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Declaration of Conformity

nVent ERICO declares that the following products comply with the technical requirements specified below.

Product Description: **nVent ERICO GEM Ground Enhancement Material**

Product Name: **GEM25A, GEM25ABKT**

Business Trade Mark/Brand Name: **nVent ERICO**

Applicable Standards : **EN IEC 62561-7:2018**
Lightning Protection System Components (LPSC) –
Part 7: Requirements for earthing enhancing compounds

Test Reports and Criteria: **Leaching per EN 12457-2**
Sulphur per ISO 14869-1
Resistivity less than 20 ohm-cm per ASTM G57-06
Corrosion per ASTM G59-97 and G102-89

Authorized by: Ward Judson

Ward Judson **Date**

Engineering Manager **December 1, 2021**

GEM25A: Specifications

IEC 62561-7 TESTING	GEM25A
Leaching: For IEC 62561-7, samples prepared per EN12457-2, toxicity per EPA TCLP limits. Additional samples tested per EPA test method.	PASSED - not toxic
Metals: For IEC 62561-7, samples of Fe, Cu, Zn, Ni, Cd, Co, Pb prepared and tested per EN 12457-2. Additional samples of As, Be, Cd, Cr, Pb, Se, Ag prepared and tested per ICP, TCLP.	PASSED - not toxic
Sulphur: Samples prepared per IPC6010. Passing criteria - less than 2%.	PASSED - 2% or less
Corrosion: Samples prepared per ASTM G59-9 and G102-89. Passing polarization resistance criteria: non-aggressive environments > [4 Ω × m2] aggressive environments > [8 Ω × m2] Loss of Cu for 30 years exposure	PASSED - not corrosive PASSED PASSED 86 [µm]
Resistivity: Cured material samples prepared in Miller Box per ASTM G57	<20 [Ωcm]
ADDITIONAL TESTING	**GEM25A**
Resistivity: Compressed powder samples prepared per ASTM G1867-12.	0.0091 [Ωcm] typical
Resistivity: Cured material samples prepared per ASTM D991.	6.4 [Ωcm] typical
Density: Loose powder	769.4 [kg/m^3] = 48.0 [lb/ foot3] typical
Density: Compressed	1,051 [kg/m3] = 65.6 [lb/$foot^3$]
Weight/bag:	25 [lb] =11.3 [kg]
Mixing Ratio:	1.5 [gal] to 2.0 [gal] (5.7 [l] to 7.6 [l]) / bag or bucket.
Flexural strength: Tested per ASTM C293	96 [psi] typical
Compressive Strength: Tested per ASTM C109	515 [psi] typical
Alkalinity/Acidity Tested per EPA1311 and EN12457-2 Acidity (mg/l) Alkalinity, Total (mg/l)	 alkaline -2058 2270
Packaging	Paper bag with plastic lining with handles or plastic bucket with locking lid. Both packaging options and weight allows for efficient/dual package carrying at the job site. Tracking numbers printed on each bag or bucket.
MSDS	Available on www.erico.com/library.asp
Shelf life	1 year
Installation Setting Consistency	Cementitious, solidifies in 5 days, matures in 28 days. Do not install in subzero temperatures.

GEM25A: IEC 62561-7, Sec. 5.4 Determination of Resistivity, Sec.5.5 Corrosion Test

LPR TESTING FINAL SUMMARY REPORT FOR GROUND ENHANCMENT MATERIAL GEM25A

Report prepared for:

Pentair / ERICO Pty. Ltd.

Prepared by:

Dr. Xiaojian Xia and Prof. Nick Birbilis

Department of Materials Science and Engineering,

Monash University

Clayton, VIC, 3800

Australia

Phone: +61399054919

24 June, 2016

Signed..... N.Birbilis .....

Project brief:

In this project, the linear polarisation resistance (LPR) of copper-plated steel rods in ground enhancement material GEM25A was determined (in triplicate) approximately every 3 days over a three-month period. Sample resistivity was determined at the beginning of and after the test period. The results of the testing in the form of a final report are included herein.

Experimental methods

Sample preparation

Cu-plated steel rods with an average diameter of 17.35 mm (sourced from Pentair / ERICO) were sectioned, and a quality fitting was tapped into the top of each sample to achieve robust electrical connection. The setup of the samples is shown in Fig. 1. The multi-layered self-adhesive heat-shrink was applied over both ends of the samples, including the connections, to seal them and protect them from possible damage. The heat shrink also defined the boundary of the exposed copper area of each ground rod sample (see Figure 1 and Appendix 1).



Figure 1: Test samples in various stages of preparation

Setup of test cell

As shown in Fig. 2, each sample was assembled in a three-electrode cell consisting of a working electrode (in this case, the Cu-plated steel with an approximately ~0.254 mm thick Cu plating), a reference electrode (in this case a saturated calomel electrode) and a counter electrode (in this case, mixed-metal-oxide coated titanium mesh which is an industrially available counter electrode).

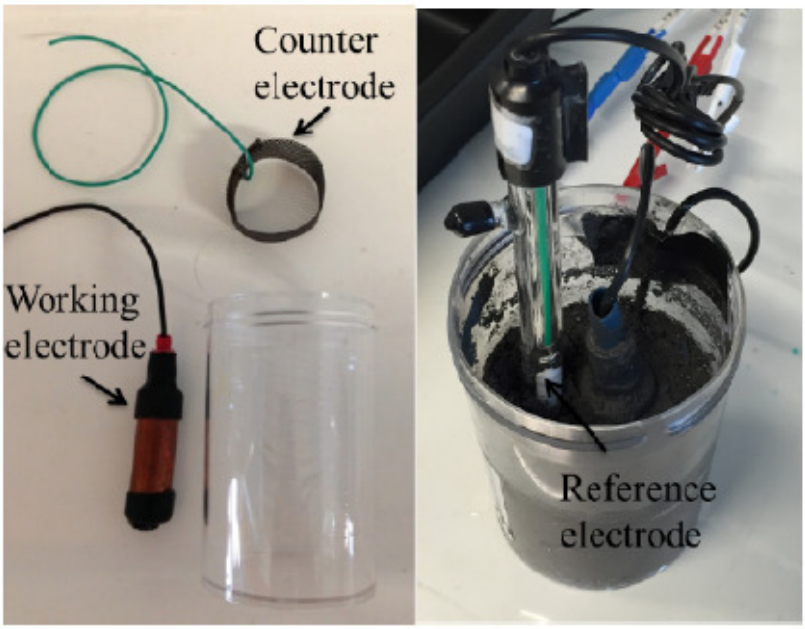


Figure 2: Setup of test cell

In this test the working electrode is represented by the exposed copper area of the Cu-plated rod. The goal of the test is to initiate an electrochemical corrosion reaction of the copper surface of the sample. The reference electrode is a standard half-cell, and its only role is to serve as a reference in measuring and controlling the working electrode potential; at no point does the reference electrode pass any current. The saturated calomel reference electrode consists of a combination of mercury and mercurous chloride in contact with a saturated potassium chloride (KCl) solution. The potential of this reference electrode is +0.241 V vs. the standard hydrogen electrode)[1]. We note that for testing herein, the reference electrode was inserted for each test, and not permanently housed in the test cell. The reason for this was that the cementituous material in sample formulations may attack and etch the glass casing of the reference electrode. Any leakage of saturated KCl solution from the reference electrode would be detrimental to the test sample. The intermittent insertion of the reference electrode is also beneficial as it allows the electrode to remain well maintained when not in use. For this study, a dedicated pool of 10 reference electrodes was used. In the laboratory, the saturated

calomel reference electrodes used for electrochemical testing are compared to a master/calibration reference electrode (which is not used for any electrochemical testing) prior to each use, assuring that electrode stability exists.

Preparation of sample electrolytes

The ground enhancement material under study was GEM25A, and was prepared by mixing the with water according to the mixing ratio (see Table. 1) provided by Pentair / ERICO. The ground enhancement sample electrolyte in each cell was prepared individually to ensure the recommended ratio of water and ground enhancement material was met.

Table 1: The mix ratio of water and material

Sample type	Ground enhancement materials GEM25A.
Water / Material	50ml / 100g

Test environment

All the tests reported herein were conducted in a controlled laboratory environment in Building 82 at Monash University (Clayton, VIC, Australia), at the constant room temperature of 25 °C.

Testing parameters for sample resistivity

Ground enhancement material GEM25A resistivity was measured prior to and after the exposure / test period. This was done in order to provide insight into any variation in the ground enhancement material resistivity from the beginning to the end of the three-month exposure/test period. The ground enhancement material was re-hydrated before the measurement were taken.

The resistivity (ρ) of the ground enhancement material was obtained by the ASTM G57-06 standard using a commercial MC Miller sample box sample box, as shown in Fig. 3.

The resistivity measurements indicate the relative ability of the ground enhancement material to carry currents, which is proportional to the corrosivity of sample.

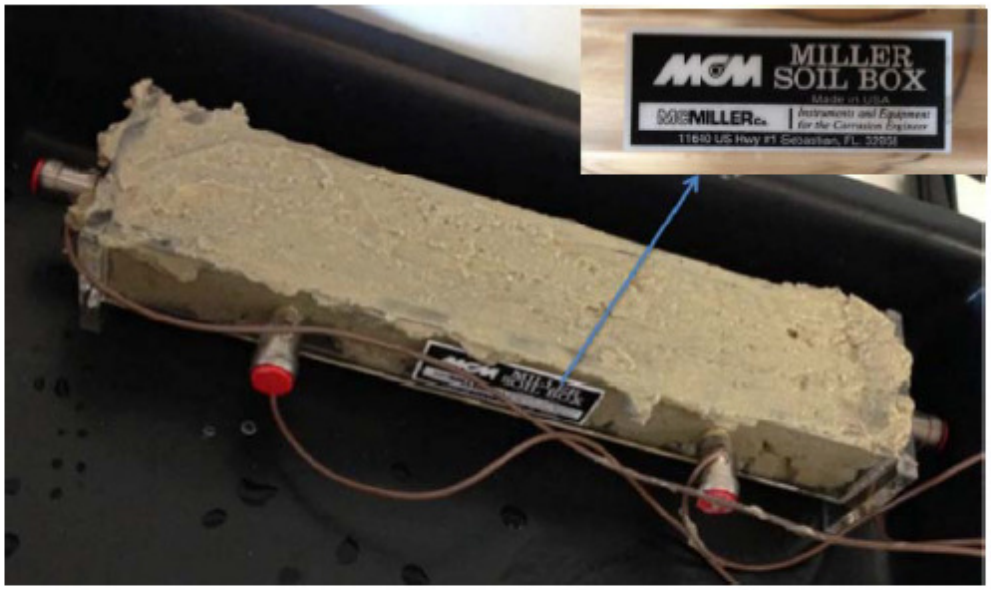


Figure 3: Commercial "Sample box" used to determine the ground enhancement material resistivity via the 4-probe method.

Testing parameters for the linear polarisation resistance (LPR) test

The linear polarisation resistance (LPR) test was used to determine the "polarisation resistance" (R_p) of test specimens, which is inversely proportional to the corrosion current density expressed by the Stern-Geary equation [1,2] (described further in Appendix 2). The LPR test is non-destructive in nature, as the applied polarisation results in small alteration of current. Therefore, a non-destructive electrochemical polarisation in the range of -10 mV to +10 mV from the rest potential (also known as the open-circuit potential) was executed at a rate of 10 mV/min. The test duration was therefore 2 minutes.

Three (3) replicate samples were tested, all in individual cells, for each ground enhancement sample type; hence a total of 36 samples were tested using the LPR method approximately every 3 - 4 days. Prior to each test, the reference electrode was calibrated.

A Bio-Logic SP-150 potentiostat (Knoxville, TN) was used for the LPR testing (as shown in Fig 4 below).



Figure 4. The Bio-Logic SP-150 potentiostat for LPR testing

Sample cleaning:

Following the 90 days of testing in the different ground enhancement sample types, the samples were taken out and cleaned for the observation of corrosion damage. The cleaning procedure is as follows.

- The sample surface was cleaned using distilled water and a soft brush to remove the residual sample.
- Corrosion morphologies were observed by visual inspection and digital photography.

Results and parameters recorded

Sample resistivity

The sample resistivity immediately prior to, and immediately after, the 3 month specimen exposure duration was measured and is reported in Table. 2. The ground enhancement materials were re-hydrated prior to the second measurement.

Table 2: Sample resistivity (ohm.cm) as measured in the freshly prepared condition, and just after the three-month exposure test for ground enhancement material GEM25A

Sample	Resistivity (ohm.cm)
Prior to specimen exposure (0 days)	4.80
After specimen exposure (90 days)	10.00

Average R_P values

The variation of R_P for the ground enhancement materials GEM25A is shown in Figure 5. The results are presented in the units recommended by the IEC62561 Section 7 standard (i.e. ohm.m^2) and also in the units conventional to the corrosion community (ohms.cm^2).

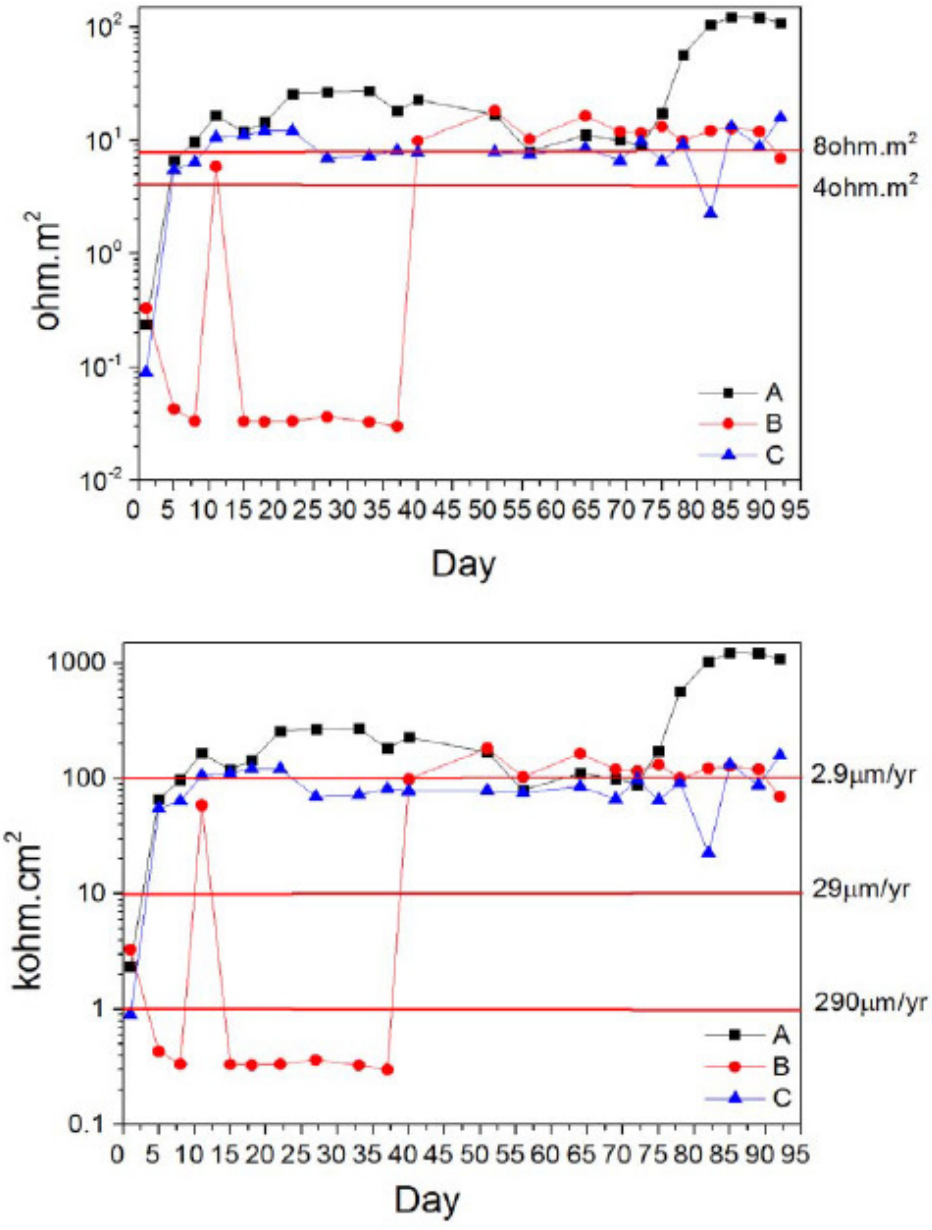


Figure 5. The results from LPR testing over the 90 day monitoring period (top) superimposed are lines that indicate the passing criteria as set out in the IEC62561 standard (bottom) superimposed are lines that indicate the calculated thickness loss from corrosion.

The results in Figure 5 reveal some minor variations in the values of R_p between triplicate samples. However, such scatter is not considered to be significant, on the basis that the measured corrosion rates for all replicates are considered to be consistent with an exceptionally low rate of corrosion (of ~3μm/yr). Based upon the results from experiments herein, it is noted that the ground enhancement material GEM25A has a consistently high R_p (higher than 8 ohm.m^2) surpassing the passing criteria for aggressive environments according to the standard, IEC62561 Section 7.

To provide an assessment of the physical damage occurring (in units that can be interpreted in an engineering context), the R_p values were converted to corrosion current densities and penetration rates further below. Such analysis allows for a sense of the magnitude of the corrosion occurring, which can also be interpreted in conjunction with images of the specimens following the 90 day test period. A sample image along with corresponding observations is included below.



Image following 90 days exposure to GEM25A

- Subsequent to mixing, the ground enhancement material became (and remained) very hard.
- The measured R_p values were stable throughout testing (however Sample B had a damaged electrode connection and this was corrected during the test period)
- The sample surface became darker following exposure test period
- Very minor levels of what appear to be pitting corrosion are observed, however the vast majority of the specimen remains uncorroded.
- Conversion of R_p to corrosion rate indicates low levels of corrosion attack (Figure 5 (bottom)).

Summary

1. LPR testing was successfully carried out on triplicate samples of Cu-plated steel rods in GEM25A.
2. LPR testing revealed a stable R_p, which was higher than the passing criteria for aggressive and non-aggressive material (in accordance to IEC62561 standard Section 7) throughout the test duration. The tabulated predicted penetrations are provided for all samples tested in Appendix 2.
3. Post-test visual inspection confirmed that very low levels of corrosion occurred upon Cu-plated steel rods in GEM25A. This correlated with the findings from LPR testing.
4. Aside from the IEC62561 standard Section 7 criteria, the work herein aimed to provide an objective characterisation. As a result, calculated penetration depths which provide a physical basis for damage measured from LPR tests have been included in Appendix 2, in order to allow for an engineering assessment.

In summary, a table that indicates the pass/fail status of each sample based on the relevant standard (IEC62561 Section 7) is included below.

Table 3. Summary table that indicates the pass/fail status of each replicate sample of GEM25A based on the IEC62561 standard Section 7. The pass/fail assessment was made on the average R_P value over the final 30 days of the 3month test/exposure period.

MATERIAL TYPE		PASSED OR FAILED ACCORDING TO AGGRESSIVE SOIL CRITERIA (>8ohm.m^2)	PASSED OR FAILED ACCORDING TO NON-AGGRESSIVE SOIL CRITERIA (>4ohm.m^2)
GEM25A	A	PASSED	PASSED
	B	PASSED	PASSED
	C	PASSED	PASSED

References:

1. D. Jones: 'Principles and prevention of corrosion', 1996, Prentice Hall.

2. J. Scully: 'The Polarization Resistance Method for Determination of Instantaneous Corrosion Rates', in 'Electrochemical Techniques in Corrosion Science and Engineering', 2002, CRC Press.New York.

Appendix 1: Exposed surface area (cm^2) of each Cu rod sample.

Sample	Exposed surface area (cm^2)
A	10.76
B	12.29
C	10.69

Appendix 2: Projected penetration for 30 years (based on the average R_P value from the final 30 days of the 3 month exposure period).

Determination of corrosion current density, i_{corr}, was based on the Stern-Geary Equation. Such calculations are not influenced by the thickness of the Cu-plating, and only require the surface area of the electrode.

$$R_p = \frac{B}{i_{corr}}$$

Where R_p is the polarisation resistance, i_{corr} the corrosion current density, and B is the proportionality constant. In this case, B was taken as being equal to 25 mV.

The origin of the value "B" arises from the Tafel slopes of the anodic and cathodic partial corrosion reactions. The true value of B is expressed as:

$$B = \beta_a.\beta_c / 2.3(\beta_a + \beta_c)$$

Where, β_a is the anodic Tafel slope, and β_c is the cathodic Tafel slope. Note: neither β_a or β_c are measured in an LPR test. The determination of B requires destructive testing. As a result, a rational value of B is used as a constant. The value of B nominally varies between ~25 and 52mV, the range covering active to passive systems. B=25mV was selected because of (i) the low R_P values determined in this work indicating non-passive conditions, and (ii) the use of a low B value is conservative, such that quoted corrosion rates are the upper bound (i.e. worst case).

Table 4. Projected penetration rate for 30 years exposure based on the average R_P of the final 30 days of the 3 months exposure. The values calculated are also the average of the expected penetration from the triplicate samples (and individual calculations are provided overleaf)

Sample	Estimated penetration for 30 years of exposure (µm)
GEM25A	86

Appendix 4: Corrosion morphology for each of the replicate Cu-plated steels samples following 90 days exposure to GEM25A.



Sample 1

GEM25A: IEC 62561-7, Sec. 5.2 Leaching Test
Sec.5.3 Sulphur Determination, Alkalinity/Acidity

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Website: www.cwmenvironmental.com

June 20, 2016

Martin Havelka
ERICO
34600 Solon Road
Solon, OH 44139
TEL:
FAX

GEM 25A Order No.: 1502330

Dear Martin Havelka:

CWM Environmental Cleveland, LLC. received 2 sample(s) on 2/13/2015 for the analyses presented in the following report. This report has been revised as follows: Sample ID changed from Sample 1 to GEM 25 A on 6/20/2016.

There were no problems with the analytical results associated with this report unless otherwise noted in an attached Case Narrative. Quality control data is within laboratory defined method(s) and specified acceptance limits, unless otherwise noted within the attached Case Narrative.

Solid samples are reported in µg/Kg or mg/Kg as received, unless specified in the units section of the report as dry weight indicated as: µg/Kg-dry or mg/Kg-dry.

If you have any questions regarding these tests results, please feel free to call.

Certifications: Ohio EPA - 4041

Ron Gribik
VP Operations-Cleveland

CWM Environmental Cleveland, LLC.
4450 Johnston Parkway · Unit B
Cleveland, OH 44128
TEL: (216) 663-0808 FAX: (216) 663-0656
Website: www.cwmenvironmental.com

Case Narrative

WO#: 1502330
Date: 4/28/2015

CLIENT: ERICO
Project: GEM 25A

1502330-001 Leaching Procedure EPA 1311:
Step 1: The liquid to solid ratio for this procedure was: 100 grams of solid material to 2000 mL of leaching fluid.
Step 2: The sample experienced a tumbling agitation for 18 +/- 2 hours.
Step 3: The liquid was then separated from the solid by passing through a 0.7 um (micro millimeter) pore filter.

All reporting limits (RL) for sample 1502330-001 are set by the Maximum Concentration of Contaminants for Toxicity Characteristics (TCLP) which are set forth by the Ohio Environmental Protection Agency (OEPA) unless otherwise noted below in this case narrative.

Regulated TCLP Metals Analysis included the following Metals: Arsenic (As), Barium (Ba), Cadmium (Cd), Chromium (Cr), Lead (Pb), Selenium (Se), Silver (Ag) and Mercury (Hg).

Metals Analysis by ICP, TCLP reporting limit (RL) for Sulfur is at 2.0% to remain consistent throughout the report per the 2.0% RL request of the client, ERICO. Sulfur analysis is not a metals regulated required analyte.
A 20x dilution factor (DF) was completed on this report for the sulfur analysis, because per the EPA 6010C procedure for EPA 1311, the Sulfur result was initially reported in mg/L or PPM and converted to percentage. The result of the sulfur for the run exceeded the highest point of analysis making a dilution necessary.

Analysis Mercury, TCLP: EPA 7470A Standard operating procedure for a solid matrix is to conduct a 20x dilution in order to protect the instrument from any corrosive properties that may lie within the matrix.

Acidity and Alkalinity results:
A negative value for acidity occurs in samples containing more alkaline properties. A negative value for alkalinity occurs in samples containing more acidic properties.
Analysis for both Acidity and Alkalinity were completed at the clients request, ERICO, per the leaching procedure EPA 1311, analysis by EN12457-2 was not necessary per standard requirements.

Acidity (ASTM Leachate) reporting limit (RL) is set at 5.0 mg/L CaCO3. This is because Acidity analysis is not a required analysis under TCLP testing. 5.0 mg/L is the minimum value below which

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Case Narrative

WO#: 1502330
Date: 4/28/2015

CLIENT: ERICO
Project: GEM 25A

data is documented without noted qualifications.

Alkalinity, Total (ASTM Leachate) reporting limit (RL) is set at 10.0 mg/L CaCO3. This is because Alkalinity analysis is not a required analysis under TCLP testing. 10.0 mg/L is the minimum value below which data is documented without noted qualifications.

1502330-002 Leaching Procedure EN 12457-2:
Step 1: The liquid to solid ratio for this procedure was: 100 grams of solid material to 1000 mL of leaching fluid.
Step 2: The sample experienced a tumbling agitation for 24 hours.
Step 3: The liquid was then separated from the solid by passing through a 0.45 um (mico millimeter) pore filter.

The procedure 12475-2 does not specify maximum concentration limits and therefor reporting limits (RL) are set by the Maximum Concentration of Contaminants for Toxicity Characteristics (TCLP) which for the following metals by the Ohio Environmental Protection Agency (OEPA): Cadmium (Cd), Lead (Pb) and Mercury (Hg).
All additional metals requested per EN 12457-2, Cobalt (Co), Copper (Cu), Iron (Fe), Nickle (Ni), and Zinc (Zn) were set to 0.100 mg/L per EPA 6010C analysis. This is the minimum value below which data is documented without noted qualifications.

Metals Analysis by ICP reporting limit (RL) for Sulfur is at 2.0% RL per the request of the client, ERICO. Sulfur result was initially reported in mg/L or PPM and converted to percentage.

Mercury Digestion, Liquid, Sample 1502330-002: Prep Method hold time was exceeded by 46.583 day(s).

It is based that upon the opinion of this laboratory and the limits set forth by Ohio Environmental Protection Agency the analytical testing performed, and only what was performed for this report, work order number 1502330, can be deemed non-hazardous.

Additionally, please see the attached photo array of the discussed leaching procedure. As well as the spreadsheet of Maximum Concentration of Contaminants limits set by the Ohio Environmental Protection Agency, for Toxicity Characteristic (TCLP) analysis.

Report revised to correct the Sample ID. Sample name changed from Sample 1 to GEM 25A.

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Analytical Report

(Consolidated-Accredited)
WO#: 1502330
Date Reported: 4/28/2015

CLIENT: ERICO
Project: GEM 25A
Lab ID: 1502330-001
Client Sample ID GEM 25A - Ohio EPA

Collection Date: 2/12/2015
Matrix: SOLID

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
METALS ANALYSIS BY ICP				**EPA 6010C**	**EPA 3050B**	Analyst: **STB**
Sulfur	ND	2.00		%	20	2/18/2015 10:41:09 AM
METALS ANALYSIS BY ICP, TCLP				**EPA 6010C**	**EPA 3010A**	Analyst: **STB**
Arsenic	ND	5.00		mg/L	1	2/20/2015 7:52:47 PM
Barium	ND	100		mg/L	1	2/20/2015 7:52:47 PM
Cadmium	ND	1.00		mg/L	1	2/20/2015 7:52:47 PM
Chromium	ND	5.00		mg/L	1	2/20/2015 7:52:47 PM
Lead	ND	5.00		mg/L	1	2/20/2015 7:52:47 PM
Selenium	ND	1.00		mg/L	1	2/20/2015 7:52:47 PM
Silver	ND	5.00		mg/L	1	2/20/2015 7:52:47 PM
TCLP ANALYSIS MERCURY, TCLP				**EPA 7470A**	**EPA 7470A**	Analyst: **NS**
Mercury	ND	0.200		mg/L	20	2/23/2015 4:33:12 PM
TCLP ANALYSIS PESTICIDES, TCLP				**EPA 8081B**	**EPA 3510C**	Analyst: **MIM**
Chlordane, total	ND	0.0300		mg/L	1	2/21/2015 4:23:00 AM
Endrin	ND	0.0200		mg/L	1	2/21/2015 4:23:00 AM
gamma-BHC	ND	0.400		mg/L	1	2/21/2015 4:23:00 AM
Heptachlor	ND	0.00800		mg/L	1	2/21/2015 4:23:00 AM
Heptachlor epoxide	ND	0.00800		mg/L	1	2/21/2015 4:23:00 AM
Methoxychlor	ND	10.0		mg/L	1	2/21/2015 4:23:00 AM
Toxaphene	ND	0.500		mg/L	1	2/21/2015 4:23:00 AM
Surr: Decachlorobiphenyl	86.6	30-150		%Rec	1	2/21/2015 4:23:00 AM
Surr: Tetrachloro-m-xylene	52.2	30-150		%Rec	1	2/21/2015 4:23:00 AM
TCLP ANALYSIS HERBICIDES, TCLP				**EPA 8151A**	**EPA 8151A**	Analyst: **MIM**
2,4,5-TP	ND	1.00		mg/L	1	2/25/2015 11:08:00 PM
2,4-D	ND	10.0		mg/L	1	2/25/2015 11:08:00 PM
Surr: DCAA	97.5	30-150		%Rec	1	2/25/2015 11:08:00 PM

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Analytical Report

(Consolidated-Accredited)

WO#: 1502330

Date Reported: 4/28/2015

CLIENT: ERICO **Collection Date:** 2/12/2015

Project: GEM 25A

Lab ID: 1502330-001 **Matrix:** SOLID

Client Sample ID GEM 25A - Ohio EPA

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
TCLP ANALYSIS				**EPA 8270C**	**EPA 3510C**	**Analyst: CS**
SEMI-VOLATILE ORGANIC COMPOUNDS, TCLP						
2,4,5-Trichlorophenol	ND	400		mg/L	1	2/24/2015 9:57:00 PM
2,4,6-Trichlorophenol	ND	2.00		mg/L	1	2/24/2015 9:57:00 PM
2,4-Dinitrotoluene	ND	0.130		mg/L	1	2/24/2015 9:57:00 PM
2-Methylphenol	ND	200		mg/L	1	2/24/2015 9:57:00 PM
3&4 Methylphenol	ND	200		mg/L	1	2/24/2015 9:57:00 PM
Hexachlorobenzene	ND	0.130		mg/L	1	2/24/2015 9:57:00 PM
Hexachlorobutadiene	ND	0.500		mg/L	1	2/24/2015 9:57:00 PM
Hexachloroethane	ND	3.00		mg/L	1	2/24/2015 9:57:00 PM
Nitrobenzene	ND	2.00		mg/L	1	2/24/2015 9:57:00 PM
Pentachlorophenol	ND	100		mg/L	1	2/24/2015 9:57:00 PM
Pyridine	ND	5.00		mg/L	1	2/24/2015 9:57:00 PM
Surr: 2,4,6-Tribromophenol	0	10-123	S	%Rec	1	2/24/2015 9:57:00 PM
Surr: 2-Fluorobiphenyl	71.4	10-110		%Rec	1	2/24/2015 9:57:00 PM
Surr: 2-Fluorophenol	0	21-100	S	%Rec	1	2/24/2015 9:57:00 PM
Surr: Nitrobenzene-d5	77.7	35-114		%Rec	1	2/24/2015 9:57:00 PM
Surr: Phenol-d6	0	10-100	S	%Rec	1	2/24/2015 9:57:00 PM
Surr: Terphenyl-d14	114	33-141		%Rec	1	2/24/2015 9:57:00 PM

NOTES:

[1] Possible low bias of acidic compounds due to the activity of the matrix, matrix destroyed all acidic surrogates as well as the last internal standard. All base/neutral surrogates exhibited normal concentrations.

TCLP ANALYSIS				**EPA 8260B**	**EPA 1311**	**Analyst: AC**
VOLATILE ORGANIC COMPOUNDS, TCLP						
1,1-Dichloroethene	ND	0.700		mg/L	1	2/17/2015 3:16:00 PM
1,2-Dichloroethane	ND	0.500		mg/L	1	2/17/2015 3:16:00 PM
1,4-Dichlorobenzene	ND	7.50		mg/L	1	2/17/2015 3:16:00 PM
Benzene	ND	0.500		mg/L	1	2/17/2015 3:16:00 PM
Carbon tetrachloride	ND	0.500		mg/L	1	2/17/2015 3:16:00 PM
Chlorobenzene	ND	100		mg/L	1	2/17/2015 3:16:00 PM
Chloroform	ND	6.00		mg/L	1	2/17/2015 3:16:00 PM
Methyl ethyl ketone	ND	200		mg/L	1	2/17/2015 3:16:00 PM
Tetrachloroethene	ND	0.700		mg/L	1	2/17/2015 3:16:00 PM
Trichloroethene	ND	0.500		mg/L	1	2/17/2015 3:16:00 PM
Vinyl chloride	ND	0.200		mg/L	1	2/17/2015 3:16:00 PM
Surr: 4-Bromofluorobenzene	99.5	80-120		%Rec	1	2/17/2015 3:16:00 PM

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Analytical Report

(Consolidated-Accredited)

WO#: **1502330**

Date Reported: **4/28/2015**

CLIENT: ERICO **Collection Date:** 2/12/2015

Project: GEM 25A

Lab ID: 1502330-001 **Matrix:** SOLID

Client Sample ID GEM 25A - Ohio EPA

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
TCLP ANALYSIS				**EPA 8260B**	**EPA 1311**	Analyst: **AC**
VOLATILE ORGANIC COMPOUNDS, TCLP						
Surr: Dibromofluoromethane	107	80-120		%Rec	1	2/17/2015 3:16:00 PM
Surr: Toluene-d8	99.8	80-120		%Rec	1	2/17/2015 3:16:00 PM
ACIDITY (ASTM LEACHATE)				**SM 2310 B**		Analyst: **KRK**
Acidity	-2058	5.0		mg/L CaCO3	1	2/27/2015 8:20:00 AM
ALKALINITY, TOTAL (ASTM LEACHATE)				**SM 2320 B**		Analyst: **MES**
Alkalinity, Total (As CaCO3)	2,270	10.0		mg/L CaCO3	1	2/23/2015 2:45:00 PM

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Analytical Report

(Consolidated-Accredited)

WO#: 1502330

Date Reported: 4/28/2015

CLIENT: ERICO **Collection Date:** 2/12/2015

Project: GEM 25A

Lab ID: 1502330-002 **Matrix:** SOLID

Client Sample ID GEM 25A - EN 62561-7

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
METALS ANALYSIS BY ICP (EN 12457-2)				**EPA 6010C**	**EPA 3010A**	Analyst: **STB**
Cadmium	ND	1.00		mg/L	1	4/27/2015 5:29:24 PM
Cobalt	ND	0.100		mg/L	1	4/27/2015 5:29:24 PM
Copper	ND	0.100		mg/L	1	4/27/2015 5:29:24 PM
Iron	ND	0.100		mg/L	1	4/27/2015 5:29:24 PM
Lead	ND	5.00		mg/L	1	4/27/2015 5:29:24 PM
Nickel	ND	0.100		mg/L	1	4/27/2015 5:29:24 PM
Zinc	ND	0.100		mg/L	1	4/27/2015 5:29:24 PM
METALS ANALYSIS BY ICP (EN 12457-2)				**EPA 6010C**	**EPA 3010A**	Analyst: **STB**
Sulfur	ND	2.00		%	1	4/28/2015 10:20:50 AM
MERCURY, LIQUID (EN 12457-2)				**EPA 7470A**	**EPA 245.1**	Analyst: **STB**
Mercury	ND	0.200	H	mg/L	1	4/28/2015 12:37:23 PM

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Definition Only

WO#: 1502330
Date: 4/28/2015

Definitions:

QUALIFIERS:
A: Accredited analyte
N: Non-accredited analyte
B: Analyte detected in the associated MB
J: Analyte found between MDL and PQL limits, result is considered estimated
U: Analyte is below detection limit
N: Tentatively identified compounds
P: Difference between primary and secondary columns exceed 40%
R: RPD outside accepted recovery limits
S: Matrix Spike is outside acceptance limits
* : Reported value exceeds Maximum Contaminant Level
H: Holding times for preparation or analysis has been exceeded
W: Per method requirements, sample was received not meeting proper temperature requirements of on ice and at 4°C ± 2°C.
M: Manual Integration used to determine area response
G: CCB or ICB contained reportable amount of analyte
MB+: MB contained reportable amount of analyte above the MDL but below the PQL
QC+: CCV recovery failed high
QC-: CCV recovery failed low
QDR: Dup RPD high
QL+: LCS recovery failed high
QL-: LCS recovery failed low
QLR: LCSD RPD failed high
QM+: MS recovery failed high
QM-: MS recovery failed low
QMR: MSD RPD failed high
QV+: ICV failed recovery high
QV-: ICV failed recovery low
U: Analye is below the MDL

DEFINITIONS:
DF: Dilution factor; the dilution factor applied to the prepared sample.

DUP: Duplicate; aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently, used to calculate Precision (%RPD).

LCS: Laboratory Control Sample; prepared by adding a known amount of target analytes to a specified

Definitions:

amount of clean matrix and prepared with the batch of samples, used to calculate Accuracy (%REC).

LCSD: A duplicate LCS sample, used to calculate both Accuracy (%REC) and Precision (%RPD).

MB: Method Blank; a sample of similar matrix that does not contain target analytes or interference that may impact the analytical results and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedure, used to assess and verify that the analytical process is free of contamination.

MDL: Method Detection Limit; The lowest concentration of analyte that can be detected by the method in the applicable matrix.

MS: Matrix Spike; prepared by adding a known amount of target analytes to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available, used to calculate Accuracy (%REC).

MSD: A duplicate MS sample, used to calculate both Accuracy (%REC) and Precision (%RPD).

%REC: Percent Recovery of a known spike (SPK); a measure of accuracy expressed as a percentage of a measured (recovered) concentration compared to the known concentration (SPK) added to the sample. This is compared to the Low Limit and High Limit.

%RPD: Relative Percent Difference; a measure of precision expressed as a percentage of the difference between two duplicates relative to the average concentration. This is compared to the RPD Limit.

PL: Permit limit:; Not included on all reports. Used primarily for wastewater discharge permits.

PQL: Practical Quantitation Limit; The lowest verified limit to which data is quantified without qualifications. Analyte concentrations below PQL are reported either as ND or as a number with a "J" qualifier.

Qual: Qualifier that applies to the analyte reported.

RL: Reporting Limit: See PQL.

SPK: Spike; used in the QC section for both SPK Value and SPK Ref Val.

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Definition Only

WO#: 1502330
Date: 4/28/2015

Definitions:

ND: Not detected at the Reporting Limit.

µg/Kg or µg/L: Units of part per billion (PPB) – microgram per Kilogram (W/W) or microgram per Liter (W/V).

mg/Kg or mg/L: Units of part per million (PPM) – milligram per Kilogram (W/W) or milligram per Liter (W/V).

Maximum Concentration of Contaminants for the Toxicity Charcteristic Leaching Procedure (TCLP)			
Regulated TCLP Metals			
Analyte	**Regulatory Level**	**Units**	**CAS Number**
Arsenic	5.0	mg/L	7440-38-2
Barium	100.0	mg/L	7440-39-3
Cadmium	1.0	mg/L	7440-43-9
Chromium	5.0	mg/L	7440-47-3
Lead	5.0	mg/L	7439-92-1
Mercury	0.2	mg/L	7439-97-6
Selenium	1.0	mg/L	7782-49-2
Silver	5.0	mg/L	7440-22-4
Regulated TCLP Semi-Volatiles			
Analyte	**Regulatory Level**	**Units**	**CAS Number**
2-Methylphenol	200.0	mg/L	95-48-7
3&4 Methylphenol	200.0	mg/L	108-39-4 & 106-44-5
2,4-Dinitrotoluene	0.13	mg/L	121-14
Hexachloroethane	3.0	mg/L	67-72-1
Hexachlorobenzene	0.13	mg/L	118-74-1
Hexachlorobutadiene	0.5	mg/L	87-68-3
Nitrobenzene	2.0	mg/L	98-95-3
Pentachlorophenol	100.0	mg/L	87-86-5
Pyridine	5.0	mg/L	110-86-1
2,4,5-Trichlorophenol	400.0	mg/L	95-95-4
2,4,6-Trichlorophenol	2.0	mg/L	88-06-2
Regulated TCLP Volatiles			
Analyte	**Regulatory Level**	**Units**	**CAS Number**
Benzene	0.5	mg/L	71-43-2
Carbon tetrachloride	0.5	mg/L	56-23-5
Chlorobenzene	100.0	mg/L	108-90-7
Chloroform	6.0	mg/L	67-66-3
1,4-Dichlorobenzene	7.5	mg/L	106-46-7
1,2-Dichloroethane	0.5	mg/L	107-06-2
1,1-Dichloroethene	0.7	mg/L	75-35-4
2-Butanone	200.0	mg/L	78-93-3
Tetrachloroethene	0.7	mg/L	127.18-4
Trichloroethene	0.5	mg/L	79-01-6
Vinyl chloride	0.2	mg/L	75-01-4
Regulated TCLP Herbicides			
Analyte	**Regulatory Level**	**Units**	**CAS Number**
2,4,5-TP	1.0	mg/L	94-75-7
2,4-D	10.0	mg/L	93-72-1
Regulated TCLP Pesticides			
Analyte	**Regulatory Level**	**Units**	**CAS Number**
Methoxychlor	10.0	mg/L	72-43-5
Chlordane, total	0.03	mg/L	57-74-9
Endrin	0.02	mg/L	72-20-8
Heptachlor	0.008	mg/L	76-44-8
gamma-BHC	0.4	mg/L	58-89-9
Toxaphene	0.5	mg/L	8001-35-2
Heptachlor epoxide	0.008	mg/L	1024-57-3