MARINA DEL REY HARBOR: WATER EFFECT RATIO (WER) STUDY

MIACC Meeting June 22, 2021
Ashley N. Parks, PhD
Southern California Coastal Water Research Project
TODAY’S PRESENTATION

- Study Objectives
- WER Sampling and Testing Design
- Study Results
  - Summary of findings
  - Sample WERs
2014 TMDL Revisions included a finding of copper impairment in the water column
- Established load allocation for copper in the water column
- Dissolved copper target of 3.1 µg/L

To meet the TMDL target, there must be an 85% reduction of copper leaching from boat hull paints by 2024
- Minor inputs of Cu from other sources

A site-specific objective study was approved
STUDY OBJECTIVES

- Characterize variability of key water quality parameters in MdRH
  - Dissolved copper
  - DOC
- Generate a Water Effects Ratio (WER) using up to six sampling events under varying water quality conditions
  - Winter and summer dry weather
  - Wet weather
  - Spring and neap tidal cycles
TODAY’S PRESENTATION

- Study Objectives
- WER Sampling and Testing Design
- Study Results
  - Summary of findings
  - Sample WERs
### SAMPLING EVENTS

<table>
<thead>
<tr>
<th>WER sampling</th>
<th>Tide Type</th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Dry Weather</td>
<td>Dry Weather</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>Neap</td>
<td>April – October</td>
</tr>
<tr>
<td>#1</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>#2</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#6</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#7</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#3</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>#5</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>
5 stations were selected to represent spatial variability within harbor
- Spatial composites of each basin
- Tidal composites (ebb and flood) for dry weather events
For wet weather events, each station was sampled once.

For dry weather events, each location was sampled at flood and ebb tides and further composited for one sample per station.
### Parameters Analyzed

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Occasion of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Field</td>
</tr>
<tr>
<td>pH</td>
<td>X</td>
</tr>
<tr>
<td>Temperature</td>
<td>X</td>
</tr>
<tr>
<td>Salinity</td>
<td>X</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>X</td>
</tr>
<tr>
<td>Dissolved Organic Carbon</td>
<td></td>
</tr>
<tr>
<td>Total and Dissolved Copper</td>
<td>X</td>
</tr>
<tr>
<td>Total and Dissolved Zinc</td>
<td></td>
</tr>
<tr>
<td>Toxicity</td>
<td></td>
</tr>
</tbody>
</table>

- Dose-response toxicity tests performed on water samples
  - Copper added to create a range of concentrations from 0-23 µg/L
WATER EFFECT RATIO (WER) CALCULATION

- EPA-recommended method to develop site-specific aquatic life criteria
  - Compares toxicity of metal in site water to reference water

\[
WER = \frac{\text{Site Water EC50}}{\text{Reference Water EC50}}
\]

- EC50 = Toxicant concentration causing 50% effect
WER INTERPRETATION

- **WER = 1**
  - Water quality objective accurate with respect to site conditions

- **WER > 1**
  - Site conditions reduce toxic potency

- **WER < 1**
  - Site conditions increase toxic potency

- **WER can be used to develop a site-specific objective (SSO)**
  - **SSO = Criterion x WER**
TODAY’S PRESENTATION

- Study Objectives
- WER Sampling and Testing Design
- Study Results
  - Summary of findings
  - Sample WERs
STUDY FINDINGS

- Dissolved copper concentrations frequently exceeded current water quality objective (>3.1 µg/L)
- DOC concentrations lowest in winter dry weather with spring tide
- Toxicity-based Water Effects Ratios suggest possible reduced copper bioavailability relative to reference water (WER > 1)
  - Dependent on season and weather
- WERs higher in wet weather > summer dry weather > winter dry weather
  - Suggests greater copper bioavailability during winter dry weather
WER SAMPLING SUMMARY: DISSOLVED COPPER

- Lowest MdRH copper concentrations are at Main Channel station
- Highest MdRH copper concentrations are at basin stations
  - WER 7 event had highest copper concentrations
  - WER 2 had lowest copper concentrations
WER SAMPLING SUMMARY: DISSOLVED ORGANIC CARBON CONCENTRATION

- DOC concentrations lowest during WER 7 (winter dry weather, spring tide)
- DOC concentration ranged from 0.65-1.60 mg/L
TOXICITY-BASED WATER EFFECT RATIOS

<table>
<thead>
<tr>
<th>Station</th>
<th>WER 1 (summer dry, neap)</th>
<th>WER 2 (summer dry, spring)</th>
<th>WER 3 (wet)</th>
<th>WER 5 (wet)</th>
<th>WER 6 (winter dry, neap)</th>
<th>WER 7 (winter dry, spring)</th>
<th>All Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>MdRH-MC3</td>
<td>1.28</td>
<td>1.33</td>
<td>--</td>
<td>1.62 (mean)</td>
<td>1.00</td>
<td>1.27</td>
<td></td>
</tr>
<tr>
<td>MdRH-A</td>
<td>1.30</td>
<td>1.35</td>
<td>1.54</td>
<td>1.72</td>
<td>0.925 (mean)</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>MdRH-B</td>
<td>1.34</td>
<td>1.35</td>
<td>1.59</td>
<td>1.76</td>
<td>1.01</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>MdRH-E</td>
<td>1.28 (mean)</td>
<td>1.44 (mean)</td>
<td>1.59</td>
<td>1.94</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>MdRH-F</td>
<td>1.36</td>
<td>1.44</td>
<td>1.57</td>
<td>2.04</td>
<td>1.09</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Geometric mean</td>
<td><strong>1.31</strong></td>
<td><strong>1.38</strong></td>
<td><strong>1.57</strong></td>
<td><strong>1.81</strong></td>
<td><strong>1.00</strong></td>
<td>--</td>
<td><strong>1.40</strong></td>
</tr>
</tbody>
</table>

- Lowest WERs in winter dry weather
  - Assumed highest copper bioavailability
- Dry weather WERs range:
  - 0.925 - 1.44
- Wet weather WERs range:
  - 1.54 – 2.04
FINAL WER

- MdRH SSO Study final WER calculation is based on the toxicity test results
  - Geometric mean
  - All 24 sample WERs
  - \( f_{\text{WER}} = 1.40 \)
- An \( f_{\text{WER}} > 1 \) indicates site conditions reduce toxic potency of copper
QUESTIONS?