Slant Well Desalination Feedwater Supply

Comparison Between Dana Point Test Slant Well and CEMEX Test Slant Well

CalAm

9-Oct-14
Doheny Ocean Desalination Project Dana Pt.

Project Location & Layout
30 mgd
9 slant wells
7 active 2 stdby
<table>
<thead>
<tr>
<th></th>
<th>Dana Pt.</th>
<th>Cemex</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dilling Method:</strong></td>
<td>Dual Rotary Drilling Rig</td>
<td>same</td>
</tr>
<tr>
<td><strong>Angle:</strong></td>
<td>23 degrees</td>
<td>19 degrees</td>
</tr>
<tr>
<td><strong>Type:</strong></td>
<td>Uniform Diameter casing and screen</td>
<td>Telescoping</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Larger Pumphouse</td>
</tr>
<tr>
<td><strong>Completed Length:</strong></td>
<td>350 ft</td>
<td>760 ft</td>
</tr>
<tr>
<td><strong>Well Screen:</strong></td>
<td>220 ft</td>
<td>475 ft</td>
</tr>
<tr>
<td><strong>Length of Blank Casing:</strong></td>
<td>130 ft</td>
<td>345 ft</td>
</tr>
<tr>
<td><strong>Casing and Screen:</strong></td>
<td>12 in. ID</td>
<td>14 in &amp; 20 in. ID</td>
</tr>
</tbody>
</table>
Dana Point Test Slant Well

Aquifer Depths 180-200 feet

Ocean Surface

Infiltration

12 in casing

220' 12 in. screen

T.L. = 350 feet

Land Surface

Ocean Bottom

* The small 12” pumphouse casing prevented full development of the well (1.5 x the design capacity)
* Larger test well casing allows full development of the well (1.5 x the design capacity) unlike Dana Point well
## Comparison in Design and Performance
### Dana Pt. and CEMEX

<table>
<thead>
<tr>
<th>Project</th>
<th>Well Length ft</th>
<th>Casing diam. Length In. / ft</th>
<th>Screen diam. Length In. / ft</th>
<th>Initial Discharge Rate and Specific Capacity</th>
<th>Final Discharge Rate and Specific Capacity</th>
<th>Start and Ending TDS mg/L</th>
<th>On Shore Groundwater Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dana Pt.</td>
<td>350 ft</td>
<td>12 in./130 ft</td>
<td>12 in./220 ft</td>
<td>2,000 gpm 69 gpm/ft</td>
<td>2,000 gpm 47 gpm/ft</td>
<td>2,500 / 17,000</td>
<td>Minimal</td>
</tr>
<tr>
<td>CEMEX</td>
<td>760 ft</td>
<td>20 in./345 ft</td>
<td>14 in and 20 in. 475 ft</td>
<td>2,500 gpm 90 gpm/ft (estimated)</td>
<td>2,500 gpm 90 gpm/ft (estimated)</td>
<td>26,000 / 32,000+</td>
<td>Negligible</td>
</tr>
</tbody>
</table>
## Comparison in Geology
### Dana Pt. and CEMEX

<table>
<thead>
<tr>
<th>Project</th>
<th>Exploratory Boreholes</th>
<th>Aquifer Thickness</th>
<th>Material Type</th>
<th>Water Quality (starting level)</th>
<th>Full Scale Feedwater Requirement</th>
<th>Full Scale Project Wells</th>
<th>Percentage Ocean Water from Full Scale System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dana Pt.</td>
<td>Yes</td>
<td>180–200 ft</td>
<td>Sands, gravels, and cobbles</td>
<td>Brackish 2,500 mg/L</td>
<td>30 mgd</td>
<td>9 total 7 active 2 standby</td>
<td>95%</td>
</tr>
<tr>
<td>CEMEX</td>
<td>Yes</td>
<td>250 ft</td>
<td>Mostly Sands and fine gravels</td>
<td>Saline 26,000 mg/L</td>
<td>24.1 mgd</td>
<td>10 total 8 active 2 standby</td>
<td>96%+</td>
</tr>
</tbody>
</table>
Comment on the Decline in Specific Capacity at the end of the two year pumping test

• Due to limited funding, the Dana Point Test Slant Well was designed as a uniform 12-inch diameter well casing and screen without a larger diameter pumphouse casing.
• Consequently, the largest diameter submersible pump that could be installed in the well was a 10-inch pump with a capacity of 2,200 gpm
• Industry standard practice is to develop a well at 1.5 x the design discharge rate
• This would have required a pump capable of 3,300 gpm for a Q of 2,200 gpm
• The well was developed at 1,700 gpm.
• The decline in specific capacity was expected due to incomplete initial development.
• The Dana Pt. full scale wells will have a telescoping design with a larger diameter pumphouse casing as does the CEMEX well
• This will allow for full development of the well and minimize losses in performance
Appendix

Dana Point Photos
DANA POINT – TEST SLANT WELL
DRILLING SITE ON DOHENY BEACH
CONSTRUCTION FOOTPRINT

Slant Well

Drill Power Plant
Optional Settling Tank
Support Truck
Flat Bed Truck
Fluid Separation System
Roll Off Box

All Terrain Forklift
15 Ton Boom Truck

Dana Point Slant Well Equipment Footprint
130 X 60 Chain Link Fenced

Ocean
DRILLING HOLES FOR THE ANCHOR PIPES
SLANT WELL CONSTRUCTION
SLANT WELL CONSTRUCTION 24 IN. OUTER CASING
WELDING THE SHOE ON THE 24 IN. CASING
24 IN./20 IN./12 IN. CASING/TREMIE PIPE
PASSIVATION OF WELD JOINTS
• INSTALLING THE FILTER PACK BY PUMPING UNDER PRESSURE
WITHDRAWING THE 20 IN. TEMPORARY CASING
DISCHARGE WATER DIFFUSER PIPE
SLANT WELL IS BURIED UNDER THE BEACH SAND

Close up
30 MGD FEED WATER SUPPLY

(7) Production Slant Wells 3,000 gpm each – 1,000 ft Lineal

(2) Standby Wells