Hydrogeologic Frameworks A borehole perspective





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Borehole Perspective

- Development can increase capacity and decrease sanding
- Development without supporting information is often ineffective
- Use of cuttings, video, downhole tools during construction can improve well capacity
- Case study North Branch, Minnesota

North Branch Well 5 record drawing

- 30"x24" cased to 324' depth
- 21cy grout
- Open hole to 467'
- Video logs
- Gamma log































Well 5 Test Pumping Data

North Bunch well No 5

Level-DTW (fl)



- Gamma Log
- Fluid temperature
- Electrical properties
- Done prior to development
- Caliper omitted









Before and After Development





Before and After Development





Before and After Development



Sandstone removed (985 cy)



Pump Test Summary							
Customer:	NORTH BRANCH WATER & LIGHT		Date:	September 6, 2007			
Project:	WELL NO 5		Hours Pumped:	72.0 HOURS			
Unique Well No:	749383		TOC from grade:	4.5 feet			
Operator:	ROD SIGAFOOS		Static Water Level:	Varies (12-20ft)			

DATE	GPM	HOURS	Total hours	Specific after 4hrs	Specific after 8hrs	Specific after 16hrs	Specific after 24hrs		
8/28/2007	1080	1.75	1.75	28.0					
August 29, 2007	830	4.00	5.75	29.5				Improving	
August 29, 2007	990	4.00	9.75		23.19			Improving	
August 30, 2007	1170	5.50	15.25	24.32				Improving	
August 30, 2007	1400	2.50	17.75		22.54			Improving	
August 31, 2007	1400	4.50	22.25	25.04				Improving	
August 31, 2007	1630	3.50	25.75		23.76			Improving	

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September 4, 2007	1630	4.00	29.75	25.51				Improving	
September 4, 2007	1850	4.00	33.75		22.42			Improving	
September 5, 2007	1850	4.00	37.75	25.17				Improving	
September 5, 2007	2000	4.00	41.75		23.28			Improving	
September 6, 2007	1500	4.00	45.75	25.81				Improving	
September 6, 2007	1500	4.00	49.75		23.18			Improving	
September 7, 2007	1500	8.00	57.75			21.93		Stable	
September 7, 2007	1500	8.00	65.75				20.98	Stable	
September 10, 2007	1200	4.00	69.75	28.63				Improving	
September 10, 2007	1200	4.00	73.75	on/off				CLEAN & CLEAR (NO SAND)	

What was done differently?

- Well siting study
- Test wells
- Gamma, electrical, and video logs
- Communication between driller and engineer



Well Siting in North Branch

Prior to 2005

- Very little geologic information available
- Acquire property
- Build Test Well
- Test Water Quality
- Gamma Log, sometimes

Since 2005

- Geologic mapping
- Identify optimal locations
- Acquire property
- Build Test Well
- Downhole Logs
- Video Log
- Test Water Quality

Old Information



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Test Wells

- Cuttings to MGS
- Gamma, electrical, and video logs
- Geologist on site during construction
- Improves quality of well design and construction schedule
- Monitor aquifer during test pumping
- Small cost compared to production well

Value of Video

- Allows rock to be correlated to gamma log
- Identify areas of interest
- Can influence design and construction methods



Lessons Learned from North Branch

- Geological analysis was effective
- Test wells useful in determining conditions
- Log well before development
- Use borehole video before development
- Allow the conditions in the well to dictate quantities

Recommendations

- Change the way wells are sited from "locate, test" to "test, locate"
- Test well for each site
- Log well <u>before</u> development
- Use a geologist or hydrogeologist in well design and construction process
- Use borehole video

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