Desalination Intake Approaches: Open Ocean Intake vs Subsurface

Monterey Bay Water Works Association

16 October 2008

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Presentation Outline

- Introduction to Desalination Intakes
- Review of open-water intakes
- Review of subsurface (beach well) intakes
- Intake approach evaluation for scwd^2 Desalination Facility
- Studies to support intake evaluation
- Questions

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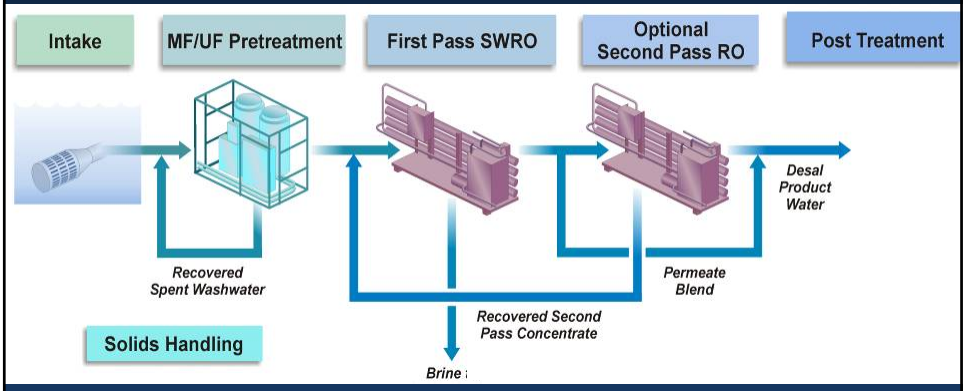
The intake is a critical component of a seawater desalination facility



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The primary objective of an intake is to supply seawater to the desalination facility

Important Considerations:

- Source water quality
- Construction impacts
- Operational impacts to marine organisms
- Capital and Maintenance Costs
- Regulatory Permitting

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Explanation of the terms "Impingement" and "Entrainment"

Movie of Impingement

- **Impingement:** fish get stuck to intake screen due to high intake velocity
- **Entrainment:** organisms that are smaller that the screen are drawn into the intake

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Major types of open-water intakes

- Velocity Caps
- Traveling Water Screens
- Vertical and Cylindrical Wedgewire Screens
- Aquatic Filter Barriers

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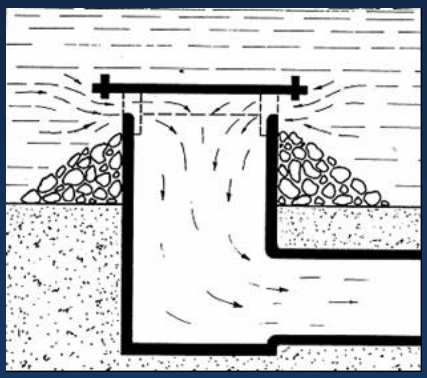
Velocity caps minimize the velocity at the intake to prevent impingement



Intake velocity < 0.5 fps

Velocity cap structure for the 38 MGD Perth, Australia Desalination Facility

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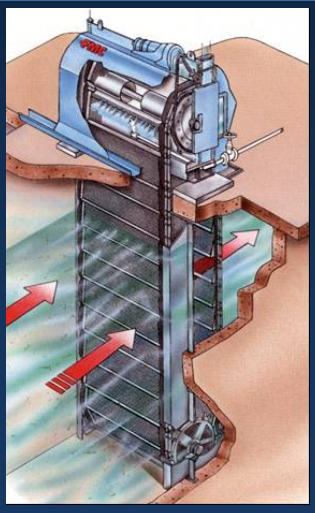
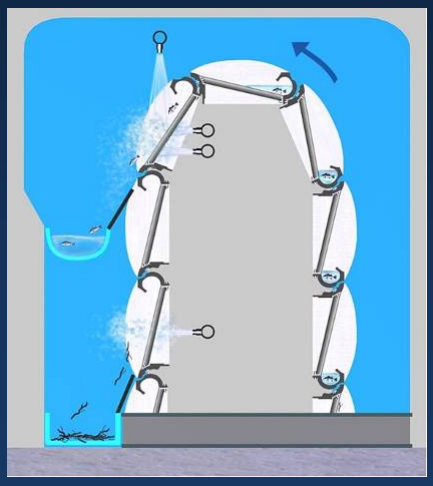
Traveling screens used with velocity cap minimize entrainment and protect downstream processes





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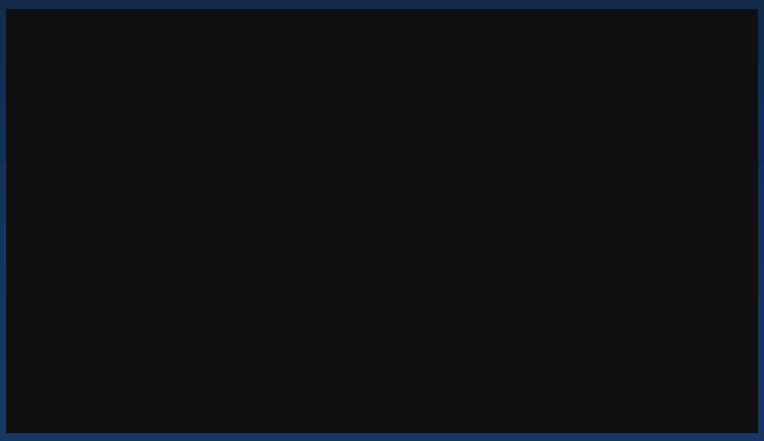
Experience from an operating velocity cap intake system in Perth Australia

Movie of Perth Intake



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Wedgewire screens use narrow slot size and low velocities to protect organisms

vertical screens

Slot size of 2 to 3 mm

Intake velocity < 0.5 fps

cylindrical screens

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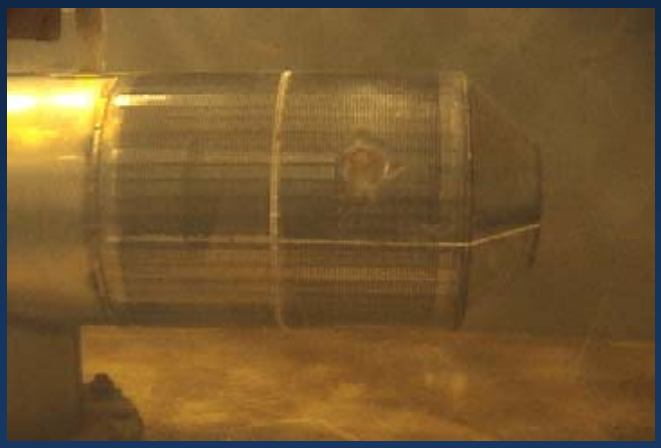
Fish larvae are not entrained floating by a properly designed wedgewire intake (Alden Research)



2mm screen; 0.5 fps intake velocity; 0.5 fps current

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Aquatic Filter Barriers have worked well in lakes with minimal current forces on the fabric barrier

- **Fabric barrier supported with floats and anchors**
- **Laser cut perforations exclude marine life**
- **Issues with current forces on fabric**
- **Bio-growth may be an issue in seawater**

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Major types of subsurface/sub-floor intakes for seawater desalination

- **Vertical Wells (Beach Wells)**
- **Horizontal Collector Wells (Ranney Collector)**
- **Slant Wells (Directionally Drilled Wells)**
- **Engineered Infiltration Gallery**

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The success of a subsurface intake depends on the local geological conditions

- **Sand and alluvial materials hydraulically connected to ocean**
- **Characteristics of the alluvial materials – fine sand and clays can impact production**
- **Sufficient horizontal area to permit multiple wells for larger facilities**
- **Depth of sand to protect intake screens from storm erosion and damage.**

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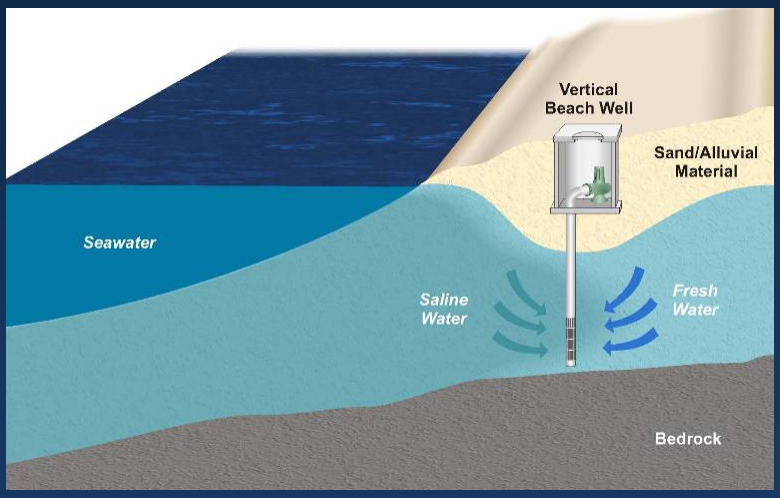
Beach wells require deep beaches with large-grain sands and good hydraulics



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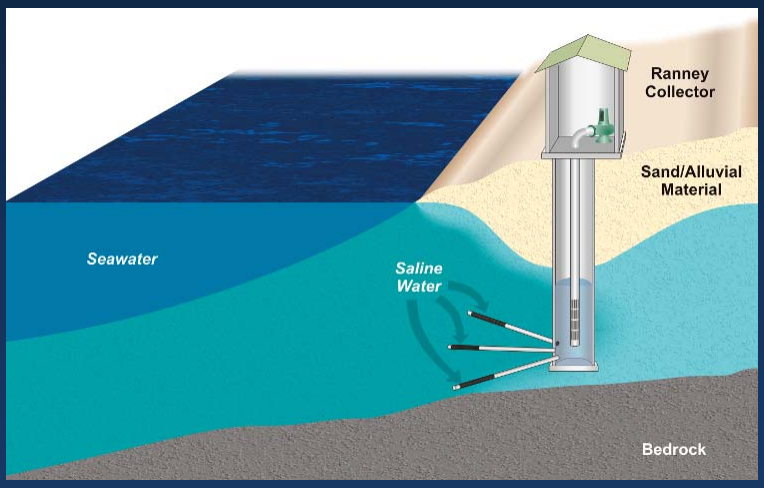
Horizontal collector wells require similar conditions as vertical beach wells



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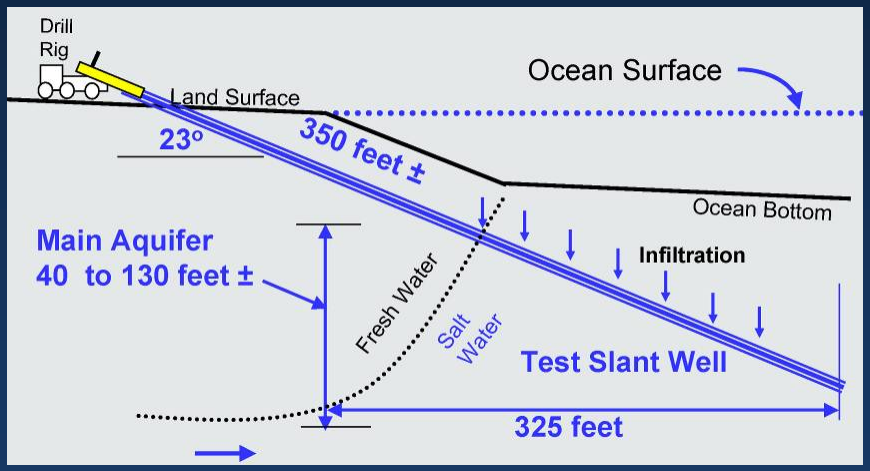
Slant wells can potentially work where vertical wells will not



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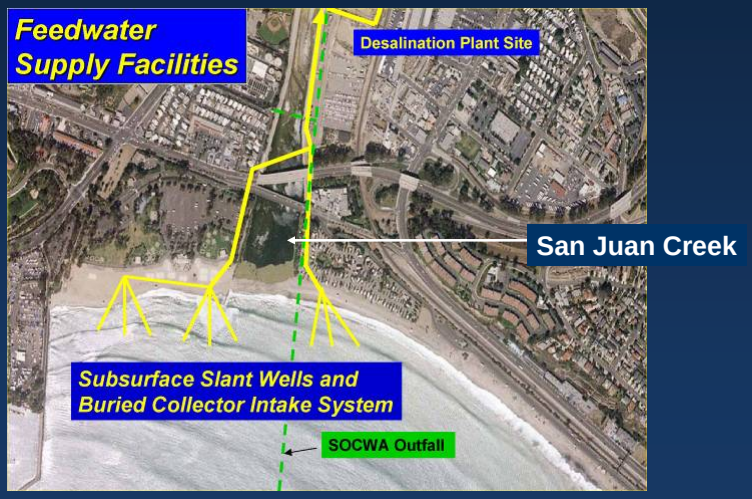
Slant wells are recommended for MWDOC 10 MGD Dana Point Desalination Project



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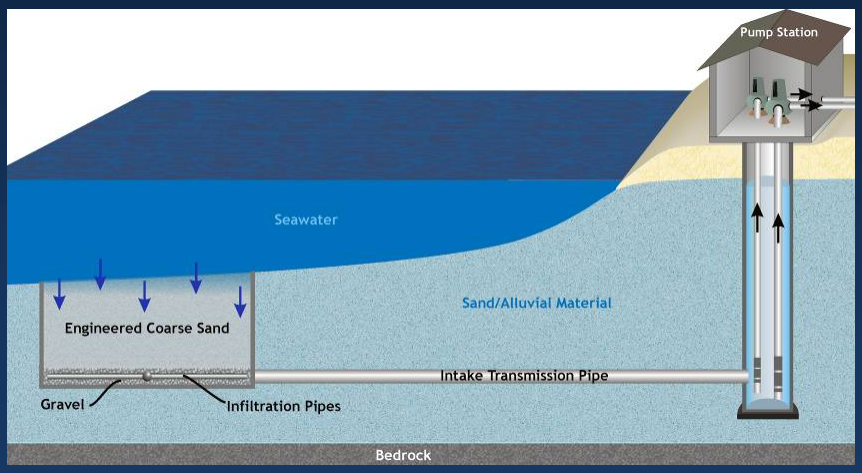
An engineered infiltration gallery could work where natural sands are not suitable



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An engineered infiltration gallery in Japan has been in operation since 2005

- **Mamizu Pia Seawater Desalination Facility in Fukuoka, Japan (13 MGD facility)**
- **~3,800 ft offshore in Sea of Japan**
- **1,100 ft long, 210 feet wide, 10 ft deep (85,500 cubic yards of excavation and fill)**
- **< 0.1 gpm/ft2 sand filtration rate**
- **Successful operation to date**

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Long Beach is evaluating an engineered beach infiltration gallery approach

(Graphic courtesy of LBWD)

- **Replace native fine-grain sands with large-grain sand**
- **Horizontal collection pipes**
- **Low filtration rates of <0.1 gpm/ft2**

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Excavation of a pilot-scale engineered beach infiltration gallery (LBWD, March 2008)

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Fine-grain native sand is removed from infiltration gallery (LBWD, March 2008)

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Engineered coarse grain sand is placed around collector pipes (LBWD, April 2008)

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Sheet walls will be removed to permit seawater to flow over gallery. (LBWD, April 2008)

Testing is underway with results expected soon

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For Santa Cruz, a 2001 Report concluded that the local geology does not support subsurface intakes

Beaches along Santa Cruz coastline

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2001 Report concluded that beach wells and collector wells would not provide sufficient water

- **Shallow beaches over bedrock**
- **Fine-grained sands**
- **Significant seasonal beach erosion**
- **San Lorenzo alluvial deposits have abundant organics, silts and clay**

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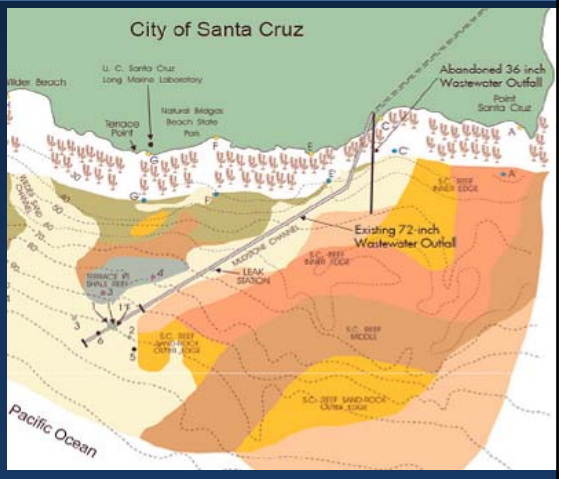
scwd² current intake approach is to convert an abandoned outfall into a screened open intake

- **Uses existing infrastructure**
- **Reduces capital costs**
- **Minimizes construction impacts to ocean floor**
- **Cylindrical wedgewire screens to protect marine life**



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However, scwd² is also investigating alternative subsurface intake approaches

Subsurface intake advantages include:

- **Potential for natural filtration pre-treatment**
- **No impingement and entrainment issues**
- **Minimizes growth of marine life on the inside of the intake pipeline**
- **Favored by regulatory agencies**

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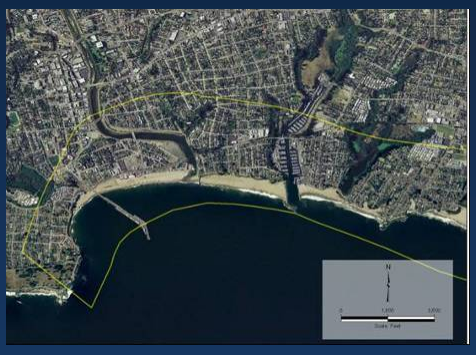
Slant well or engineered infiltration gallery intake has potential for Santa Cruz coast geology



Possible offshore sand channel near Santa Cruz Harbor

- **Probable ancient offshore marine alluvial channel out into Santa Cruz Harbor**
- **Slant well(s) or engineered infiltration gallery could be constructed in probable offshore channel**

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Next steps for scwd² intake evaluation

Screened, Open-Water Intake Approach

- Conduct 12-month entrainment study and impact assessment
- Survey the existing outfall to determine optimum intake screen location

Subsurface/Sub-floor Intake Approach

- Survey for probable offshore marine channel
- Take borings to characterize the offshore alluvium

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Similar entrainment study for MMWD Desalination Project showed no significant impact to SF Bay marine life

- 2.4 mm narrow-slot wedgewire screen
- < 0.5 fps intake velocity
- Copper-nickel materials minimize corrosion and bio-fouling

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From the intake studies and conceptual designs scwd² will select appropriate intake approach

- **Capital costs of intake systems and piping to the desalination facility**
- **Operations and Maintenance costs of intake systems**
- **Environmental impacts and mitigation costs**
  - **Construction impacts**
  - **Operational impacts**

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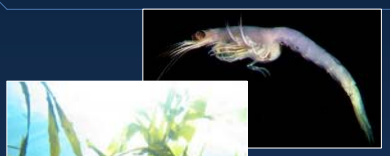
Questions

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