The Affect of Salt Impacted Water on the Expansive Capability of Sodium Bentonite Clay – Bench Test Study

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Stantec

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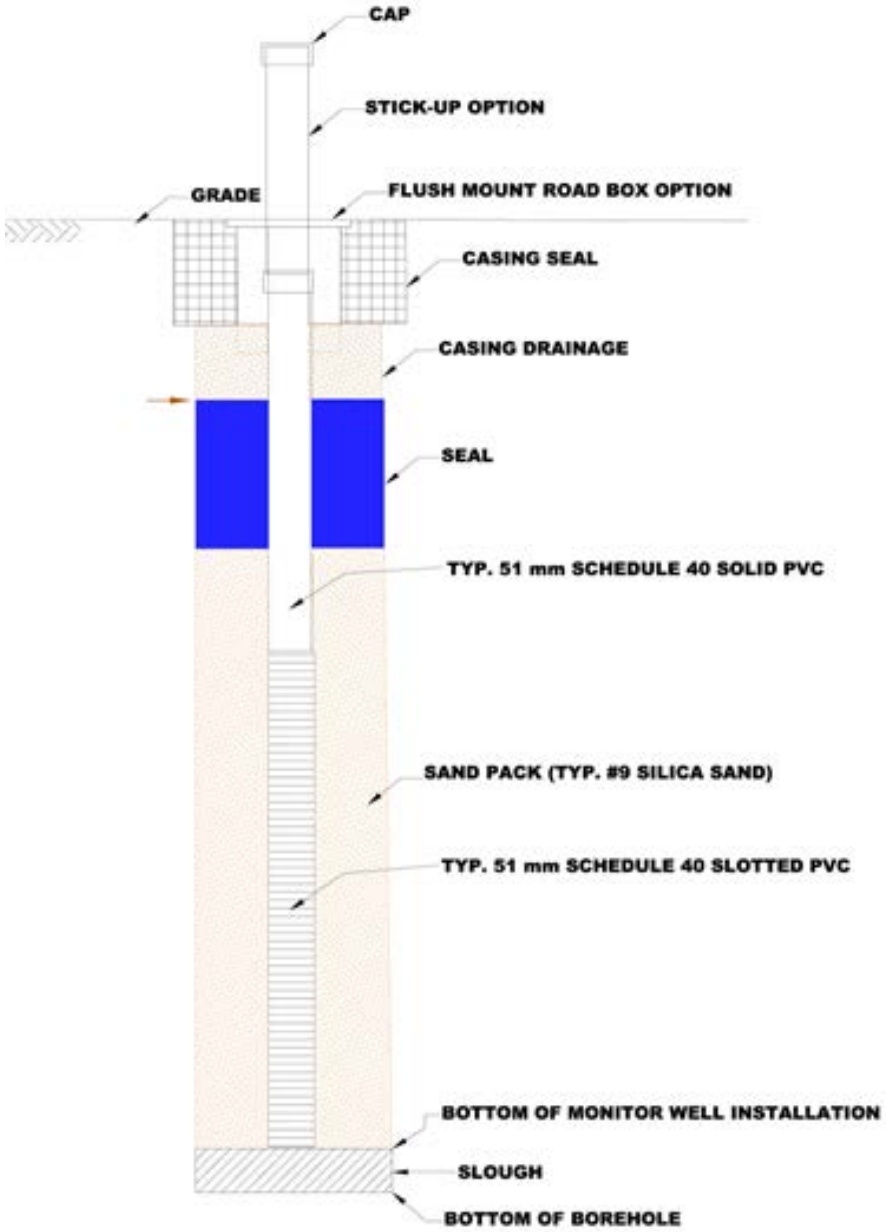
- Over 7 years of experience
- Environmental projects include:
  - Site assessment
  - Risk assessment and management
  - Remediation
- Commercial, industrial, and government properties supervision include:
  - Environmental site assessments
  - Environmental remediation's
  - Remedial design projects
- Environmental assessment projects in Alberta, British Columbia, and Saskatchewan

Introduction

- Background
- Initial Study
- Follow up Study
  - Methodology
  - Results
  - Photos
  - Demonstration
- Discussion
- Questions

Background

- Use of sodium bentonite chips to seal of the borehole annulus in groundwater monitoring wells
- Salt impacted water may retard the seal
- Bentonite chips may not provide an adequate layer of impermeable material to isolate the well screen
- Exposed sodium bentonite chips to salt affected water and the expansion was observed


CAP
STICK-UP OPTION
GRADE
FLUSH MOUNT ROAD BOX OPTION
CASING SEAL
CASING DRAINAGE
SEAL
TYP. 51 mm SCHEDULE 40 SOLID PVC
SAND PACK (TYP. #9 SILICA SAND)
TYP. 51 mm SCHEDULE 40 SLOTTED PVC
BOTTOM OF MONITOR WELL INSTALLATION
SLOUGH
BOTTOM OF BOREHOLE

Initial Study

Sodium Bentonite Chips

- 30 grams of sodium bentonite chips
- 100 mL of water in jar
- Varying concentrations of Salt

Initial Study – Tap Water

After 6 Hours

- Thick putty consistency
- 4 times original volume
- Shallow voids visible

After 24 Hours

- Expanded slightly more
- Voids were not visible
- No free water remained

Initial Study – 5,000 mg/L NaCl

0.5 g NaCl/100 mL water

After 6 Hours

- Thick soft paste
- Double the volume
- Appeared silty

After 24 Hours

- 2.5 times the volume
- Same consistency as 6 hours

Initial Study – 25,000 mg/L NaCl

2.5 g NaCl/100 mL water

After 10 Minutes

- Chips had crumbled
- Sediment layer at the bottom of the jar

After 24 Hours

- No additional expansion was observed

Initial Study – 50,000 mg/L NaCl

5.0 g NaCl/100 mL water

Within 10 Minutes

- Bentonite chips had crumbled
- Sediment layer formed at the bottom of the jar

After 24 Hours

- No additional expansion
- Gentle shaking the mixture became muddy and settled into segregated layering

Initial Study – 100,000 mg/L NaCl

10 g NaCl/100 mL water

After 24 Hours

- Chips remained as individual
- No evidence of bonding or expanding
- Some “crumbling” was observed

After 150 Days

- No change was observed in bentonite for all test samples

Follow Up Study - Methodology

- Constructed six model monitoring wells
  - 0.3 m of slotted pipe (1 inch diameter)
  - 0.9 m of solid pipe (1 inch diameter)
  - 0.4 m of 4 - 8 sand
  - 0.2 m of Sodium bentonite chips (not hydrated)
- Saturated bentonite using 4 L of water with varying concentrations of NaCl

Follow Up Study - Methodology

- Checked for bentonite layer expansion
- After seven days, the water:
  - Above the bentonite seal was dyed red
  - Level was increased to 15 cm above the top of the seal
- Peristaltic pump removed the water and the draw down was measured

Follow Up Study - Methodology

NaCl (ppm)	Na (ppm)	Cl (ppm)	Conductivity (mS/m)
Tap Water	n/a	n/a	0.416
5,000	1,967	3,033	10.02
10,000	3,934	6,066	18.64
25,000	9,834	15,166	43.15
50,000	19,669	30,331	77.33
100,000	39,337	60,663	140.0

Conductivity was determined using a YSI probe

Follow up Study - Results

NaCl (ppm)	Time Elapsed (days)	Initial Thickness of Bentonite Chips (cm)	Final Thickness of Hydrated Seal (cm)	% Change in Thickness of Seal
Tap Water	7	20	32	60%
5,000	7	20	25	25%
10,000	7	20	24	20%
25,000	7	20	23	15%
50,000	7	20	22	10%
100,000	7	20	20	0%

Follow up Study - Results

NaCl (ppm)	Initial Water Level (cm)	Water Level After Purging (cm)	Water Level After 3 Days (cm)	Water Level After 7 Days (cm)	Water Level After 10 Days (cm)
Tap Water	15.0	15.0	15.0	15.0	15.0
5,000	15.0	15.0	15.0	15.0	15.0
10,000	15.0	15.0	15.0	15.0	15.0
25,000	15.0	15.0	14.7	14.0	14.0
50,000	15.0	15.0	11.5	7.5	5.0
100,000	15.0	0	0	0	0

Follow up Study - Photos

7 Days After Saturation

Follow up Study - Photos

Tap Water
After 7 Days

Bentonite thickness increased by 12 cm

5,000 ppm
After 7 Days

Bentonite thickness increased by 5 cm

Follow up Study - Photos

10,000

After 7 Days

Bentonite thickness increased by 4 cm

25,000 ppm

After 7 Days

Bentonite thickness increased by 3 cm

Follow up Study - Photos

50,000

After 7 Days

Bentonite thickness increased by 2 cm

100,000 ppm

After 7 Days

Bentonite thickness no increase

Follow up Study - Demonstration

100,000 ppm

Discussion

- Increased conductivity levels corresponded with:
  - A decrease in the expansion of the hydrated bentonite layer in the monitoring well
  - The amount surface water infiltration to the well as shown by the draw down in the sample wells
- Follow up study: monitoring well integrity is negatively impacted by salt impacted water
- Establish industry best-practice when installing monitoring wells at Sites where salt impacted groundwater is suspected

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Questions