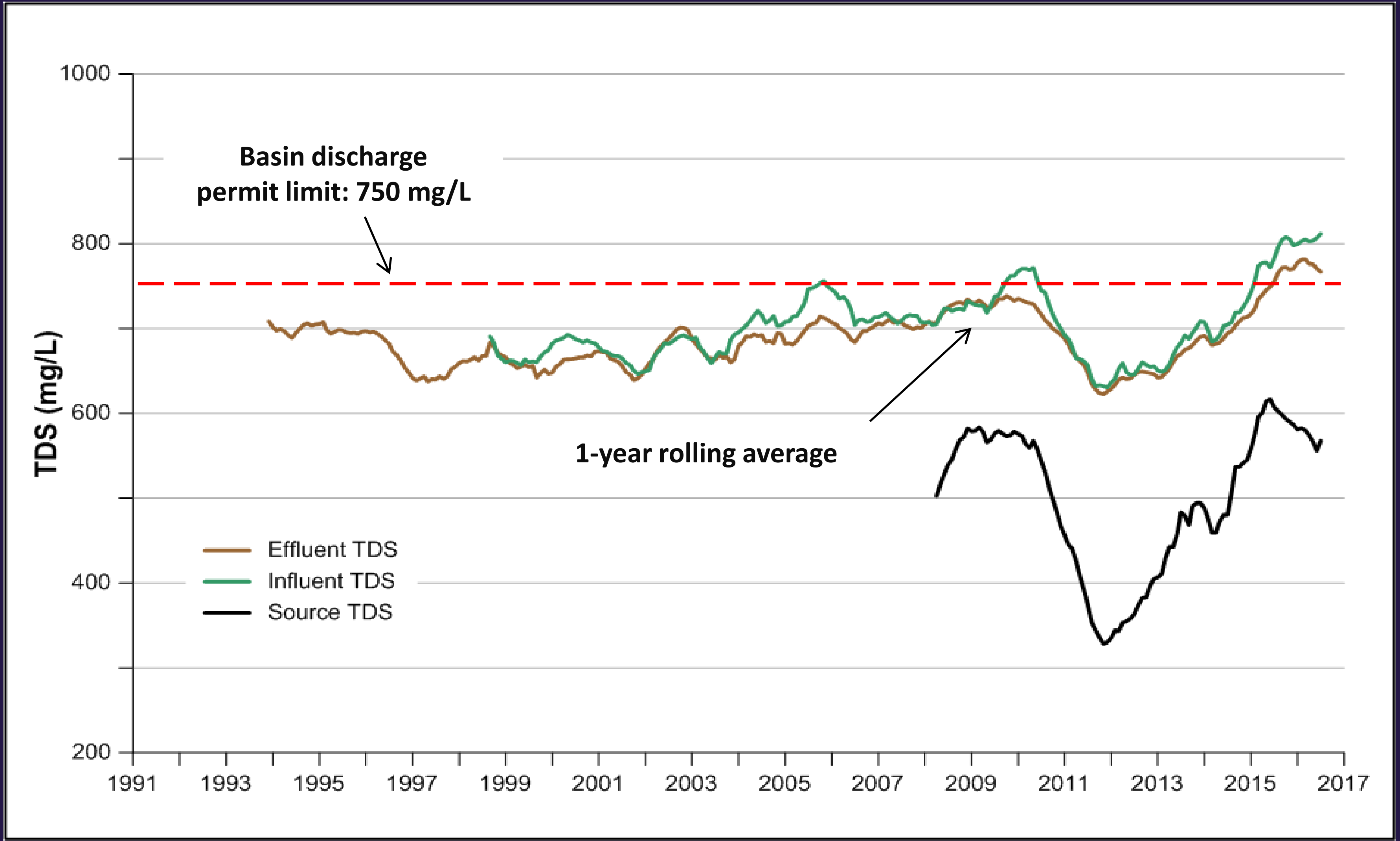
Long-term rolling averages

- How does the volume-weighted average TDS concentration in recycled water, and the related increment of use, vary using a range of rolling averaging periods (e.g., 1, 5, 10, and 15 years)?
- Longer-term rolling average periods smooth out annual variations of effluent trends. 10 year averages account for seasonal cyclicity.

TDS Trends Example - Temecula Valley

Considerations:

- Rolling average period
- Discharge limits based on Management Zone Water Quality Objectives
- Long term trends
- Sessional cyclicity (drought vs wet years)



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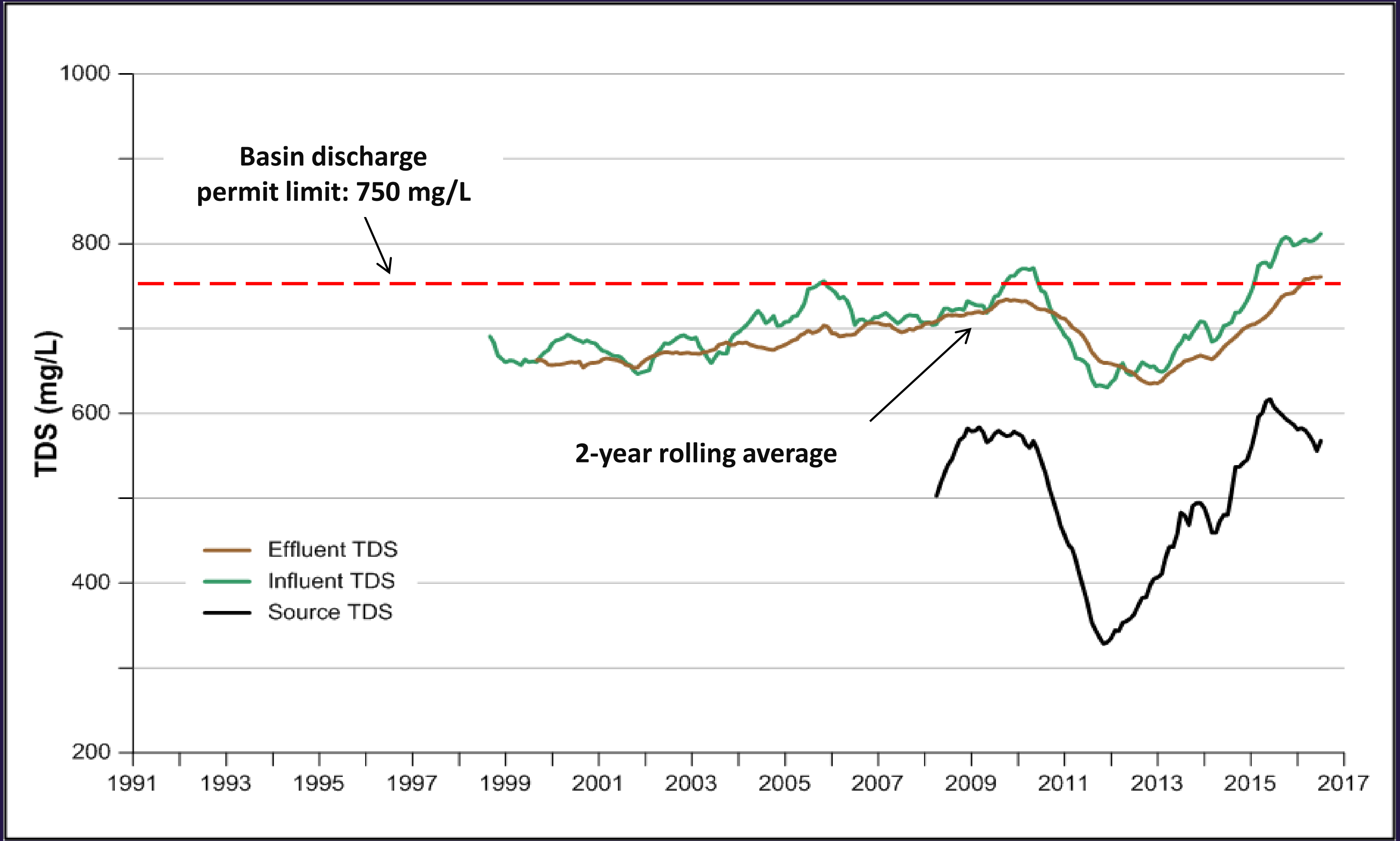

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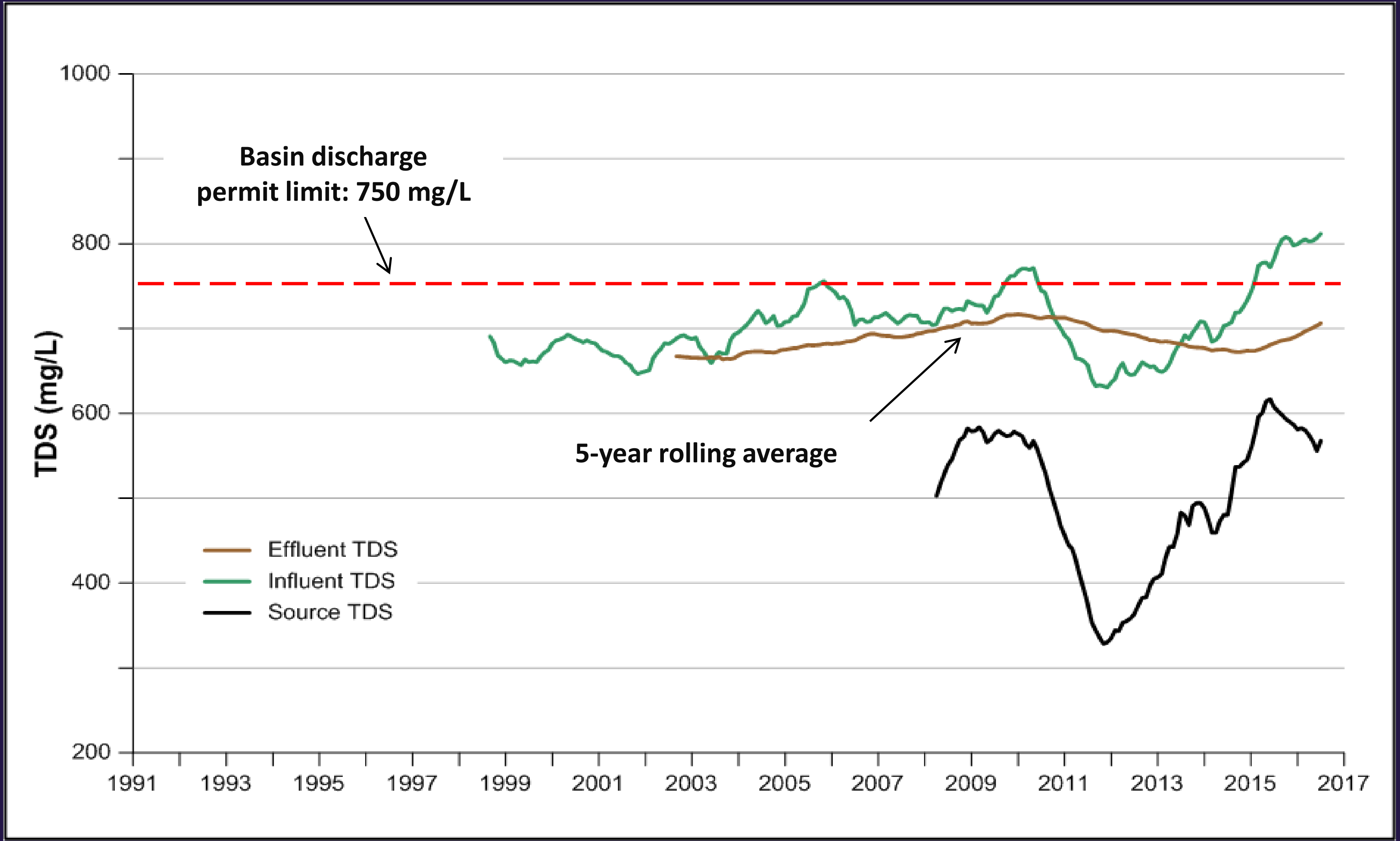

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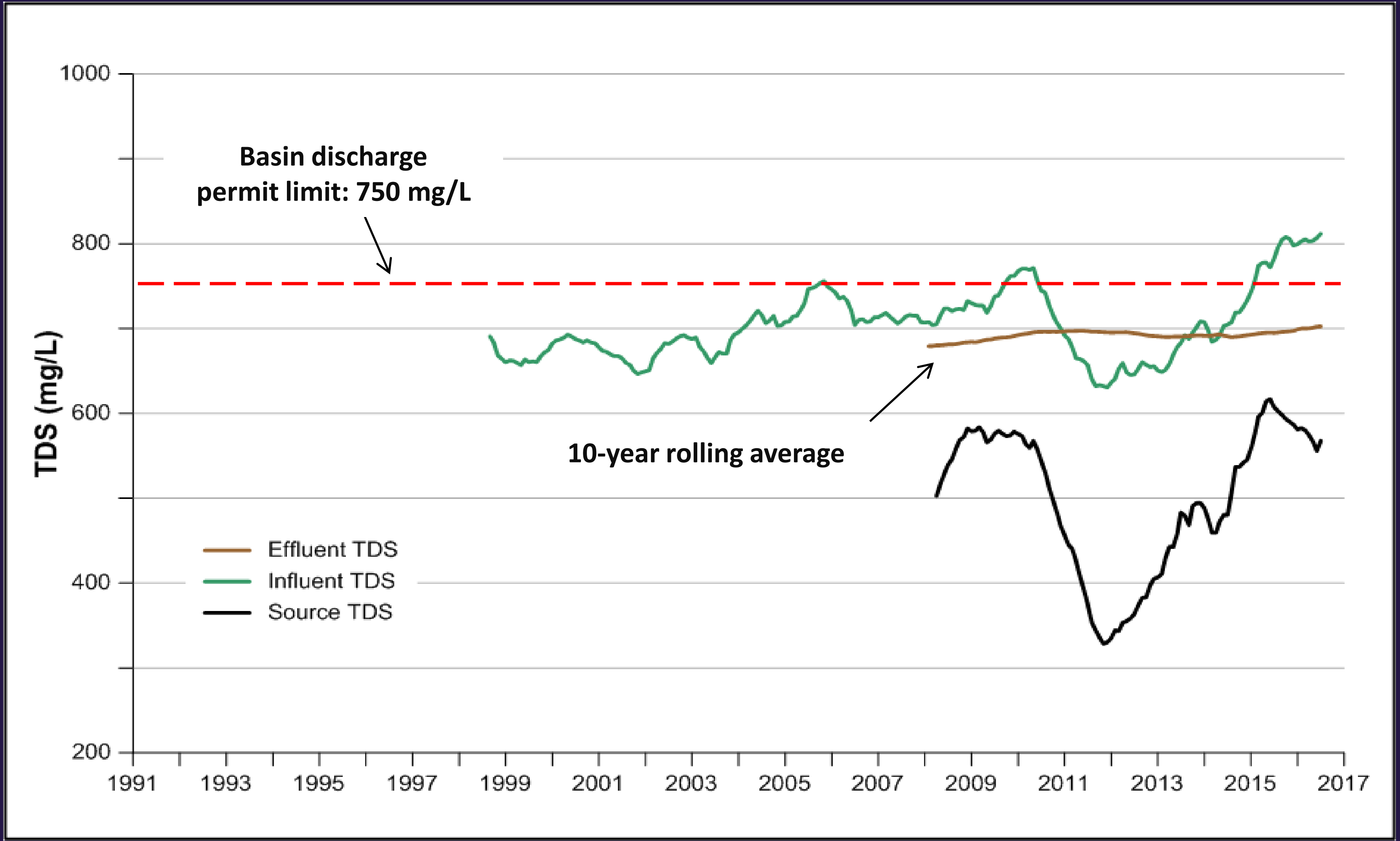

Summary

- Longer rolling averages (>5-years) minimize the influence of drought cycles. Long-term upward trends in TDS will still be present.
- Statistical modeling suggests that for every 1.0 gallon per capita per day that is conserved there will be an increase in TDS concentrations to the WWTPs of 1.2 mg/L to 1.7 mg/L
- Unintended consequences from water conservation measures
  - lower water quality (higher TDS)
  - less quantity of recycled water
  - less revenue
  - infrastructure O&M
  - Less energy uses
  - Less GHG emissions