San Joaquin River Selenium TMDL

Regional Board Staff Workshop
16 May 2001

Matt McCarthy
Les Grober
Workshop Agenda

• Welcome and Introductions
• Overview of Regional Board’s TMDL Development Process and Timelines
• San Joaquin River Selenium TMDL
Overview of Regional Board’s TMDL Development Process and Timelines
What Is a TMDL and Why Do One?

- TMDL = Total Maximum Daily Load
- TMDLs are required under section 303(d) of the Federal Clean Water Act
  - TMDLs must be developed for pollutants and waterbodies that have been identified on 303(d) list of impaired waterbodies
What Is a TMDL?

- A total maximum daily load (TMDL) is the amount of a specific pollutant that a waterbody can receive and still maintain a water quality standard.
- TMDLs allocate pollutant loads to point and nonpoint sources...
What Is a TMDL?

- TMDL = WLA + LA + MOS + background

WLA: waste load allocation for point sources
LA: load allocations for nonpoint sources
MOS: margin of safety
Components of TMDLs

- TMDL Description (Problem Statement)
- Numeric Targets (will often be new water quality objectives)
- Source Analysis
- Allocations
- Linkage Analysis (relationship between sources, allocations, and targets)
- TMDL Report
- Implementation Plan
Region 5
San Joaquin River Basin
Lower San Joaquin River Basin

- Stockton
- Old River
- Vernalis
- Modesto
- Crows Landing
- Tuolumne River
- Merced River
- Stanislaus River
- Delta Mendota Canal
- Mud Slough
- Salt Slough
- Mendota Dam

Extent of seasonally low dissolved oxygen
## TMDL Timeline

### Current Activities

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>San Joaquin River</td>
<td>Selenium, Salt &amp; boron</td>
<td>Diazinon &amp; chlorpyrifos</td>
<td>Dissolved oxygen, Diazinon &amp; chlorpyrifos, Mercury</td>
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<tr>
<td>Delta</td>
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<tr>
<td>Sacramento River</td>
<td>Copper, zinc, &amp; cadmium</td>
<td>Diazinon</td>
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<tr>
<td>Clear Lake</td>
<td>Mercury</td>
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<td>Cache Creek</td>
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<td>Mercury</td>
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</table>
San Joaquin River
Selenium TMDL
Components of TMDL

TMDL Description
Numeric Target
Source Analysis
Load Allocation
Linkage Analysis
TMDL Report
Implementation Plan
TMDL Description

Project Area
Magnitude of the Impairment
Background and History
Beneficial Uses
Reasons for Listing
Project Area for Selenium TMDL

- Stanislaus River
- Tuolumne River
- Merced River
- Salt Slough
- Mud Slough
- Modesto
- Crows Landing
- Grasslands Watershed (370,000 acres)
- Drainage Project Area (97,000 acres)
- Mendota Pool

Westland Water District
Magnitude of the Impairment

Total = 330 miles
Impaired = 50 miles from Salt Slough to Vernalis

Westland Water District
San Joaquin River near Crows Landing - 1986 to 1999

Historical Monthly Concentration

Selenium Concentration (µg/L)

Jan-86  Jan-88  Jan-90  Jan-92  Jan-94  Jan-96  Jan-98  Jan-00
Background and History

- Construction of San Luis Drain to convey agricultural subsurface drainage from Westland Water District
- Drain construction stopped at Kesterson
  - Tile drainage used as wetland water supply
- Avian deformities found in 1983
  - Selenium found to be the cause
- Westland Water District discharge to San Luis Drain stopped
**Background and History**

- New scrutiny on agricultural subsurface drainage and selenium
- Grasslands Watershed, just north of Westland Water District, naturally high in selenium
- Drainage Project Area (DPA) in Grassland Watershed historically discharged agricultural subsurface drainage with high selenium concentrations to wetland supply channels
- “Flip-flop” system initiated to reduce selenium loading from 1985 to 1996
Lower San Joaquin River

Impaired
88 miles natural channels
75 miles wetland channels
61,810 acres wetlands

Unimpaired

88 miles natural channels
75 miles wetland channels
61,810 acres wetlands

Delta

Stanislaus River
Tuolumne River
Merced River
Crows Landing
Vernalis
Mud Slough
Salt Slough

North Grassland
South Grassland

Drainage Project Area
Background and History

- “Flip-flop system”
  - Agricultural drainage and freshwater supplies are alternately conveyed by wetland supply channels
  - Agricultural subsurface drainage alternately discharged to Mud Slough or Salt Slough
Background and History

- Grassland Bypass Project implemented in 1996
- Diverts drainage away from wetlands using portion of San Luis Drain
- Basin Plan Amendment for the Control of Agricultural Subsurface Drainage in 1996
- Waste Discharge Requirements for Grassland Bypass Project in 1998
- TMDL development
Lower San Joaquin River
Pre-Bypass Conditions

Impaired
- 88 miles natural channels
- 75 miles wetland channels
- 61,810 acres wetlands

Unimpaired

Delta

Stanislaus River
Tuolumne River
Merced River
San Joaquin River

Vernalis

Crows Landing

Mud Slough

Salt Slough

North Grassland

South Grassland

Drainage Project Area
Lower San Joaquin River
Current Conditions
With Grassland Bypass

Impaired
57 miles natural channels

Improved
31 miles natural channels
75 miles wetland channels
61,810 acres wetlands

Unimpaired
Beneficial Uses

- Beneficial uses outlined for the lower San Joaquin River in the Regional Board Water Quality Control Plan:
  - Agriculture
  - Industry
  - Recreation
  - Warm/Cold Freshwater Habitat
  - Migration of Aquatic Organisms
  - Spawning of Fish
  - Wildlife Habitat
Beneficial Uses

• Beneficial uses outlined for the lower San Joaquin River in the Regional Board Water Quality Control Plan:
  – Agriculture
  – Industry
  – Recreation
  – Warm/Cold Freshwater Habitat
  – Migration of Aquatic Organisms
  – Spawning of Fish
  – Wildlife Habitat
Reasons for Listing

- SJR important for wildlife habitat
- Selenium found to be toxic to waterfowl
- Water routinely exceeds USEPA criteria and Regional Board Water Quality Objectives for selenium
Components of TMDL

- TMDL Description
- Numeric Target
- Source Analysis
- Load Allocation
- Linkage Analysis
- TMDL Report
- Implementation Plan
Numeric Target

- Use USEPA aquatic life criteria
- 5 µg/L 4-day average
- Water Quality Objective already in place from 1996 Basin Plan Amendment
- Approved by State Water Resources Control Board and Office of Administrative Law
San Joaquin River near Crows Landing - 1986 to 1999

Selenium Concentration (µg/L)

Historical Monthly Concentration

Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00
San Joaquin River near Crows Landing - 1986 to 1999

Historical Monthly Concentration

Selenium Concentration (µg/L)

Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00

5 µg/L objective
Components of TMDL

- TMDL Description
- Numeric Target
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San Joaquin River near Vernalis - 1986 to 1998
Source Analysis

Subsurface Agricultural Drainage
Surface Agricultural Return Flows and Wetland Discharges
Groundwater Accretions
Tributary Inflows
Drainage Project Area

Other Sources*

- Subsurface Agricultural Return Flows
- Surface Agricultural Return Flows and Wetland Discharges
- Groundwater Accretions
- Tributary Inflows

* Other sources calculated by difference between the San Joaquin River near Vernalis and the Drainage Project Area
Components of TMDL

- TMDL Description
- Numeric Target
- Source Analysis
- Load Allocation
- Linkage Analysis
- TMDL Report
- Implementation Plan
Load Allocation

- Determine Assimilative Capacity
- Allocate loads among the various sources
- Use a Margin of Safety to account for uncertainties in the analyses
- Use TMML Model to calculate load allocations
TMML Model Overview

- Originally developed by Regional Board staff in 1994
- Updated with new flow data by USBR staff in 2000
- Uses historic flow data to calculate design flows
- Based on a monthly (TMML) rather than daily (TMDL) time step
- Design flows combined with WQOs to provide TMMLs
Flow Data

- Data for 1970 to 1999
- Flow record divided into four water year groups
- Further divided into four seasons
  - Based on drainage and river flow patterns
- Results in 16 flow regimes
• TMML = Design flow x WQO
• Design flow is the 4-day low flow for the flow regime that results in the allowable rate of exceedance
• One in three year exceedance of WQO
Load Allocation

Load allocation = TMML - background - margin of safety

No waste load allocation (no point sources)
Background Load

- Calculated from three major sources of flow and selenium: Merced River, San Joaquin River upstream of Grassland Watershed, Grassland wetlands
  - Merced River = 0.2 µg/L
  - San Joaquin River upstream of Grassland Watershed = 0.5 µg/L
  - Grassland wetlands = 1.0 µg/L
Margin of Safety

- Required by Clean Water Act
- Accounts for uncertainty in the process
- Explicit ten percent margin of safety used in this TMDL
## Annual Load Allocation Values

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Year Type</th>
<th>TMML</th>
<th>Background Load</th>
<th>Margin of Safety</th>
<th>Load Allocation</th>
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<tbody>
<tr>
<td>Oct-Sept</td>
<td>C</td>
<td>1,320</td>
<td>115</td>
<td>132</td>
<td>1,073</td>
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<tr>
<td>Oct-Sept</td>
<td>D/BN</td>
<td>2,963</td>
<td>172</td>
<td>296</td>
<td>2,495</td>
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<tr>
<td>Oct-Sept</td>
<td>AN</td>
<td>4,996</td>
<td>333</td>
<td>500</td>
<td>4,163</td>
</tr>
<tr>
<td>Oct-Sept</td>
<td>W</td>
<td>5,367</td>
<td>351</td>
<td>537</td>
<td>4,479</td>
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</tbody>
</table>
Components of TMDL

- TMDL Description
- Numeric Target
- Source Analysis
- Load Allocation
- Linkage Analysis
- TMDL Report
- Implementation Plan
Linkage Analysis

• Describes relationship between numeric target, identified sources, and allocations
• Provides assurance that load limits will result in attainment of water quality objectives
Methods

• Flow Record: WY 1986 to 1999
• Calculate background selenium loads based on historical tributary flows and estimated mean concentrations:
  – SJR upstream of Grassland Watershed
  – Merced River
  – Mud Slough and Salt Slough
• Add load allocation from GBP
• Calculate SJR selenium concentration
## San Joaquin River near Crows Landing - 1986 to 1999

<table>
<thead>
<tr>
<th>Year Type</th>
<th>Month</th>
<th>Load Allocation (lbs)</th>
<th>Tributary Loads (lbs)</th>
<th>SJR @ Crow’s Landing Flow (cfs)</th>
<th>Conc (µg/L)</th>
<th>Violation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>May-86</td>
<td>512</td>
<td>195</td>
<td>240,407</td>
<td>1</td>
<td>NO</td>
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<tr>
<td>C</td>
<td>Feb-91</td>
<td>93</td>
<td>16</td>
<td>14,360</td>
<td>3</td>
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<tr>
<td>C</td>
<td>Dec-92</td>
<td>152</td>
<td>19</td>
<td>20,226</td>
<td>3</td>
<td>NO</td>
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<tr>
<td>W</td>
<td>Aug-98</td>
<td>366</td>
<td>97</td>
<td>108,061</td>
<td>2</td>
<td>NO</td>
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</table>
San Joaquin River near Crows Landing - 1986 to 1999

Linkage Analysis Estimated Monthly Concentration

5 µg/L objective

Selenium Concentration (µg/L)
San Joaquin River near Crows Landing - 1986 to 1999

Historical Monthly Concentration

5 µg/L objective
San Joaquin River near Crows Landing - 1986 to 1999

Linkage Analysis Estimated Monthly Concentration

Historical Monthly Concentration

5 µg/L objective
Linkage Analysis

- No violations of 5 µg/L mean monthly objective for 15 year period from 1986 through 1999
- Detailed look at 4-day average selenium...
- Six violations of 5 µg/L 4-day average objective for 15 year period from 1986 through 1999
Components of TMDL

- TMDL Description
- Numeric Target
- Source Analysis
- Load Allocation
- Linkage Analysis

TMDL Report

Implementation Plan
TMDL Report

- Technical TMDL
  - Draft Technical TMDL Report completed May 2001
  - Final Technical TMDL Report to be submitted to USEPA June 2001
Components of TMDL

TMDL Description
Numeric Target
Source Analysis
Load Allocation
Linkage Analysis
TMDL Report

Implementation Plan
TMDL Implementation

- 1996 Basin Plan Amendment established implementation framework for this TMDL
  - Selenium water quality objectives and performance goals
  - Prohibition of discharge to wetland channels
  - Grassland Bypass Project and use of San Luis Drain
  - Establishment of waste discharge requirements
  - Establishment of consensus based interim load limits

- TMDL load limits will be implemented through updated Waste Discharge Requirements
## Selenium Performance Goals and Water Quality Objectives

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<tbody>
<tr>
<td>Wetland Channels listed in App 40 of Basin Plan</td>
<td>2 µg/L</td>
<td>monthly avg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SJR below SJR below Merced River (W and AN)</td>
<td>5 µg/L</td>
<td>monthly avg</td>
<td>5 µg/L</td>
<td>4-day avg</td>
</tr>
<tr>
<td>SJR below Merced River (D/BN and C)</td>
<td>8 µg/L</td>
<td>monthly avg</td>
<td>5 µg/L</td>
<td>monthly avg</td>
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<td>Mud Slough (north) and SJR from Sack Dam to Merced River</td>
<td>5 µg/L</td>
<td>4-day avg</td>
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<td></td>
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<td></td>
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*Performance Goals (in italics) and Water Quality Objectives (in bold)*
# Selenium Load Limits

SJR at Crow’s Landing

<table>
<thead>
<tr>
<th>Year Type</th>
<th>2001 TMDL Load Allocation (lbs)</th>
<th>2001 Draft WDR Load Limits (lbs)</th>
<th>2003 WDR Load Limits (lbs)</th>
<th>2006 WDR Load Limits (lbs)</th>
<th>2011 WDR Load Limits (lbs)</th>
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<tbody>
<tr>
<td>C</td>
<td>1,073</td>
<td>4,995</td>
<td>3,915</td>
<td>1,073</td>
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<tr>
<td>D/BN</td>
<td>2,495</td>
<td>4,995</td>
<td>4,057</td>
<td>2,495</td>
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<td>4,995</td>
<td>4,479</td>
<td>4,479</td>
<td></td>
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</table>
Selenium Load Limits

GBP Selenium Loading (lbs)

- Current
Selenium Load Limits

GBP Selenium Loading (lbs)

Year

W  AN  D/BN  C
Selenium Load Limits

GBP Selenium Loading (lbs)

Year

W AN D/BN C
Lower San Joaquin River (2001) All Years

- **Impaired**
  - 57 miles natural channels
- **Improved**
  - 31 miles natural channels
  - 75 miles wetland channels
  - 61,810 acres wetlands
- **Unimpaired**

Drainage Project Area

- Crows Landing
- Vernalis
- Delta

- Stanislaus River
- Tuolumne River
- Merced River
- San Joaquin River
- Mud Slough
- Salt Slough

North Grassland

South Grassland
Lower San Joaquin River
(2006)
Wet, Above Normal Years

- Stanislaus River
- Tuolumne River
- Merced River
- San Joaquin River
- Mud Slough
- Salt Slough
- North Grassland
- South Grassland
- Drainage Project Area
- Vernalis
- Crows Landing
- San Luis Drain

- Impaired
  - 11 miles natural channels
- Improved
  - 77 miles natural channels
  - 75 miles wetland channels
  - 61,810 acres wetlands
- Unimpaired
Lower San Joaquin River (2006)
Below Normal, Dry, Critical Years

Impaired
57 miles natural channels

Improved
31 miles natural channels
75 miles wetland channels
61,810 acres wetlands

Unimpaired

San Luis Drain

Delta

Vernalis

Crows Landing

Stanislaus River

Tuolumne River

Merced River

San Joaquin River

Mud Slough

Salt Slough

North Grassland

South Grassland

Drainage Project Area
Selenium Load Limits

GBP Selenium Loading (lbs) vs Year

- W
- AN
- D/BN
- C
Lower San Joaquin River (2011) All Years

- Impaired: 11 miles natural channels
- Improved: 77 miles natural channels, 75 miles wetland channels, 61,810 acres wetlands
- Unimpaired

Diagram:
- Stanislaus River
- Tuolumne River
- Merced River
- San Joaquin River
- Vernalis
- Crows Landing
- San Luis Drain
- Mud Slough
- Salt Slough
- North Grassland
- South Grassland
- Drainage Project Area
- Delta
## Selenium Performance Goals and Water Quality Objectives

<table>
<thead>
<tr>
<th>Water Body (Year Type)</th>
<th>1 Oct 1996</th>
<th>1 Oct 2002</th>
<th>1 Oct 2005</th>
<th>1 Oct 2010</th>
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<tbody>
<tr>
<td>Wetland Channels listed in App 40 of Basin Plan</td>
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<td></td>
<td></td>
</tr>
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<td>5 µg/L</td>
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- **Performance Goals** (in italics)
- **Water Quality Objectives** (in bold)
Lower San Joaquin River (2011)
All Years

Impaired
0 miles natural channels

Improved
88 miles natural channels
75 miles wetland channels
61,810 acres wetlands

Unimpaired

San Luis Drain

Delta

Vernalis

Stanislaus River

Tuolumne River

Merced River

Salt Slough

Mud Slough

North Grassland

South Grassland

Drainage Project Area
# Staff Contacts

<table>
<thead>
<tr>
<th>Staff</th>
<th>Topic</th>
<th>Phone</th>
<th>e-mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matt McCarthy</td>
<td>San Joaquin River Selenium TMDL Project Lead</td>
<td>(916) 255-0735</td>
<td><a href="mailto:mccartm@rb5s.swrcb.ca.gov">mccartm@rb5s.swrcb.ca.gov</a></td>
</tr>
<tr>
<td>Les Grober</td>
<td>San Joaquin River TMDL Unit Chief</td>
<td>(916) 255-3091</td>
<td><a href="mailto:groberl@rb5s.swrcb.ca.gov">groberl@rb5s.swrcb.ca.gov</a></td>
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