# In-Situ Comparison of Water Supply Well Gravel Packs

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**CA-NV AWWA Fall Conference**
**October 23, 2018**

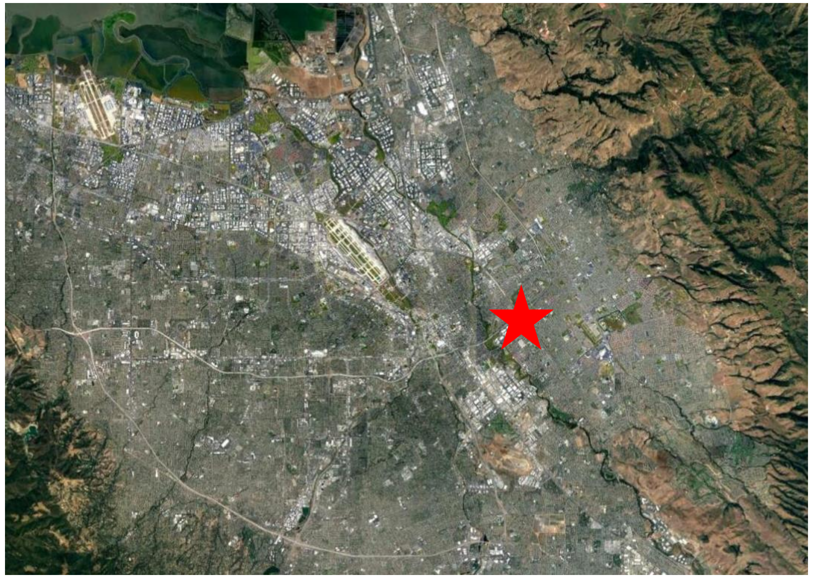
# Introduction



- Overview of SJW's McLaughlin Station Project
- Comparison of different gravel pack materials
    - Design
    - Constructability
    - Development
    - Performance
    - Cost
- Project challenges

# SJWC – McLaughlin Station

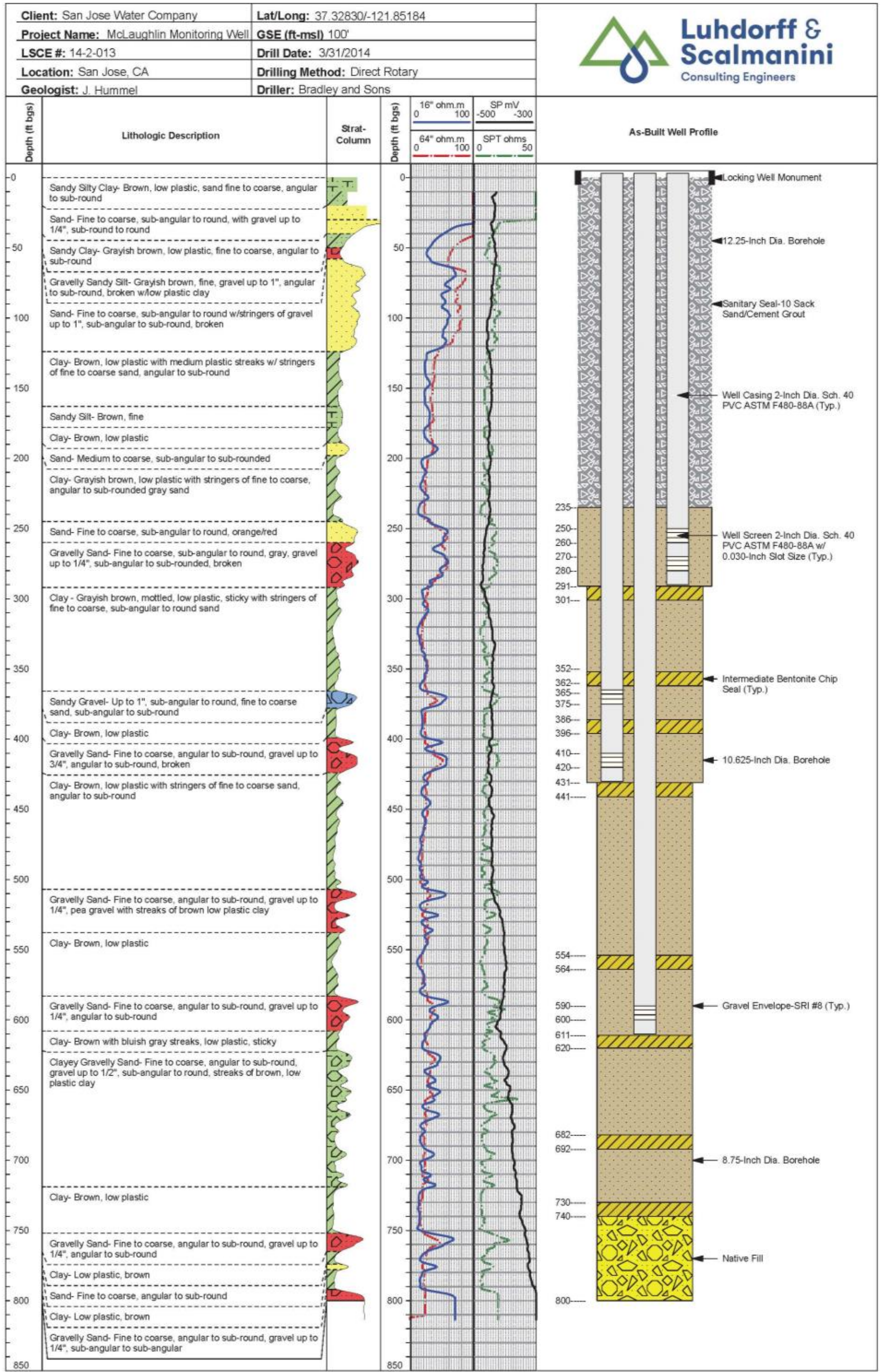
CA-NV AWWA
October 23, 2018

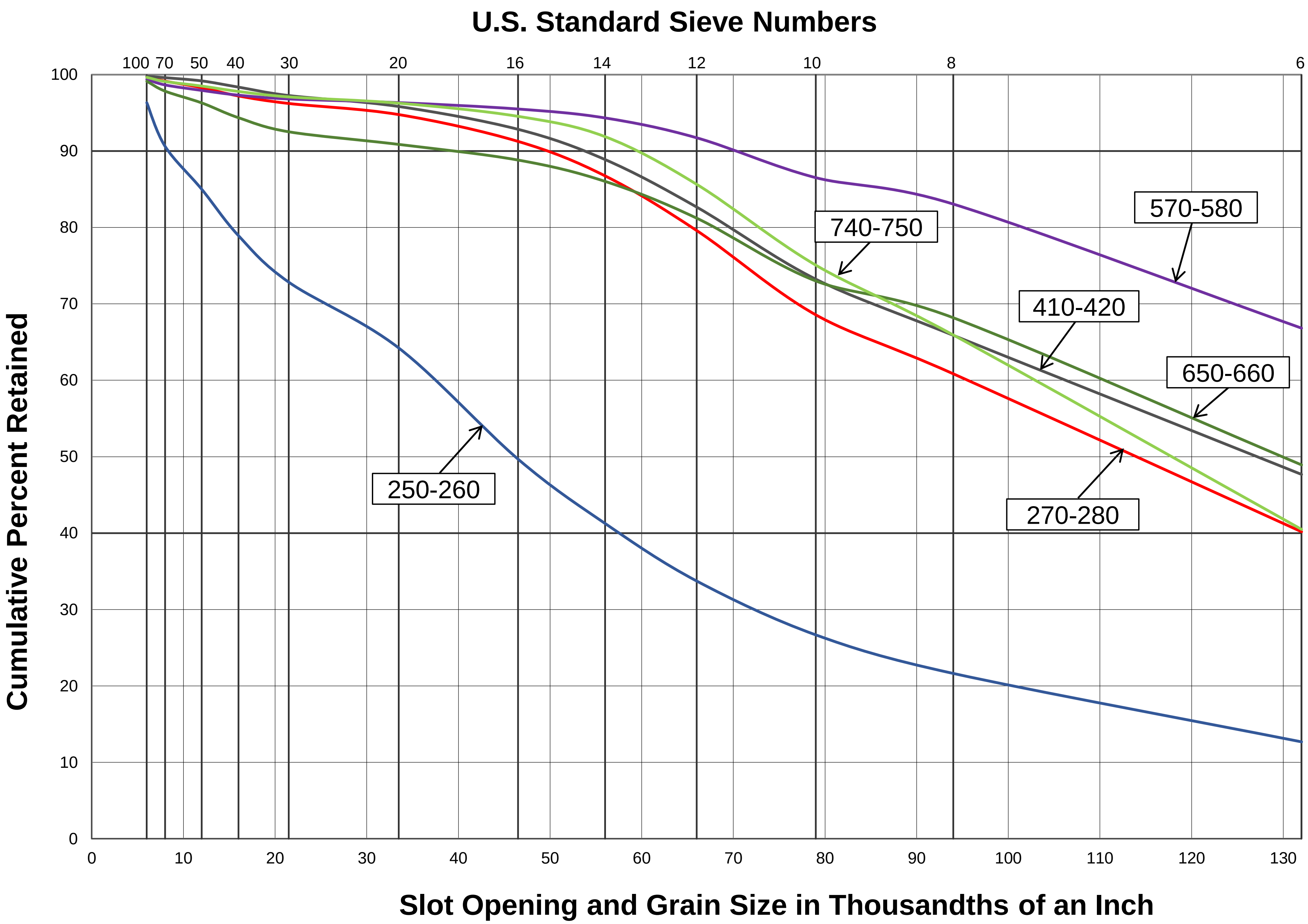


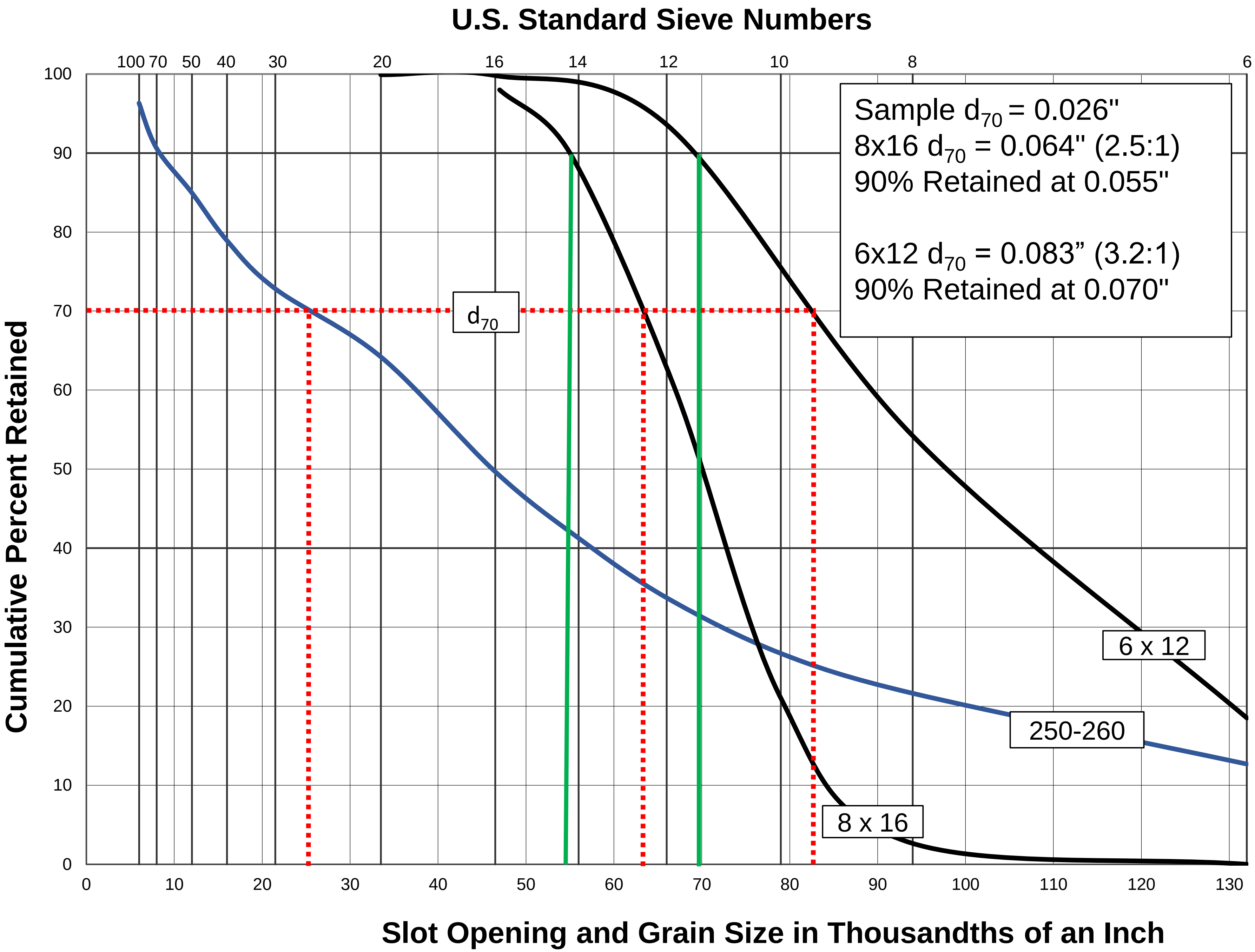
- Four+ acre site
- Room for multiple wells
- Existing homes
- Recreation field

# Test Hole-Monitoring Well

- Small diameter test hole
- Sample collection
- Geophysical surveys
- Installation of multiple piezometers
- Sieve analysis
- Collection & analysis of water samples
- Long term water level monitoring



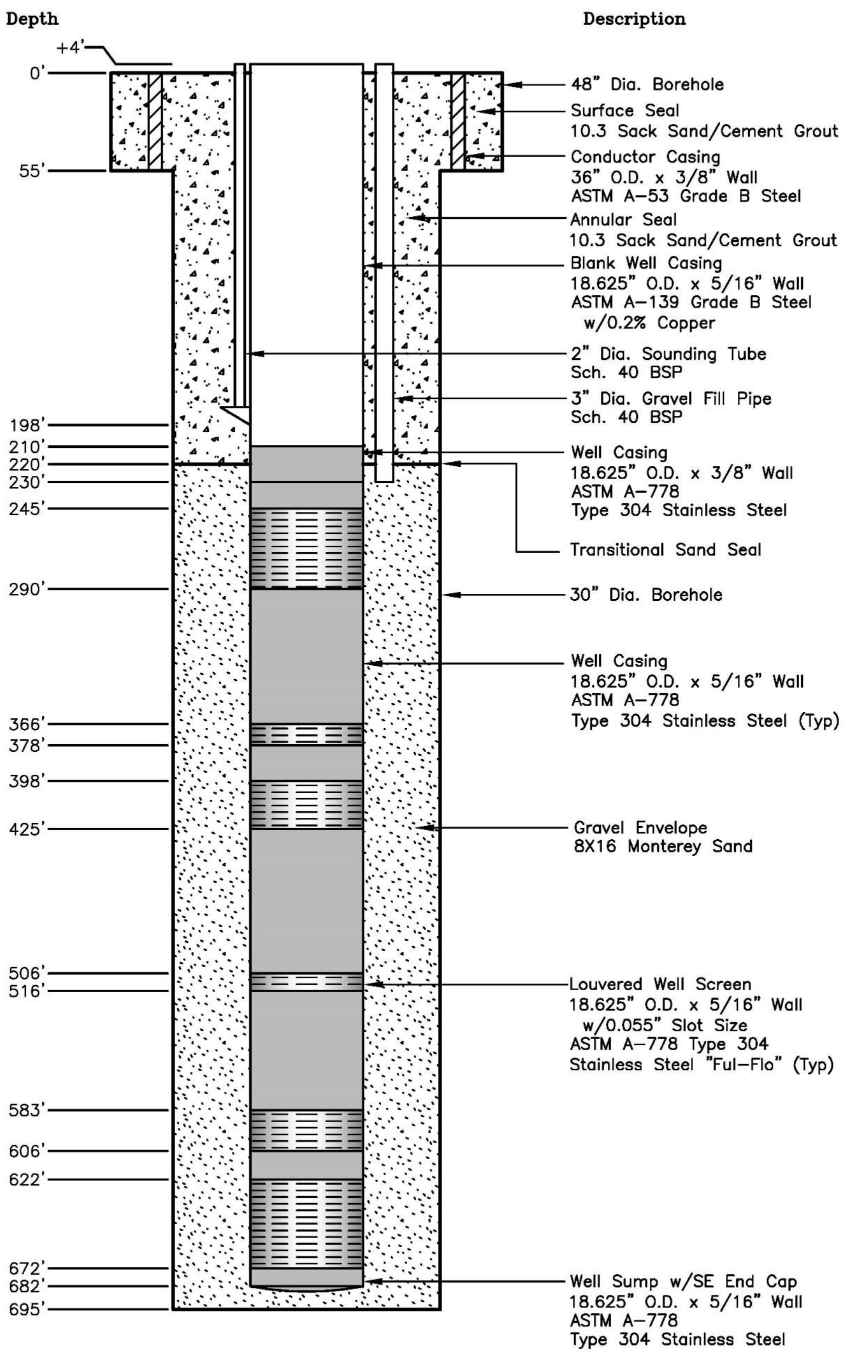

U.S. Standard Sieve Numbers
100 70 50 40 30 20 16 14 12 10 8 6
Cumulative Percent Retained
0 10 20 30 40 50 60 70 80 90 100
Slot Opening and Grain Size in Thousandths of an Inch
0 10 20 30 40 50 60 70 80 90 100 110 120 130
570-580
740-750
410-420
650-660
250-260
270-280



U.S. Standard Sieve Numbers
100 70 50 40 30 20 16 14 12 10 8 6
Cumulative Percent Retained
100
90
80
70
60
50
40
30
20
10
0
0 10 20 30 40 50 60 70 80 90 100 110 120 130
Slot Opening and Grain Size in Thousandths of an Inch
d70
Sample d70 = 0.026"
8x16 d70 = 0.064" (2.5:1)
90% Retained at 0.055"
6x12 d70 = 0.083" (3.2:1)
90% Retained at 0.070"
6 x 12
250-260
8 x 16

# McLaughlin Production Well

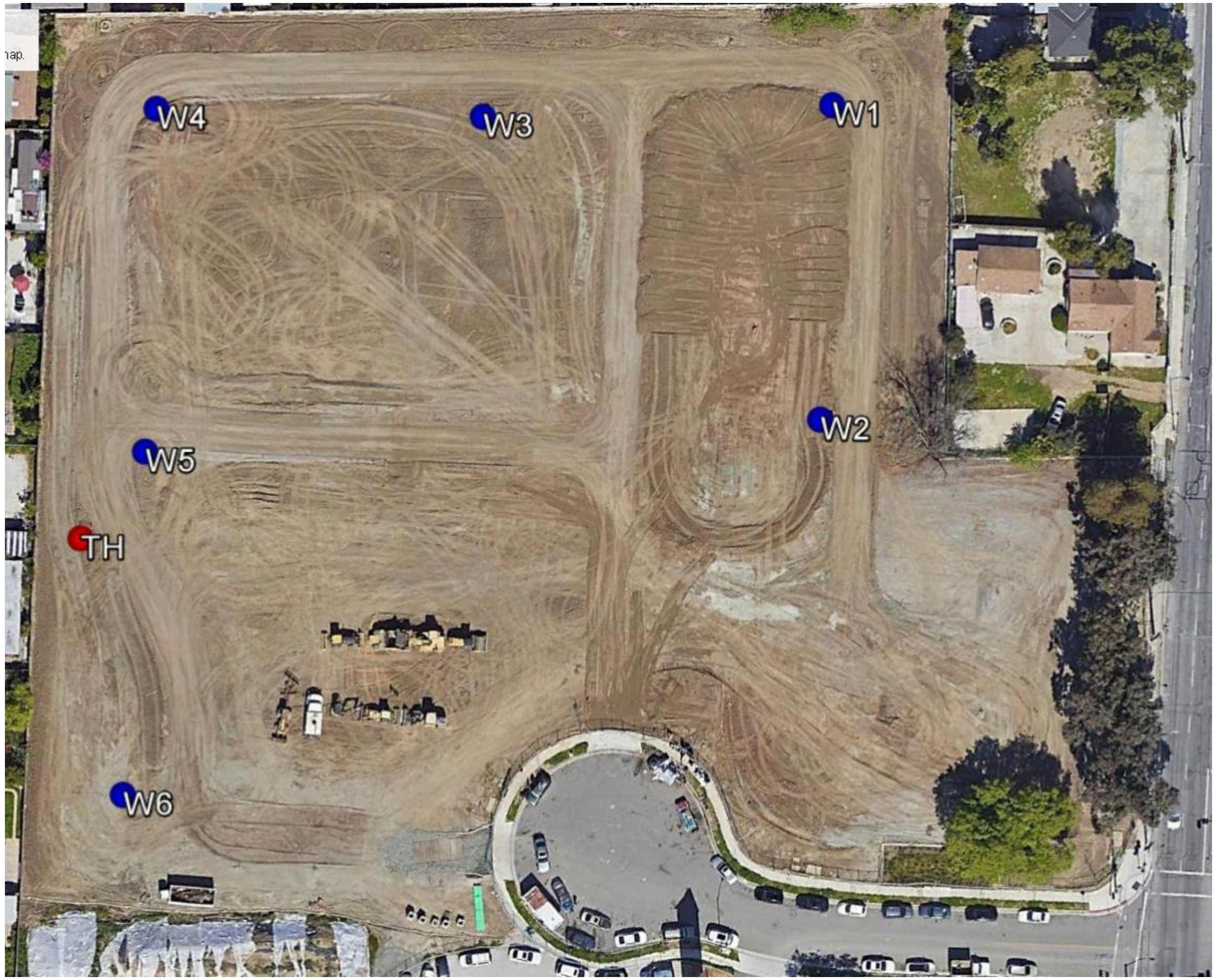
- 1,800 GPM
- Deep annular seal
- 18” Diameter
  - 0.3125” Copper bearing blank
  - 0.3125” and 0.375” Stainless steel blank
  - 0.3125”, 0.055” Louvered well screen
- Gravel fill and sounding pipes
- 8x16 Cemex (Monterey) gravel



# McLaughlin Station Layout

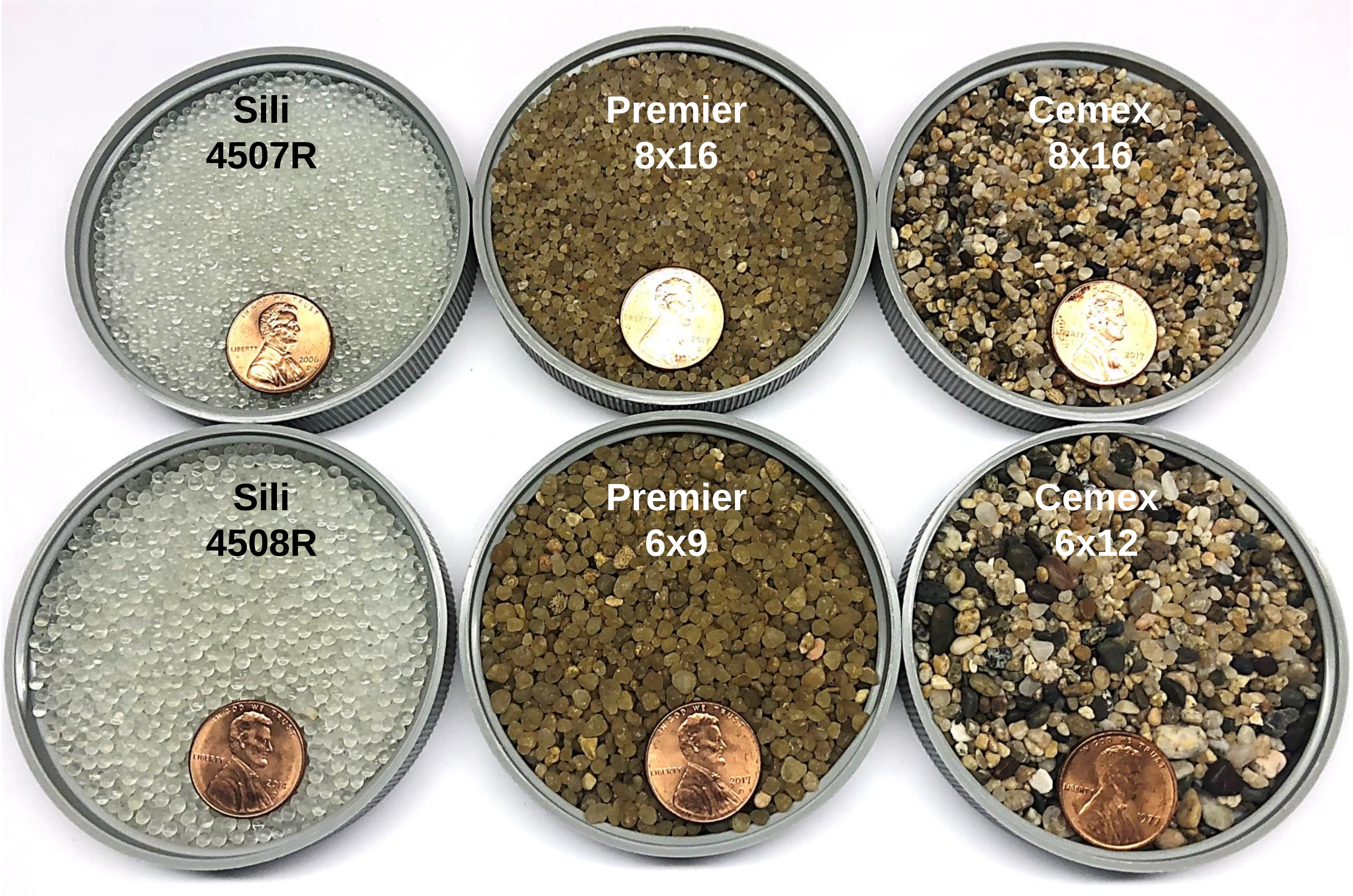


- Six production wells
- Test hole/monitoring well
- Minimum spacing - 150’
- All wells constructed by same contractor
- Wells constructed and tested between March 2016 & April 2017



# Gravel Pack Materials





# Premier Silica



- Texas
- Rounded, spherical sand
- Uniform shape
- 99% Silica
- Chemical resistant
- Standard gradations and blends
- NSF certified

Premier Silica 6x9

# CEMEX



- Monterey, CA
- Rounded – sub rounded
- Spherical to lenticular
- 91% Silica
- Chemical resistant
- Standard gradations and blends
- NSF certified
- Works well in fine sands

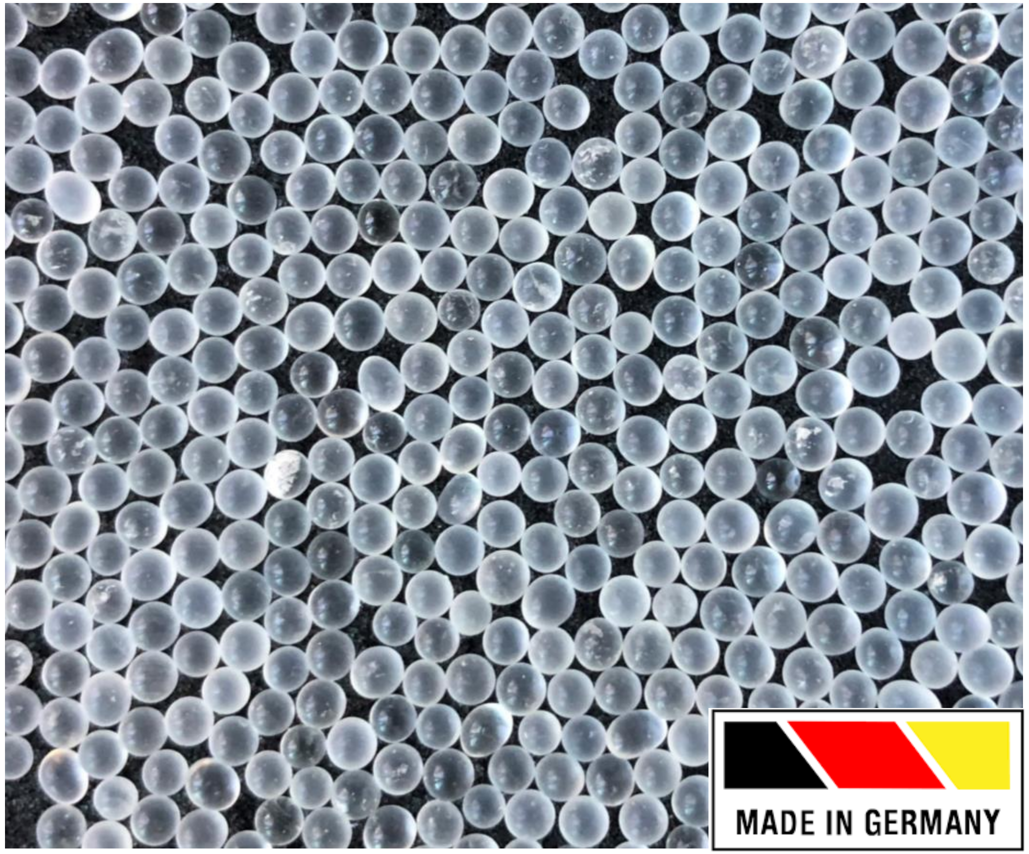
CEMEX 6x12

# Sili (Sigmund Linder) Beads

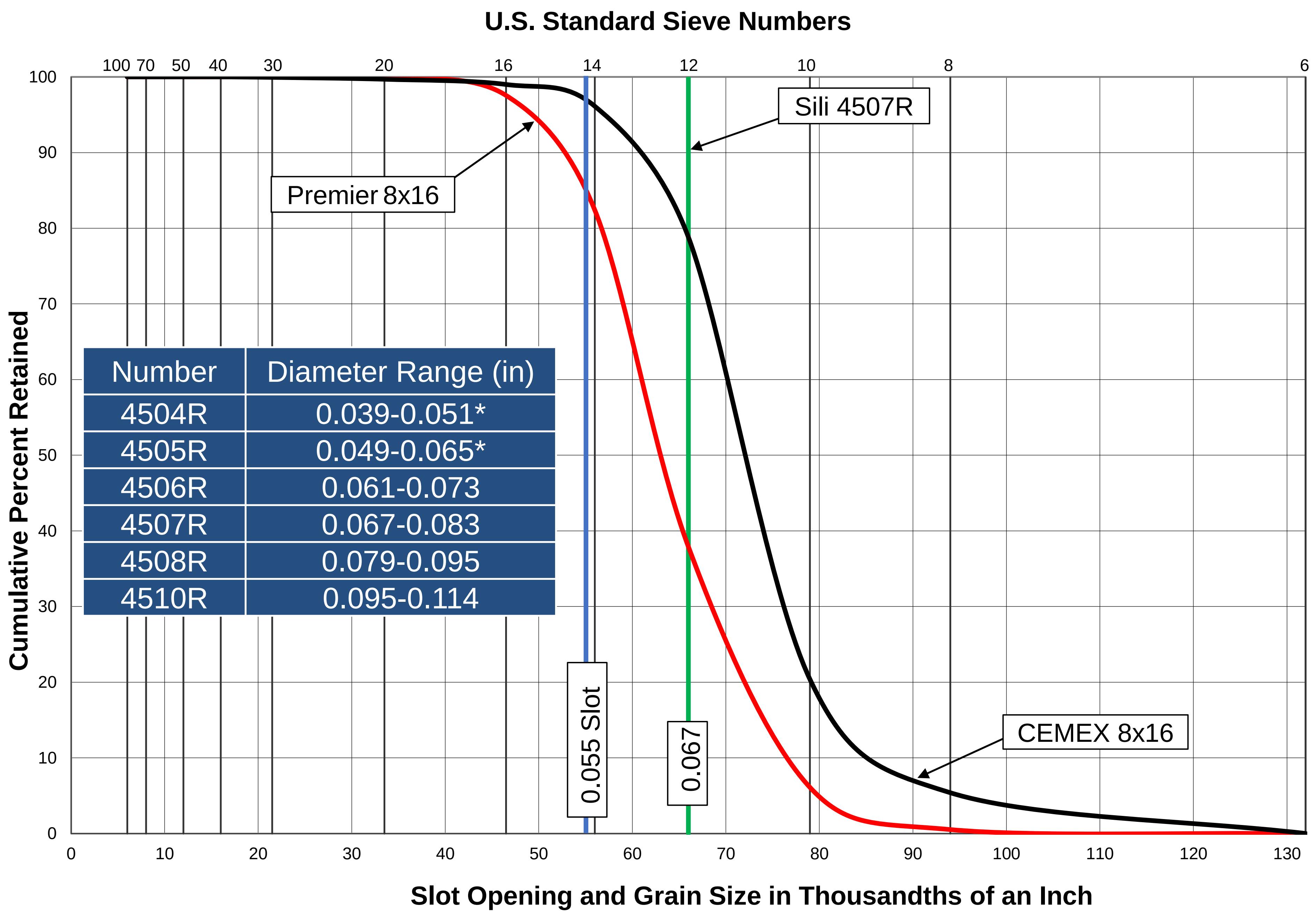


Spherical glass beads
Uniform size, shape
No stratification
Consistent, optimal packing
Smooth
Resistant to compression
Soda Lime Glass
Chemical resistant

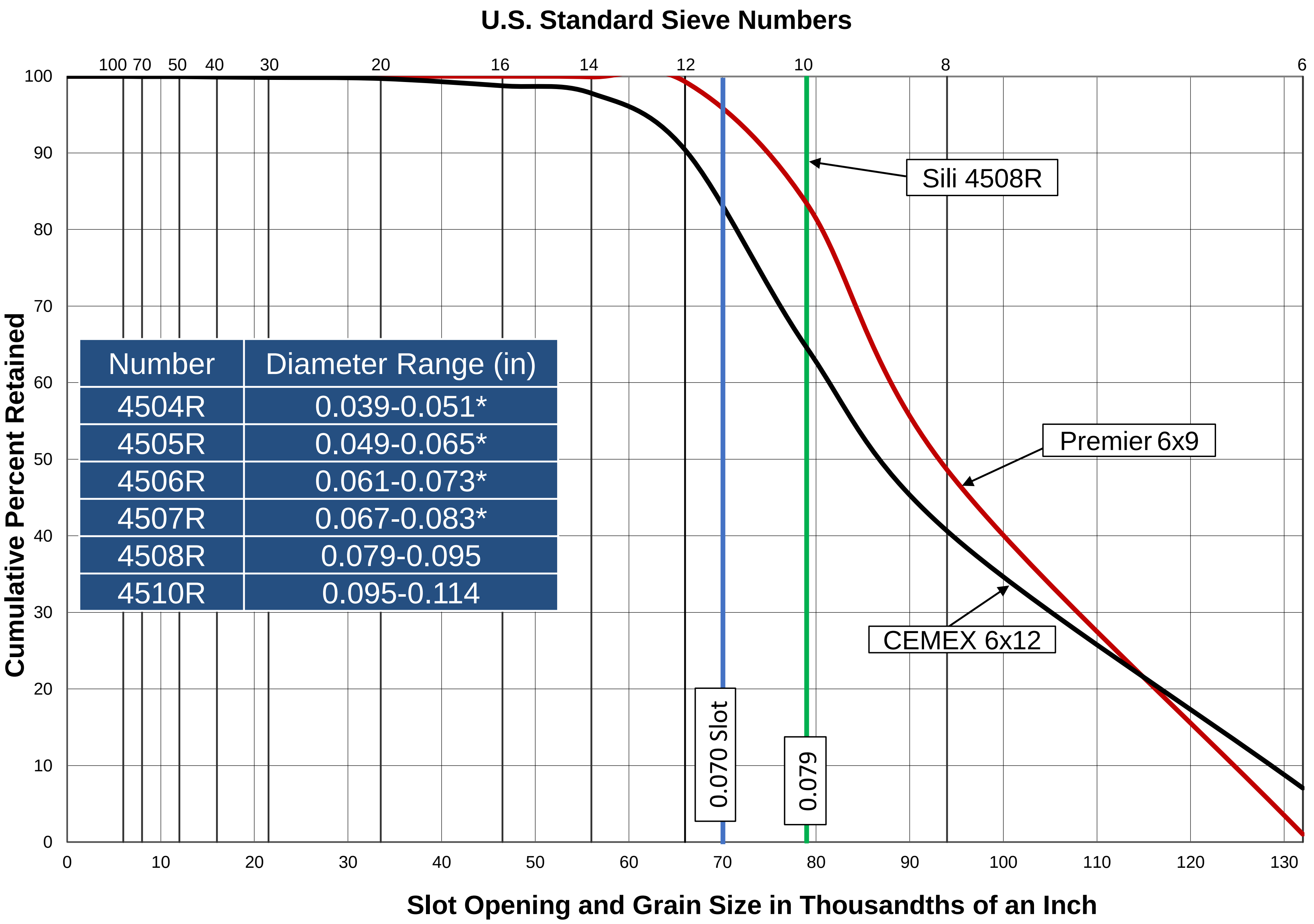
Shorter development times
Higher yields, specific capacity
Longer rehabilitation intervals, more effective




Sili 4508R
0.0787”-0.0945”




| Number | Diameter Range (in) |
|---|---|
| 4504R | 0.039-0.051* |
| 4505R | 0.049-0.065* |
| 4506R | 0.061-0.073 |
| 4507R | 0.067-0.083 |
| 4508R | 0.079-0.095 |
| 4510R | 0.095-0.114 |

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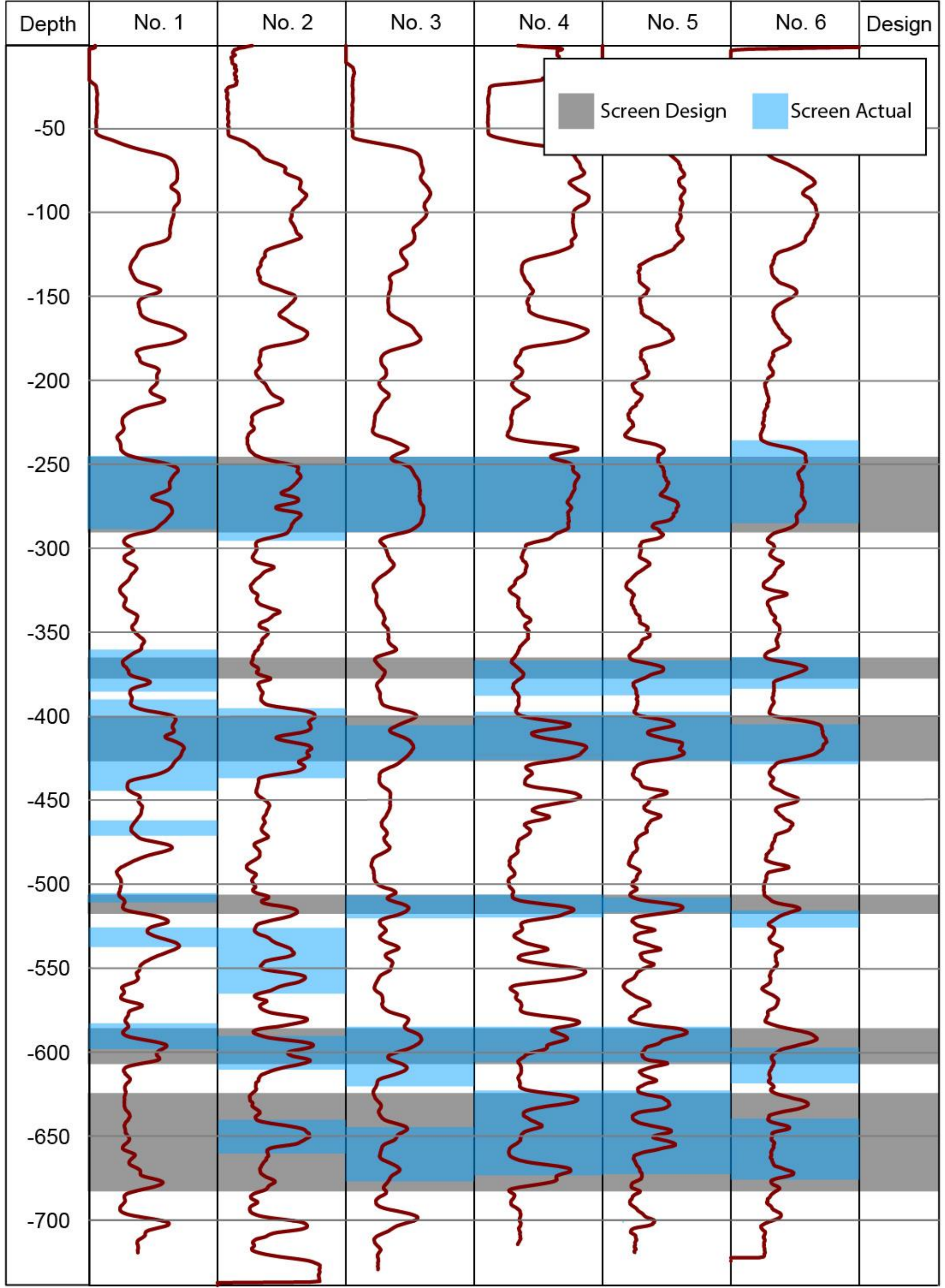
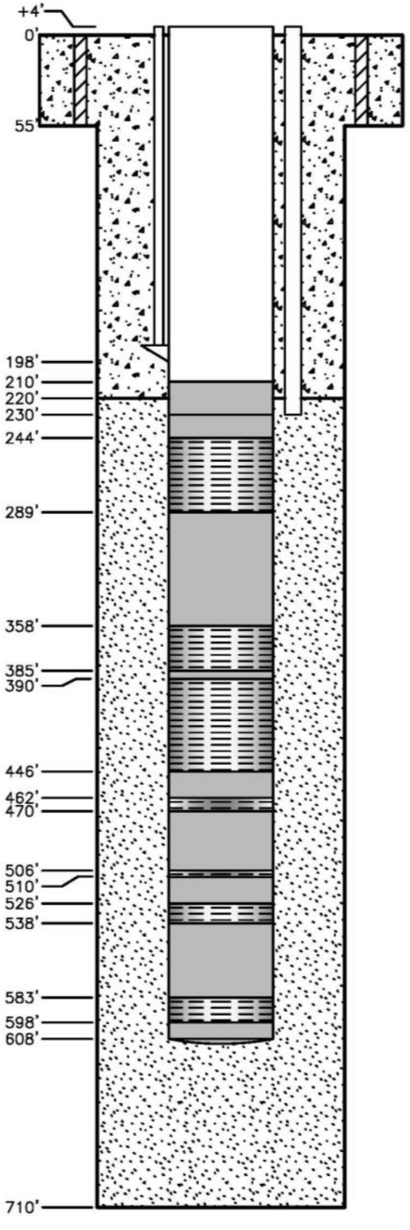
# Production Well Elogs

- Test hole 45’ from Well No. 5
- Upper zones consistent across site
- Formation depths/thickness diverged with depth
- Wells were redesigned in field

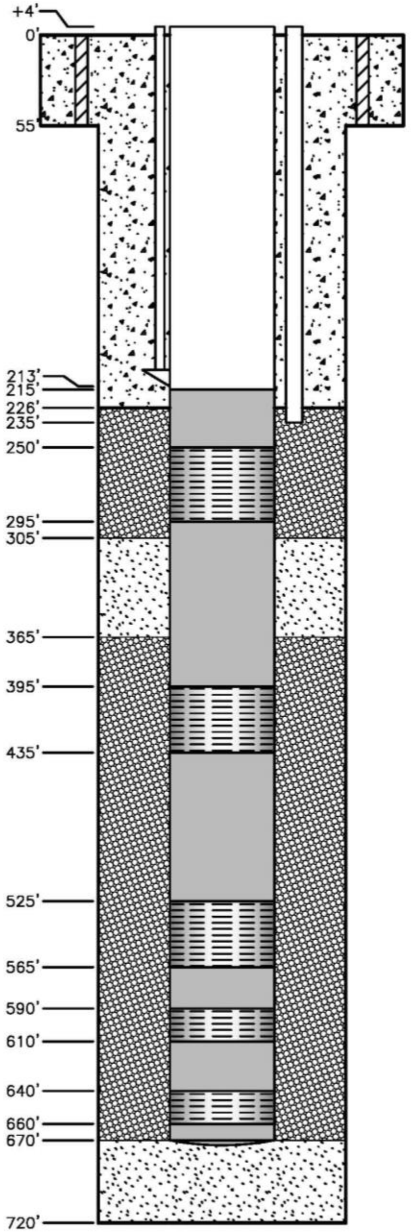


**PRODUCTION WELL NO. 1**



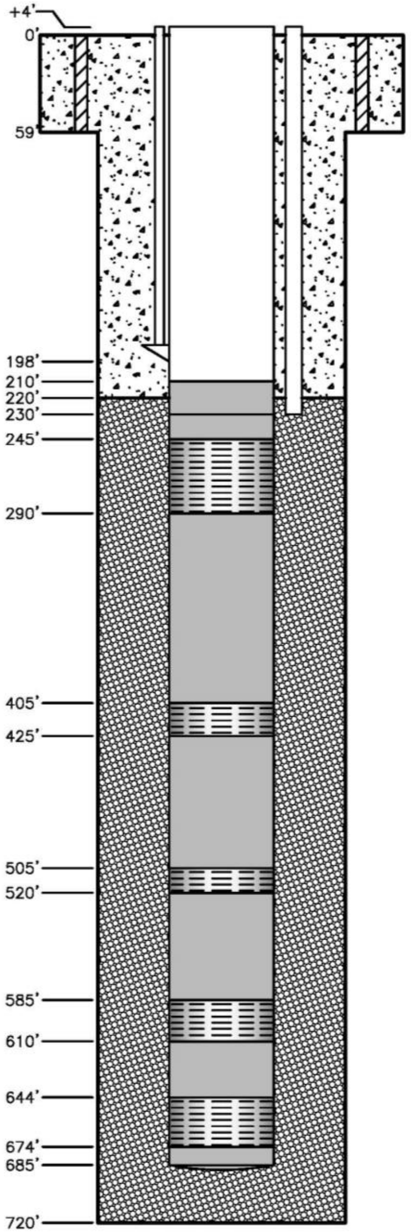

6X12 Monterey Sand
w/0.070" Slot Size

**PRODUCTION WELL NO. 2**



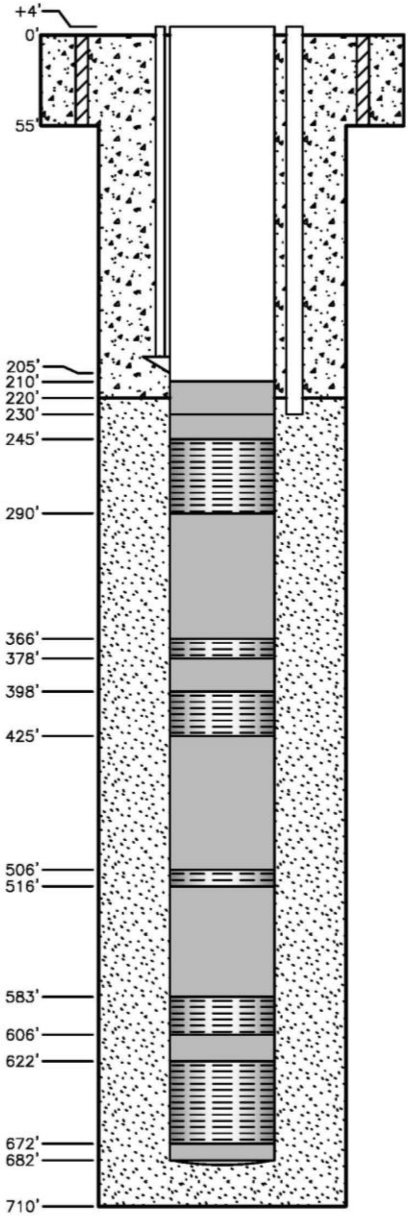

Silibeads (4508R)
6X12 Premier Silica

**PRODUCTION WELL NO. 3**



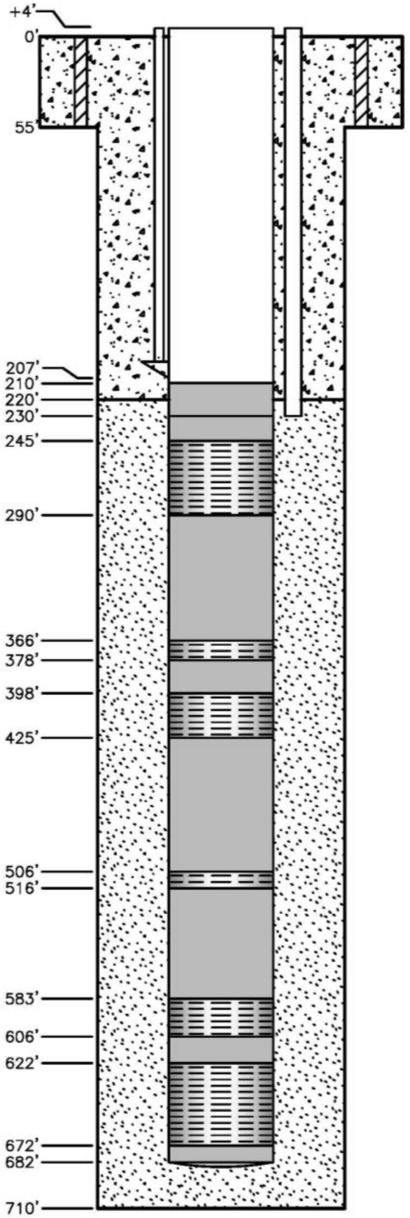

SiliBeads (4507R)
w/0.055" Slot Size

**PRODUCTION WELL NO. 4**



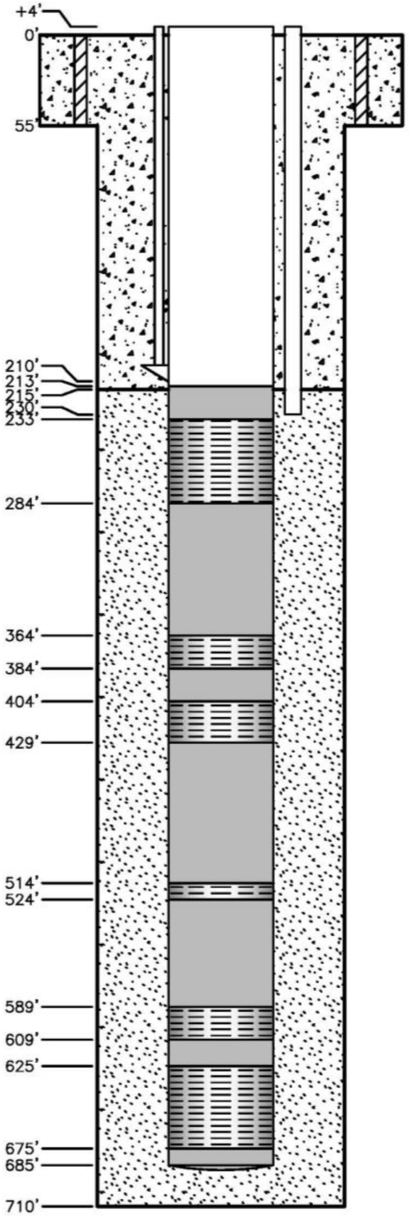

8X16 Monterey
w/0.055" Slot Size

**PRODUCTION WELL NO. 5**




8X16 Premier Silica
w/0.055" Slot Size

**PRODUCTION WELL NO. 6**



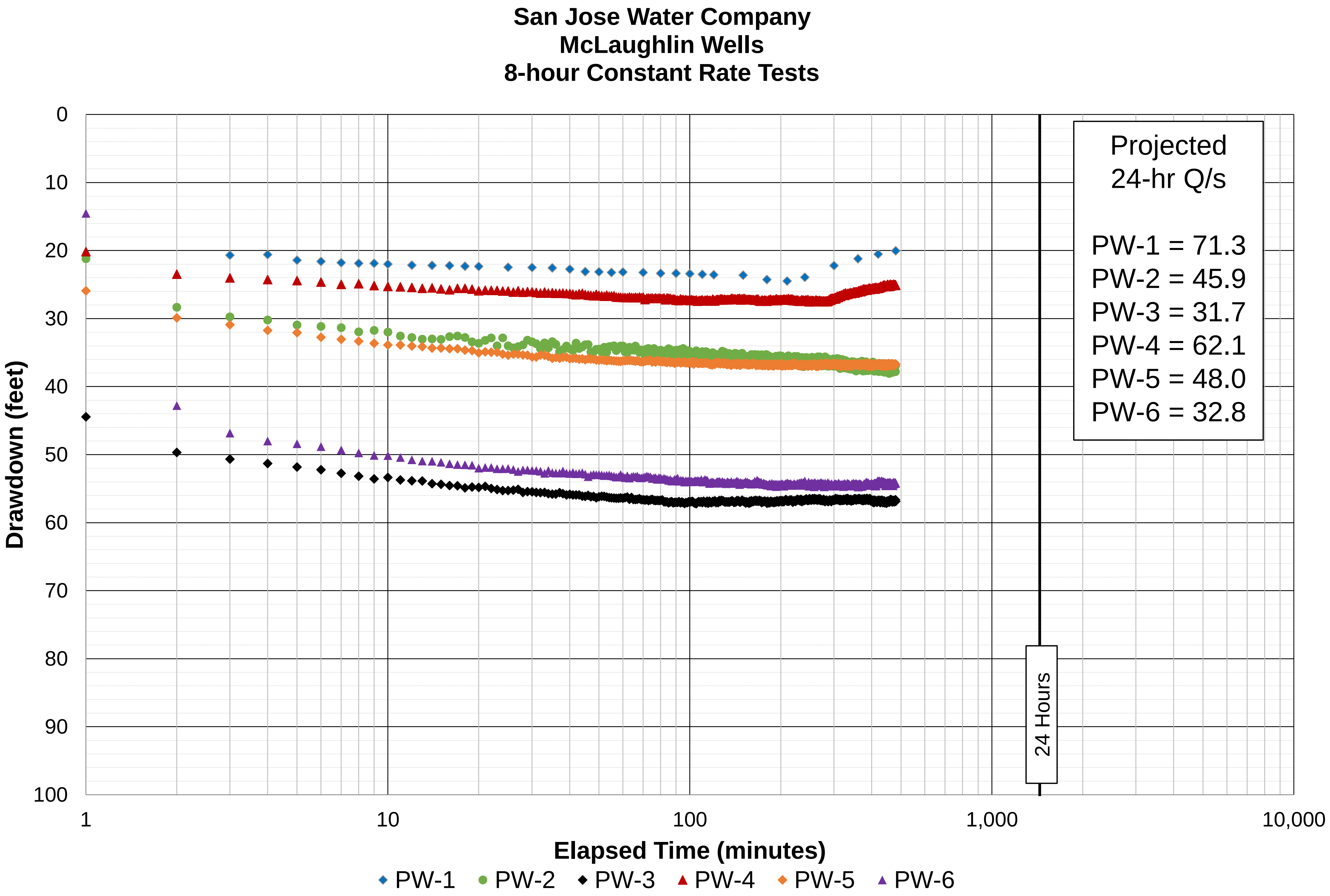

6X9 Premier Silica
w/0.070" Slot Size

# Well Development



| Well | Slot Size (in) | Pack Material | Screen (ft) | Open Ended (hrs) | Swab/Airlift (min/ft) | Pump Development (hrs) |
|---|---|---|---|---|---|---|
| 1 | 0.070 | 6x12 C | 167 | 3.8 | 14.4 | 40.0 |
| 2 | 0.070 | 4508R | 165 | 2.5 | 13.9 | 38.3 |
| 3 | 0.055 | 4507R | 135 | 6.0 | 18.2 | 41.0 |
| 4 | 0.055 | 8x16 C | 167 | 3.0 | 18.0 | 50.0 |
| 5 | 0.055 | 8x16 P | 167 | 3.8 | 14.6 | 40.5 |
| 6 | 0.070 | 6x9 P | 166 | 4.5 | 13.4 | 37.0 |
| | | | Average Times | 3.9 | 15.4 | 41.1 |

- Average swab/airlift development for larger slot/gravel designs: 13.9 min/ft
- Average swab/airlift development for smaller slot/gravel designs: 16.9 min/ft
- Time savings of 8.3 hours

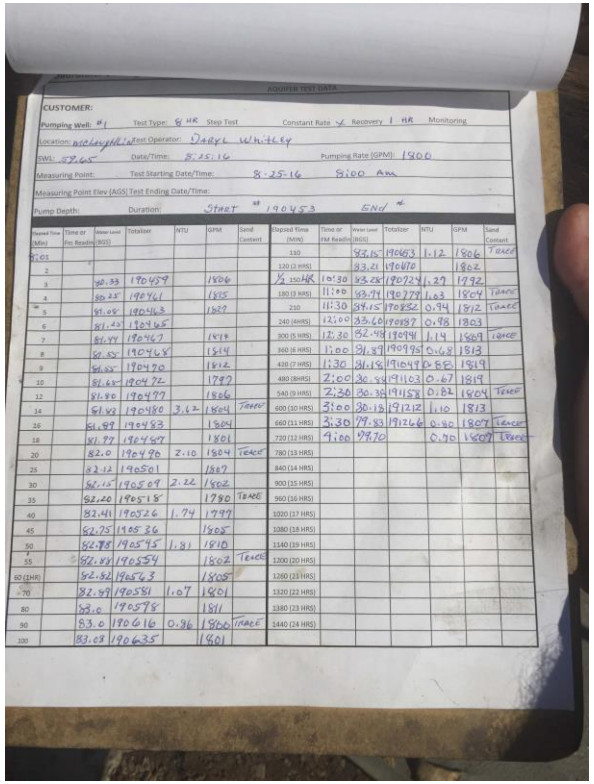


San Jose Water Company
McLaughlin Wells
8-hour Constant Rate Tests
Drawdown (feet)
0
10
20
30
40
50
60
70
80
90
100
1
10
100
1,000
10,000
Elapsed Time (minutes)
Projected
24-hr Q/s
PW-1 = 71.3
PW-2 = 45.9
PW-3 = 31.7
PW-4 = 62.1
PW-5 = 48.0
PW-6 = 32.8
24 Hours
PW-1
PW-2
PW-3
PW-4
PW-5
PW-6

# Pump Testing



| Well | Slot Size (in) | Pack Material | Screen (ft) | Flow Rate (gpm) | Specific Capacity (24 hr, gpm/ft) |
|---|---|---|---|---|---|
| 1 | 0.070 | 6x12 C | 167 | 1,831 | 75 |
| 4 | 0.055 | 8x16 C | 167 | 1,773 | 62 |
| 5 | 0.055 | 8x16 P | 167 | 1,773 | 48 |
| 2 | 0.070 | 4508R | 165 | 1,806 | 46 |
| 6 | 0.070 | 6x9 P | 166 | 1,848 | 33 |
| 3 | 0.055 | 4507R | 135 | 1,808 | 32 |



# Sili Beads Vs Traditional Gravels



- Must handle Sili Bead bags carefully
- No observed time savings during gravel packing operations
- Sili Beads bagged in smaller bags than gravel – potential lost time
- Uniformity of Sili Beads means no stratification in bags or annulus
- Consistent packing (Optimal?)
- No clear advantage during development
- Not readily available – long lead time
- Cost $$$

# Pack Material Costs



| Material | Cost Per Ton[1] | Cost for McLaughlin Well[2] | Additional Cost for Sili |
|---|---|---|---|
| Sili 450708 (0.066”-0.098”) | $1,406 | $108,262 | -- |
| Premier 6x9 | $390 | $30,030 | $78,232 |
| Premier 8x16 | $362 | $27,874 | $80,388 |
| Cemex 6x12 | $242 | $18,643 | $91,616 |
| Cemex 8x16 | $197 | $15,169 | $93,093 |

[1] – List Price, [2] – 77 tons

Beads are 3.5-7x more than gravels

# Conclusions



- Not an ideal comparison of gravel pack performance due to:
  - Changes in lithology across site
  - Inconsistent well designs
  - Water level variations throughout project
- No one pack material stood out as clearly superior in regards to constructability or development
- Monterey sands had highest specific capacity
- Sili Beads are 3.5 to 7 times the cost of other pack materials
- Supply/distribution infrastructure for Sili Beads not adequate

# Next Steps



- Testing of all wells once equipped to define baseline performance values
- Develop standardized well performance testing protocol and schedule
- Long term program to collect and analyze well performance data
- Track cost, effort, frequency, and effectiveness of well rehabilitations

# Acknowledgements



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Glassbeads Product Manager

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