NORTON CORROSION LIMITED

8820 222nd Street SE, Woodinville, WA 98077
Phone (425) 483-1616 • Fax (425) 485-1754
Email: sales@nortoncorrosion.com

July 16, 2015

Port of Olympia
Attn: Don Bache
donb@portolympia.com

Subject: **2015 CATHODIC PROTECTION INSPECTION**
SHORELINE CONTAINMENT WALL
CASCADE POLE SITE

Mr. Bache:

On July 13, 2015, Norton Corrosion Limited (NCL) personnel completed an inspection of the impressed current cathodic protection (CP) system that protects the buried environmental containment wall at the Cascade Pole site from corrosion. Written authorization to perform this work was issued on June 3, 2015.

Work Performed

NCL thoroughly inspected all accessible components of the CP system to assure safe and reliable operation. The rectifier was tested to assure proper operation of the unit and all of its components. Electrical components were cleaned to remove marine salt deposits. Current output measurements were recorded for individual anodes. Structure-to-soil potential measurements were recorded at representative test locations to evaluate the level of CP being received. Both on and instant-off potential measurements were obtained along the inboard and outboard sides of the wall while interrupting the output of the rectifier. Minor adjustments and maintenance were performed as necessary.

Notably, the state environmental inspector conducted a site visit in conjunction with this survey to gain a better understanding of the CP system.

Criteria

NACE International has established criteria that indicate, when used separately or in combination, that adequate CP is being provided. NCL has evaluated your CP system based on the following criteria:

- Adequate CP is indicated by a potential difference of -0.850 volts or more negative between a steel structure and a saturated copper/copper sulfate (CSE) half-cell. This criterion requires all voltage drops, other than those across the structure-to-electrolyte boundary, to be considered for a valid interpretation of the potential data. Instant-off potential measurements recorded to account for the voltage drops (IR drop) have been used to evaluate the level of protection achieved. The equivalent criterion applicable to a saturated silver/silver chloride (sat. Ag/AgCl) half-cell is -0.750 volts.

- Adequate protection is also indicated by a cathodic polarization shift of not less than 100 millivolts. This is equivalent to the difference between the instant-off (polarized) and native (depolarized) potential measurements.

Results and Conclusions

The attached data sheets detail inspection results. Data obtained indicates the CP system was functioning properly. All equipment was in good and operable condition except two anodes and a half-cell that failed years ago as previously indicated. The system had a total current output of 15.0 amps compared to 13.8 amps one year prior. This was the result of tidal fluctuation. NCL deemed no adjustment to the level of protection was required.

Structure-to-soil potential measurements indicated adequate protection was being received at all locations tested with one exception. The permanent half-cell at the east test station indicated less than adequate protection. Comparison of the cell's potential to the portable CSE recorded during the off cycle indicated a 0.140 volt difference, as compared to 0.098 volt in 2014. These cells consist of a silver rod in a silver chloride solution encased in a porous ceramic. Over time, the concentration of the silver chloride may change due to ion migration through the ceramic impacting the accuracy. Considering the measured drift in the permanent cell, it is no longer accurate. Based on the high level of protection indicated by the calibrated portable cells at all other locations tested and comparison to the historical record, NCL expresses confidence the wall is receiving adequate protection.

Recommendations

NCL recommends monitoring the rectifier voltage and current output at least once every 60 days. The system should operate near 5 volts and a minimum current output of 12 amps. The current may vary with the tide, increasing as more water covers the anodes.

This system should be inspected on an annual basis, so your next inspection should be scheduled for the summer of 2016.

NCL appreciates the opportunity to serve the Port of Olympia. If you have any questions or additional concerns, please contact our office.

Sincerely,

John F. Keppler, P.E.
Corrosion Engineer

NORTON CORROSION LIMITED

PORT OF OLYMPIA
CASCADE POLE SITE
SHORELINE CONTAINMENT WALL
CATHODIC PROTECTION SYSTEM

DATA SHEET: 1 OF 3
NCL JOB: O-21723-M
DATE: JULY 13, 2015
BY: J. KEPPLER

SHORELINE CONTAINMENT WALL

Rectifier Information

Manufacturer:	Universal Rectifiers
Model No:	CSA-ASAI 20-40
Serial No:	011757
AC Input Rating	115/230 volts, 9.9/4.9 amps, 1Ø, set to low primary
DC Output Rating:	20 volts, 40 amps
Anode Bed:	24 – 1 ½ "ø x 60" cast iron canister anodes

Field Measurements	Reading
Panel Meters:	4.5 volts
	14.0 amps
Transformer (C4/F5 max.):	C1/F4
Portable Meter:	121.0 volts AC Input
	6.228 volts AC on taps
	4.513 volts
	15.0 amps
Shunt (50A/50 mV)	15.0 millivolts

Weather: 1330 hrs, 80°s F, dry ground, mid to high incoming tide.

NORTON CORROSION LIMITED

PORT OF OLYMPIA
CASCADE POLE SITE
SHORELINE CONTAINMENT WALL
CATHODIC PROTECTION SYSTEM

DATA SHEET: 2 OF 3
NCL JOB: O-21723-M
DATE: JULY 13, 2015

Anode Output Measurements

Anode Location	Shunt Reading	Current Output
1 - West	4.88 mV	0.488 amps
2	0.05	0.005
3	3.05	0.305
4	3.63	0.363
5	7.66	0.766
6	9.00	0.900
7	7.69	0.769
8	8.04	0.804
9	8.11	0.811
10	7.67	0.767
11	7.78	0.778
12	7.88	0.788
13	8.09	0.809
14	7.99	0.799
15	8.17	0.817
16	7.59	0.759
17	8.09	0.809
18	8.08	0.808
19	7.65	0.765
20	7.74	0.774
21	0.03	0.003
22	2.30	0.230
23	3.09	0.309
24 – East	2.48	0.248

Shunts are 0.01 ohm.

NORTON CORROSION LIMITED

PORT OF OLYMPIA
CASCADE POLE SITE
SHORELINE CONTAINMENT WALL
CATHODIC PROTECTION SYSTEM

DATA SHEET: 3 OF 3
NCL JOB: O-21723-M
DATE: JULY 13, 2015
BY: J. KEPPLER

Cathodic Protection Readings

Structure-to Soil Potential Measurements (volts DC ref. CSE)

Location	Onshore of Wall (Ref. CSE) Native*	On	Instant Off	Offshore of Wall (Ref Ag/AgCl[sat]) Native*	On	Instant Off
Portable Cell:						
Fence post 1		-1.172	-1.072	-0.750	-1.114	-0.986
Post 5, adj. E TS	-0.600	-0.874	-0.828	-0.696	-1.115	-0.983
Post 10	-0.665	-0.893	-0.872	-0.806	-1.137	-0.988
Post 15	-0.692	-0.894	-0.880	-0.814	-1.180	-1.083
Post 20	-0.692	-0.921	-0.904	-0.820	-1.194	-1.009
Post 25	-0.644	-0.966	-0.934	-0.833	-1.206	-1.015
Post 27, adj. rect	-0.630	-0.972	-0.941	-0.832	-1.217	-1.017
Post 30	-0.656	-0.971	-0.925	-0.840	-1.222	-1.018
Post 35	-0.699	-1.195	-1.017	-0.843	-1.210	-1.018
Post 40	-0.710	-0.947	-0.930	-0.844	-1.204	-1.020
Post 45	-0.691	-0.891	-0.872	-0.810	-1.156	-1.012
Post 50		-0.978	-0.936	-0.756	-1.131	-1.002
East T.S. (Post 5):						
Perm. Sat Ag/AgCl Cell	-0.596	-0.662	-0.641			
Port. Cell	-0.560	-0.874	-0.828			
Perm. Ag/Port. CSE			+0.140			
West T.S. (Post 48):						
Perm. Sat Ag/AgCl Cell	previously failed					
Port. Cell	-0.741	-1.055	-1.010			

Note: Native potentials were previously recorded in March 2012.

NORTON CORROSION LIMITED

RECTIFIER LOG

OWNER: PORT OF OLYMPIA – Cascade Pole Site

STRUCTURE: Shoreline Environmental Containment Wall

RECOMMENDED CURRENT OUTPUT: 12 to 16 amps (may vary with tide)

DATE	VOLTS	AMPS	TAPS	INITIAL	COMMENTS
7/13/2015	4.5	15	1/4	JFK	NCL annual inspection. Mid tide.

For assistance, contact NCL at 425-483-1616.
John Keppler, mob. 425.501.3401