Celtic enGlobe

The Royal Mint

THE ROYAL MINT

ELECTROKINETIC FIELD TRIAL REPORT

R1722/19/4953

ADDENDUM FEBRUARY 2020

Client:	**The Royal Mint**
Report Number:	**R1722/19/4953**
Report Title:	**Electrokinetic Field Trial Report**
Report Status:	**Final**
Author(s):	**Kirsty Sweeny**
(Signature & Date)	17/02/20
Project Manager:	**Kirsty Sweeny**
(Signature & Date)	17/02/20
QA Approved:	**Stephen Kidley**
(Signature & Date)	17/2/20

TABLE OF CONTENTS

TABLES

FIGURES

1.0 INTRODUCTION

Celtic EnGlobe (Celtic) was commissioned by The Royal Mint to carry out a field trial to assess the potential full-scale implementation of electrokinetic remediation. The aim of which was to remove dissolved-phase heavy metals, primarily Nickel, from contaminated groundwater within the Nickel Plating area (NP1) located at the eastern site boundary of The Royal Mint. The Royal Mint commissioned a further extension of the field trial until September 2019, following the continued positive results as outlined in the progress report submitted in December 2018. The Royal Mint have since commissioned a further extension of the field trial until March 2020 following continued positive results and support from Natural Resources Wales (NRW).

This report is an addendum to the report issued on 7th August 2019 'Electrokinetic Field Trial Report_Jul 19 V2' this report includes monitoring and analysis results for the trial period June to October 2019 which completes the data for the trial using mild steel rods, prior to the change to using stainless steel rods in the treatment system.

1.1 Site Location

The manufacturing facility is located approximately 2 km north-west of Llantrisant, Mid Glamorgan, South Wales, CF72 8YT, at National Grid Reference 304000, 184900.

The site is located in Llantrisant Business Park, a mixed commercial and industrial area. The site location and boundaries are shown on Drawing D1722/4822/A1, Appendix A.

1.2 Electrokinetic Remediation Overview

Electrokinetic processes involve passing a low intensity electric current between a cathode and an anode, imbedded in the contaminated medium. Ions and small charged particles, in addition to water, are transported between the electrodes. Anions move towards the positive electrode (Anode) and cations travel towards the negative electrode (Cathode). An electric gradient initiates movement by electromigration, electro-osmosis and electrophoresis. The resultant migration of charged particles to their oppositely charged electrodes enables removal of ionic species and colloids through electroplating of the electrode, precipitation at the electrode, or pumping the waste out from the vicinity of the electrodes.

1.3 Previous Reports

Full results for previous field trial works are included within the previous reports, this report provides results for the period June to October 2019. Previous reports including the bench-scale trial reports and field trial reports are as follows;

- Celtic Englobe, Electrokinetic Bench-scale Trial Report, R1662-16-4654, dated February 2016;
- Celtic Englobe, Electrokinetic Bench-scale Trial 2 Report, R1662-16-7419, dated September 2016;
- Celtic Englobe, Electrokinetic Field Trial Report, R1722-18-4822, dated November 2017;
- The Royal Mint Electrokinetic Field Trial Report R1722/18/4935 December 2018; and
- The Royal Mint Electrokinetic Field Trial Report R1722/19/4953 July 2019.

1.4 Extended Trial Objectives

The main aims of the extended field trial were to strengthen the conclusions previously made from the initial field trials and to achieve longer term results. This ultimately helps to determine if full-scale implementation is a viable and cost-effective technique. The data collected during the field trial will also be used to assist the design of a full-scale treatment system.

Additionally, the extended field trial is reducing Nickel mass in the groundwater on the peripheries of the source of contamination within the NP1 building and is subsequently reducing Nickel contamination impact to the River Mychydd until such time that the full-scale remediation can be carried out.

2.0 PROGRAMME OF WORKS

2.1 Programme of Works

A summary of the programme and sequence of works carried out since the last Field Trial Report from June 2019 to October is presented in Table 1, below, but to summarise:

- A further nearly 5 months of data was collated utilising mild steel rods as the anode and cathode since the last Field Trial Report;
- Quarterly groundwater and surface water monitoring was undertaken throughout the extended trial at locations BHE1 – BHE6, BH26, SW0 – SW4 and SWA; and
- Monthly treatment system samples were taken at locations CBH17-1 – CBH17-6, and BH26.

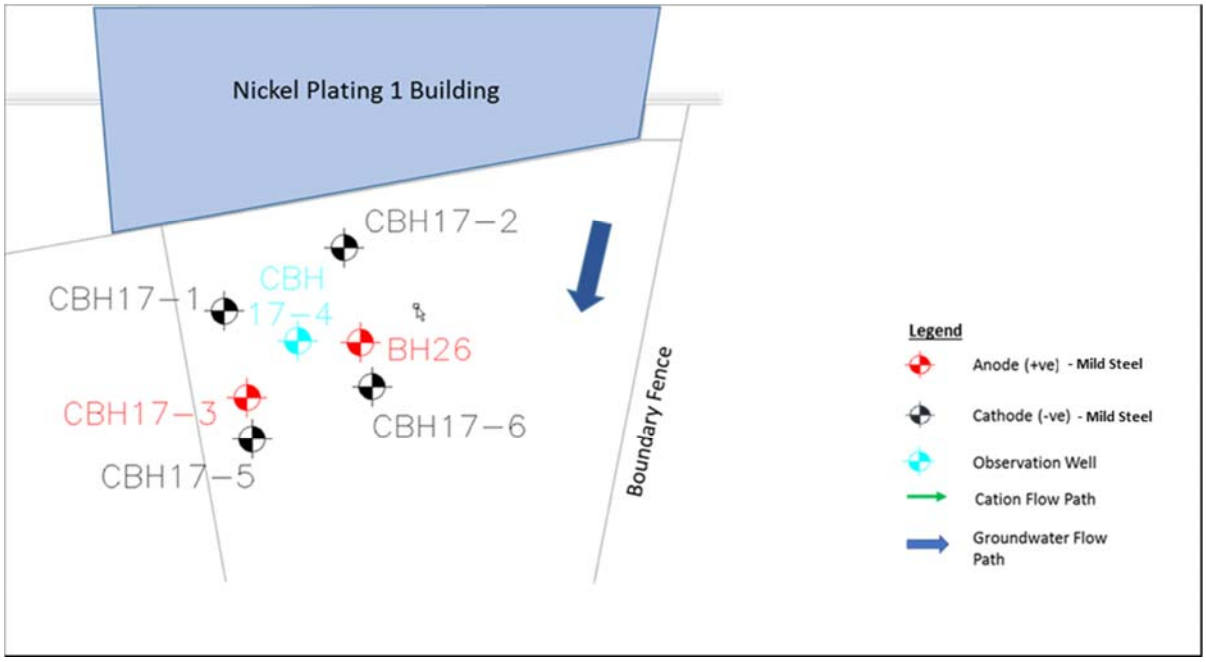
Table 1 – Extended Field Trials Programme of Works

Activities	Tasks	Date
Treatment System Groundwater Sampling Rounds – June 2019	• Groundwater monitoring at trial boreholes CBH17-1, CBH17-2, CBH17-3, CBH17-4, CBH17-5, CBH17-6 and BH26. • Quarterly groundwater and surface water monitoring at trial at locations BHE1 – BHE6, BH26, SW0 – SW4 and SWA.	3rd June 2019 28th June 2019
Treatment System Groundwater Sampling Rounds – July 2019	• Groundwater monitoring at trial boreholes CBH17-1, CBH17-2, CBH17-3, CBH17-4, CBH17-5, CBH17-6 and BH26.	8th July 2019 29th July 2019
Treatment System Groundwater Sampling Rounds – August 2019	• Groundwater monitoring at trial boreholes CBH17-1, CBH17-2, CBH17-3, CBH17-4, CBH17-5, CBH17-6 and BH26.	5th August 2019 12th August 2019 23rd August 2019
Treatment System Groundwater Sampling Rounds – September 2019	• Groundwater monitoring at trial boreholes CBH17-1, CBH17-2, CBH17-3, CBH17-4, CBH17-5, CBH17-6 and BH26.	6th September 2019 16th September 2019
Treatment System Groundwater Sampling Rounds – October 2019	• Quarterly groundwater and surface water monitoring at trial at locations BHE1 – BHE6, BH26, SW0 – SW4 and SWA. • Groundwater monitoring at trial boreholes CBH17-1, CBH17-2, CBH17-3, CBH17-4, CBH17-5, CBH17-6 and BH26.	1st October 2019 7th October 2019 18th October 2019 25th October 2019 29th October 2019
Replacement of Mild Steel Rods with Solid Stainless Steel Rods following NRW comment in CAR August 2019	• All rods replaced with solid steel rods following NRW comments on preference for using solid steel.	25th October 2019

2.2 Field Trial Set-Up

Extensions of the field trial ran firstly to March 2019 and subsequently to September 2019. In March 2019, Additional electrodes were installed and the relative positions of anodes and cathodes were reconfigured. The configuration remains the same since March 2019, however, on October 25th 2019 the mild steel rods were replaced with solid stainless steel rods following the NRW Compliance Assessment Report comments. The configuration from March 2019 to the present is shown in Figure 1 overleaf.

Figure 1 – Field Trial Electrodes Set-Up Configuration (March 2019 Onwards)



3.0 FIELD TRIAL RESULTS

During the extended trial, samples were taken at least monthly from all treatment wells (CBH17-1 – CBH17-6 and BH26), and on a quarterly basis a full validation round was undertaken for all monitoring wells (BHE1 – BHE6 and BH26) and the surface water (River Mychydd) sample locations (SWA and SW0 – SW4).

All samples collected during the extended trial were sent to a UKAS and MCERTS accredited laboratory and all results are presented in Appendix B.

A summary of the extended trial results to date are provided in Table 2 overleaf.

- Extended Trial No. 5 – Mild Steel Rods – 4th March 2019 – 24th October 2019 (latest results) – Amended Electrode Configuration – 235 Days.
- Extended Trial No. 6 – Stainless steel rods – 25th October 2019 – to date (these results will be included and discussed in the next Field Trial Report following on from this report.

A summary of the groundwater and surface water monitoring round results is provided in Table 3, overleaf.

Table 2 – Extended Trial No. 5 – Mild Steel Rods – 4th March 2019 – 24th October 2019 (latest results) – Amended Electrode Configuration – 97 Days – Summary of Results (Nickel µg/L)

Borehole	Date and Trial Time (days)								
	0	7	14	29	49	69	77	83	97
	12/03/2019	19/03/19	26/03/2019	10/04/2019	30/04/2019	20/05/2019	28/05/2019	03/06/2019	17/06/2019
CBH17-1 (Cathode)	270	< 1.0	< 1.0	< 1.0	22	7.1	0.0075	9.3	0.0068
CBH17-3 (Anode)	15000	18000	17000	1300	9500	26000	4.6	5100	5.4
Percentage Reduction (anode - cathode)	98%	>99.9%	>99.9%	>99.9%	99.77%	99.97%	99.84%	99.82%	99.87%
CBH17-5 (Cathode)	220	550	910	29	230	130	0.12	160	0.51
CBH17-3 (Anode)	15000	18000	17000	1300	9500	26000	4.6	5100	5.4
Percentage Reduction (anode - cathode)	98.53%	96.94%	94.65%	97.77%	97.58%	99.50%	97.39%	96.86%	90.56%
CBH17-2 (Cathode)	150	2.8	300	1	290	120	0.059	77	0.14
BH26 (Anode)	2900	1200	12000	1800	2700	4400	2.2	9500	8.2
Percentage Reduction (anode - cathode)	94.83%	99.77%	97.50%	99.94%	89.26%	97.27%	97.32%	99.19%	98.29%
CBH17-6 (Cathode)	180	86	320	56	53	30	0.044	39	0.12
BH26 (Anode)	2900	1200	12000	1800	2700	4400	2.2	9500	8.2
Percentage Reduction (anode - cathode)	93.79%	92.83%	97.33%	96.89%	98.04%	99.32%	98.00%	99.59%	98.54%
CBH17-4 (Mid- Monitoring Well)	29000	32000	33000	40000	15000	35000	15	19000	11

Reported in last Field Trial Report, included for completeness to show completed extended trial #5

Table 2 - continued

Borehole	Date and Trial Time (days)								
	118	139	28	153	164	178	188	203	209
	08/07/2019	29/07/2019	05/08/2019	12/08/2019	23/08/2019	06/09/2019	16/09/2019	01/10/2019	07/10/2019
CBH17-1 (Cathode)	11	24	28	30	83	80	110	160	130
CBH17-3 (Anode)	4000	3500	4500	3100	1	600	4600	310	5000
Percentage Reduction (anode - cathode)	99.73	99.31	99.38	99.03	-8200	86.67	97.61	48.39	97.40
CBH17-5 (Cathode)	59	76	310	310	130	260	200	1100	410
CBH17-3 (Anode)	4000	3500	4500	3100	1	600	4600	310	5000
Percentage Reduction (anode - cathode)	98.53	97.83	93.11	90.00	-12900	56.67	95.65	-254.84	91.80
CBH17-2 (Cathode)	26	200	160	19	110	100	200	410	8.9
BH26 (Anode)	6300	6500	9800	8700	100	3000	510	1100	1600
Percentage Reduction (anode - cathode)	99.59	96.92	98.37	99.78	-10	96.67	60.78	62.73	99.44
CBH17-6 (Cathode)	72	68	210	35	53	27	67	140	30
BH26 (Anode)	6300	6500	9800	8700	100	3000	510	1100	1600
Percentage Reduction (anode - cathode)	98.86	98.95	97.86	99.60	47	99.10	86.86	87.27	98.13
CBH17-4 (Mid- Monitoring Well)	9100	6100	8700	31000	16000	30000	40000	2500	18000

Table 3 – Groundwater and Surface Water Summary of Results (Nickel µg/L)

Date	BHE1	BHE2	BHE3	BHE4	BHE5	BHE6	BH26	SWO	SW1	SW2	SW3	SW4
01/10/2019	2,200	28,000	1,400	150	41	7.6	1,100	2	2.2	< 1.0	1.4	< 1.0

3.1 Discussion of Field Trial Results

Dissolved phase nickel concentrations in groundwater have been maintained at levels below the derived NRW agreed remedial target and at levels significantly below the baseline reading for extended periods of time over the field trial programme. The electrokinetic cell that has been set-up generally maintains in excess of 95% reduction across the anode – cathode (51 of the 72 results of the most recent trial up until the recent rod replacement exceed 95% reduction).

Following the installation of additional electrodes (in total, 4 no. cathodes and 2 no. anodes) in the wells in March 2019, as indicated in Figure 1, an overall reduction in nickel concentrations in the trial area has continued to occur, as shown in Table 2 and further illustrated in Figure 2, overleaf.

This electrode configuration will be maintained for the duration of Extended Field Trial no. 5.

3.2 Degradation of the electrodes

The trial was re-commenced on 29th March 2018 with mild steel electrodes. Although degradation is visible with the mild steel rods after only one month of treatment, the lifespan of the rods has ranged between two and five months, noting that, as expected, the frequency of replacement of anodes, due to degradation through mass loss, has been greater than that of the cathodes.

Following issue of National Resources Wales Compliance Assessment Report in August which discussed their preference for the use of stainless steel rods, the mild steel rods were replaced with solid stainless steel on 25th October 2019 details of any degradation of the solid steel rods will be included within the next full field trial report.

3.3 Long-term Monitoring of NP1 Area

The latest dissolved phase nickel concentrations in groundwater within the field trial area are shown in the Surfer plots in Figure 2 and Figure 3.

Figure 4, overleaf, shows the long-term trend of the contamination plume across the NP1 area along with the affect it is having on the River Mychydd. This data shows that, from the beginning of the Celtic works, the overall mass of Nickel has reduced from the main part of the plume that is currently accessible (BHE1, BH2 and BH26). This area has reduced from an average of approximately 111,000 µg/L to an average of approximately 8,800 µg/L (93% reduction over 8 years).

Figure 5, overleaf, shows the average nickel concentration (BHE1, BHE2 and BH26) over time showing the overall effect the work has been having on the contamination plume. The long- term data does still show some peaks in the data overtime. This will be due to seasonal variation and the mass flux of nickel coming from the source zone under the NP1 building and over time replenishing the outer plume that is being treated.

The peaks within the data are seen throughout the pumping works and throughout the electrokinetic trial. It is the seasonal variation and mass flux of nickel that means the electrokinetic trial cannot show a smooth reduction in concentration over time. However, the short-term results are still positive and indicate the suitability of this technique in the field, along with the long-term results that show the cathode can be maintained at a very low level.

Figure 2 – Dissolved Phase Nickel Concentrations in the Field Trial Cell – June 2019 to October 2019 Surfer Plots

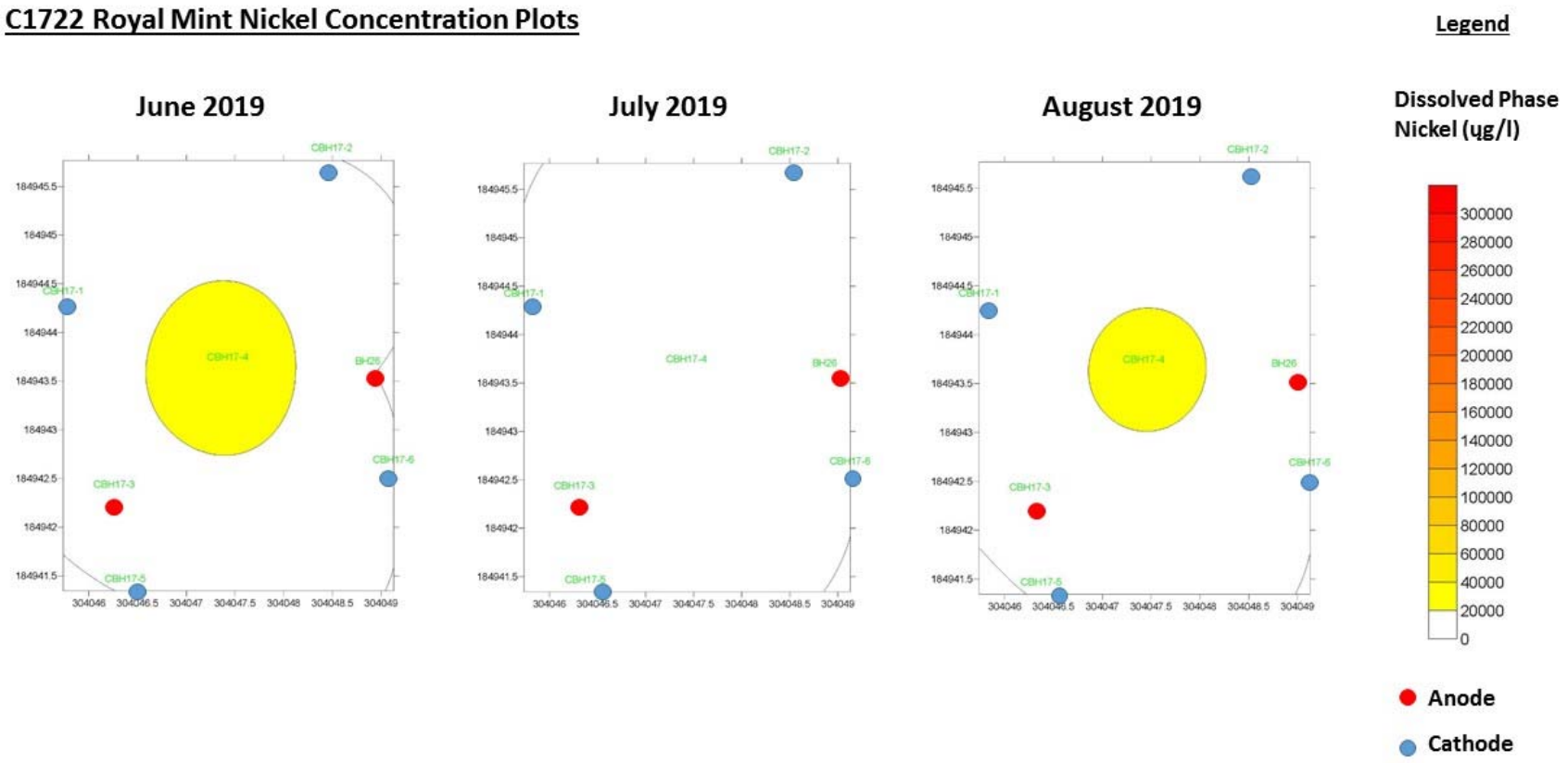


Figure 3 – Dissolved Phase Nickel Concentrations in the Field Trial Cell – June 2019 to October 2019 Surfer Plots- continued

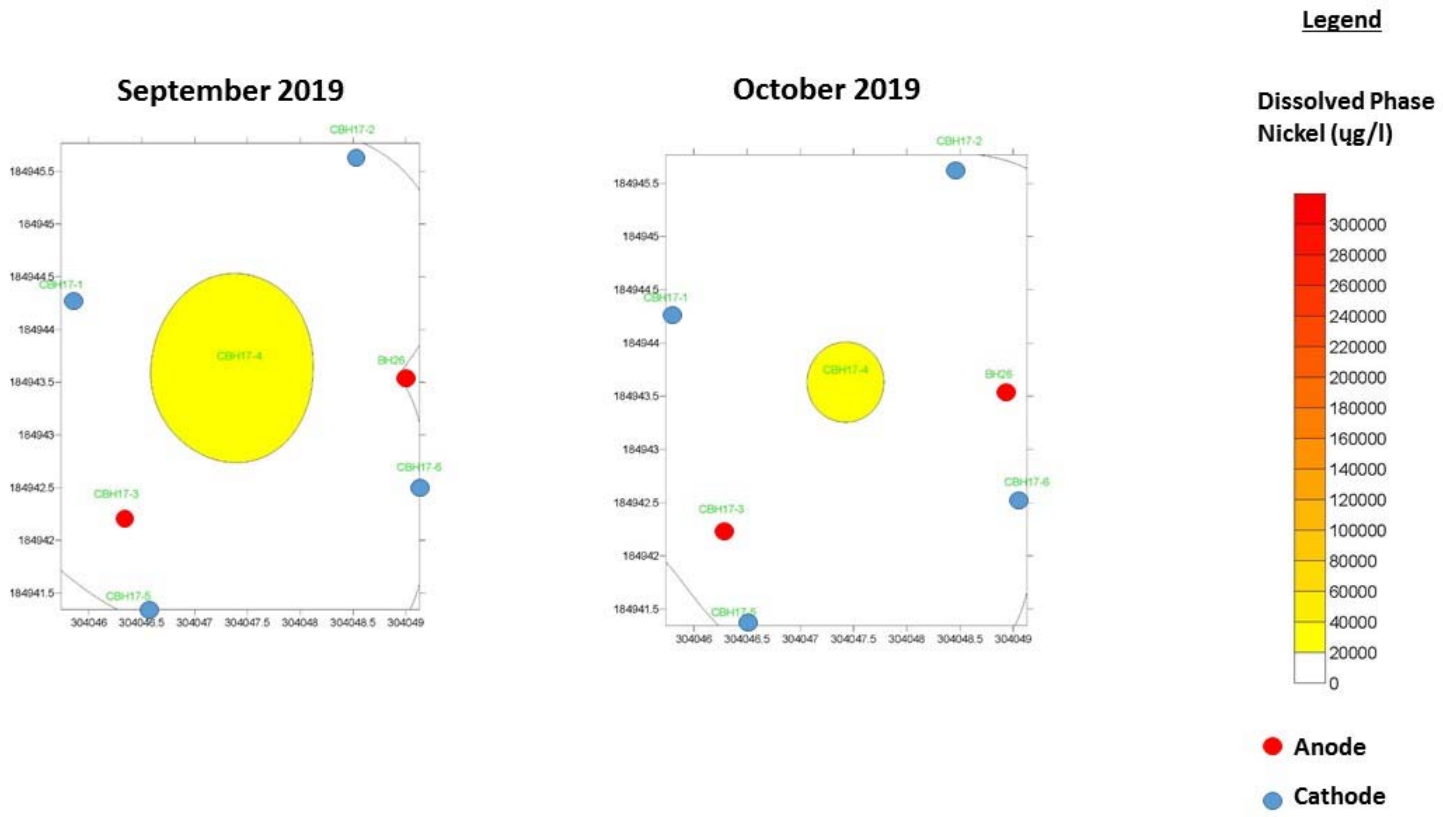


Figure 4 – Nickel Concentration over time – March 2010 – September 2019

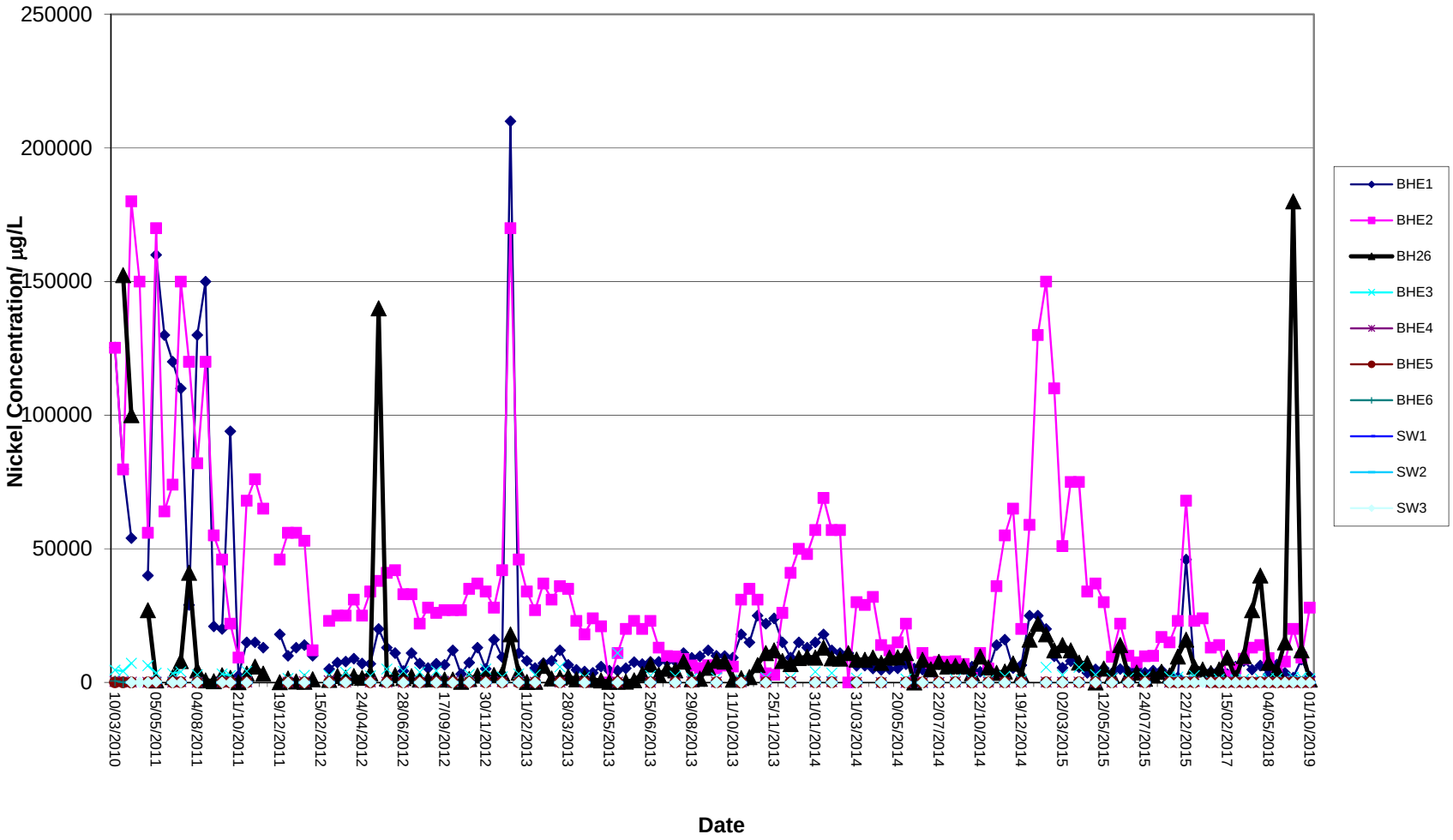
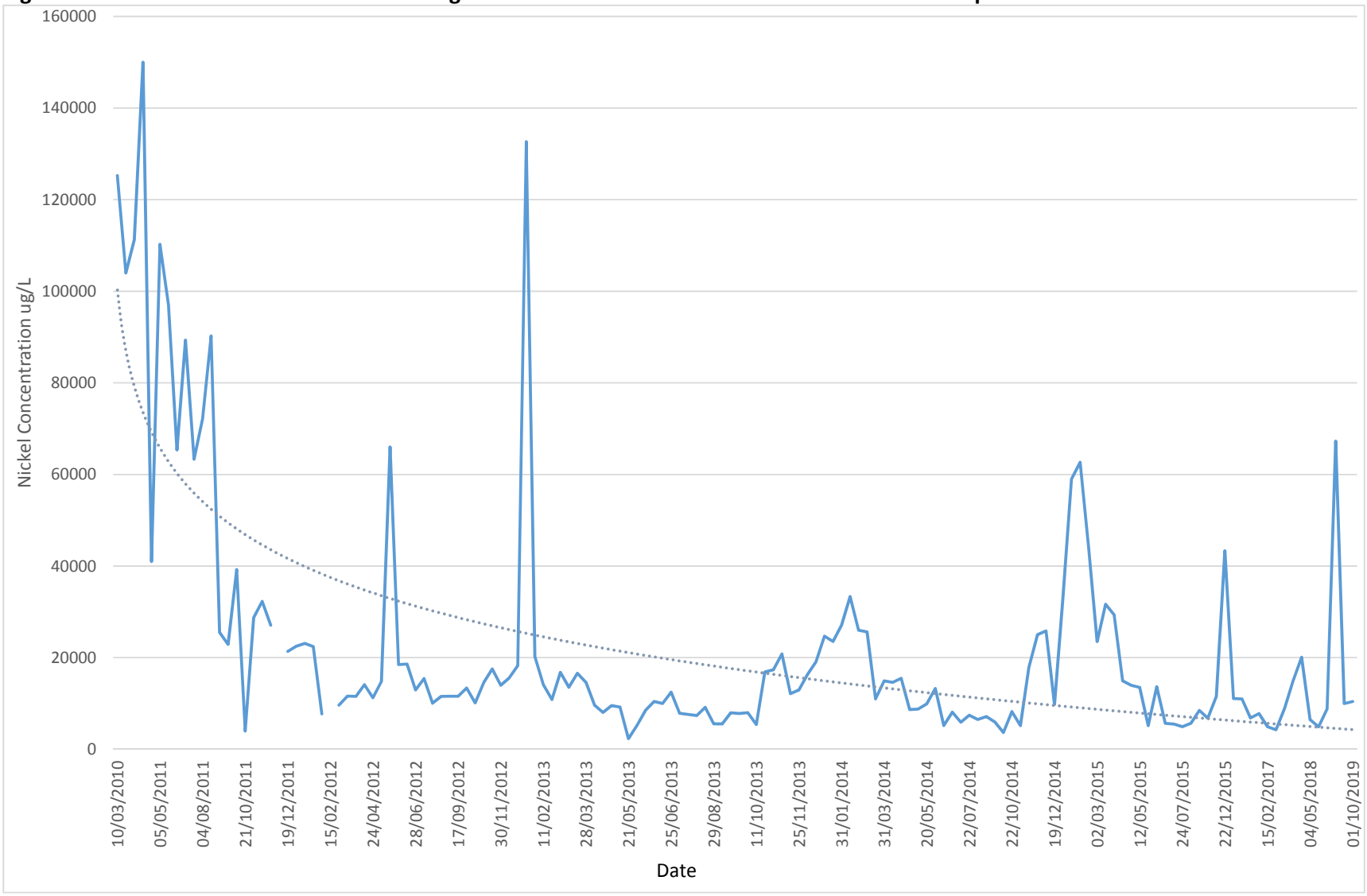


Figure 5 – NP1 Contamination Plume – Average Nickel Concentration over time – March 2010 – September 2019



4.0 CONCLUSIONS

- The electrokinetic extended field trials have been successful to date and are to continue at present until March 2020. This report updates the recently submitted data from the June 2019 Field Trial Report to include data up until the 18th October 2019 (before the rods were changed from mild steel rods to solid stainless steel rods).

- During the extended trials long term data has been collected to assess the comparison of stainless steel and mild steel as electrodes.

- Stainless steel electrodes have been proven to not show degradation for very long periods of time, however, mild steel electrodes have been shown to have approximately a 4-month timeframe prior to degradation.

- The extended field trial has indicated that stainless steel and mild steel electrodes maintain the nickel concentration at the cathode monitoring well at a significantly reduced level, below the derived NRW agreed remedial target, and compared to the baseline reading for extended periods of time.

- NRW have indicated their preference for stainless steel rods, due to their better lifespan and efficiency, in their Compliance Assessment Report (dated 8th August 2019) and in recent discussions; as previously discussed, the rods were changed to solid stainless steel at the end of October and therefore results following this change will be discussed in the next full Field Trial Report.

- The electrokinetic cell generally maintains a 95% reduction in nickel concentrations across the anode – cathode.

- The addition of two electrodes in the treatment cell during March 2019 has further decreased the dissolved phase nickel concentrations within the cell. This configuration will continue until March 2020.

- Throughout the works to the periphery of the plume (pumping works and electrokinetic trials) the overall outer plume has been shown to have reduced by 92% over 9 years, despite seasonal fluctuations and continual mass flux of nickel from the source zone.

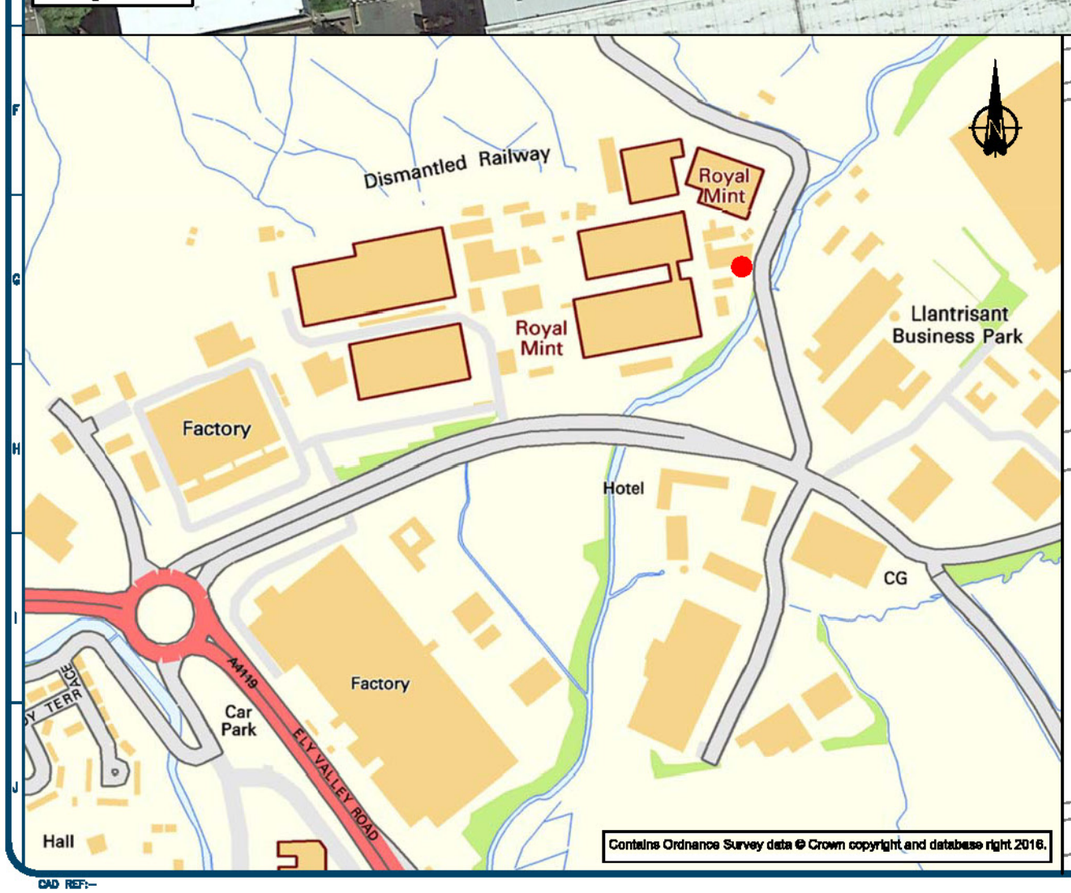
- The electrokinetic trial will continue until March 2020.

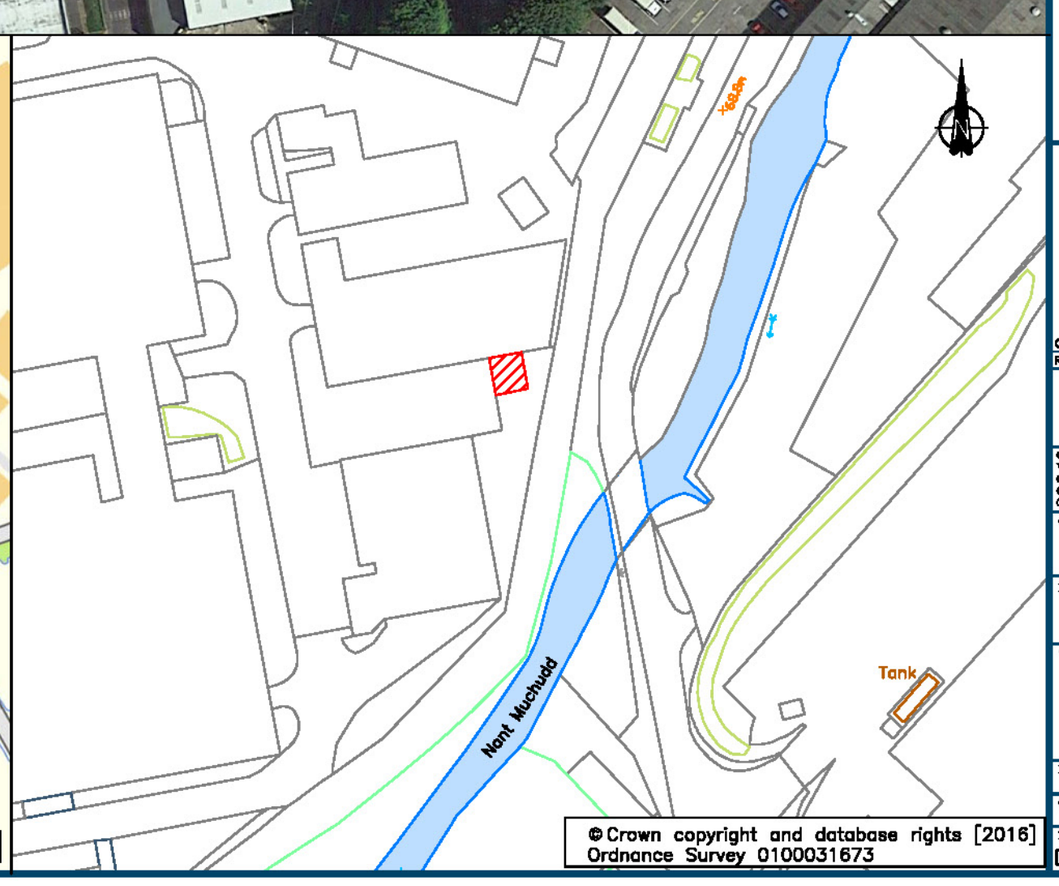
- If the Royal Mint Effluent Treatment Plant can accept the groundwater, Celtic would like to propose pumping from the monitoring wells and from the anodes to enhance the mass removal of Nickel over time. The Abstraction License for this remains in place. Celtic are currently discussing this with the Royal Mint.

APPENDICES

Appendix A

Drawings





Legend

Site Co-ords:
304048.45,184943.14

Field Trial Area

REV	COMMENT	DATE
0	ISSUED FOR COMMENT	01/08/17

Celtic enGlobe
Columbus House
Village Way
Cardiff
CF15 7NE
029 2036 8836
enquiries@celtic-ltd.com
www.celtic-ltd.com

Client
The Royal Mint

Project
Royal Mint,Pontyclun

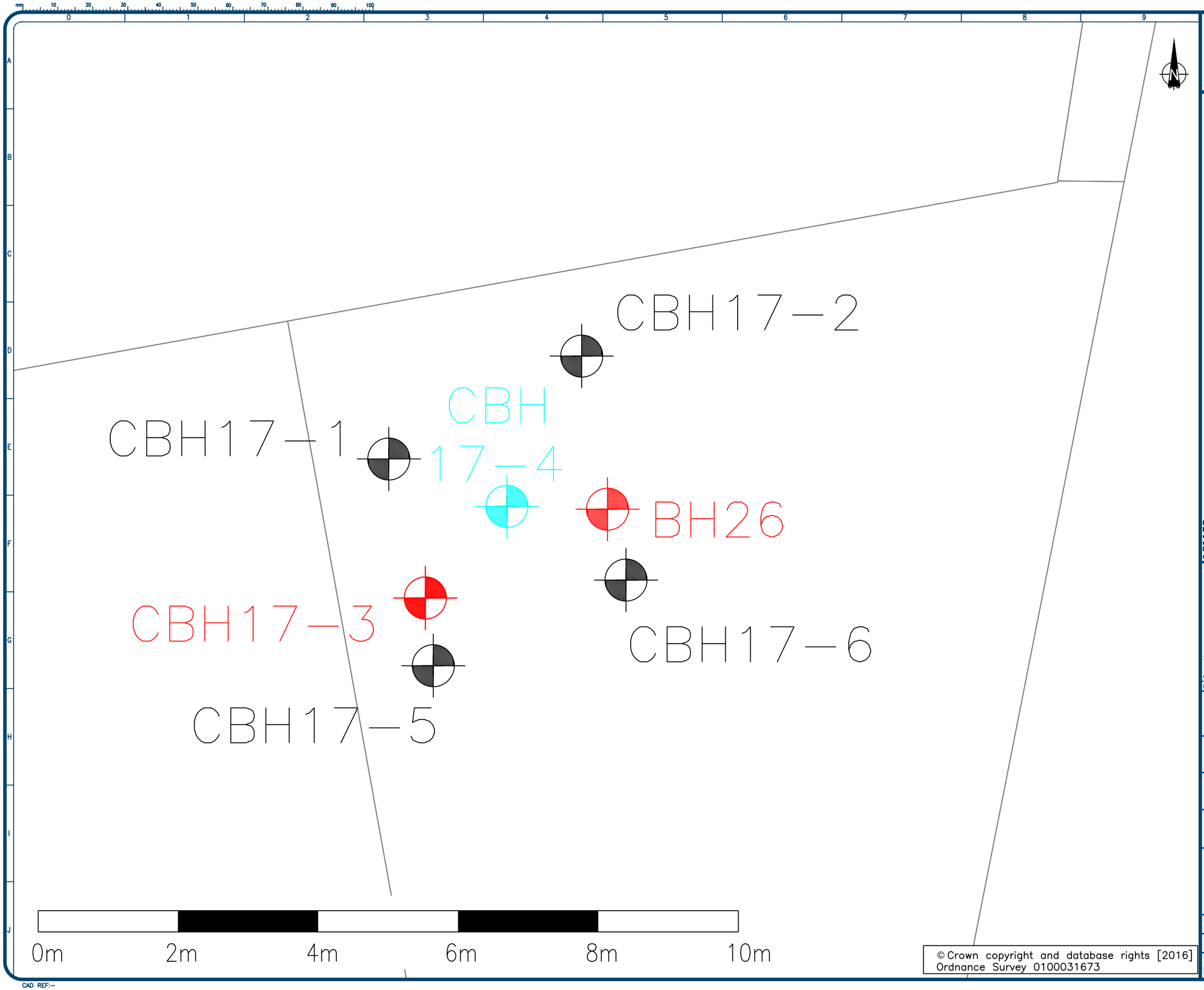
Title
Site Location Plan

Drawn by	Checked Date	Authorised Date
GEP	ME 01/08/17	KD 01/08/17

Original Scale	Date	Rev	Paper
N.T.S	01/08/17	0	A3

Drawing Number
D1722/4822/A1

CAD REF:-



Legend

- Monitoring Well
- Cathode Well
- Anode Well

Please note: Reasonable care and diligence has been taken in detecting and recording the locations of services. There is the possibility that further undetected services are present on the site. Actual locations routes and depths are to be checked on site prior to any excavation/construction works.

REV	COMMENT	DATE
2	Drawing Updates	01/07/19
1	Borehole Locations Surveyed	14/03/17
0	ISSUED FOR COMMENT	31/01/17

Celtic enGlobe
Columbus House
Village Way
Cardiff
CF15 7NE
029 2036 8636
enquiries@celtic-ltd.com
www.celtic-ltd.com

Client
The Royal Mint

Project
Royal Mint,Pontyclun

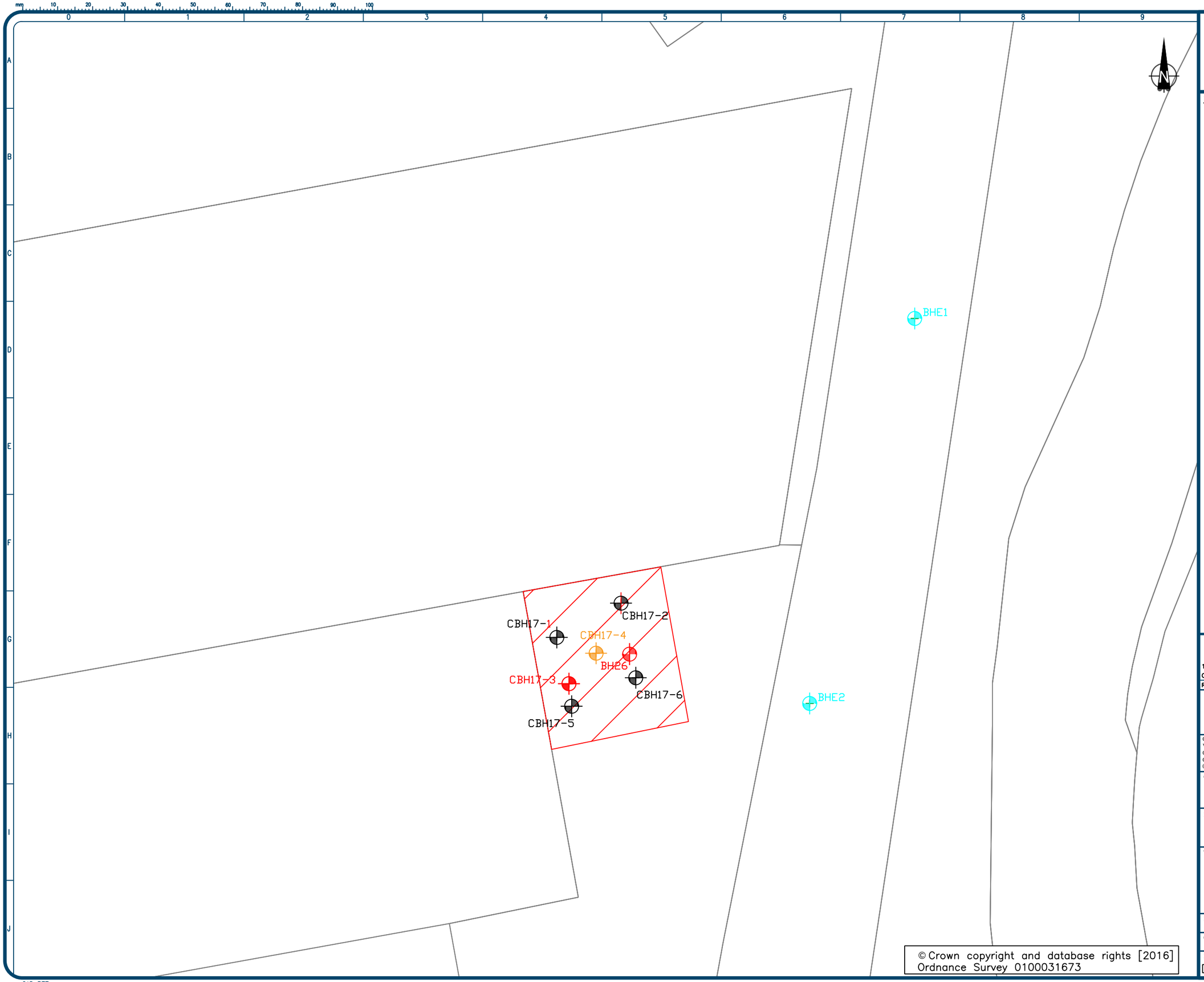
Title
Current Electrode Arrangements

Drawn by	Checked Date	Authorised Date
GEP	ME 31/01/17	JT 02/07/19

Original Scale	Date	Rev	Paper
1:50	31/01/17	1	A3

Drawing Number
D1722/4953/A2

CAD REF:–



Legend

- Pilot Trial Area
- Existing Monitoring Well
- Anode
- Cathode
- Monitoring Well

REV	COMMENT	DATE
1	Drawing Amended	02/07/19
0	ISSUED FOR COMMENT	23/11/17

Celtic enGlobe
Columbus House
Village Way
Cardiff
CF15 7NE
029 2036 8636
enquiries@celtic-ltd.com
www.celtic-ltd.com

Client: The Royal Mint

Project: Royal Mint,Pontyclun

Title: Pilot Trial System Treatment Well Layout

Drawn by	Checked Date	Authorised Date
LP	KD 23/11	

Original Scale	Date	Rev	Paper
1:150	23/11/17	0	A3

Drawing Number: D1722/4953/A3

CAD REF:-

Appendix B

Chemical Analysis Results

Electrokinetic Trial Treatment Wells
Chemical Analysis Results

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.:	19-18934-1
Initial Date of Issue:	10-Jun-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Dennis Paul Lambe Stephen Kidley Katie Walker
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	05-Jun-2019
Order No.:	79251	**Date Instructed:**	05-Jun-2019
No. of Samples:	7		
Turnaround (Wkdays):	5	**Results Due:**	11-Jun-2019
Date Approved:	07-Jun-2019		

Approved By:

Details: Robert Monk, Technical Manager

Chemtest
The right chemistry to deliver results

Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-18934	19-18934	19-18934	19-18934	19-18934	19-18934	19-18934
Quotation No.:		**Chemtest Sample ID.:**			837941	837942	837943	837944	837945	837946	837947
		Client Sample ID.:			CBH 17-1	CBH 17-2	CBH 17-3	CBH 17-4	CBH 17-5	CBH 17-6	BH26
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled:			03-Jun-2019	03-Jun-2019	03-Jun-2019	03-Jun-2019	03-Jun-2019	03-Jun-2019	03-Jun-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
pH	U	1010		N/A	11.8	11.7	7.2	7.5	12.1	11.8	7.4
Nickel (Dissolved)	U	1450	µg/l	1.0	9.3	77	5100	19000	160	39	9500

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

Chemtest
The right chemistry to deliver results

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.:	19-20499-1
Initial Date of Issue:	24-Jun-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Dennis Paul Lambe Katie Walker Stephen Kidley
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	19-Jun-2019
Order No.:	79251	**Date Instructed:**	19-Jun-2019
No. of Samples:	7		
Turnaround (Wkdays):	5	**Results Due:**	25-Jun-2019
Date Approved:	24-Jun-2019		

Approved By:

Details: Robert Monk, Technical Manager

Chemtest
The right chemistry to deliver results

Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-20499	19-20499	19-20499	19-20499	19-20499	19-20499	19-20499
Quotation No.:		**Chemtest Sample ID.:**			844685	844686	844687	844688	844689	844690	844691
		Client Sample ID.:			CBH	CBH	CBH	CBH	CBH	CBH	BH
		Sample Location:			17-1	17-2	17-3	17-4	17-5	17-6	26
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled:			17-Jun-2019	17-Jun-2019	17-Jun-2019	17-Jun-2019	17-Jun-2019	17-Jun-2019	17-Jun-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
pH	U	1010		N/A	10.4	10.3	7.0	7.2	8.3	9.2	7.6
Nickel (Dissolved)	U	1450	mg/l	0.0010	0.0068	0.14	5.4	11	0.51	0.12	8.2

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

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Report Information

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Sample Retention and Disposal

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UKAS TESTING
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Final Report

Report No.:	19-25637-1
Initial Date of Issue:	02-Aug-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Dennis Katie Walker Paul Lambe Stephen Kidley
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	31-Jul-2019
Order No.:	79981	**Date Instructed:**	31-Jul-2019
No. of Samples:	7		
Turnaround (Wkdays):	5	**Results Due:**	06-Aug-2019
Date Approved:	02-Aug-2019		

Approved By:

Details: Amy Parekh-Pross, Technical Projects Manager

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Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd					**Chemtest Job No.:**	19-25637	19-25637	19-25637	19-25637	19-25637	19-25637
Quotation No.:					**Chemtest Sample ID.:**	866014	866015	866016	866017	866018	866019	866020
Order No.: 79981					Client Sample Ref.:	17 - 1	17 - 2	17 - 3	17 - 4	17 - 5	17 - 6	26
					Sample Location:	CBH	CBH	CBH	CBH	CBH	CBH	BH
					Sample Type:	WATER	WATER	WATER	WATER	WATER	WATER	WATER
					Date Sampled:	29-Jul-2019	29-Jul-2019	29-Jul-2019	29-Jul-2019	29-Jul-2019	29-Jul-2019	29-Jul-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**								
pH	U	1010		N/A		12.2	11.7	10.0	8.5	10.9	10.6	8.2
Nickel (Dissolved)	U	1450	µg/l	1.0		24	200	3500	6100	76	68	6500

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

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Final Report

Report No.:	19-22233-1
Initial Date of Issue:	08-Jul-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Dennis Katie Walker Paul Lambe Stephen Kidley
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	02-Jul-2019
Order No.:	79251	**Date Instructed:**	02-Jul-2019
No. of Samples:	7		
Turnaround (Wkdays):	5	**Results Due:**	08-Jul-2019
Date Approved:	08-Jul-2019		

Approved By:

Details: Robert Monk, Technical Manager

Chemtest
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Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-22233	19-22233	19-22233	19-22233	19-22233	19-22233	19-22233
Quotation No.:		**Chemtest Sample ID.:**			851954	851955	851956	851957	851958	851959	851960
Order No.: 79251		Client Sample Ref.:			4	17-1	17-2	17-3	17-4	17-5	17-6
		Sample Location:			SW	CBH	CBH	CBH	CBH	CBH	CBH
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled:			28-Jun-2019	28-Jun-2019	28-Jun-2019	28-Jun-2019	28-Jun-2019	28-Jun-2019	28-Jun-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
Total Hardness as CaCO3	U	1270	mg/l	15	73						
Arsenic (Dissolved)	U	1450	µg/l	1.0	< 1.0						
Boron (Dissolved)	U	1450	µg/l	20	< 20						
Cadmium (Dissolved)	U	1450	µg/l	0.080	< 0.080						
Chromium (Dissolved)	U	1450	µg/l	1.0	< 1.0						
Copper (Dissolved)	U	1450	µg/l	1.0	< 1.0						
Mercury (Dissolved)	U	1450	µg/l	0.50	< 0.50						
Nickel (Dissolved)	U	1450	µg/l	1.0	< 1.0	9.8	18	21000	8700	150	19
Lead (Dissolved)	U	1450	µg/l	1.0	< 1.0						
Selenium (Dissolved)	U	1450	µg/l	1.0	< 1.0						
Zinc (Dissolved)	U	1450	µg/l	1.0	1.5						

Test Methods

SOP	Title	Parameters included	Method summary
1270	Total Hardness of Waters	Total hardness	Calculation applied to calcium and magnesium results, expressed as mg l-1 CaCO3 equivalent.
1415	Cations in Waters by ICP-MS	Sodium; Potassium; Calcium; Magnesium	Direct determination by inductively coupled plasma - mass spectrometry (ICP-MS).
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

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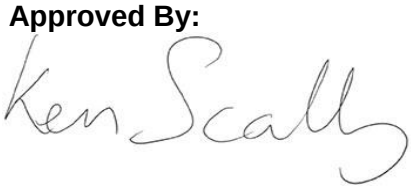
Final Report

Report No.:	19-26465-1
Initial Date of Issue:	09-Aug-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Dennis Katie Walker Kirsty Sweeny Paul Lambe Stephen Kidley
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	07-Aug-2019
Order No.:	79981	**Date Instructed:**	07-Aug-2019
No. of Samples:	7		
Turnaround (Wkdays):	5	**Results Due:**	13-Aug-2019
Date Approved:	09-Aug-2019		

Approved By:



Details: Ken Scally, Technical Director

Chemtest
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Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-26465	19-26465	19-26465	19-26465	19-26465	19-26465	19-26465
Quotation No.:		**Chemtest Sample ID.:**			869553	869554	869555	869556	869557	869558	869559
		Sample Location:			CBH 17-1	CBH 17-2	CBH 17-3	CBH 17-4	CBH 17-5	CBH 17-6	BH 26
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled:			05-Aug-2019	05-Aug-2019	05-Aug-2019	05-Aug-2019	05-Aug-2019	05-Aug-2019	05-Aug-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
pH	U	1010		N/A	11.5	10.6	8.4	8.4	9.6	9.3	8.3
Nickel (Dissolved)	U	1450	µg/l	1.0	28	160	4500	8700	310	210	9800

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

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UKAS TESTING
2183

Final Report

Report No.:	19-28560-1
Initial Date of Issue:	29-Aug-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Dennis Katie Walker Paul Lambe Stephen Kidley
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	27-Aug-2019
Order No.:	79981	**Date Instructed:**	27-Aug-2019
No. of Samples:	7		
Turnaround (Wkdays):	5	**Results Due:**	02-Sep-2019
Date Approved:	29-Aug-2019		

Approved By:

Details: Amy Parekh-Pross, Technical Projects Manager

Chemtest
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Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-28560	19-28560	19-28560	19-28560	19-28560	19-28560	19-28560
Quotation No.:		**Chemtest Sample ID.:**			878739	878740	878741	878742	878743	878744	878745
		Sample Location:			CBH 17-1	CBH 17-2	CBH 17-3	CBH 17-4	CBH 17-5	CBH 17-6	BH26
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled:			23-Aug-2019	23-Aug-2019	23-Aug-2019	23-Aug-2019	23-Aug-2019	23-Aug-2019	23-Aug-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
pH	U	1010		N/A	11.8	12.1	6.5	7.5	12.2	11.9	6.5
Nickel (Dissolved)	U	1450	µg/l	1.0	83	110	< 1.0	16000	130	53	100

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

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Initial Date of Issue:	29-Aug-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Dennis Katie Walker Paul Lambe Stephen Kidley
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	27-Aug-2019
Order No.:	79981	**Date Instructed:**	27-Aug-2019
No. of Samples:	7		
Turnaround (Wkdays):	5	**Results Due:**	02-Sep-2019
Date Approved:	29-Aug-2019		

Approved By:

Details: Amy Parekh-Pross, Technical Projects Manager

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Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-28560	19-28560	19-28560	19-28560	19-28560	19-28560	19-28560
Quotation No.:		**Chemtest Sample ID.:**			878739	878740	878741	878742	878743	878744	878745
		Sample Location:			CBH 17-1	CBH 17-2	CBH 17-3	CBH 17-4	CBH 17-5	CBH 17-6	BH26
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled:			23-Aug-2019	23-Aug-2019	23-Aug-2019	23-Aug-2019	23-Aug-2019	23-Aug-2019	23-Aug-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
pH	U	1010		N/A	11.8	12.1	6.5	7.5	12.2	11.9	6.5
Nickel (Dissolved)	U	1450	µg/l	1.0	83	110	< 1.0	16000	130	53	100

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

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Final Report

Report No.:	19-30181-1
Initial Date of Issue:	13-Sep-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Dennis Katie Walker Paul Lambe Stephen Kidley
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	09-Sep-2019
Order No.:	79981	**Date Instructed:**	09-Sep-2019
No. of Samples:	7		
Turnaround (Wkdays):	5	**Results Due:**	13-Sep-2019
Date Approved:	13-Sep-2019		

Approved By:

Details: Amy Parekh-Pross, Technical Projects Manager

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Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-30181	19-30181	19-30181	19-30181	19-30181	19-30181	19-30181
Quotation No.:		**Chemtest Sample ID.:**			885282	885283	885284	885285	885286	885287	885288
		Sample Location:			CBH 17-1	CBH 17-2	CBH 17-3	CBH 17-4	CBH 17-5	CBH 17-6	BH 26
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled ($):			06-Sep-2019	06-Sep-2019	06-Sep-2019	06-Sep-2019	06-Sep-2019	06-Sep-2019	06-Sep-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
pH	U	1010		N/A	10.8	12.3	9.5	8.0	12.0	12.1	8.2
Nickel (Dissolved)	U	1450	µg/l	1.0	80	100	600	30000	260	27	3000

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

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Sample Retention and Disposal

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If you require extended retention of samples, please email your requirements to:
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Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.:	19-31307-1
Initial Date of Issue:	23-Sep-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Dennis Katie Walker Paul Lambe Stephen Kidley
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	18-Sep-2019
Order No.:	79981	**Date Instructed:**	18-Sep-2019
No. of Samples:	7		
Turnaround (Wkdays):	5	**Results Due:**	24-Sep-2019
Date Approved:	23-Sep-2019		

Approved By:

Details: Robert Monk, Technical Manager

Chemtest
The right chemistry to deliver results

Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-31307	19-31307	19-31307	19-31307	19-31307	19-31307	19-31307
Quotation No.:		**Chemtest Sample ID.:**			890654	890655	890656	890657	890658	890659	890660
		Sample Location:			CBH 17-1	CBH 17-2	CBH 17-3	CBH 17-4	CBH 17-5	CBH 17-6	BH 26
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled ($):			16-Sep-2019	16-Sep-2019	16-Sep-2019	16-Sep-2019	16-Sep-2019	16-Sep-2019	16-Sep-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
pH	U	1010		N/A	12.0	11.7	8.9	9.4	10.9	11.8	7.7
Nickel (Dissolved)	U	1450	µg/l	1.0	110	200	4600	40000	200	67	510

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

Report Information

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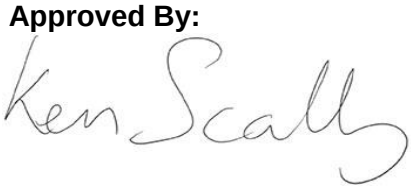
Amended Report

Report No.:	19-33538-2		
Initial Date of Issue:	14-Oct-2019	**Date of Re-Issue:**	28-Oct-2019
Client	Celtic Ltd		
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE		
Contact(s):	Katie Walker Kirsty Sweeny Paul Lambe Stephen Kidley		
Project	C1722 Royal Mint		
Quotation No.:		**Date Received:**	08-Oct-2019
Order No.:	79981	**Date Instructed:**	08-Oct-2019
No. of Samples:	7		
Turnaround (Wkdays):	5	**Results Due:**	14-Oct-2019
Date Approved:	14-Oct-2019		

Approved By:



Details: Ken Scally, Technical Director

Chemtest
The right chemistry to deliver results

Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-33538	19-33538	19-33538	19-33538	19-33538	19-33538	19-33538
Quotation No.:		**Chemtest Sample ID.:**			901548	901549	901550	901551	901552	901553	901554
		Sample Location:			CBH 17.1	CBH 17.2	CBH 17.3	CBH 17.4	CBH 17.5	CBH 17.6	BH 26
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled ($):			07-Oct-2019	07-Oct-2019	07-Oct-2019	07-Oct-2019	07-Oct-2019	07-Oct-2019	07-Oct-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
pH	U	1010		N/A	12.5	12.5	5.3	6.7	12.4	12.4	6.5
Nickel (Dissolved)	U	1450	µg/l	1.0	130	8.9	5000	18000	410	30	1600

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

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Final Report

Report No.:	19-35105-1
Initial Date of Issue:	28-Oct-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Dennis Katie Walker Kirsty Sweeny Paul Lambe Stephen Kidley
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	21-Oct-2019
Order No.:	79981	**Date Instructed:**	21-Oct-2019
No. of Samples:	7		
Turnaround (Wkdays):	5	**Results Due:**	25-Oct-2019
Date Approved:	28-Oct-2019		

Approved By:

Details: Glynn Harvey, Laboratory Manager

Chemtest
The right chemistry to deliver results

Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-35105	19-35105	19-35105	19-35105	19-35105	19-35105	19-35105
Quotation No.:		**Chemtest Sample ID.:**			909327	909328	909329	909330	909331	909332	909333
		Sample Location:			CBH 17-1	CBH 17-2	CBH 17-3	CBH 17-4	CBH 17-5	CBH 17-6	BH 26
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled ($):			18-Oct-2019	18-Oct-2019	18-Oct-2019	18-Oct-2019	18-Oct-2019	18-Oct-2019	18-Oct-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
pH	U	1010		N/A	12.3	12.0	7.4	7.8	12.0	11.8	7.1
Nickel (Dissolved)	U	1450	µg/l	1.0	150	31	2100	26000	270	44	4300

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

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Final Report

Report No.:	19-35948-1
Initial Date of Issue:	30-Oct-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Walker Kirsty Sweeny Paul Lambe Stephen Kidley
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	28-Oct-2019
Order No.:	79981	**Date Instructed:**	28-Oct-2019
No. of Samples:	7		
Turnaround (Wkdays):	5	**Results Due:**	01-Nov-2019
Date Approved:	30-Oct-2019		

Approved By:

Details: Robert Monk, Technical Manager

Chemtest
The right chemistry to deliver results

Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-35948	19-35948	19-35948	19-35948	19-35948	19-35948	19-35948
Quotation No.:		**Chemtest Sample ID.:**			913431	913432	913433	913434	913435	913436	913437
		Sample Location:			CBH 17-1	CBH 17-2	CBH 17-3	CBH 17-4	CBH 17-5	CBH 17-6	BH 26
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled ($):			25-Oct-2019	25-Oct-2019	25-Oct-2019	25-Oct-2019	25-Oct-2019	25-Oct-2019	25-Oct-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**							
pH	U	1010		N/A	12.2	11.4	11.4	7.9	11.7	11.7	8.4
Nickel (Dissolved)	U	1450	µg/l	1.0	140	18	1100	27000	470	58	15000

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

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Final Report

Report No.:	19-22221-1
Initial Date of Issue:	08-Jul-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Dennis Paul Lambe Katie Walker Stephen Kidley
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	02-Jul-2019
Order No.:	79981	**Date Instructed:**	02-Jul-2019
No. of Samples:	12		
Turnaround (Wkdays):	5	**Results Due:**	08-Jul-2019
Date Approved:	08-Jul-2019		

Approved By:

Details: Robert Monk, Technical Manager

Chemtest
The right chemistry to deliver results

Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd					**Chemtest Job No.:**	19-22221	19-22221	19-22221	19-22221	19-22221	19-22221	19-22221	19-22221	19-22221
Quotation No.:					**Chemtest Sample ID.:**	851903	851904	851905	851906	851907	851908	851909	851910	851911	851912
Order No.: 79981					Client Sample Ref.:	1	2	3	4	5	6	26	A	0	1
					Sample Location:	BHE	BHE	BHE	BHE	BHE	BHE	BH	SW	SW	SW
					Sample Type:	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
					Date Sampled:	28-Jun-2019	28-Jun-2019	28-Jun-2019	28-Jun-2019	28-Jun-2019	28-Jun-2019	28-Jun-2019	28-Jun-2019	28-Jun-2019	28-Jun-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**											
Total Hardness as CaCO3	U	1270	mg/l	15		100	89	170	83	84	74	90	68		72
Arsenic (Dissolved)	U	1450	µg/l	1.0		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		< 1.0
Boron (Dissolved)	U	1450	µg/l	20		1100	970	130	46	28	28	730	60		24
Cadmium (Dissolved)	U	1450	µg/l	0.080		0.19	0.32	< 0.080	< 0.080	< 0.080	< 0.080	14	0.40		< 0.080
Chromium (Dissolved)	U	1450	µg/l	1.0		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		< 1.0
Copper (Dissolved)	U	1450	µg/l	1.0		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	160	4.6		< 1.0
Mercury (Dissolved)	U	1450	µg/l	0.50		< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50		< 0.50
Nickel (Dissolved)	U	1450	µg/l	1.0		15000	15000	1200	68	8.7	6.2	6900	170	8.2	2.9
Lead (Dissolved)	U	1450	µg/l	1.0		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		< 1.0
Selenium (Dissolved)	U	1450	µg/l	1.0		1.2	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		< 1.0
Zinc (Dissolved)	U	1450	µg/l	1.0		6.7	2.0	14	1.3	< 1.0	< 1.0	4.8	3.7		< 1.0

Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd			**Chemtest Job No.:**	19-22221	19-22221
Quotation No.:			**Chemtest Sample ID.:**	851913	851914
Order No.: 79981			Client Sample Ref.:	2	3
			Sample Location:	SW	SW
			Sample Type:	WATER	WATER
			Date Sampled:	28-Jun-2019	28-Jun-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**		
Total Hardness as CaCO3	U	1270	mg/l	15	70	73
Arsenic (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0
Boron (Dissolved)	U	1450	µg/l	20	21	< 20
Cadmium (Dissolved)	U	1450	µg/l	0.080	< 0.080	< 0.080
Chromium (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0
Copper (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0
Mercury (Dissolved)	U	1450	µg/l	0.50	< 0.50	< 0.50
Nickel (Dissolved)	U	1450	µg/l	1.0	1.6	1.4
Lead (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0
Selenium (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0
Zinc (Dissolved)	U	1450	µg/l	1.0	< 1.0	2.2

Test Methods

SOP	Title	Parameters included	Method summary
1270	Total Hardness of Waters	Total hardness	Calculation applied to calcium and magnesium results, expressed as mg l-1 CaCO3 equivalent.
1415	Cations in Waters by ICP-MS	Sodium; Potassium; Calcium; Magnesium	Direct determination by inductively coupled plasma - mass spectrometry (ICP-MS).
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

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UKAS TESTING
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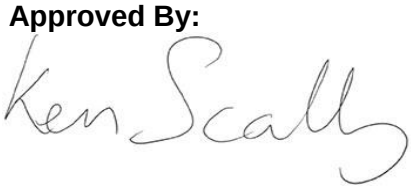
Final Report

Report No.:	19-33142-1
Initial Date of Issue:	10-Oct-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Dennis Paul Lambe
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	03-Oct-2019
Order No.:	79981	**Date Instructed:**	03-Oct-2019
No. of Samples:	19		
Turnaround (Wkdays):	5	**Results Due:**	09-Oct-2019
Date Approved:	10-Oct-2019		

Approved By:



Details: Ken Scally, Technical Director

Chemtest
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Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-33142	19-33142	19-33142	19-33142	19-33142	19-33142	19-33142	19-33142	19-33142	19-33142
Quotation No.:		**Chemtest Sample ID.:**			899516	899517	899518	899519	899520	899521	899522	899524	899525	899526
		Sample Location:			BHE 1	BHE 2	BHE 3	BHE 4	BHE 5	BHE 6	BH26	SW0	SW1	SW2
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled ($):			01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**										
Total Hardness as CaCO3	U	1270	mg/l	15	100	190	180	130	92	80	19		40	40
Arsenic (Dissolved)	U	1450	µg/l	1.0	1.5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		< 1.0	< 1.0
Boron (Dissolved)	U	1450	µg/l	20	160	1100	59	36	< 20	< 20	160		< 20	< 20
Cadmium (Dissolved)	U	1450	µg/l	0.080	< 0.080	0.32	< 0.080	< 0.080	< 0.080	< 0.080	< 0.080		< 0.080	< 0.080
Chromium (Dissolved)	U	1450	µg/l	1.0	5.5	< 1.0	< 1.0	< 1.0	14	< 1.0	< 1.0		< 1.0	< 1.0
Copper (Dissolved)	U	1450	µg/l	1.0	110	34	8.8	< 1.0	< 1.0	< 1.0	< 1.0		1.2	< 1.0
Mercury (Dissolved)	U	1450	µg/l	0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50		< 0.50	< 0.50
Nickel (Dissolved)	U	1450	µg/l	1.0	2200	28000	1400	150	41	7.6	1100	2.0	2.2	< 1.0
Lead (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		< 1.0	< 1.0
Selenium (Dissolved)	U	1450	µg/l	1.0	< 1.0	1.8	1.7	1.0	< 1.0	< 1.0	3.4		< 1.0	< 1.0
Zinc (Dissolved)	U	1450	µg/l	1.0	20	380	< 1.0	< 1.0	< 1.0	< 1.0	11		< 1.0	< 1.0

Chemtest
The right chemistry to deliver results

Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-33142	19-33142	19-33142	19-33142	19-33142	19-33142	19-33142	19-33142
Quotation No.:		**Chemtest Sample ID.:**			899527	899528	899529	899530	899531	899532	899533	899534
		Sample Location:			SW3	SW4	CBH17-1	CBH17-2	CBH17-3	CBH17-4	CBH17-5	CBH17-6
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled ($):			01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**								
Total Hardness as CaCO3	U	1270	mg/l	15	41							
Arsenic (Dissolved)	U	1450	µg/l	1.0	< 1.0							
Boron (Dissolved)	U	1450	µg/l	20	< 20							
Cadmium (Dissolved)	U	1450	µg/l	0.080	< 0.080							
Chromium (Dissolved)	U	1450	µg/l	1.0	< 1.0							
Copper (Dissolved)	U	1450	µg/l	1.0	2.2							
Mercury (Dissolved)	U	1450	µg/l	0.50	< 0.50							
Nickel (Dissolved)	U	1450	µg/l	1.0	1.4	< 1.0	160	410	310	2500	1100	140
Lead (Dissolved)	U	1450	µg/l	1.0	< 1.0							
Selenium (Dissolved)	U	1450	µg/l	1.0	< 1.0							
Zinc (Dissolved)	U	1450	µg/l	1.0	< 1.0							

Test Methods

SOP	Title	Parameters included	Method summary
1270	Total Hardness of Waters	Total hardness	Calculation applied to calcium and magnesium results, expressed as mg l-1 CaCO3 equivalent.
1415	Cations in Waters by ICP-MS	Sodium; Potassium; Calcium; Magnesium	Direct determination by inductively coupled plasma - mass spectrometry (ICP-MS).
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
$	This information has been supplied by the client and can affect the integrity of test data.

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

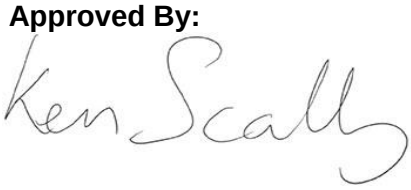
UKAS TESTING
2183

Final Report

Report No.:	19-33142-1
Initial Date of Issue:	10-Oct-2019
Client	Celtic Ltd
Client Address:	Columbus House Greenmeadow Springs Tongwynlais Cardiff Glamorgan CF15 7NE
Contact(s):	Katie Dennis Paul Lambe
Project	C1722 Royal Mint

Quotation No.:		**Date Received:**	03-Oct-2019
Order No.:	79981	**Date Instructed:**	03-Oct-2019
No. of Samples:	19		
Turnaround (Wkdays):	5	**Results Due:**	09-Oct-2019
Date Approved:	10-Oct-2019		

Approved By:



Details: Ken Scally, Technical Director

Chemtest
The right chemistry to deliver results

Results - Water

Project: C1722 Royal Mint

Client: Celtic Ltd		**Chemtest Job No.:**			19-33142	19-33142	19-33142	19-33142	19-33142	19-33142	19-33142	19-33142	19-33142	19-33142
Quotation No.:		**Chemtest Sample ID.:**			899516	899517	899518	899519	899520	899521	899522	899524	899525	899526
		Sample Location:			BHE 1	BHE 2	BHE 3	BHE 4	BHE 5	BHE 6	BH26	SW0	SW1	SW2
		Sample Type:			WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
		Date Sampled ($):			01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019	01-Oct-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**										
Total Hardness as CaCO3	U	1270	mg/l	15	100	190	180	130	92	80	19		40	40
Arsenic (Dissolved)	U	1450	µg/l	1.0	1.5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0		< 1.0	< 1.0
Boron (Dissolved)	U	1450	µg/l	20	160	1100	59	36	< 20	< 20	160		< 20	< 20
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Chemtest
The right chemistry to deliver results

Results - Water

Project: C1722 Royal Mint

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