NATURE-BASED SOLUTIONS FOR NUTRIENT MANAGEMENT

BACWA Annual Meeting // August 18, 2020
The Project

- Requirement of Provision VI.C of the 2019 Nutrient Watershed Permit
- Estimate nutrient reduction potential, on a regional scale, via treatment wetlands (open water & horizontal levees)
- Secondary objective to address barriers to implementation and encourage multi-agency coordination
Project Elements

1. Data Collection & Screening
   (In progress)
2. Site Specific Evaluation
   (2021-2022)
3. Barriers & Coordination
   (on-going)
Current Status

1. Scoping & Evaluation Plan complete

2. Preparing for submission of 2nd main deliverable in Dec 2020 to quantify areas of potential suitability for each POTW
   a. Survey
   b. Desktop Analysis
   c. Facility-Specific Factsheets & Report
What are Nature-based Solutions?

“actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.”

IUCN, 2016
What are Nature-based Solutions?

“Nature-based solutions beneficially exploit natural processes providing stand-alone solutions or hybrid approaches integrated with technology-based or engineered solutions to foster urban resilience and sustainability.”

Frantzeskaki et. al., 2019
Engineered Solutions
- Pump Stations
- Outfalls & Stage Controls
- Attached/Fixed Growth Nitrification
- Distribution
- Impermeable Liners

Natural Processes
- Photolysis
- Denitrification
- Infiltration
- Carbon sequestration
- Habitat connectivity

Nature-Based Solutions
- Open-Water Wetlands
- Subsurface Flow Wetlands
- Agriculture & Forest Irrigation
- Woodchip Bioreactors
- Horizontal Levees
Back to the Future

Wastewater treatment evolved from natural systems and is constantly iterating.

Unit-Cell Open Water Wetlands

Photo: David Sedlak
Horizontal levees

Oro Loma horizontal levee. Photo: SFEP
Nutrient Watershed Permittee Survey

- Joint request for information from HDR (recycled water) and SFEI (NbS)
- Complete responses to the web-based NbS survey from 35 of 37 permittees
- Results will inform selection of facilities for site-specific investigation
Survey

Has your agency considered nature-based solutions for wastewater treatment/disposal?
Has your agency prepared any reports related to the planning or evaluation of NbS for wastewater treatment?
Survey

Do your capital improvement plans consider or plan for implementation of NbS for wastewater treatment or other purposes?

- Not sure: 20.0%
- Yes: 13.3%
- No: 66.7%
Describe the level of planning/implementation performed to date.
Is your agency interested in potentially participating in the alternatives development process?

- Yes: 56.4%
- Maybe: 28.2%
- No: 15.4%
Survey

Is your agency interested in exploring partnerships with other agencies and landowners?

- Yes: 47.6%
- Maybe: 42.9%
- No: 9.5%
Are you able to identify potentially suitable sites for NbS within your service area or nearby areas?
Rate your agency's interest in pursuing NbS according to the following objectives:
Tidal Water Height in Feet

monthly maximum water levels

Source: NOAA, BCDC 2020 & OPC 2018
22 OUT OF 37 POTWS AT SIGNIFICANT SLR RISK
OVER THE COURSE OF THE 21ST CENTURY

Source: NOAA, BCDC 2020 & OPC 2018
Has your agency prepared any reports related to sea-level rise assessment or adaptation?
Rate the following factors, in terms of preventing or constraining your agency's adoption of NbS for wastewater treatment:
A mixed-methods approach to strategic planning for multi-benefit regional water infrastructure

Sasha Harris-Lovett, Judit Lienert, David Sedlak

* Energy and Resources Group, University of California, Berkeley, United States
b Eawag: Swiss Federal Institute of Aquatic Science and Technology, Switzerland
c Engineering Research Center for Reinventing the Nation's Urban Water Infrastructure (ReNUWH), United States
d Department of Civil and Environmental Engineering, University of California, Berkeley, United States

Abstract
Finding regional solutions for water infrastructure and other environmental management challenges requires coordination, communication, and a shared understanding among different stakeholders. To develop a more versatile and collaborative decision-making process for nutrient management in the San Francisco Bay Area, we used a mixed-methods approach consisting of stakeholder analysis with cluster analysis, multi-criteria decision analysis (MCDA), and scenario planning. These methods allowed us to identify agreements and disagreements in stakeholder objectives and preferences, clarify ways in which different options could meet the goals of diverse stakeholders, and elucidate how scientific uncertainty about technical performance and future conditions could affect management strategies. Results of the analysis indicate that several non-conventional nutrient management options like constructed wetlands and increased water recycling for irrigation met the goals of many stakeholders under a variety of future scenarios. A comparison of MCDA results with a more traditional ‘cost-efficiency’ measure (i.e., optimizing for the lowest cost per mass of nutrients removed) revealed little correlation...
Towards a New Paradigm of Urban Water Infrastructure: Identifying Goals and Strategies to Support Multi-Benefit Municipal Wastewater Treatment

Sasha Harris-Lovett 1,2,*, Judit Lienert 3 and David L. Sedlak 2,4

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Abstract: Over the past decade, water professionals have begun to focus on a new paradigm for urban water systems, which entails the recovery of resources from wastewater, the integration of engineered and natural systems, and coordination among agencies managing different facets of
Fig. 3. The probability of the top three ranked options for each of nine stakeholders (SH) given uncertainty in attribute predictions, Status quo scenario. Color coding options see legend and Table 1. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)
INSTITUTIONAL
- lack of leadership
- interagency collaboration
- regulatory constraints
- risk tolerance

SOCIAL
- public opinion
- public compliance

TECHNICAL
- effects on existing treatment train
Desktop Study of Opportunities & Constraints

- Leverage SFEI’s Adaptation Atlas and GreenPlanIT tools to identify opportunities for open water treatment wetlands and horizontal levees
- Refine the model outputs in consultation with BACWA representatives and local experts
- Generate factsheets to communicate opportunities and constraints
- Inform site-specific analyses at WWRFs with high NbS potential
Las Gallinas
Oro Loma

- POTW
- 2 mile buffer
- Ecotone levee
- Ecotone levee, alternative alignments shown
- Suitable for open water treatment wetland
- High ranking
- Lower ranking

2 Miles

Suitable for open water treatment wetland
High ranking
Lower ranking
## Nature-based treatment solutions

There are multiple opportunities for nature-based treatment at the Hayward Water Pollution Control Facility. One possibility is to convert the existing wet weather storage ponds into open water treatment wetlands. These could be integrated with a horizontal levee on the outboard side of the ponds, which would provide additional nutrient reduction benefits.

This horizontal levee could also provide multiple co-benefits, including valuable high tide refuge habitat for marsh species, wave attenuation to reduce flood risk, and marsh migration space for adjacent Cogswell Marsh.

### PRELIMINARY FINDINGS

**Table 1. Open water wetland suitability**

<table>
<thead>
<tr>
<th>Open water wetland suitability</th>
<th>350</th>
<th>85</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acres</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T reduction (kg)</td>
<td>1,560</td>
<td>800</td>
<td>37%</td>
</tr>
<tr>
<td>T reduction (ft)</td>
<td>94%</td>
<td>93%</td>
<td>91%</td>
</tr>
</tbody>
</table>

*Estimated by outflow performance, assuming an inflow prior to discharge of 1.25 times open water wetland.*

**Table 2. Horizontal levee suitability**

<table>
<thead>
<tr>
<th>Horizontal levee suitability</th>
<th>11.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (km)</td>
<td></td>
</tr>
<tr>
<td>T reduction (ft)</td>
<td>3200</td>
</tr>
<tr>
<td>T reduction (%)</td>
<td>90%</td>
</tr>
</tbody>
</table>

*Values optimal for reduction relative to length of levee, including the presence of a high tide refuge marsh on the north side of the levee.*

### OPPORTUNITIES & CONSTRAINTS

Based on mapping and survey responses received from all regional WWRFs, several key opportunities or barriers to NBS implementation have been identified. Recognizing unique situations apply to each WWRF, a relative weighing of generalized opportunities and constraints will influence evaluations going forward.

<table>
<thead>
<tr>
<th>Opportunity/Barrier</th>
<th>Relative Likelihood</th>
<th>Regulatory/Environmental Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative legend</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Regulatory</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Environmental</td>
<td>High</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

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**Hayward Water Pollution Control Facility**

- Q: Main buffer
- Horizontal levee opportunity
- Single alignment shown
- Alternative alignments shown
- Open water wetland opportunity
- Highly suitable
- Moderately suitable
- Less suitable
- Hayward Water Pollution Control Facility
Near-term Schedule

- **Oct 19**: Compiled Draft Factsheets and supporting documentation to BACWA
- **Nov 6**: Stakeholders return comments
- **Nov 24**: SFEI submits the Final Report to BACWA
- **Dec 1**: BACWA submits final to the Water Board
Next Steps

1. Identify those WWRFs with the highest NbS potential in consultation with the Project CMG
2. Perform site visits (as permitted) and outreach to 10-15 sites
3. Develop brief memo on each
4. Identify 5-10 sites for deeper dive to develop planning-level designs, cost estimates, SLR adaptation pathways
5. Continually engage partners and aligned projects, to encourage cooperation, address regulatory hurdles, and reduce barriers to implementation
Leveraging the Adaptation Atlas: example alternative adaptation strategies

Novato OLU case study from Marin Adaptation Framework
## Evaluating tradeoffs

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Indicator</th>
<th>Units</th>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost considerations</td>
<td></td>
<td></td>
<td><strong>Hold the line</strong></td>
</tr>
<tr>
<td>Low cost construction</td>
<td>Fill volume for ecotone levees(^1)</td>
<td>million cubic yards</td>
<td>0.00</td>
</tr>
<tr>
<td>Low cost maintenance</td>
<td>Linear distance of existing shoreline protection that would need to be raised or maintained(^2)</td>
<td>miles</td>
<td>21</td>
</tr>
<tr>
<td>Supporting services</td>
<td></td>
<td></td>
<td><strong>Hold the line</strong></td>
</tr>
<tr>
<td>Biodiversity support (habitat, species)</td>
<td>Projected area of marsh in 2030</td>
<td>acres</td>
<td>980</td>
</tr>
<tr>
<td>Cultural/social services</td>
<td></td>
<td></td>
<td><strong>Hold the line</strong></td>
</tr>
<tr>
<td>Recreation</td>
<td>Length of new trails(^3)</td>
<td>miles</td>
<td>0</td>
</tr>
</tbody>
</table>
## Adaptation Pathways

### Seabright State Beach: Public Property: Incremental Retreat

<table>
<thead>
<tr>
<th>Phase</th>
<th>Adaptation Strategy</th>
<th>Secondary Consequences of Strategy</th>
<th>Trigger(s) to Next Phase</th>
<th>Pathway Visualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td>Dune restoration Wide beach</td>
<td>Improved beach habitat, wide beach</td>
<td>Dune failure, narrowing of beach width, loss of public use and access</td>
<td>Present → 2000</td>
</tr>
<tr>
<td>1</td>
<td>Dune construction/ Living shoreline with cobble</td>
<td>Improved beach habitat, potential impact on dredging</td>
<td>Dune failure, narrowing of beach width, cliff erosion</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Managed retreat: 1-way traffic, maintain lateral cliff &amp; beach access</td>
<td>Loss of one lane traffic</td>
<td>Cliff erosion</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Managed retreat: No vehicle access, maintain rec/ped access</td>
<td>Loss of road and parking (retain sidewalk)</td>
<td>Cliff erosion, loss of public use and access</td>
<td></td>
</tr>
<tr>
<td>4a</td>
<td>Managed retreat: Remove vulnerable private infrastructure</td>
<td>Loss of private property maintenance of bluff top public access</td>
<td>NA</td>
<td>OR</td>
</tr>
<tr>
<td>OR 4b</td>
<td>Armor: Construct armor to protect private property</td>
<td>Private property maintained, loss of public access</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Source: City of Santa Cruz
Nature-based wastewater treatment is an emerging regional priority.

How to integrate a diversity of priorities is the challenge:

- Habitat restoration
- Recreation & education
- Flood risk
- Recycled water concentrate management
Nexus to Other Projects

- Transforming Shorelines (SFEP)
- Bay Adapt (BCDC)
- ReNUWIt / Bay Area One Water
- Valley Water - RO concentrate management
- Plan Bay Area (MTC)
- Regional Board Basin Planning
- BCDC Bay Plan Amendments
THANK YOU AND PLEASE GET IN TOUCH!

Ian Wren, Ellen Plane, Julie Beagle, Dave Senn