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August 6, 2013
Ref AJ2013-018

Mr. Drew Lander
Carmel Area Wastewater District
3945 Rio Road
PO Box 221428
Carmel, CA 93922

Subject: Cathodic Protection System Testing for Outfall Pipeline

Dear Mr. Lander,

As indicated in our proposal of July 2, 2013, field testing of the cathodic protection system for the outfall piping was conducted on July 30.

From review of documents contained in your files, the pipeline and cathodic protection system were installed in 1982. Details that were included in the files indicated that 20 anodes were installed. The design details show that the anodes were to have been installed in a single anode well, to a depth of 400-feet. From review of the daily inspection reports, a total of 20 anodes were installed in 3 anode wells, at depths of 185-feet and the remaining 2 at a depth of 140-feet. The documentation indicates that the anodes were Durichlor 51 Type M, which are cast iron anodes. Unfortunately, the documentation does not provide the dimensions or weight of the anodes that were installed.

The testing that was performed at the site included measurement of voltage and current outputs at the rectifier, measurement of individual anode current output at the anode junction box, located within the plant site and measurement of potentials at the two test stations, which are located along the pipeline. The potentials were measure at each of the three test leads in the test stations, with current applied ("on" potential) and with the rectifier temporarily interrupted ("off" potential). Potentials were measured using a copper copper sulfate reference electrode and a portable multi-meter with high input impedance. The reference electrode was placed in contact with the soil. One lead from the voltmeter was connected to the reference electrode and the other was connected to the lead in the test station. The data obtained during the testing is shown in Table 1.



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Test Location	Voltage (volts)	Current (amps)	On Potential (millivolts)	Off Potential (millivolts)
Rectifier	23.5	21.1		
Coarse C				
Fine 4				
Anode J Box				
A 1		0.7		
A 2		0.6		
A 3		0.5		
A 4		0.7		
A 5		1.2		
A 6		1.0		
A 7		1.3		
A 8		0.8		
A 9		1.0		
A 10		1.8		
A 11		1.1		
A 12		1.5		
A 13		0.8		
A 14		1.5		
A 15		1.1		
A 16		1.1		
A 17		0.9		
A 18		0.8		
A 19		0.9		
A 20		1.8		
Test Station along pipe				
Test Lead			1333	1128
Test Lead			1333	1128
Test Lead (ref)			181	152
Test Station at beach				
Test Lead			1220	920
Test Lead			1220	920
Test Lead (ref)			510	389

The cathodic protection system is providing adequate levels of protection along the outfall pipeline. The National Association of Corrosion Engineers (NACE) recommended practice 0169 provides criteria for achieving cathodic protection for buried steel piping. The most often used criteria is a potential of 850 millivolts



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versus a copper copper sulfate reference electrode, with current interrupted, or "off". The off potentials at both test stations exceed the criteria for adequate levels of protection.

As discussed above, the details do not indicate the dimensions or weight of anodes that were installed at the site. The details indicate that the anodes were to have been Durichlor 51, Type M anodes. I found a reference to Type M anodes that lists the weight as 60-pounds. If the anodes installed at the site were 60-pounds, using an anode consumption rate for cast iron of 1-pound/amp year, and an average current output of 20 amps over the life of the installation, which is believed to be approximately 31 years, to this point, approximately 620 pounds of anode material has been consumed. Leaving a remaining anode weight of 580 pounds. Using an efficiency factor of 80 percent, that would leave 340 pounds of effective anode weight and an estimated remaining life of 15 to 17 years. Again, this is based upon the assumption that the anodes weighed 60-pounds and the average total current output since the original installation was 20 amps.

It is recommended that the system be tested and adjusted, if necessary, on an annual basis to ensure continued protection of the pipeline. The annual testing will also allow the District to be aware of any premature failure of anodes which would lead to a decrease in the estimate of the remaining service life of the cathodic protection system. It is further recommended that the rectifier be inspected on a monthly basis to confirm that it is operational. Should there be any significant changes in the voltage or current output at the rectifier, please contact me right away to investigate further.

It has been a pleasure to be of service and I trust that you will feel free to contact me with any questions you may have regarding the testing and recommendations. I can be reached at 916-849-6420.

Sincerely,
ATLANTIC CONSULTANTS, INC.

A handwritten signature in black ink, appearing to read "Kerri M. Howell".

Ms. Kerri M. Howell, P.E.
President

