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4 July 2024

Goodman Limited
The Hayesbury
1-11 Hayes Road
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Attention: Mr James Crouch
Email to: james.crouch@goodman.com
Phone: 0406 619 335

Dear James,

ELECTROLYSIS RISK REPORT
85-97 WATERLOO ROAD, MACQUARIE PARK NSW 2113

As requested, please find attached our report following electrolysis risk testing at the above site.

We trust you find our field services and report satisfactory. However, should you have any queries, please do not hesitate to contact us.

Yours sincerely,

Corrosion Control Engineering (Holdings) Pty Limited

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NACE Cathodic Protection Technologist #200553

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ELECTROLYSIS RISK REPORT

85-97 WATERLOO ROAD, MACQUARIE PARK NSW 2113

DOCUMENT NUMBER: N-000173/P100361

REVISION: 0

DATE: 4 July 2024



PURPOSE AND SCOPE

This document was developed to address the following requirements:

- To outline the methodology Corrosion Control Engineering followed during the inspection.
- Present and discuss the results of the inspection.
- Provide recommendations based on our findings

DISTRIBUTION

CLIENT CONTACT NAME AND EMAIL

Mr James Crouch

Contact: 0406 619 335; Email: james.crouch@goodman.com

TECHNICAL REVIEW

CONSULTED PERSON	POSITION/CERTIFICATION	SIGNATURE
Adam Dunn	Corrosion Engineer NACE Cathodic Protection Technologist (#200553)	

DOCUMENT CONTROL

REVISION	DATE	REASON FOR ISSUE	PREPARED	QUALITY CHECK	TECHNICAL APPROVAL
0	4/07/2024	First Issue	E. Cheng	R. Shrestha	A.Dunn

UPDATES SINCE LAST REVISION

New document

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1. Introduction

Corrosion Control Engineering (Holdings) Pty Ltd (CCE) was engaged to assess the electrolysis risk at 85-97 Waterloo Road, Macquarie Park NSW 2113, prior to the construction of the proposed development. As requested, on Monday 24th and Tuesday 25th June 2024, CCE conducted testing on site to measure the stray traction currents due to the Sydney Metro North-West Line. The site runs adjacent to the Sydney Metro corridor.

2. The Electrolysis Problem

Most of the DC current to power the electric trains (trains, metro, and light rail) returns to the railway substations via the rail lines. However, some leaks to ground (stray traction current) and in returning to the substation via this path can be picked up (and discharged) from buried metallic structures, leading to possible electrolysis type corrosion problems. This corrosion of the metal occurs at the discharge point.

The problems can be significant if:

- The metallic structures are sufficiently large or long enough and close to the electrified railway lines.
- The stray traction current leakages to soil are of sufficient frequency and magnitude.

3. Test Method

The in-ground stray traction, causing voltage fluctuations on the development site, was monitored by data logging voltage gradients and potentials with reference to Cu/CuSO₄ as follows:

1. Data logging voltage gradients between steel earth stakes parallel to the rail at the southwest boundary of 97 Waterloo Road. The earth stakes were approximately 35m apart.
2. Data logging voltage gradients between steel earth stakes parallel to the rail at the southwest boundary of 85 Waterloo Road. The earth stakes were approximately 106m apart.
3. Data logging the potential of a fence at the southeast corner of 97 Waterloo Road.
4. Data logging voltage gradients between steel earth stakes perpendicular to the rail at the southeast boundary of 97 Waterloo Road. The earth stakes were approximately 68m apart.
5. Data logging voltage gradients between steel earth stakes perpendicular to the rail at the southeast boundary of 85 Waterloo Road. The earth stakes were approximately 76m apart.
6. Data logging the potential of a Firewater piping at the northwest boundary of 97 Waterloo Road.
7. Data logging the potential of a water pipe at the northeast corner of 85 Waterloo Road.

Note, TfNSW standard 'THRCI 12051 ST: Development Near Rail Tunnels, Version 2.0', and Sydney Metro Guideline 'Sydney Metro Underground Corridor Protection Technical Guidelines, Version 2.0', does not provide any acceptance criteria for stray current effects. The NSW Electrolysis Committee adopts acceptance criteria (low risk) of 20 mV anodic and 100 mV cathodic time weighted average shift over a period of up to 24 hours. Given there are no specified mitigation methods, the conclusions and recommendations in this report are based on CCE's experience in this field.

4. Test Results

A summary of the test results is presented in the following table. The corresponding data logger charts are presented in Appendix A.

Test Number	Data Logging Test Performed	Test Duration	Observed Fluctuations
1	Data logging voltage gradients between steel earth stakes parallel to the rail at the southwest boundary of 97 Waterloo Road. The earth stakes were approximately 35m apart	20-hours	Most fluctuations within 10 mV. Maximum fluctuation of 36 mV.
2	Data logging voltage gradients between steel earth stakes parallel to the rail at the southwest boundary of 85 Waterloo Road. The earth stakes were approximately 106m apart	20-hours	Most fluctuations within 40 mV. Maximum fluctuation of 170 mV.
3	Data logging the potential of a fence at the southeast corner of 97 Waterloo Road.	20-hours	Most fluctuations within 10 mV. Maximum fluctuation of 20 mV.
4	Data logging voltage gradients between steel earth stakes perpendicular to the rail at the southeast boundary of 97 Waterloo Road. The earth stakes were approximately 68m apart.	20-hours	Most fluctuations within 10 mV. Maximum fluctuation of 30 mV.
5	Data logging voltage gradients between steel earth stakes perpendicular to the rail at the southeast boundary of 85 Waterloo Road. The earth stakes were approximately 76m apart	20-hours	Most fluctuations within 20 mV. Maximum fluctuation of 108 mV.
6	Data logging the potential of a Firewater piping at the northwest boundary of 97 Waterloo Road.	20-hours	Most fluctuations within 5 mV.
7	Data logging the potential of a water pipe at the northeast corner of 85 Waterloo Road	20-hours	Most fluctuations within 10 mV. Maximum fluctuation of 45 mV.

5. Discussion

The test results show that five of the seven test locations recorded stray current effects that exceed acceptable limits.

1. Data logging voltage gradients between steel earth stakes parallel to the rail at the southwest boundary of 97 Waterloo Road shows stray current effects that are within, but at time exceed acceptable limits.
2. Data logging voltage gradients between steel earth stakes parallel to the rail at the southwest boundary of 85 Waterloo Road shows stray current effects that exceed acceptable limits.
3. Data logging the potential of a fence at the southeast corner of 97 Waterloo Road shows stray current effects that are within acceptable limits.
4. Data logging voltage gradients between steel earth stakes perpendicular to the rail at the southeast boundary of 97 Waterloo Road shows stray current effects that are within, but at time exceed acceptable limits.
5. Data logging voltage gradients between steel earth stakes perpendicular to the rail at the southeast boundary of 85 Waterloo Road shows stray current effects that are within, but at time exceed acceptable limits.
6. Data logging the potential of a Firewater piping at the northwest boundary of 97 Waterloo Road shows stray current effects that are within acceptable limits.
7. Data logging the potential of a water pipe at the northeast corner of 85 Waterloo Road shows stray current effects that are within, but at time exceed acceptable limits.

6. Drawings & Documents Reviewed

The relevant drawings and documents provided to and reviewed by CCE are detailed below.

- Project Title: 85 – 97 Waterloo Road, Macquarie Park, NSW 2113
- Date Drawings Received by CCE: 20/06/24.

Document Name	Document No.	Revision	Date
Ground Site Plan	DA1006	B - WIP	14/05/24
Ground Floor	DA2002	B - WIP	14/05/24
Basement Plan 1	DA2001	B - WIP	14/05/24
Basement Plan 2	DA2000	B - WIP	14/05/24
Building A, B & - C – Ground Floor	DA2102	B - WIP	14/05/24
Building A, B & - C – Basement	DA2100	B - WIP	14/05/24
Building A, B & - C – Basement	DA2101	B - WIP	14/05/24
Building E, F & - G – Basement	DA2200	B - WIP	14/05/24
Building E, F & - G – Ground Floor	DA2201	B - WIP	14/05/24

7. Conclusion

The test results show stray current effects are within, but at time exceed acceptable limits. Hence, there is a corrosion risk to on-ground and in-ground metallic structures.

Stray current activity can change with time and may become a higher corrosion risk. The below recommendations should be adopted to minimise stray current effects as part of any future developments.

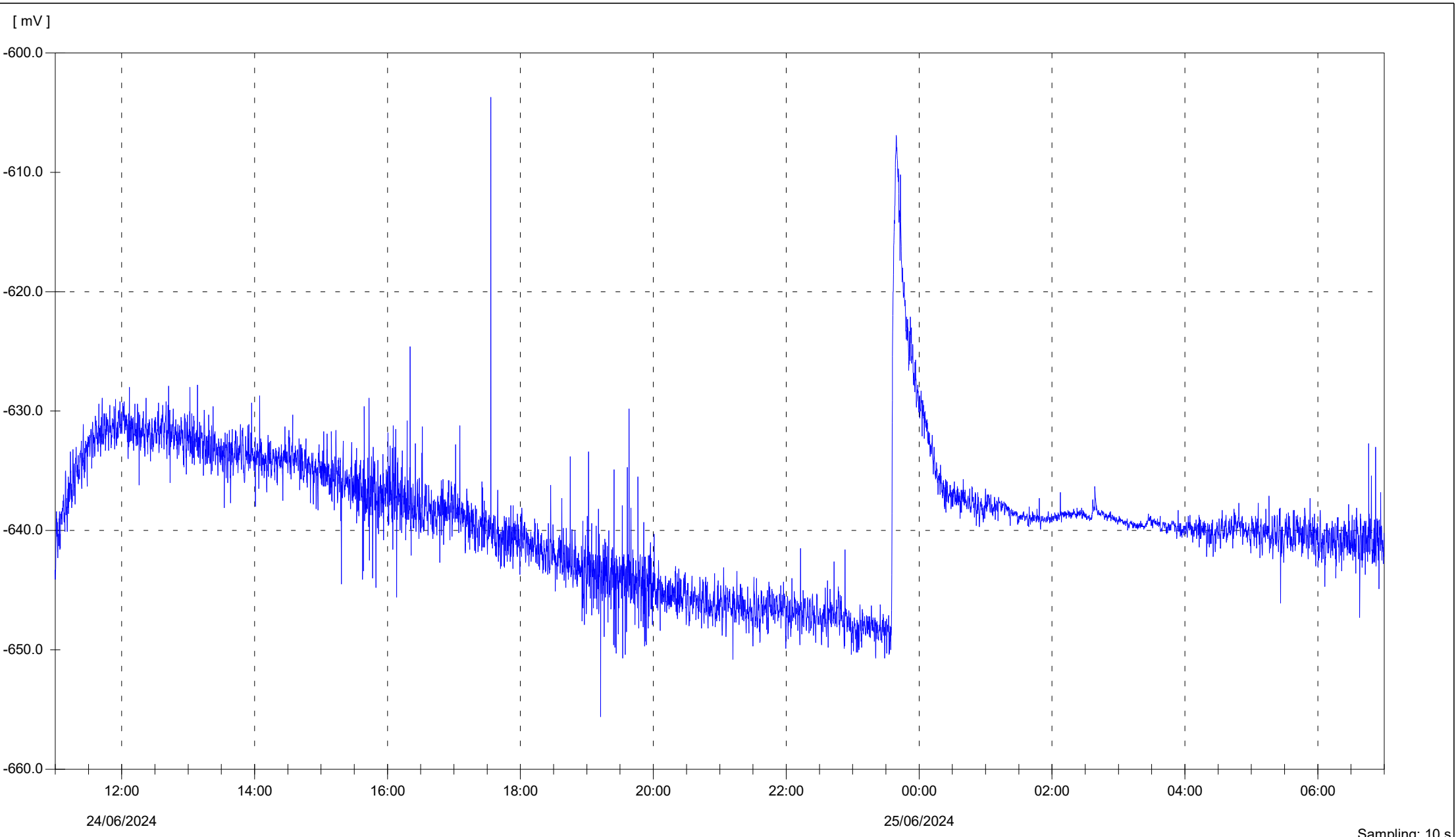
8. Recommendations

Based on the site testing and review of the available development drawings/documents, CCE recommend the following conservative protective measures, where possible/practical, to mitigate against long-term stray current corrosion at on-ground and in-ground metallic structures:

1. The installation of heavy plastic membrane (e.g. Fortecon) under (or behind) all reinforced concrete slabs, permanent retaining walls, permanent anchors, piers/piles, and metallic posts/bollards to electrically isolate from soil and stray currents. *Note, this may not always be possible/practical at piers/piles or when friction is relied upon for structural purposes.*
2. Ensure the high strength (minimum 32 MPa), high cover (minimum 50 mm) concrete is used to effectively prevent/limit soil moisture penetrating through to the steel/metal.
3. The use of plastic, rather than metallic, in-ground pipework and tanks. In the event buried metallic pipework and/or cables are installed within the site, installation within sealed non-metallic conduit is recommended. Where this is not possible (for example at metal water main feeds), insulating flanges/fittings/unions at the property boundary/meter can be used to electrically isolate the property piping.
4. A minimum of two (2-off) electrolysis test points such as an Erico Earthbridge DB12CS701, in conjunction with an Ag/AgCl permanent reference electrode installed close to the reinforcing steel, shall be provided at every at/below ground level. This is to assist with potential (stray current) monitoring (See Appendix B for details).

In order to comply with the TfNSW standard 'THRCI 12051 ST: Development Near Rail Tunnels, Version 2.0, section 9.2.1' and Sydney Metro Guideline 'Sydney Metro Underground Corridor Protection Technical Guidelines, Version 2, section 9.4', CCE recommend installation of basement rebar test points to allow for future electrolysis testing of the basement rebar post-construction. This can be achieved via SS316 welded test studs that protrude from the basement walls, at approximately knee-high level. CCE recommend 2-off rebar test points be installed for each basement level, with one at each end of the basement level. Note, these welded studs can be installed relatively flush with or recessed in the concrete surface, allowing sufficient space (minimum 10 mm) for a temporary electrical connection (e.g. via alligator clip or similar). Alternatively, the Erico Earthbridge DB12CS701 can be installed for test points.

Appendix A: Data Logger Charts



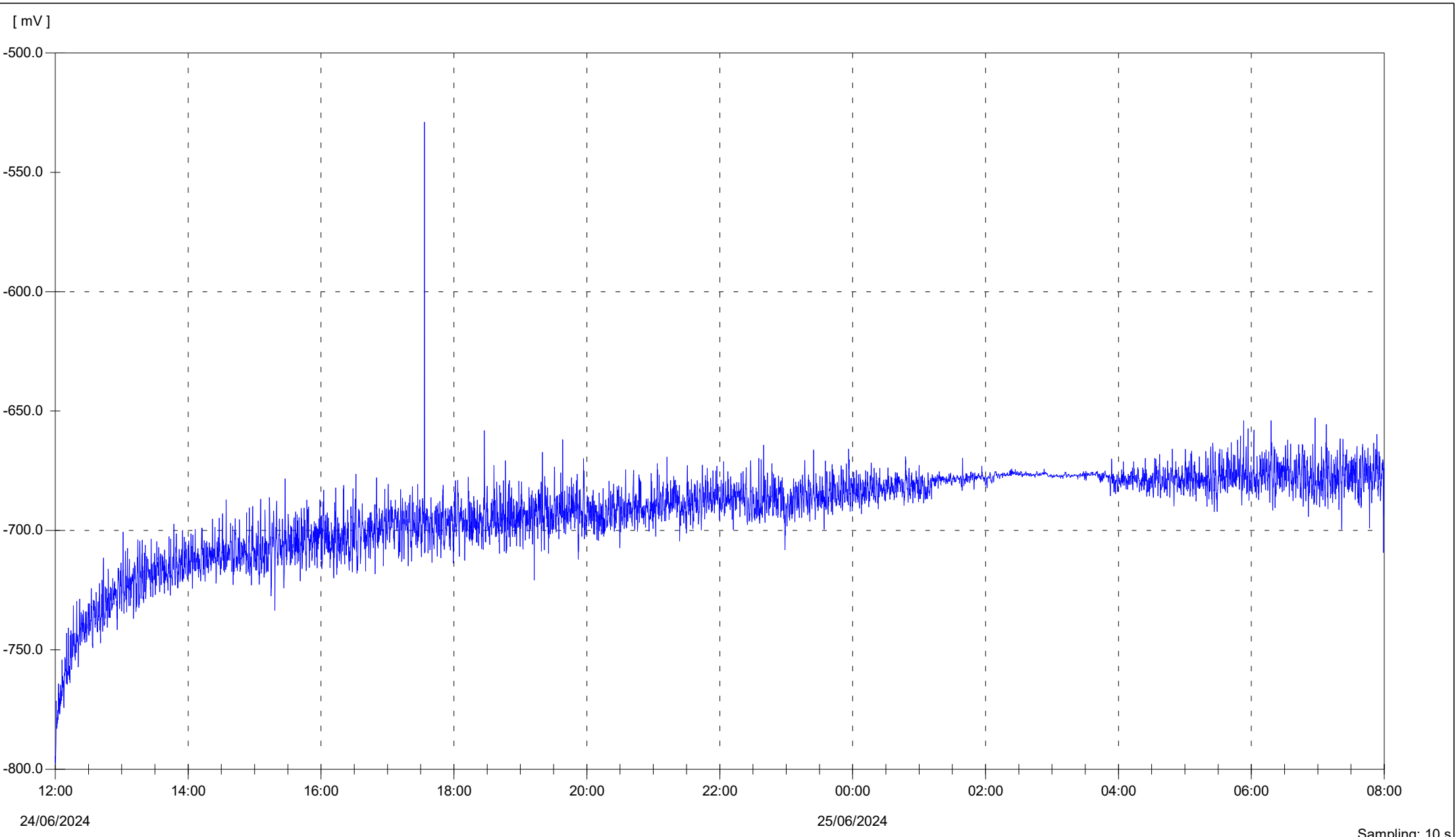
Sampling: 10 s

— : Volts Vs Cu/CuSO4

	Min	Max	Average	Std. dev.
DC 1	-0.656 V	-0.604 V	-0.639 V	0.006 V

Electrolysis Risk Reporting
85-97 Waterloo Road, Macquarie Park NSW
Parallel to the rail (97 Waterloo Road)
Logger Serial Number: 2742





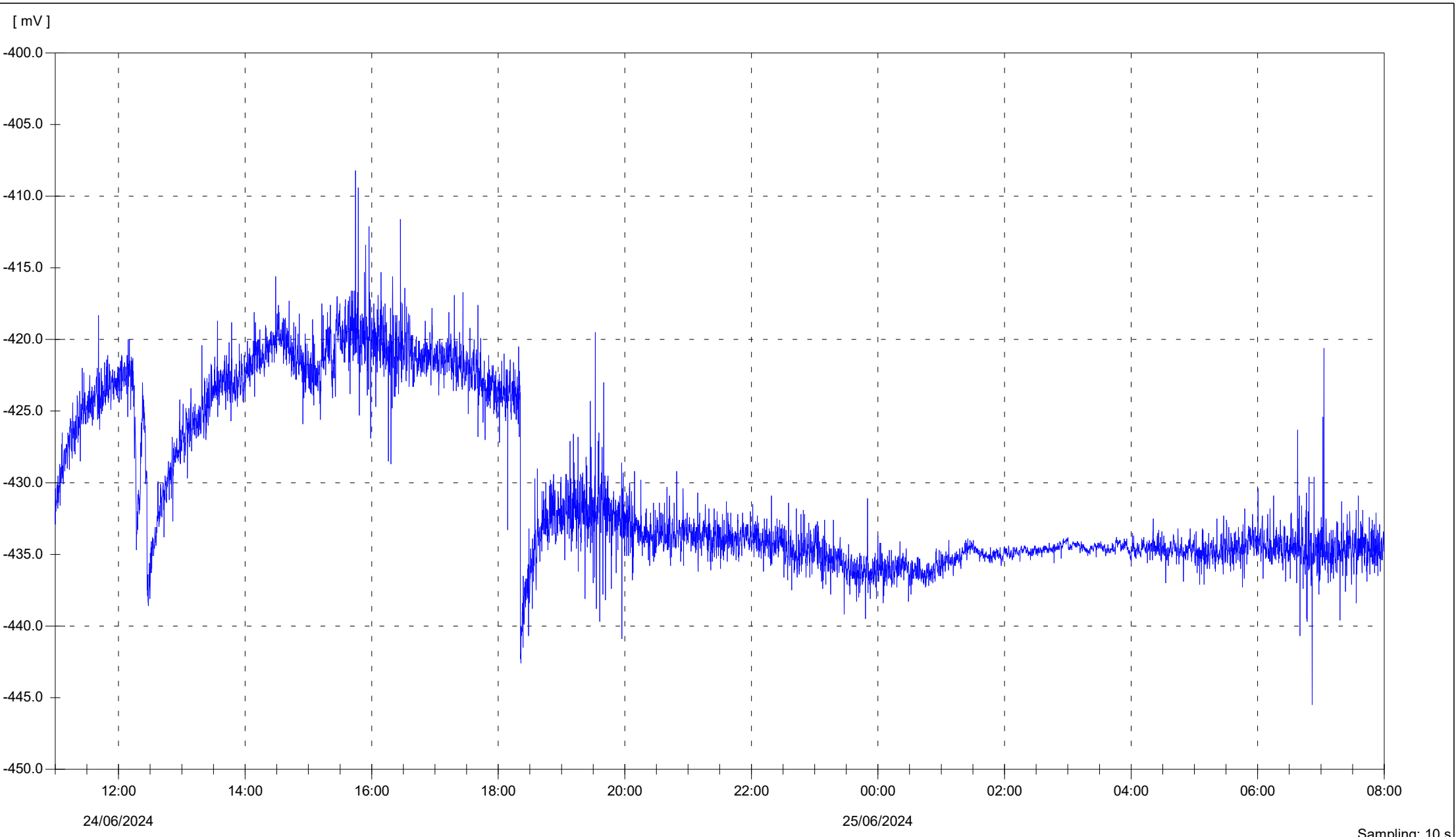
Sampling: 10 s

— : Volts Vs Cu/CuSO4
MiniLog2

	Min	Max	Average	Std. dev.
DC 1	-0.798 V	-0.529 V	-0.692 V	0.018 V

Electrolysis Risk Reporting
85-97 Waterloo Road, Macquarie Park NSW
Parallel to the rail (85 Waterloo Road)
Logger Serial Number: 2731





Sampling: 10 s

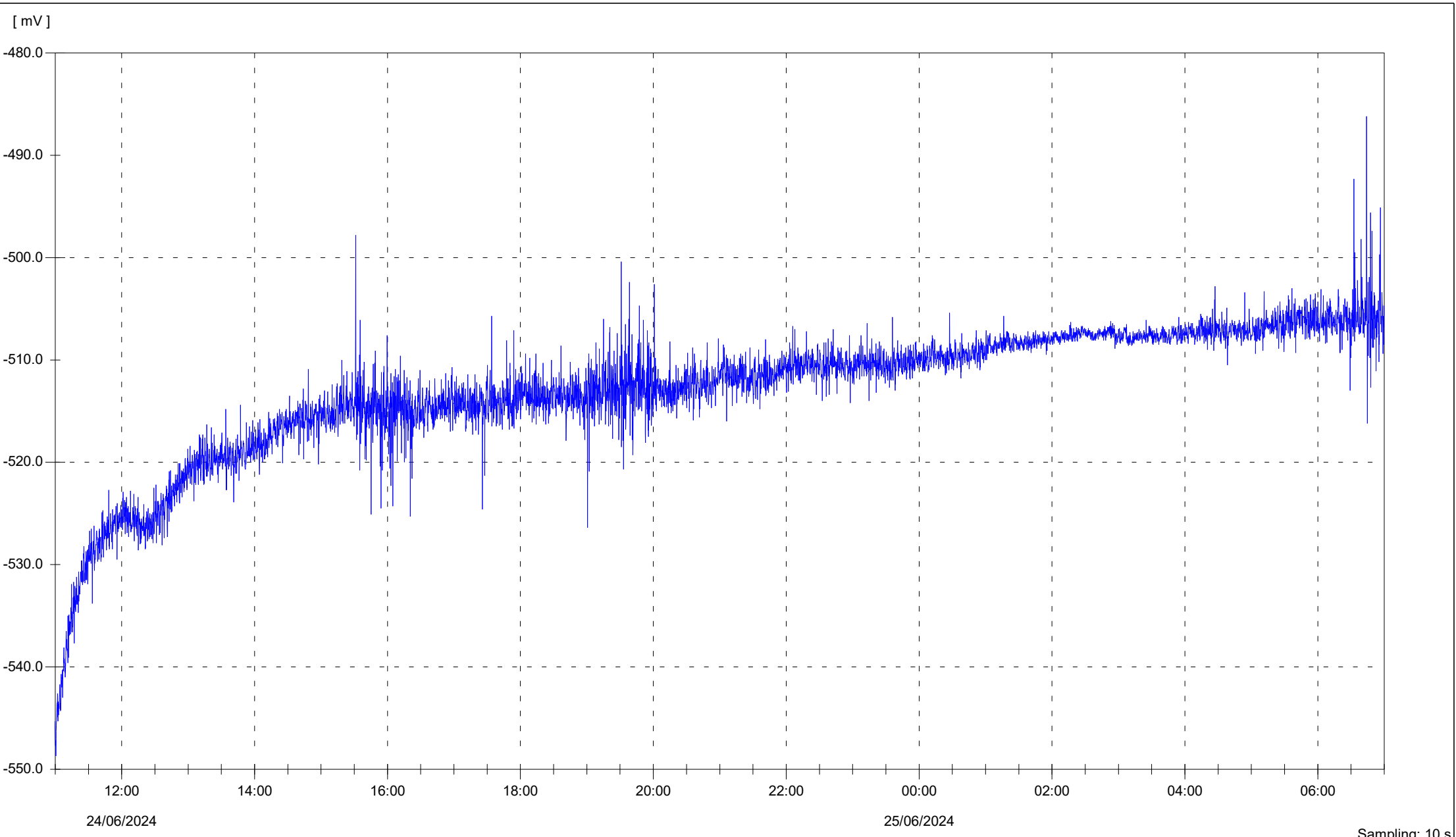
— : Volts Vs Cu/CuSO4

MiniLog2

	Min	Max	Average	Std. dev.
DC 1	-0.446 V	-0.408 V	-0.431 V	0.006 V

Electrolysis Risk Reporting
85-97 Waterloo Road, Macquarie Park NSW
Parallel to the rail - Fence (97 Waterloo Road)
Logger Serial Number: 3405





Sampling: 10 s

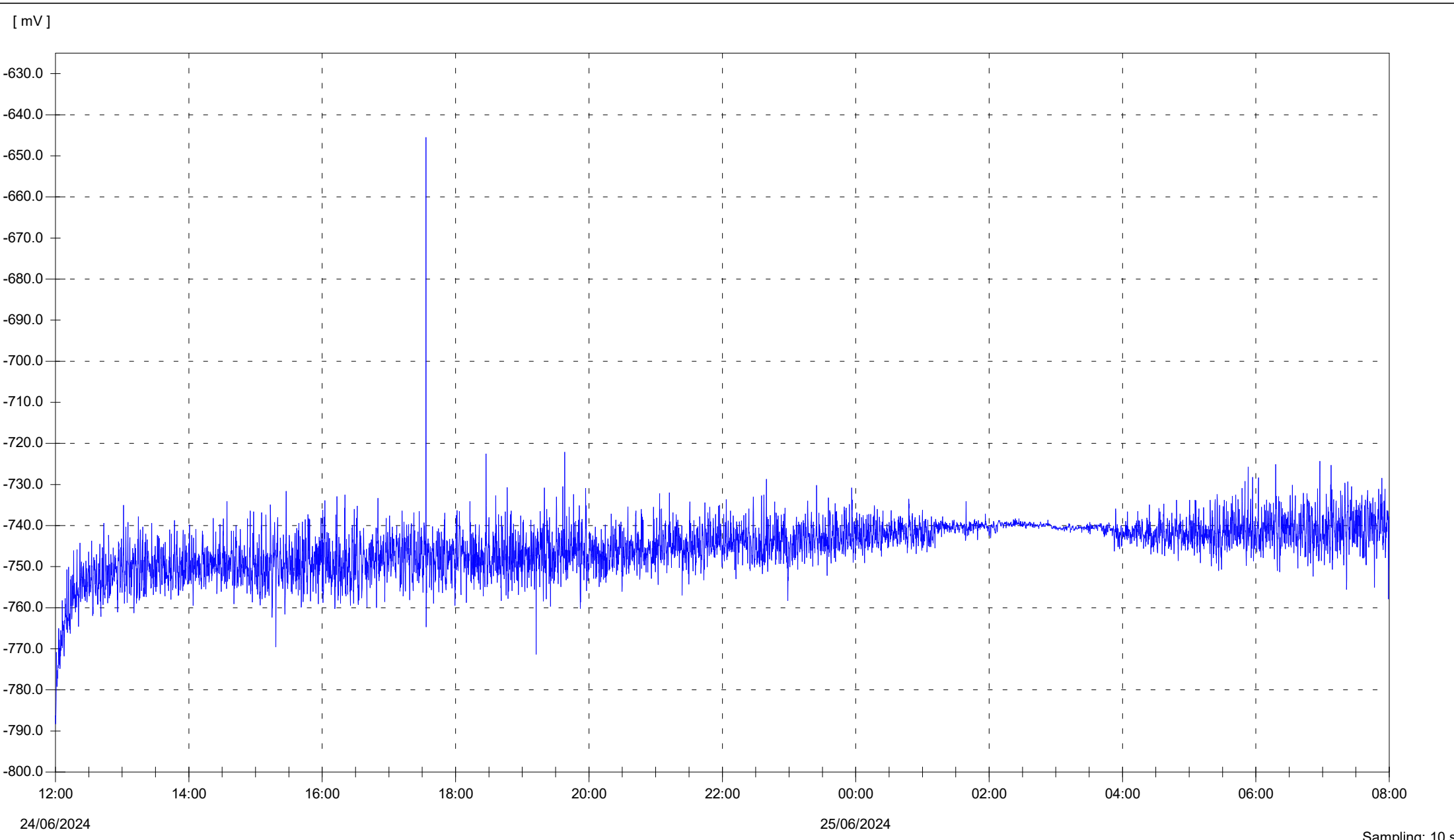
— : Volts Vs Cu/CuSO4

MiniLog2

	Min	Max	Average	Std. dev.
DC 1	-0.549 V	-0.486 V	-0.513 V	0.007 V

Electrolysis Risk Reporting
85-97 Waterloo Road, Macquarie Park NSW
Perpendicular to the rail (97 Waterloo Road)
Logger Serial Number: 2738





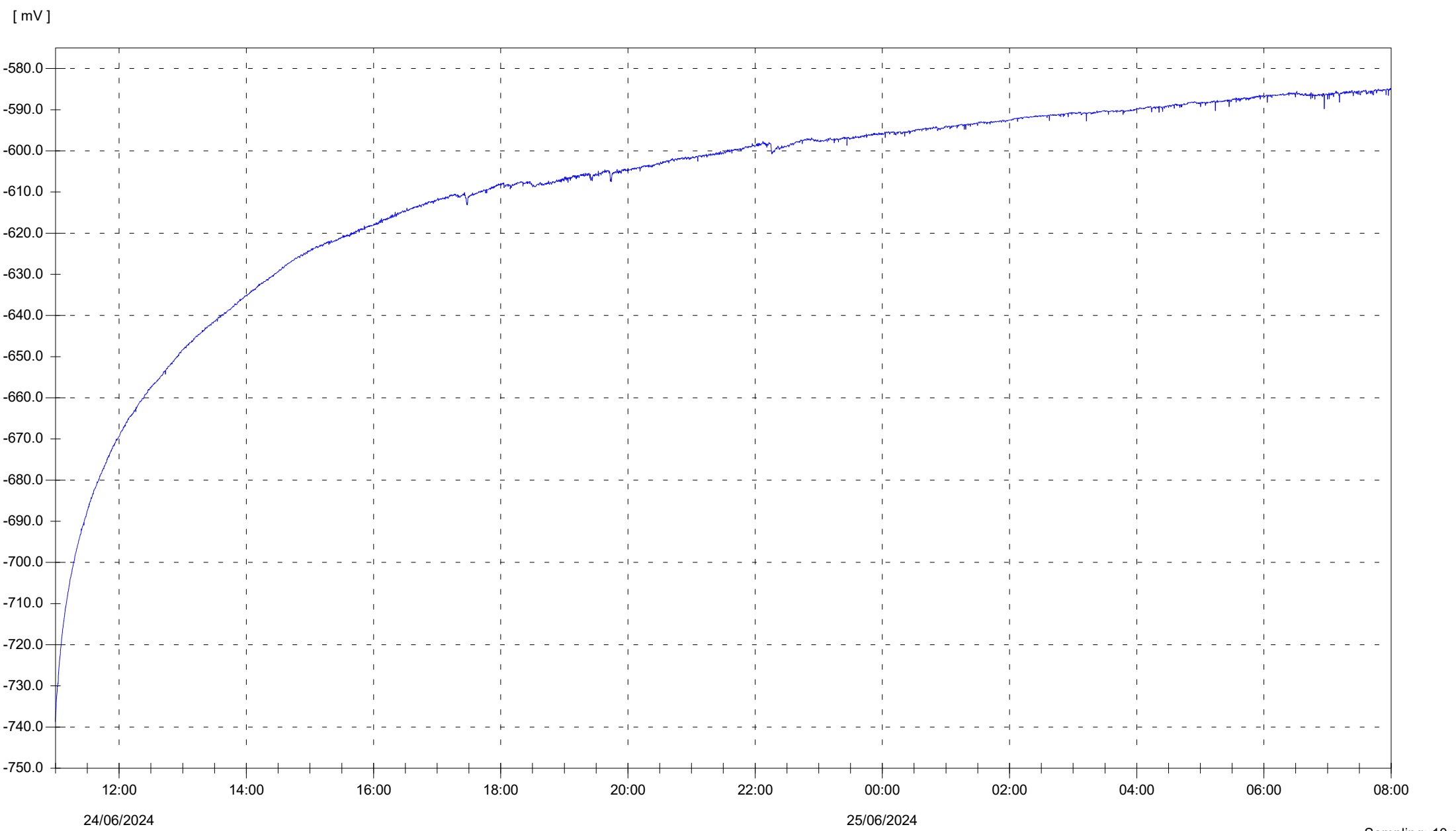
Sampling: 10 s

— : Volts Vs Cu/CuSO4

	Min	Max	Average	Std. dev.
DC 1	-0.788 V	-0.646 V	-0.745 V	0.006 V

Electrolysis Risk Reporting
85-97 Waterloo Road, Macquarie Park NSW
Perpendicular to the rail (85 Waterloo Road)
Logger Serial Number: 2747





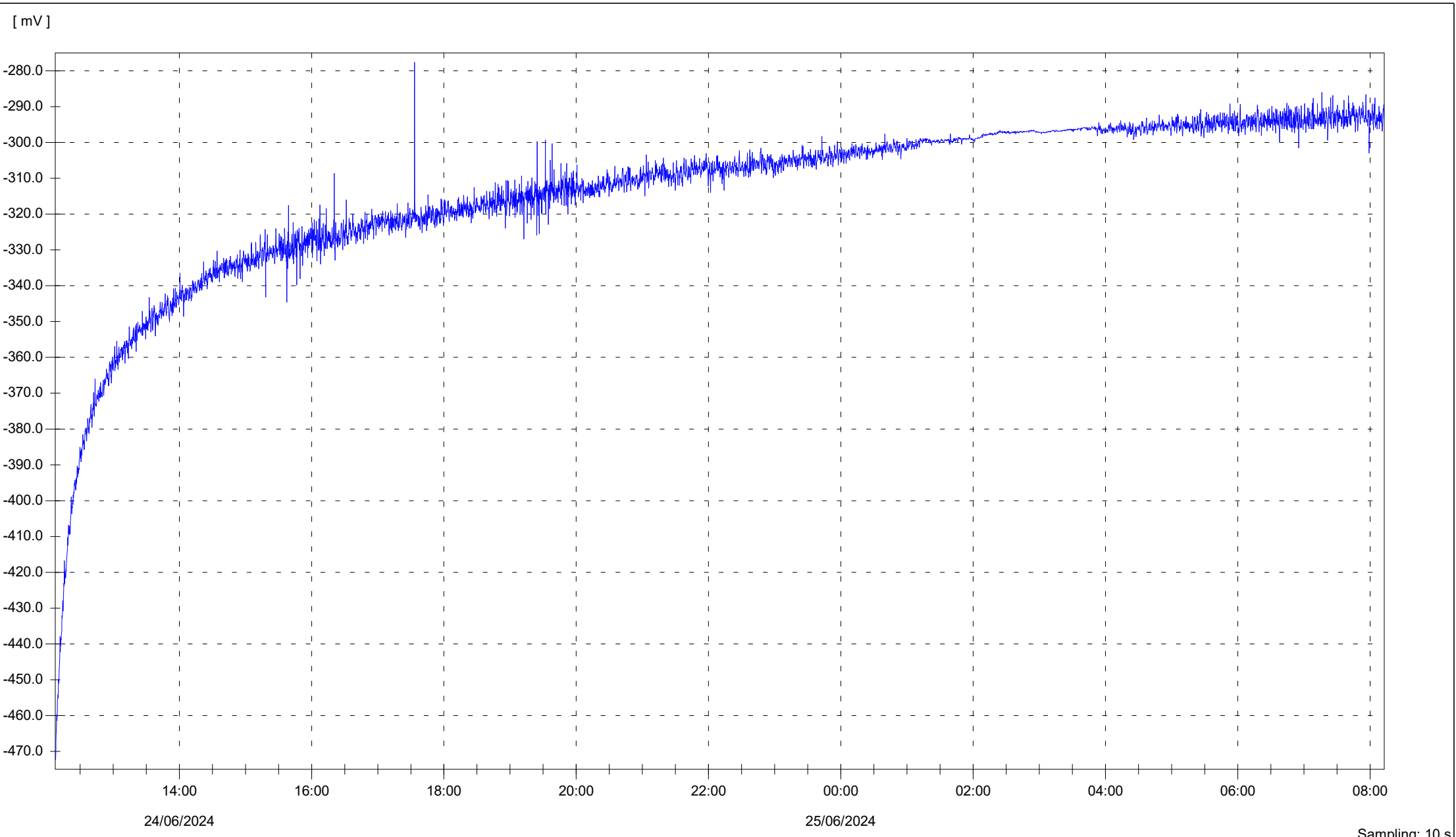
Sampling: 10 s

— : Volts Vs Cu/CuSO4

	Min	Max	Average	Std. dev.
DC 1	-0.737 V	-0.585 V	-0.609 V	0.026 V

Electrolysis Risk Reporting
85-97 Waterloo Road, Macquarie Park NSW
Firewater Piping (Hydrant, 97 Waterloo Road)
Logger Serial Number: 3397





Sampling: 10 s

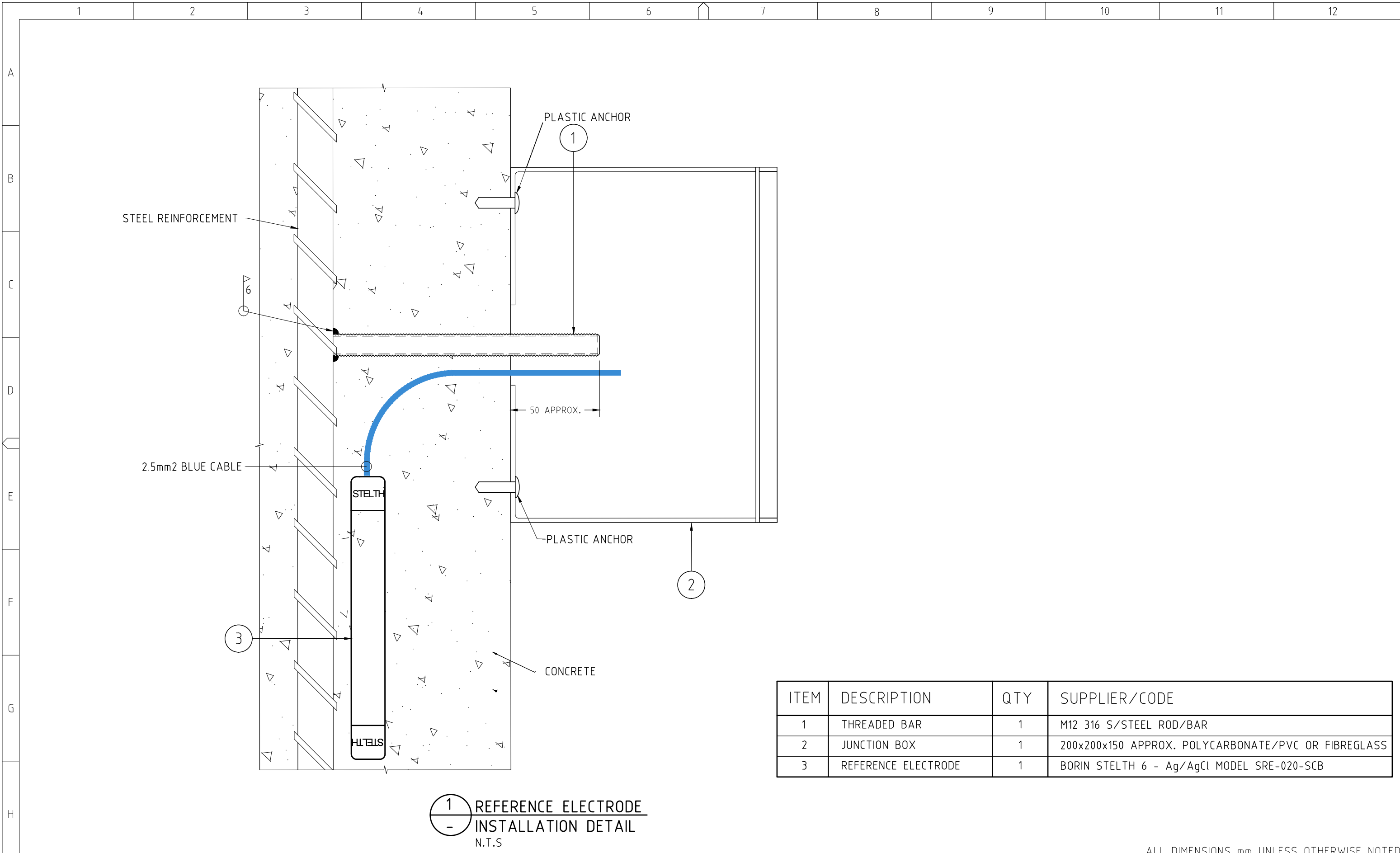
— : Volts Vs Cu/CuS)4

	Min	Max	Average	Std. dev.
DC 1	-0.473 V	-0.278 V	-0.314 V	0.024 V

Electrolysis Risk Reporting
85-97 Waterloo Road, Macquarie Park NSW
Water Pipe (Utilities piping, 85 Waterloo Road)
Logger Serial Number: 2731



Appendix B: Electrolysis Test Point Drawing



ITEM	DESCRIPTION	QTY	SUPPLIER/CODE
1	THREADED BAR	1	M12 316 S/STEEL ROD/BAR
2	JUNCTION BOX	1	200x200x150 APPROX. POLYCARBONATE/PVC OR FIBREGLASS
3	REFERENCE ELECTRODE	1	BORIN STELTH 6 - Ag/AgCl MODEL SRE-020-SCB

1 REFERENCE ELECTRODE
- INSTALLATION DETAIL
N.T.S

ALL DIMENSIONS mm UNLESS OTHERWISE NOTED

REF DWG No.	REFERENCE DRAWING TITLE	REV	DATE	REVISION DESCRIPTION	DESIGNED	DRAWN	CHECKED	APPROVED
	REFERENCES			REVISION HISTORY				

CCE CORROSION CONTROL ENGINEERING
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CORROSION CONTROL ENGINEERING STANDARD DRAWING TYPICAL ELECTROLYSIS MONITORING BOX INSTALLATION DETAILS		
CLIENT DRAWING No.	DRAWING No. CSD-DES-08-001	SCALE SIZE REV N.T.S A3 A