Gaskell and 152nd Well

Figure 1. Well at Gaskell and 152nd

This well was originally selected to be the 50kW project demonstration site for APH. The SCE Interconnection application (NST-206659) was submitted in November 2021.

SCE performed well tests on the WSWB wells in October and November of 2021. These tests (Table 1) found some results for the Gaskell/152nd (G152) well that were worrisome. Historically this well had produced about 1,200 gpm but that production level had dropped to between 919 and 819 gpm. Especially worrisome was the drawdown of between 111 and 125 feet. This meant that the well was pumping water out faster than the water could enter the well casing.

SCE Hydraulic/Industrial Services **Multiple Point Test Summary** EDISON

ANTELOPE VLY WATER STORAGE LLC

Pumping Plant Name	WELL G160SE			KINGBIRD 170 WELL			WELL 160 KINGBIRD			WELL AVE A 165			WELL G152		
Test Date	10/7/21			11/8/21			11/8/21			11/8/21			11/9/21		
Pump Tester Name	Frederick J Koch			Frederick J Koch			Frederick J Koch			Frederick J Koch			Frederick J Koch		
Contract ID	8002087301			8002085989			8001939531			8001323688			8002925397		
Meter Number	345M-001174			259000-072396			345M-007094			259000-071242			259000-062195		
Reference Number	2710			2870			2914			25880			25881		
Rate	TP2D49			TP2E49			TP2E49			TP2E49			TP2D49		
Average $ Cost/kWh	$0.14476			$0.18000			$0.18000			$0.18000			$0.18000		
Pump Type	Turbine Well			Turbine Well			Turbine Well			Turbine Well			Turbine Well		
Motor HP	200			200			150			200			250		
Motor Mfg.	US			US			US			GE			US		
Pump Mfg.	JOHNSTON			PEERLESS						L & B			PEERLESS		
Test Points / Frequency															
Discharge Pressure, PSI	46.1	64.3	88.9	123.0			30.8	50.8		15.6			38.1	89.5	
Suction Pressure, PSI															
Drawdown, Ft.	60.4	55.4	43.4	11.0			43.2	42.0		21.0			124.8	111.4	
Pumping Level, Ft.	336.0	331.0	319.0	252.4			299.2	298.0		249.7			420.4	407.0	
Standing Level, Ft.	275.6	275.6	275.6	241.4			256.0	256.0		228.7			295.6	295.6	
Discharge Head Ft.	106.5	148.5	205.4	284.1			71.1	117.3		36.0			88.0	206.7	
Suction Head Ft.	336.0	331.0	319.0	252.4			299.2	298.0		249.7			420.4	407.0	
Total Head Ft.	442.5	479.5	524.4	536.5			370.3	415.3		285.7			508.4	613.7	
Customer GPM	1,216						851						910		
Capacity GPM	1,131	976	762	880			773	725		1,682			919	819	
GPM/Ft. Drawdown, Ft.	18.7	17.6	17.6	80.0			17.9	17.3		80.1			7.4	7.4	
Acre Ft./24 Hour	4.999	4.314	3.368	3.890			3.417	3.205		7.434			4.062	3.620	
KW Input	159.1	156.0	148.0	151.4			112.2	112.5		182.9			134.3	138.8	
HP Input	213.4	209.2	198.5	203.0			150.5	150.9		245.3			180.1	186.1	
Pump Speed, RPM	1,783			1,785			1,782			1,779			1,790		
Motor Load %	99.7	97.8	92.8	94.9			93.3	93.5		114.7			69.0	71.3	
kWh/Acre Ft.	764	868	1,055	934			788	843		591			794	920	
Overall Plant Eff., %	59.23	56.50	50.84	58.73			48.05	50.41		49.48			65.51	68.20	
Improved Plant Eff., %	70			69			70			69			75		
Improved kWh/Acre Ft.	646			795			541			424			693		
Potential Savings, $	$11,856			$0			$1			$1			$0		

Note: For more detailed information pertaining to pump test results, please refer to Pump Test Results and Cost Analysis Letters

Table 1. SCE Pump Test Results

A well video log was performed to find out what was the issue was. The well casing was perforated with vertical slots approximately 1/8 inch in width and 1inch in length, spaced about 2-inch intervals to let water into the well itself. Significant tuberculation (iron oxide blisters formed by aerobic bacteria known as biofouling) was observed. Below about 490 feet deep 80 percent of the casing slots were blocked (Figure 2), increasing to 100 percent of the casing slots blocked below 580 ft (the well is about 800 ft deep) as Figure 3 shows. This biofouling was an issue. Not only did it compromise the ability of the well to produce water but, under an APH scenario where we are putting water back down into the well, this would force the biofouling into the aquifer, contaminating the aquifer.

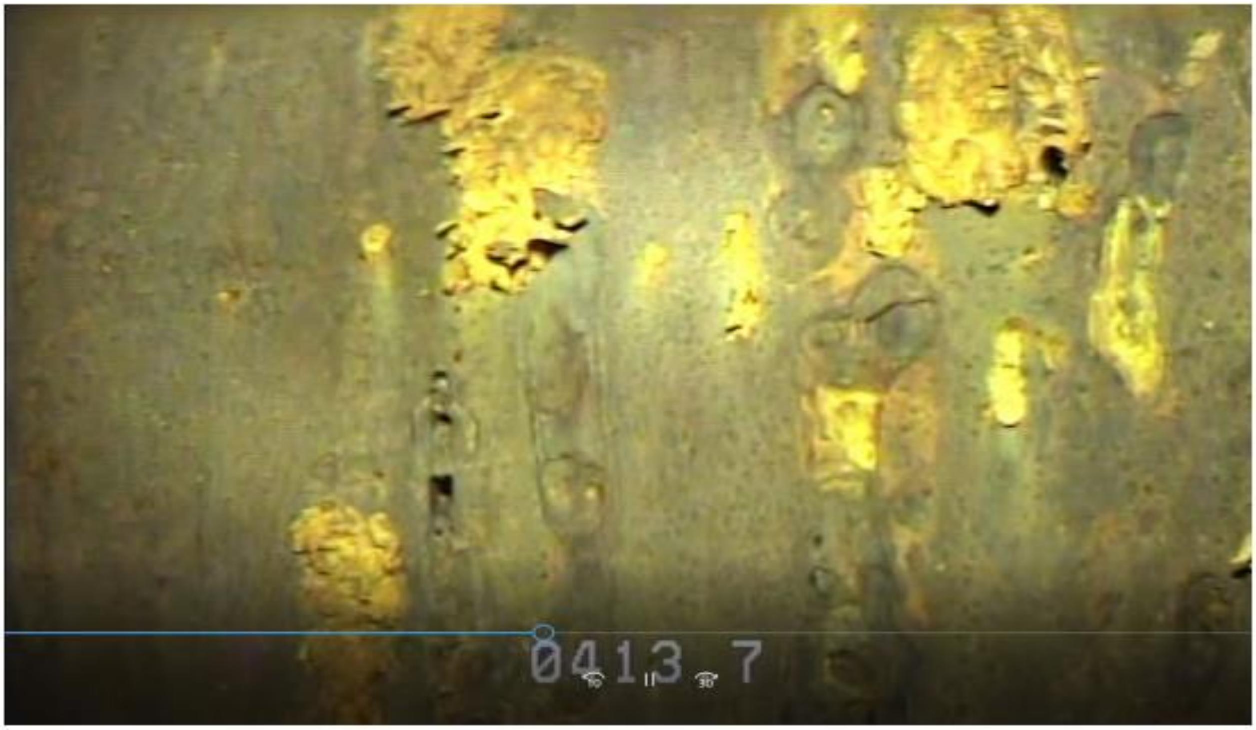

Figure 2.Biofouling with some open casing perforations at 414 ft deep

Figure 3. Completely blocked casing perforations at 540 ft deep.

Rehabilitation of the well would include mechanically cleaning the casing, acidifying the well with phosphoric acid and swabbing it out, and purging the well to try and remove accumulated sediment. The cost of this rehabilitation would be several hundred thousand dollars with no guarantee of success – the biofouling on the well casing usually indicates that gravel pack and formation on the outside of the casing is also plugged and simply cleaning the well casing will not solve the problem

The Interconnection application (NST-206659) approved by SCE on March 22, 2022. We notified SCE that we were not going to use this well for the APH demonstration project due to biofouling issue and needed to switch to an adjacent well.

Gaskell and 160thSE Well

Figure 4. Well at Gaskell and 160thSE

The well just around the corner (Gaskell and 160thSE) from the original fouled well was selected for the replacement demonstration project. It is a slightly smaller well (200 hp versus 250hp) but there was no indication of any issues with this well from the pump tests (Table 1). The interconnection application (NST-290291) was submitted in early July 2022.

Pulling the well (removing all the well pipe in the well hole) and installing the APH valve below the pump impellers (Figure 5) and then reinstalling the pipe down the well hole was scheduled August 30-September 2, 2022. We immediately ran into two problems.

Figure 5. Pump Bowls and Impellers

Patch

The well pipe hung up pulling it out of the well hole. While the drilling crew was able to pull the pipe out but we had to find out what the pipe caught on, so a well video log was conducted. At about 353 ft down there was a perforation in the well column that had been patched (basically taking a sheet of metal and pressing it up against the sides of the well column[1]) and the patch had deteriorated, resulting in a very rough internal surface to the well column (Figure 6).

[1] Perforations in the well column allow sand and small gravel bits into the well when it is being pumped, resulting in significantly increased wear and tear on the pumping equipment and eventual clogging the well.

Figure 6. Patch and Obtrusions at 353 Ft.

This was a serious problem. The APH valve at the bottom of the well operates using hydraulic tubing ruining down the side of the well pipes (Figure 7), and the protrusions at 553 ft would chafe and eventually sever the tubing, rendering the APH valve inoperable.

Figure 7. APH Valve Hydraulic Hoses on Exterior of Well Pipe

Severe Rust on Pipes

The second issue we ran into was severe rusting on some of the column pipes. The interior of some of the pipes was as bad or worse than the rusting shown in Figure 8. This was another concern. The pulsing of water in the well (pumping it out and then reinjecting it) would dislodge large areas of scale and rust on the pipes and clog the APH valve and can get trapped in the pump impellors and ruin them. The scaling can increase pipe friction and reduce the efficiency of the energy storage.

Figure 8. Severe Rusting on Well Pipes

The Solution

There was enough good pipe available that it was decided to install the APH valve (Figure 9) at a depth of above 350 ft, above where the torn patch was in the well[2], and include a screen (Figure 10) above the valve to catch any debris that would fall through the pipes before it entered the APH valve. The APH valve was installed at the bottom of the well piping (Figure 11).

[2] This level was still below the standing water level minus the recorded draw down, so APH should continue to work.

Figure 9. APH Valve

Figure 10. Screen above APH Valve

Figure 11. APH Valve Installed at Bottom of Pipe Column

The well at Gaskell and 160thSE installation with the APH valve was completed on September 6th and all the components tested out working correctly.