



Public Works
Manly Hydraulics Laboratory

NSW ESTUARY AND RIVER WATER QUALITY ANNUAL SUMMARY 2011-2012

Report MHL2161
November 2012



prepared for
NSW Office of Environment and Heritage



Office of
Environment
& Heritage

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NSW Estuary and River Water Quality Annual Summary 2011-2012

Report MHL2161
November 2012

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Cover photograph: Bega Salinity Buoy, Bega River, March 2012

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Foreword

Manly Hydraulics Laboratory (MHL) is a business group within NSW Public Works, a division of the Department of Finance and Services. The NSW water quality database has been developed by MHL to support a number of programs associated with coastal, floodplain and estuary management for the NSW Office of Environment and Heritage (OEH), NSW Office of Water (NOW) and the Lake Illawarra Authority (LIA).

This summary presents the results of water quality measurements captured by the automatic recording stations along the coastal estuaries and rivers of New South Wales, from 1 July 2011 to 30 June 2012, and catalogues data collected in NSW by Manly Hydraulics Laboratory.

This summary has been prepared to provide ready access to MHL's water quality database and the data analysis capabilities at the Laboratory.

Requests for further information should be directed to:

Environmental Data Programs	email	:	data-request@mhl.nsw.gov.au
Manly Hydraulics Laboratory	WWW	:	http://www.mhl.nsw.gov.au/
110B King Street	Telephone	:	(02) 9949 0200
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Summary

This report contains:

- a brief description of the water quality programs
- guidelines on how to use this report
- information on how to access the database
- significant developments which occurred in 2011-2012
- the data summaries and station location maps for each station
- [Appendix A](#) detailing the data available online
- [Appendix B](#) which shows data output formats available at MHL
- [Appendix C](#) a list of other publications which may be of interest
- [Appendix D](#) station location maps.

Contents

FOREWORD	I
SUMMARY	II
1. WATER QUALITY MONITORING PROGRAMS	1
2. HOW TO USE THIS REPORT	3
3. HOW TO ACCESS THE DATA	4
4. SIGNIFICANT EVENTS AND DEVELOPMENTS	5
5. INDEX OF FIGURES	6

APPENDICES

- A** Data On-line
- B** Sample Outputs
- C** Other Publications of Interest
- D** Station Location Maps

TABLES

1 Station List	1
2 NSW Flood Classifications	5
3 Index of Figures	6
4 Index of Appendix B Figures	6

1. Water Quality Monitoring Programs

This report presents a summary of the water quality data currently collected by Manly Hydraulics Laboratory. The network of recorders and the associated analysis routines enable MHL to provide an efficient service in accessing water quality data. As well as real time water quality information at more than 25 stations in NSW, an historical database of water quality data can be made available on request (refer [Appendix A](#)).

The present program is based on a network of automatic recording stations installed at various estuaries (see [Station Location Maps](#)). This network consists of over 25 permanent stations funded by OEH, NOW and LIA (see Table 1). The logging systems consist of Campbells Scientific CR800 data loggers which record water quality information every 15 minutes. Data is transmitted via IP telemetry to the database every six hours.

Table 1 Station List

River/ Estuary System	Station Name	Station No.	MGA	Easting	Northing	Station Owner	Data start
Richmond	Coraki	203403	56	527976	6793772	OEH/NOW	21-Oct-09
Richmond	Oakland Road	203470	56	526684	6791185	NOW	06-Mar-12
Richmond	Bungawalbin	203450	56	527019	6788273	OEH/NOW	21-Oct-09
Clarence	Mylneford	204460	56	483442	6722845	NOW	21-May-10
Clarence	Rogans Bridge	204414	56	488813	6723401	OEH/NOW	03-Dec-09
Clarence	Grafton	204400	56	493398	6715149	OEH/NOW	04-Dec-09
Macleay	Kempsey	206468	56	485099	6561395	OEH/NOW	09-Feb-10
Manning	Wingham	208400	56	440523	6473219	OEH/NOW	08-Dec-09
Manning	Taree-West	208420	56	447161	6469672	NOW	30-Apr-10
Manning	Taree	208410	56	448684	6468641	OEH/NOW	16-Feb-10
Myall Lakes	Bombah Point	209475	56	434680	6403299	OEH	13-Jul-09
Myall River	Tea Gardens	209480	56	421723	6385111	OEH	20-Oct-09
Paterson	Dunmore	210409	56	369238	6383269	OEH/NOW	15-Oct-09
Paterson	Hinton Bridge	210410	56	373245	6379624	OEH/NOW	15-Oct-09
Hunter	McKimms Corner	210455	56	368162	6378933	OEH/NOW	08-Oct-09
Hunter	Hexham	210448	56	376768	6367608	OEH/NOW	13-Apr-11
Hunter	Green Rocks	210432	56	377459	6378142	OEH/NOW	15-Oct-09
Williams	Raymond Terrace	210452	56	382352	6375361	OEH/NOW	15-Oct-09
Hawkesbury	Sackville	212406	56	303238	6292029	OEH/NOW	30-Oct-09
Colo	Colo Junction	212407	56	303218	6298170	OEH/NOW	07-Nov-09
Hawkesbury	Leets Vale	212461	56	309195	6299263	NOW	22-Jun-10
Hawkesbury	Wisemans Ferry Wharf	212460	56	312963	6304569	NOW	10-Jun-10
Lake Illawarra	Koonawarra Bay	214440	56	300064	6179621	LIA	15-Jun-93
Lake Illawarra	Cudgerie Bay	214416	56	303885	6177264	LIA	09-Feb-93
Shoalhaven	Gradys Caravan Park	215430	56	268024	6138282	OEH/NOW	06-Oct-10
Bega River	Bega Salinity Buoy	219411	55	766036	5933971	NOW	14-Mar-12

The network features three distinctive water quality probes for obtaining temperature and conductivity readings:

- EC1500: designed for long-term deployment at unattended monitoring stations. The sensor head is epoxy encapsulated and has a large toroid to allow the flow of water through it. The sensor will measure conductivity from zero to full scale with the resolution of $EC \pm 1\%$ at full scale and temperature $\pm 0.2^\circ\text{C}$.
- Aquistar CT2X: a submersible sensor with built-in datalogging. The CT2X incorporates 4-pole electrode cell measurement technology with a resolution of $EC \pm 1$ microsiemen/cm and temperature $\pm 0.01^\circ\text{C}$
- YSI Sonde 6820 V2: a multi-parameter probe with a resolution of $EC \pm 1$ microsiemen/cm and temperature $\pm 0.01^\circ\text{C}$.

In 2010 NOW requested that logger programs at all NOW-funded sites be modified to output salinity (Practical Salinity Units (psu)) and specific conductivity at 25°C (microseimens/cm) in addition to the standard outputs of water level, temperature and conductivity. This request is intended to make the real-time data more usable by the diverse range of end users.

Temperature and conductivity values are obtained directly from the instrumentation. Specific conductivity at 25°C is calculated using the equation:

$$\text{Specific Conductivity } [\mu\text{s/cm}] = C / (1 + 0.0198933 * (T - 25))$$

Salinity is calculated using the UNESCO formula (seawater salinity calculation) and the full equation can be found in:

UNESCO Technical Papers in Marine Science, #36 (1981a) 'The Practical Salinity Scale 1978 and the International Equation of State of Seawater 1980', UNESCO Division of Marine Sciences (Paris), 25pp.

Water quality data is transferred to the NSW Data Collection Warehouse, Data Centre 1 at Ultimo and to MHL's data server using a variety of telemetry techniques including internet protocol (IP), landline telephone and cellular networks. The incoming raw data is then immediately available to external users to view via the web.

The data is stored in a database and subjected to a quality assurance process which involves several control steps to ensure data quality is maintained. Computer programs are used to further format and analyse data.

The database is backed up daily and data archived to magnetic tape as a security measure at regular intervals. A complete mirrored backup database is also kept at Data Centre 1.

2. How to Use this Report

This report aims to streamline access to the Laboratory's services and to the water quality database.

The NSW coastline has been divided into geographic regions based on river systems. Location maps display the station locations and the annual plots confirm the availability and suitability of data for the particular period of interest. The historical database of water quality data can be made available on request (refer [Appendix A](#)).

Once a choice has been made of the period for which information is required, data and services can be obtained in a variety of formats, according to their intended use.

3. How to Access the Data

The Laboratory provides a full on-line data access service via the Internet for its clients, and a restricted service for the general public at <http://www.mhl.nsw.gov.au>

Typically the last seven days of data are available on-line in a non-quality controlled form to aid the fastest possible access to data records. The on-line service for clients can provide access to all data catalogued in [Appendix A](#).

Quality controlled data may be ordered via the MHL web page (<http://www.mhl.nsw.gov.au>), by emailing data-request@mhl.nsw.gov.au, or via customised decision support tools that can be provided upon request.

The MHL website has been updated in association with an updated database and data warehouse capability via Data Centre 1. The new website was launched in March 2012 and includes updated functionality, data access and availability of water level time-series plots.

4. Significant Events and Developments

During the reporting period; flooding, as described by the Bureau of Meteorology's NSW flood classification scale occurred, as listed in Table 2. Floods introduce significant freshwater inflows which impact on electrical conductivity and temperature, as shown in the data summaries.

Table 2 NSW Flood Classifications

River Basin	Flood Classification	Date
Richmond River	Moderate to major	January 2012
Richmond River	Minor	June 2012
Clarence River	Moderate to major	January 2012
Macleay River	Minor to moderate	November 2011
Macleay River	Moderate	January 2012
Macleay River	Minor	February 2012
Paterson River	Minor	February 2012
Hunter River	Minor	November 2011
Hunter River	Minor	March 2012
Hawkesbury River	Minor to moderate	March 2012
Hawkesbury	Minor	April 2012
Shoalhaven River	Minor	March 2012
Bega River	Minor to moderate	March 2012

In March, May and June 2012, longitudinal water quality profiling was undertaken on the Macleay, Manning, Hunter and Hawkesbury rivers, as part of the NOW monitoring program.

Significant infrastructure repair works were undertaken at Mylneford and Grafton during this reporting period. Both stations were damaged during flood events in the previous year.

Buoy-mounted instrumentation was deployed in the Bega River in March 2012 to resolve ongoing issues with sediment build-up at the original station. Shifting sand banks adjacent to the bridge had been a constant issue at the Bega station and, in early 2012, it was decided to move the instrumentation to a specially manufactured buoy.

In March 2012 a new station was commissioned at Oakland Road on the Richmond River at the request of NOW.

5. Index of Figures

Table 3 Index of Figures

River /Estuary System	Station Name	Station No.	Figure
Station Locality Map			1
Richmond	Coraki	203403	2
Richmond	Oakland Road	203470	3
Richmond	Bungawalbin	203450	4
Station Locality Map			5
Clarence	Mylneford	204460	6
Clarence	Rogans Bridge	204413	7
Clarence	Grafton	204400	8
Station Locality Map			9
Macleay	Kempsey	206468	10
Station Locality Map			11
Manning	Wingham	208400	12
Manning	Taree West	208420	13
Manning	Taree	208410	14
Station Locality Map			15
Myall Lakes	Bombah Point	209475	16
Station Locality Map			17
Myall River	Tea Gardens	209480	18
Station Locality Map			19
Paterson	Dunmore	210409	20
Paterson	Hinton Bridge	210410	21
Station Locality Map			22
Hunter	McKimms Corner	210455	23
Hunter	Green Rocks	210432	24
Williams	Raymond Terrace	210452	25
Hunter	Hexham	210448	26
Station Locality Map			27
Hawkesbury	Sackville	212406	28
Colo	Colo Junction	212407	29
Hawkesbury	Leets Vale	212461	30
Hawkesbury	Wisemans Ferry Wharf	212460	31
Station Locality Map			32
Lake Illawarra	Koonawarra Bay	214440	33
Lake Illawarra	Cudgeree Bay	214416	34
Station Locality Map			35
Shoalhaven	Gradys Caravan Park	215430	36
Station Locality Map			37
Bega River	Bega Salinity Buoy	219411	38

Table 4 Index of Appendix B Figures

Sample Data Plots	B1
15-minute Sample Data File	B2
Sample Thermistor Chain Data Temperature Distribution Time Series	B3
Sample Flow, Weather Data and Temperature Contours	B4
Hawkesbury River Salinity Profile	B5



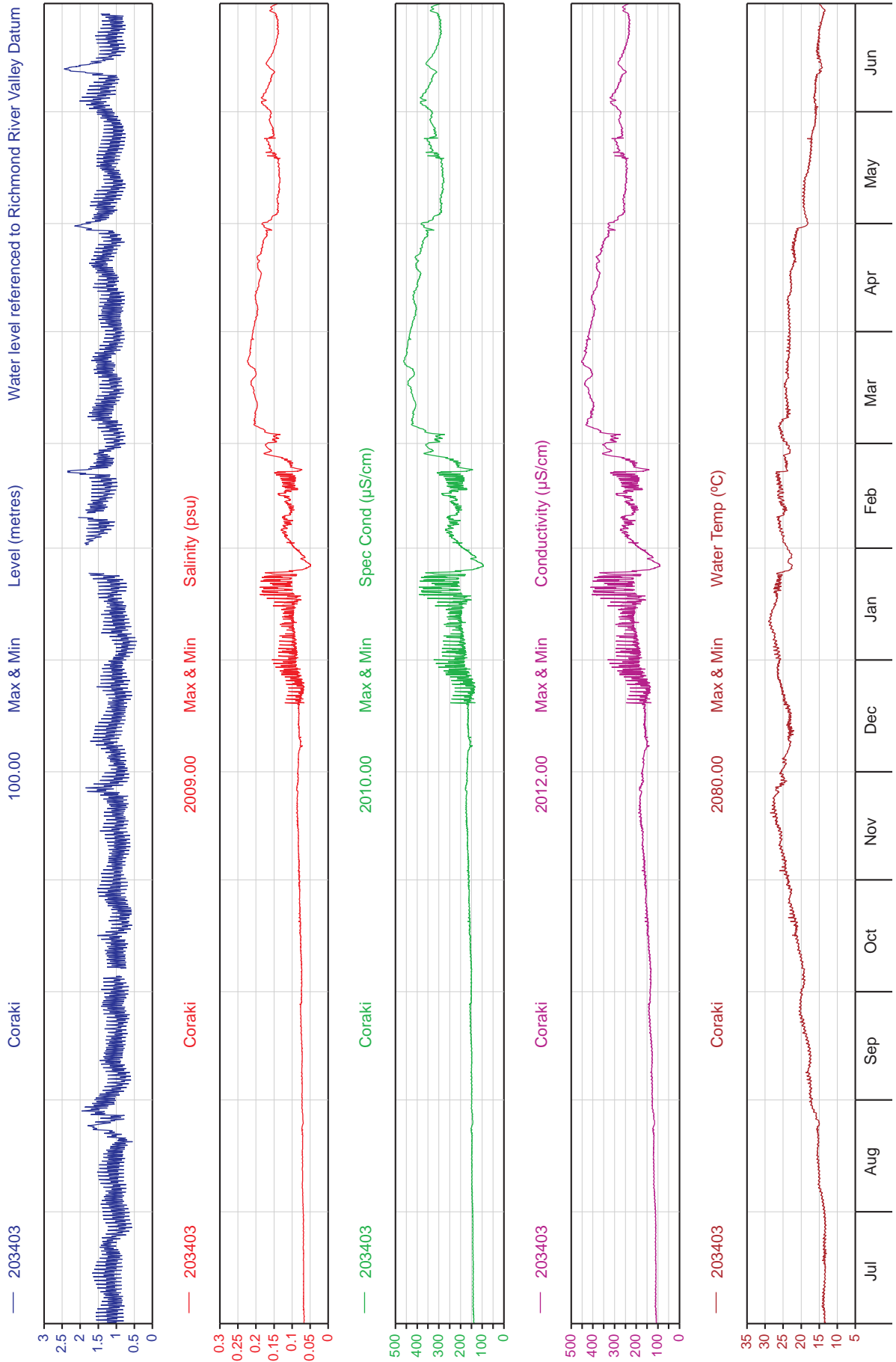
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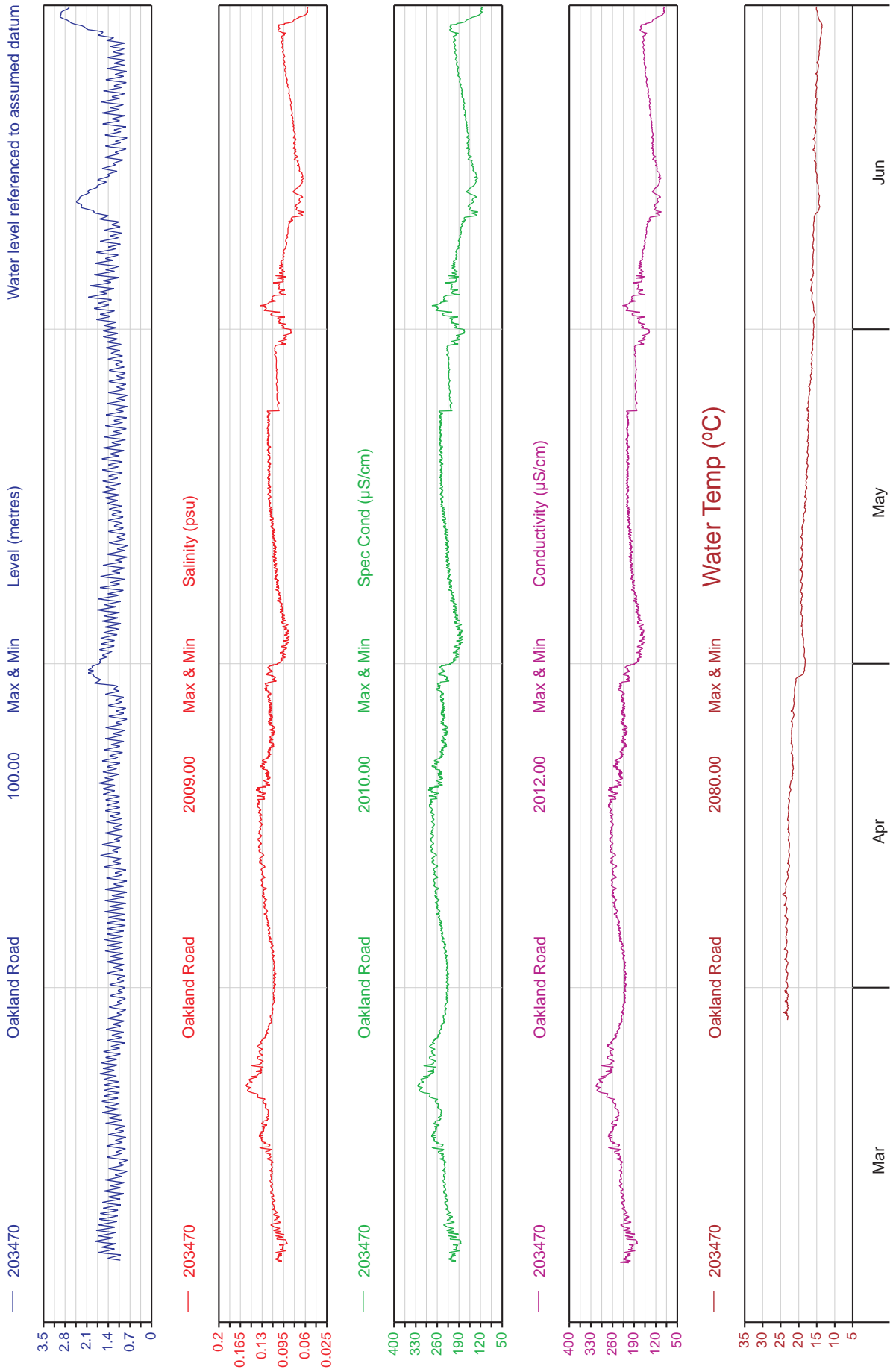
STATION LOCATIONS RICHMOND RIVER REGION

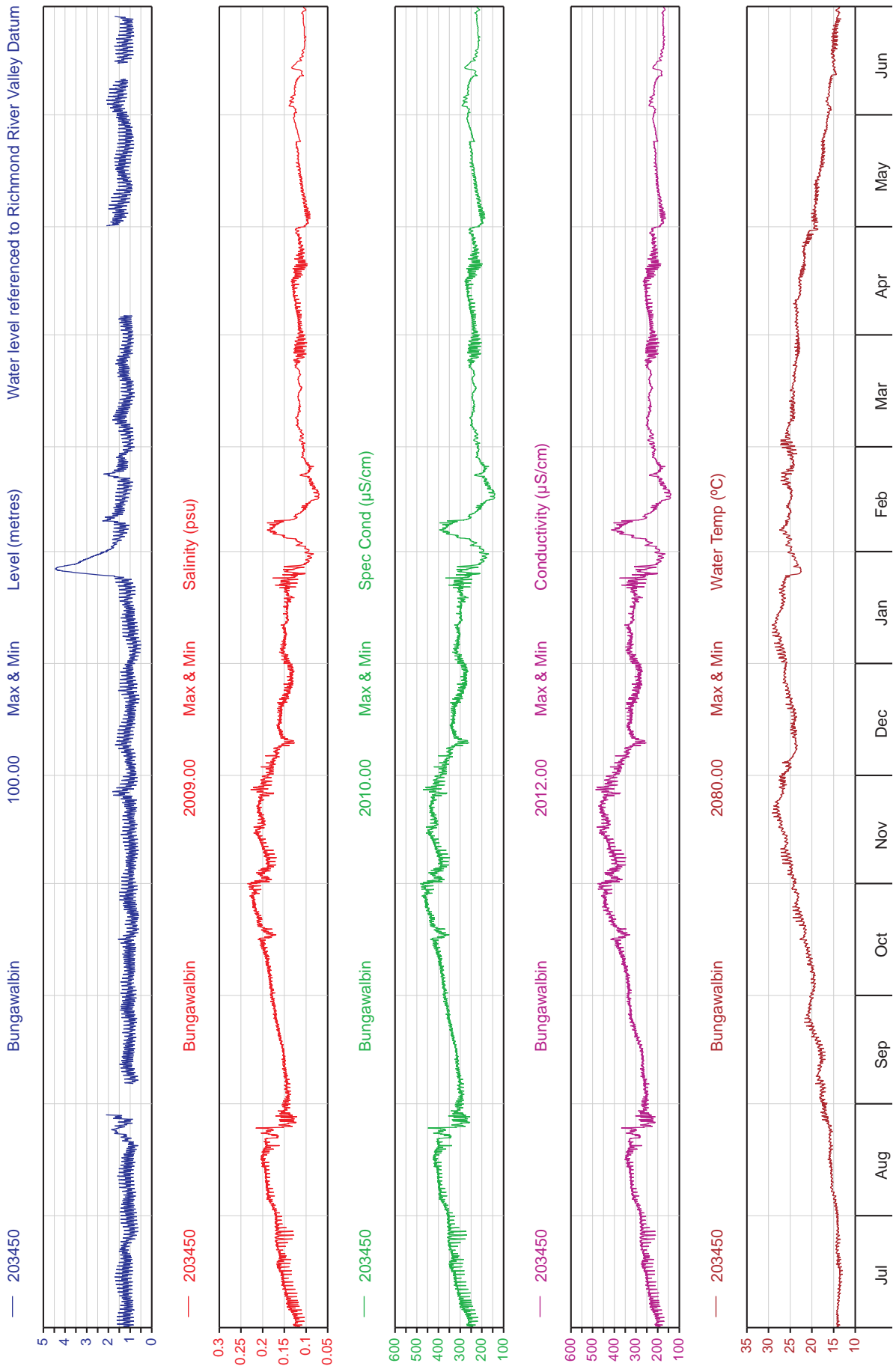
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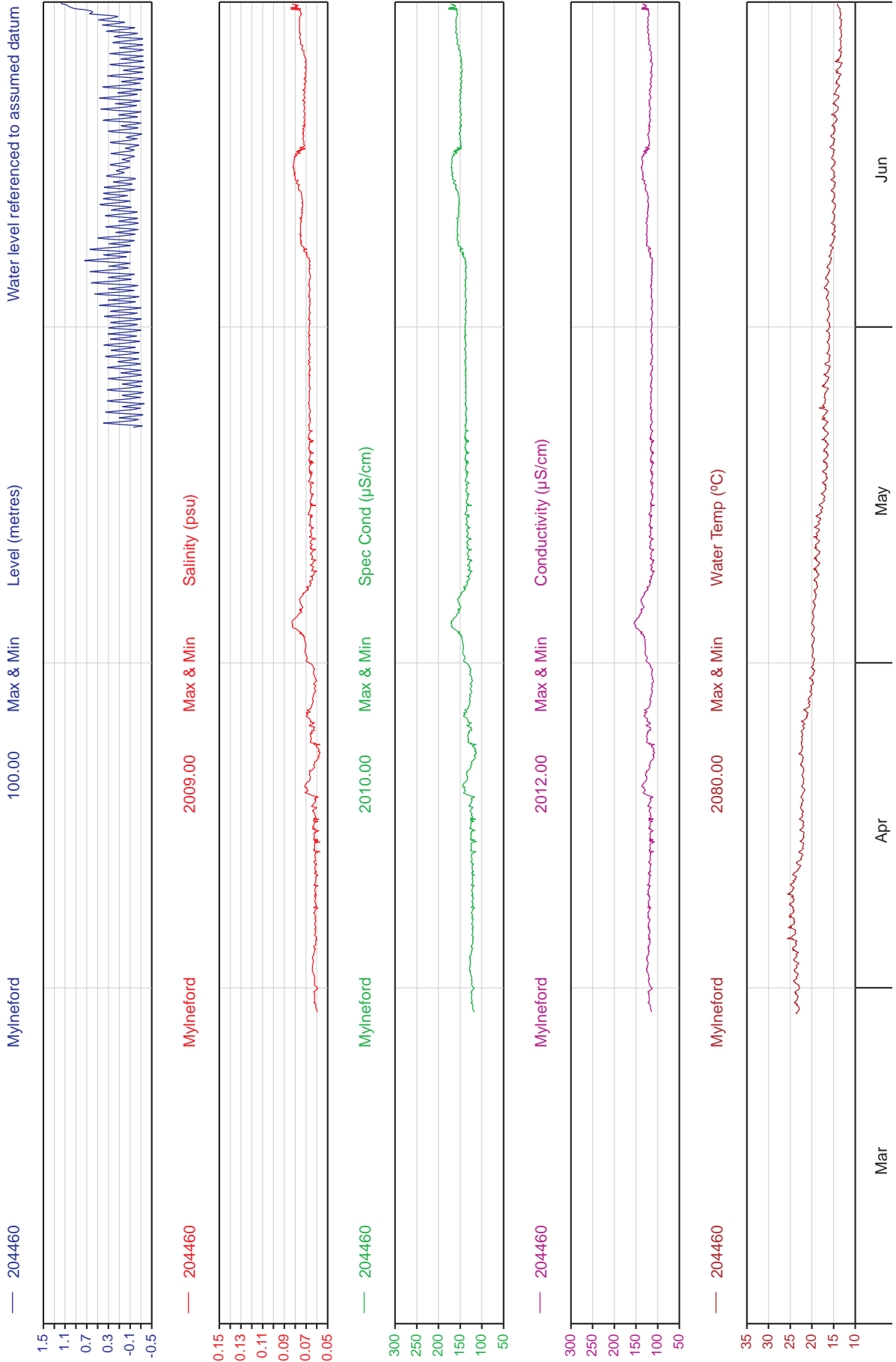
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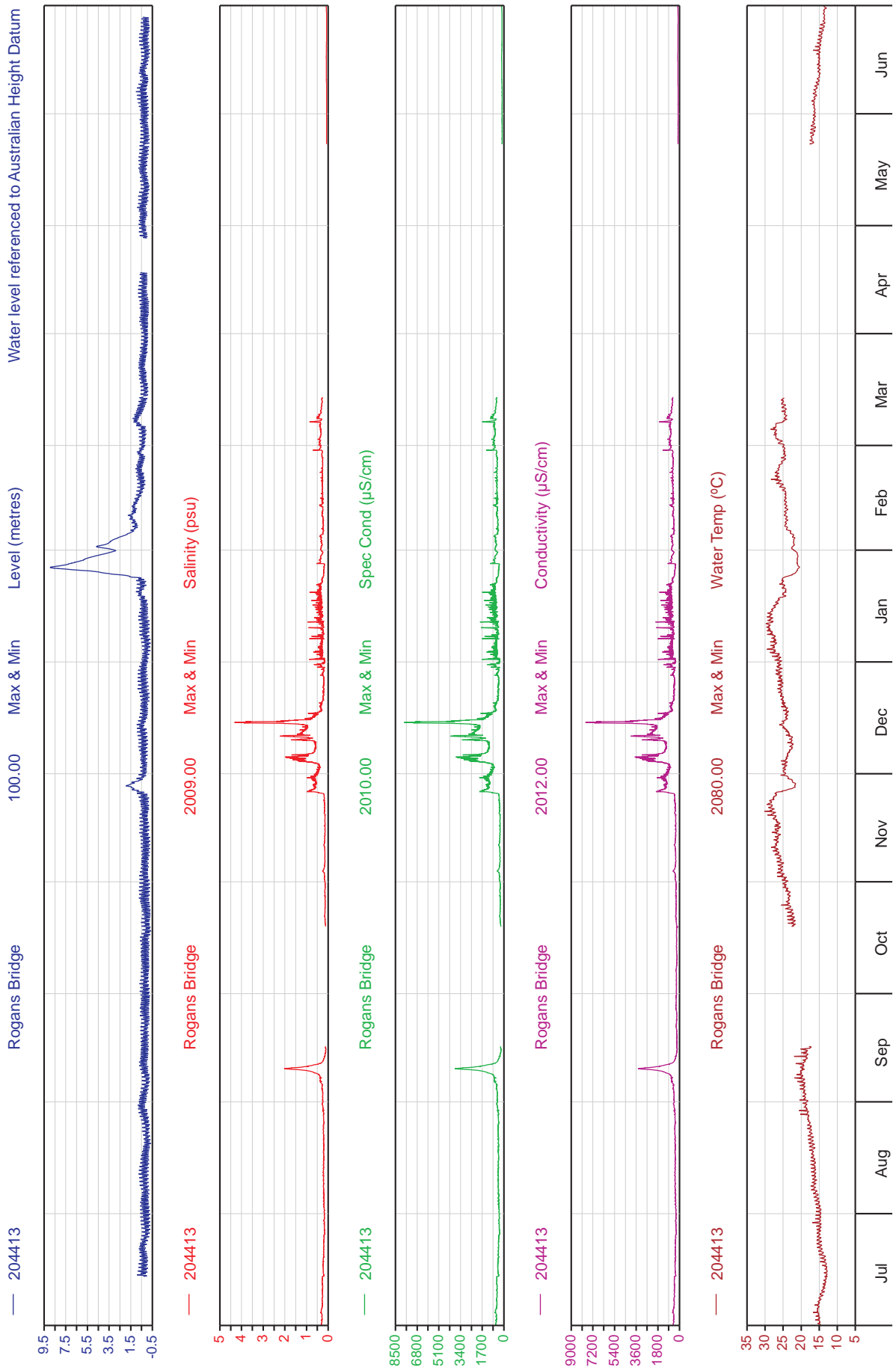
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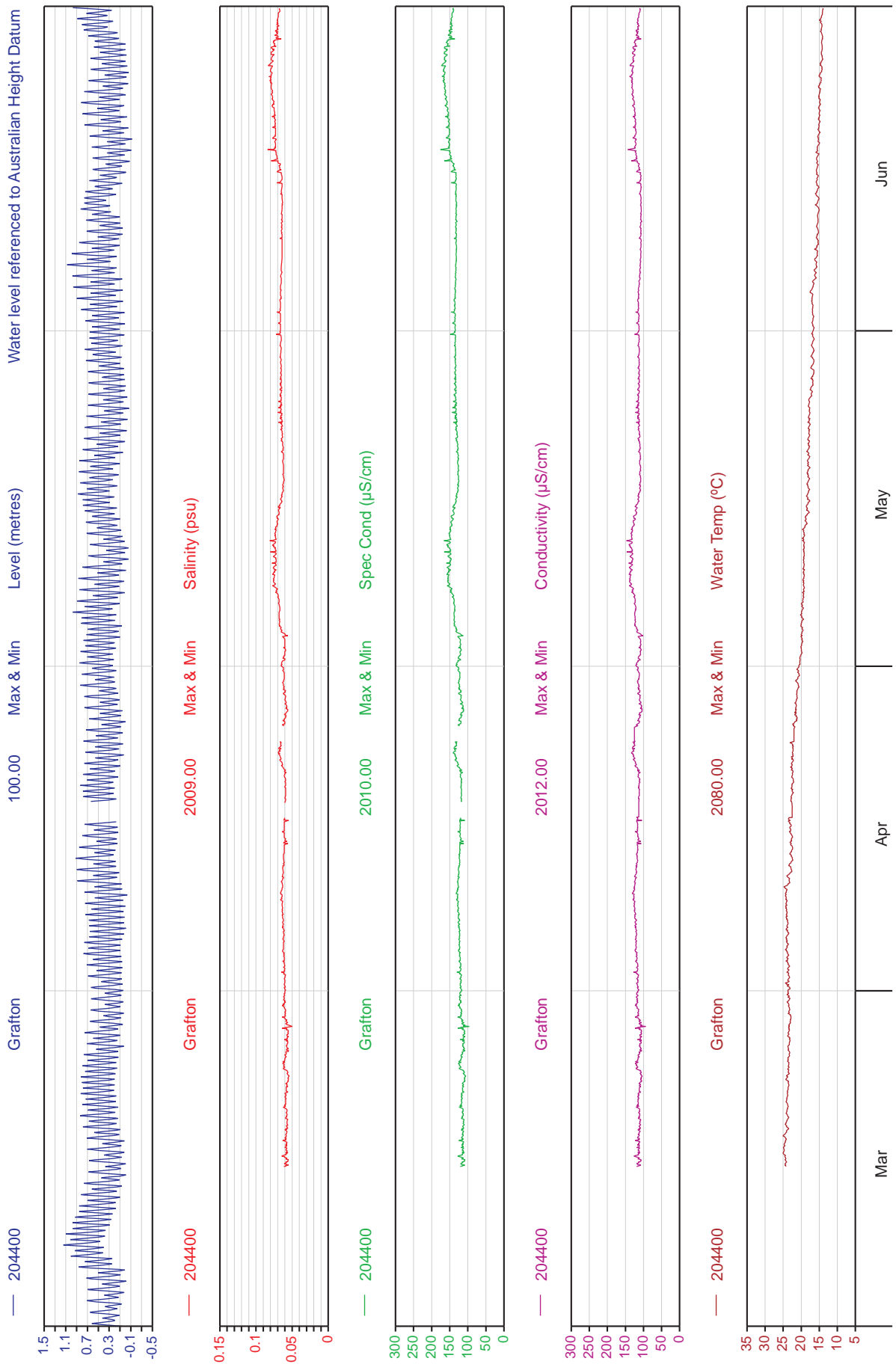
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Figure
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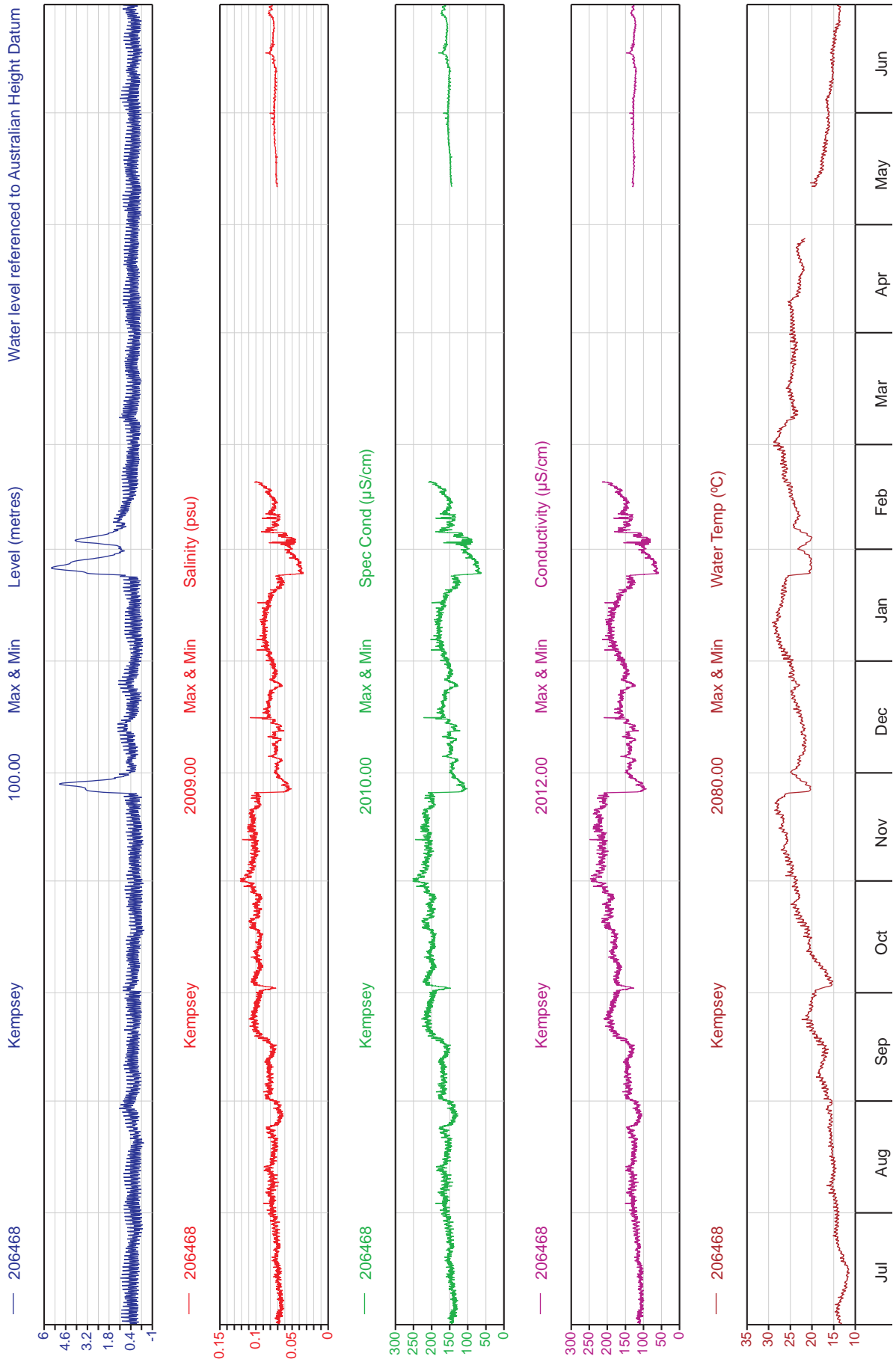
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WATER LEVEL AND WATER QUALITY DATA
2011-2012
KEMPSEY

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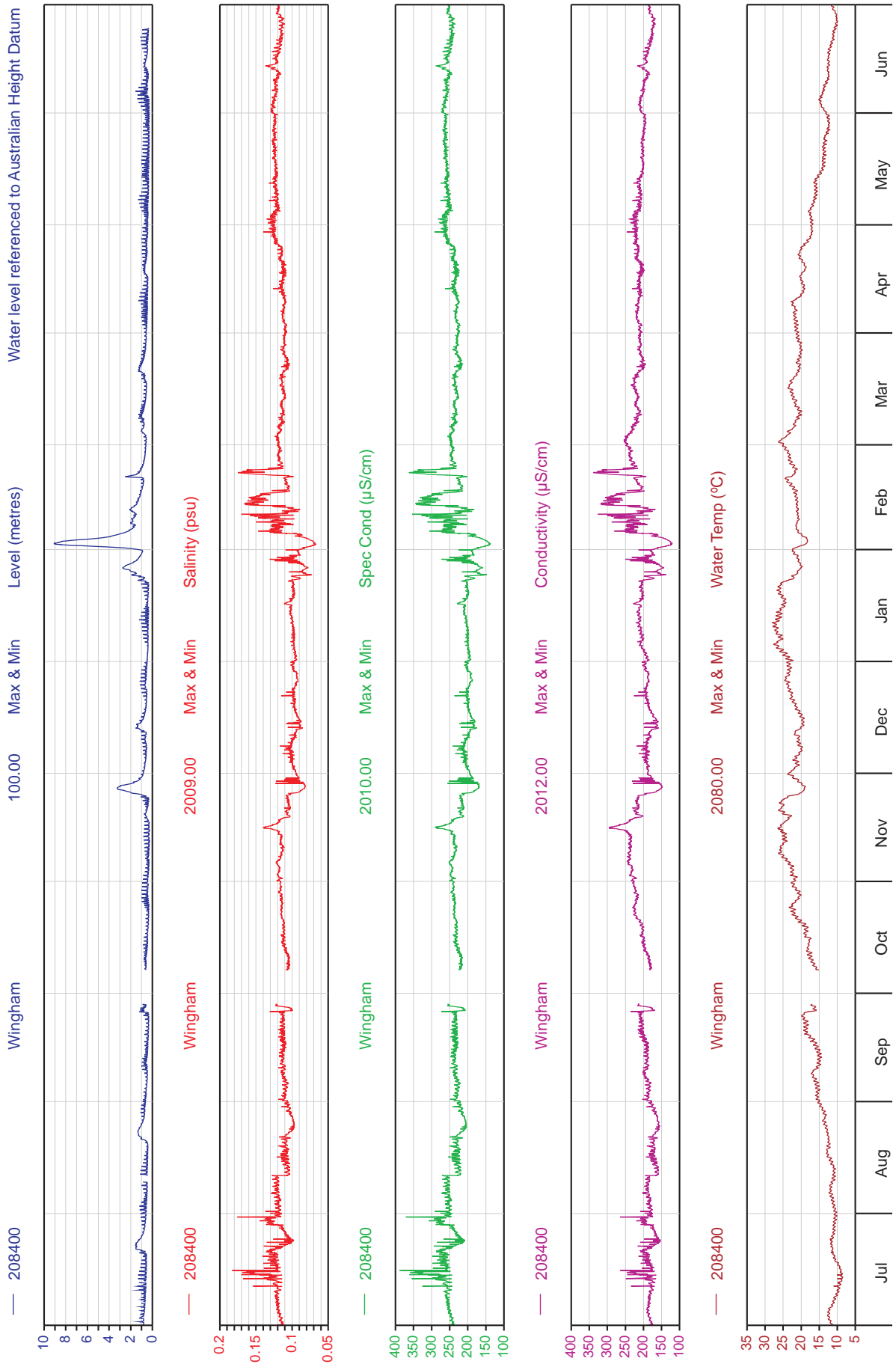
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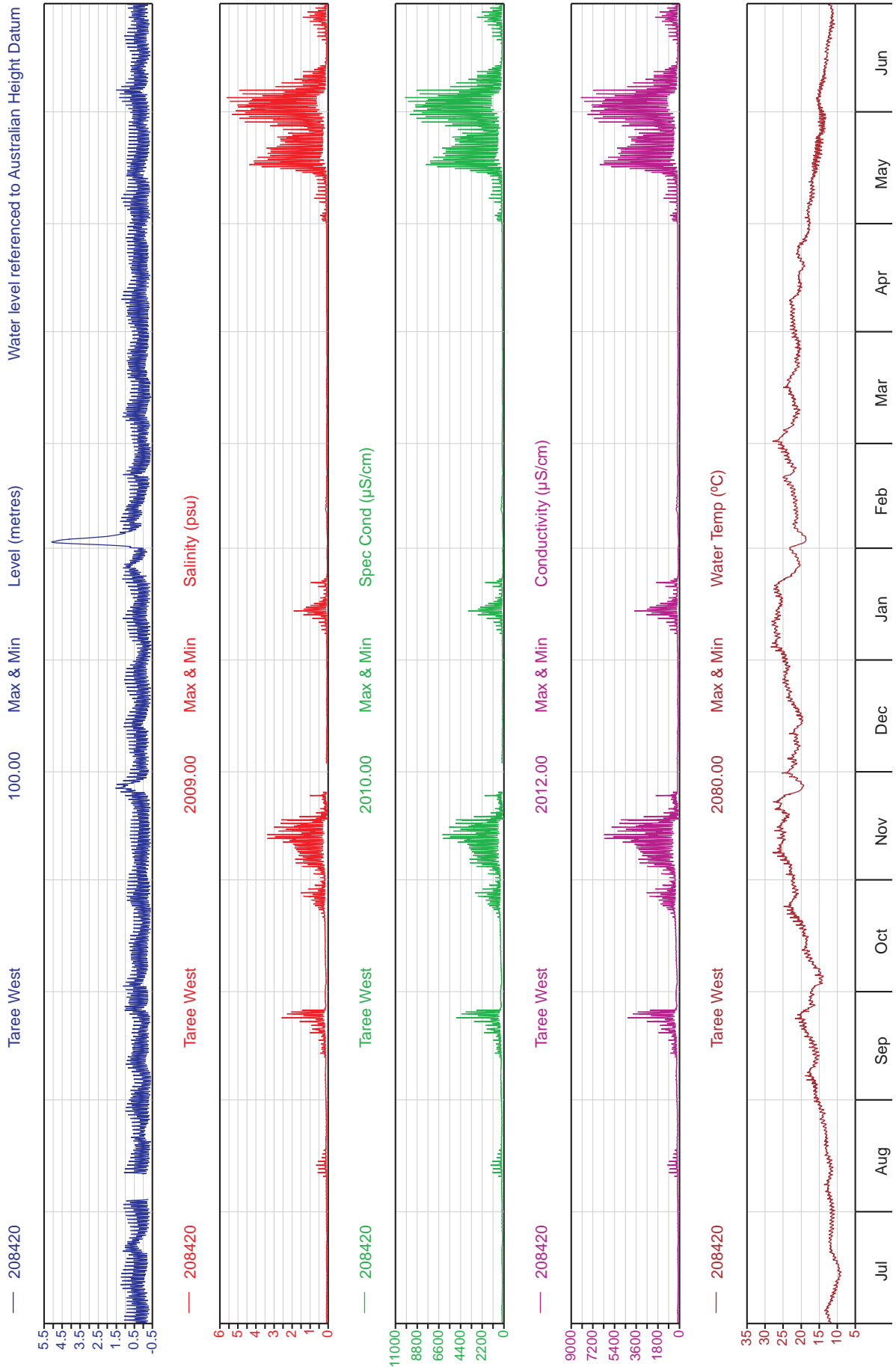
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Figure
11

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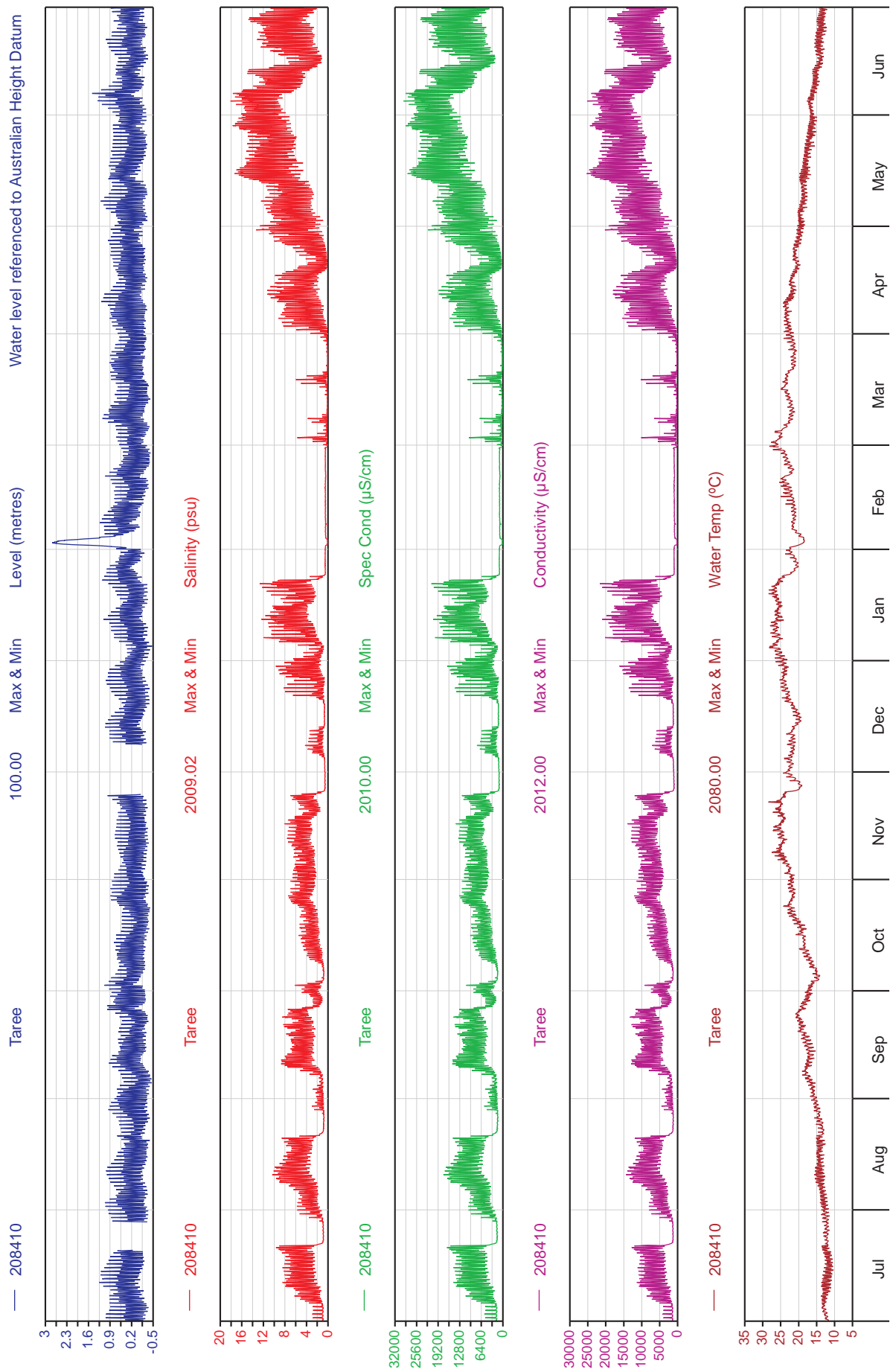
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WATER LEVEL AND WATER QUALITY DATA
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MHL
Report 2161

Figure
13

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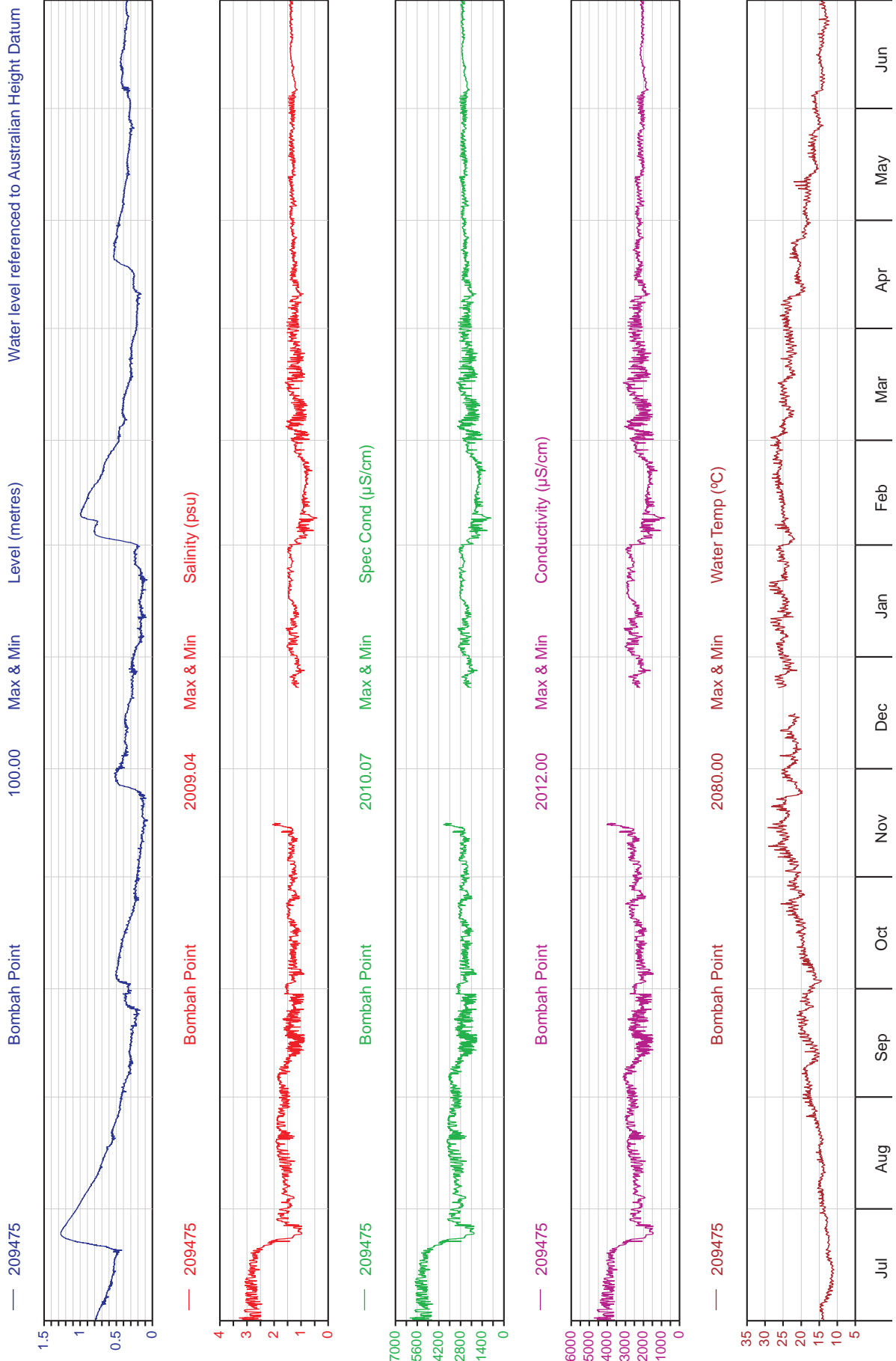
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WATER LEVEL AND WATER QUALITY DATA
2011-2012
TAREE

MHL
Report 2161

Figure
14







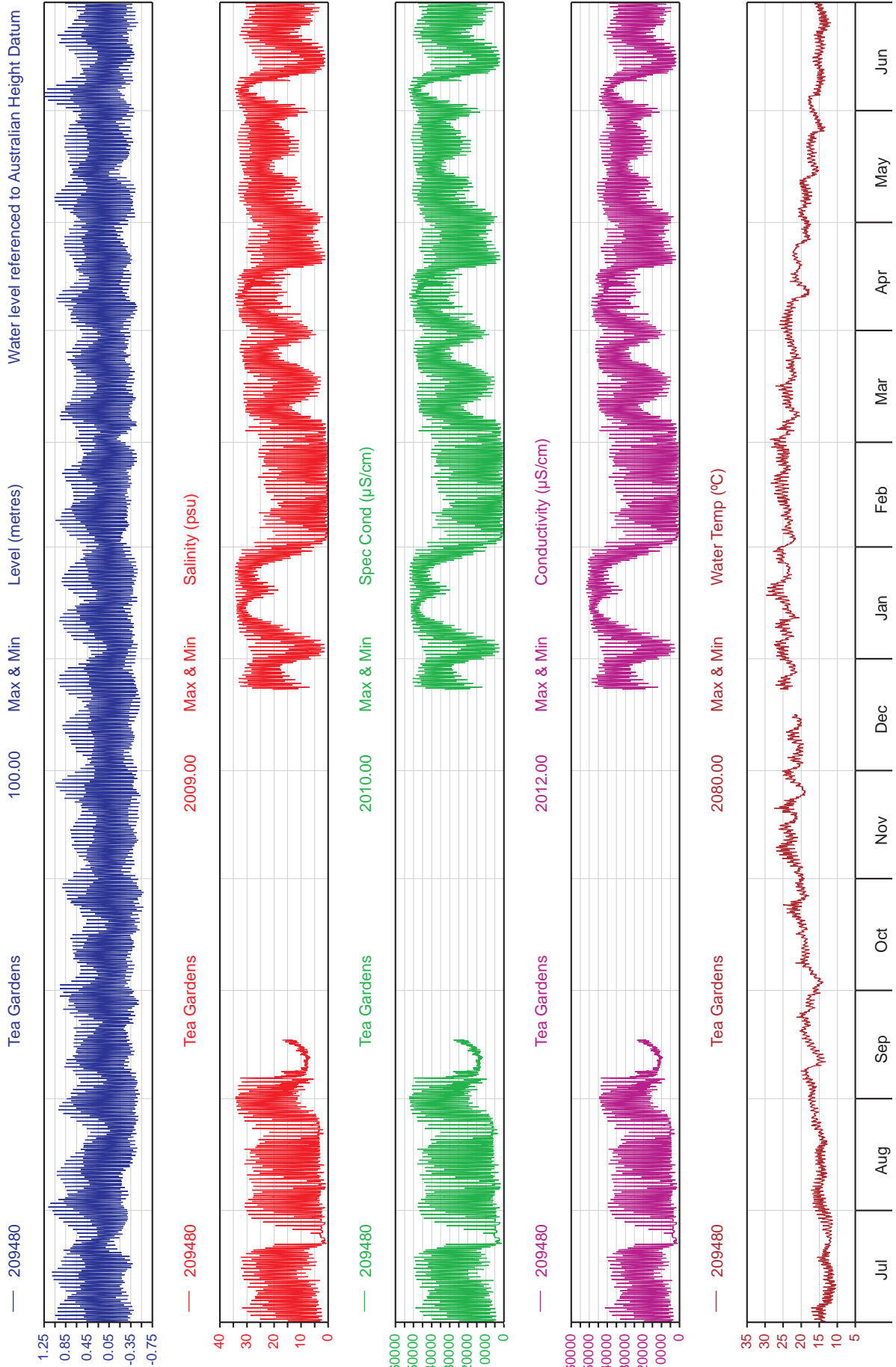
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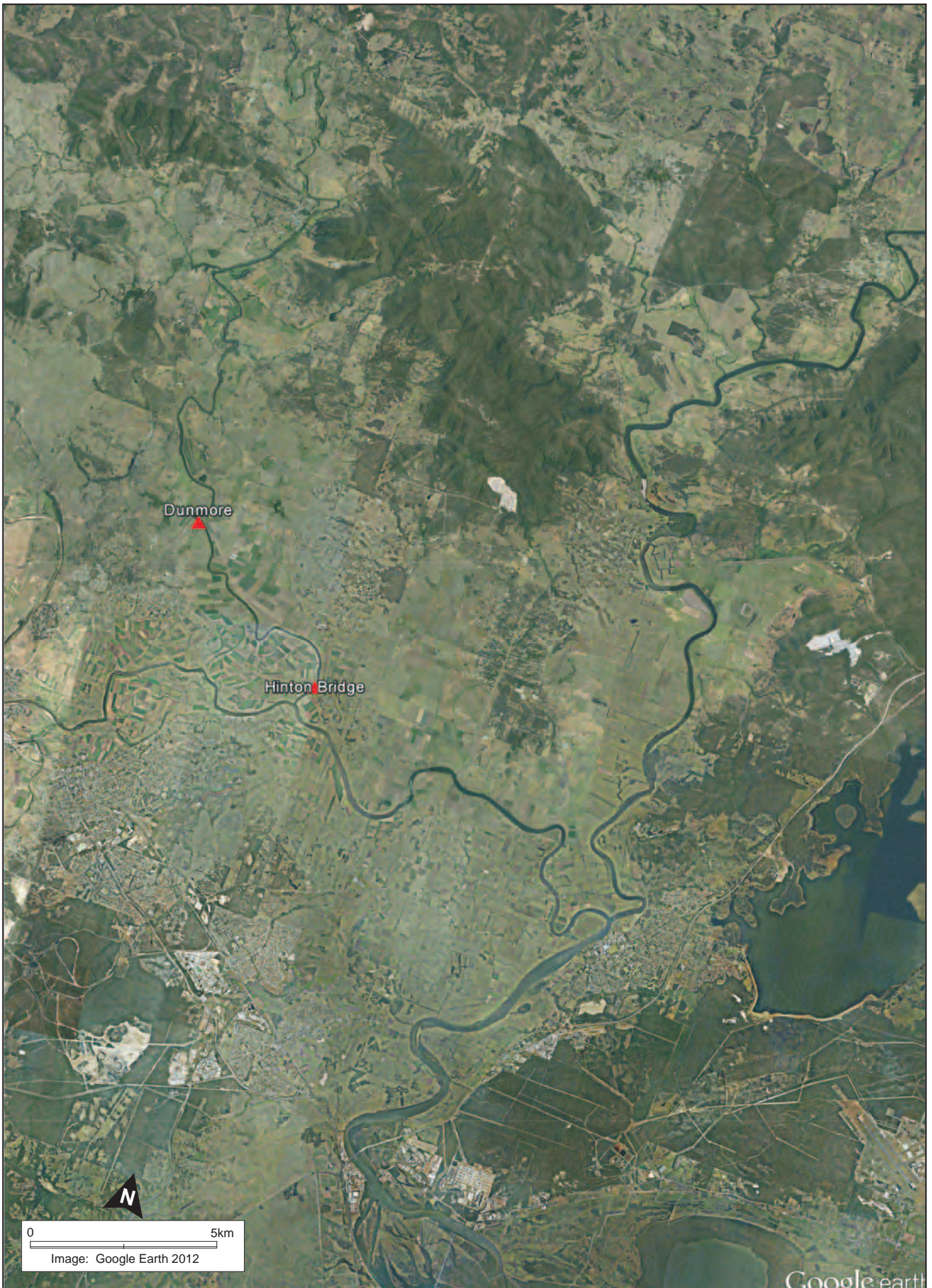
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MHL
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17

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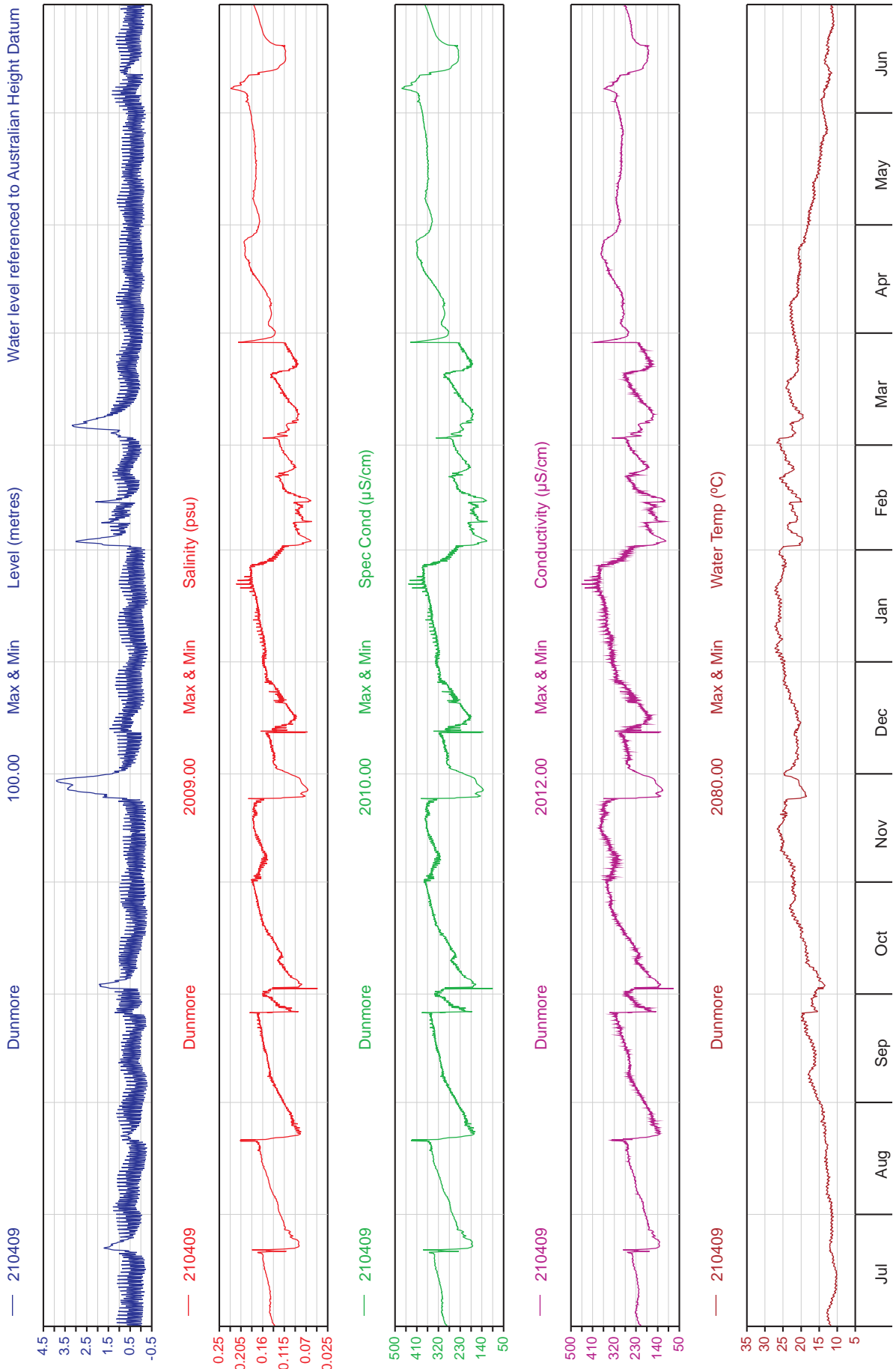
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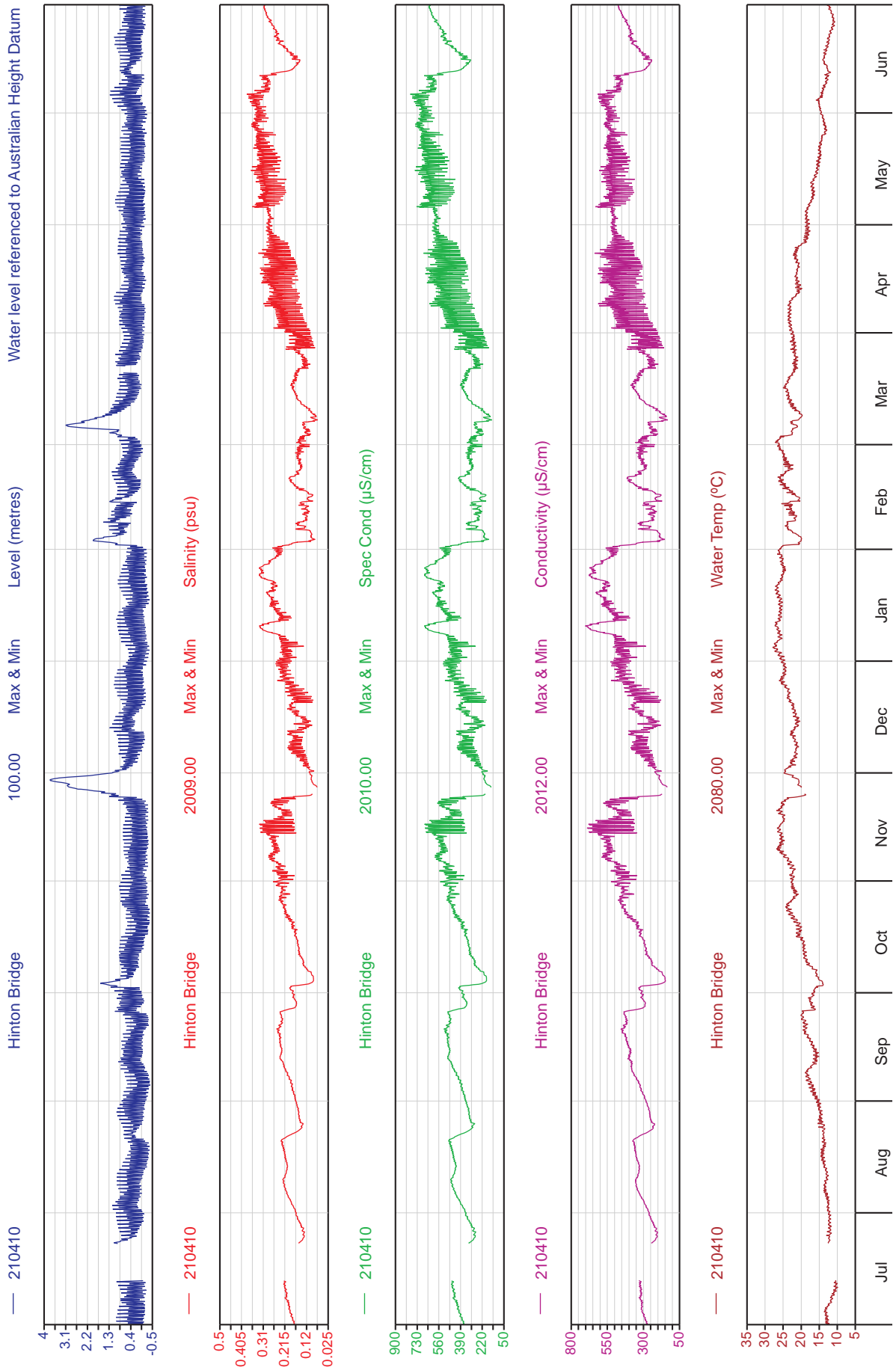
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MHL
Report 2161

Figure
19

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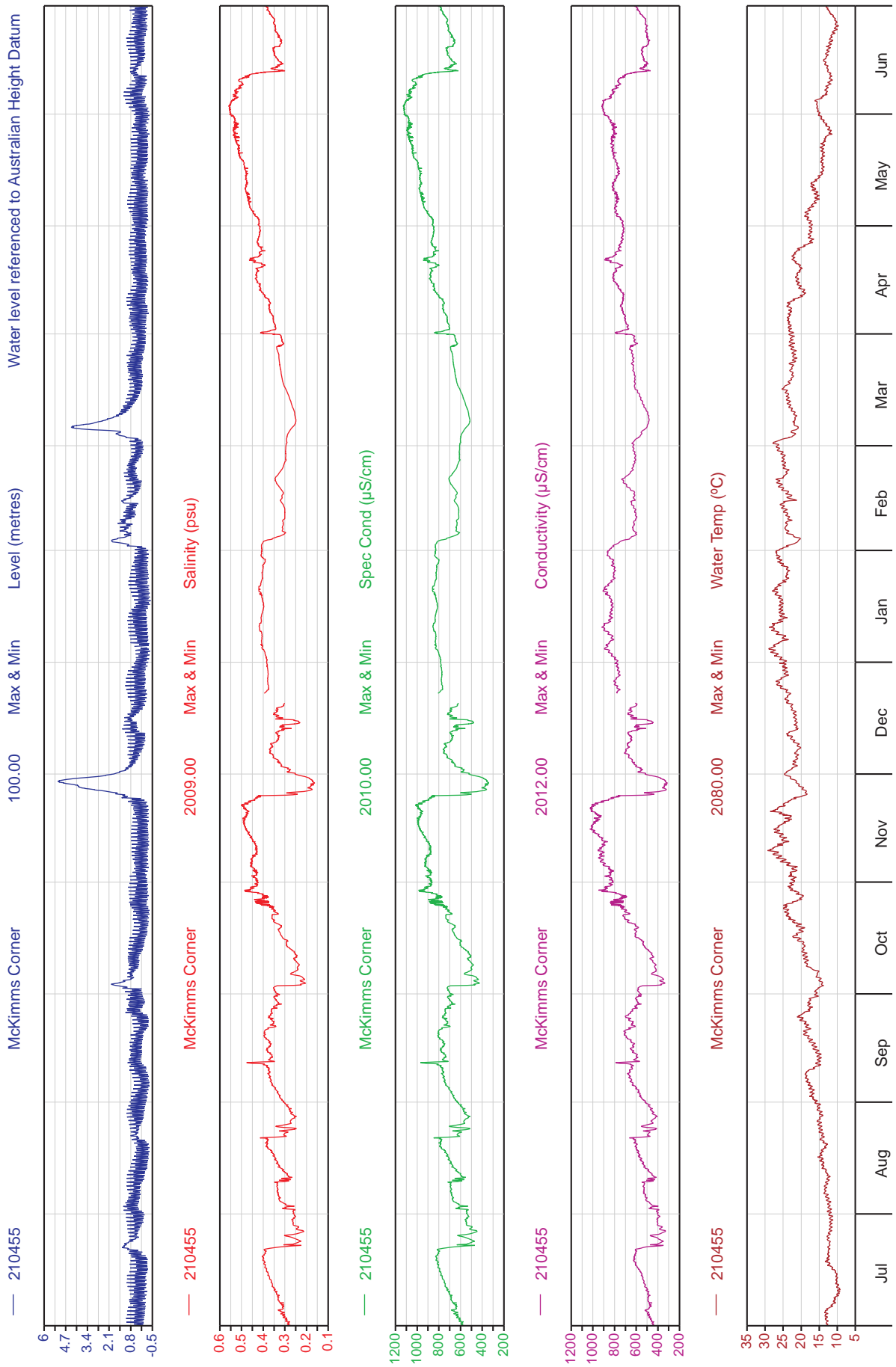
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STATION LOCATION HUNTER RIVER REGION

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Report 2161

Figure
22

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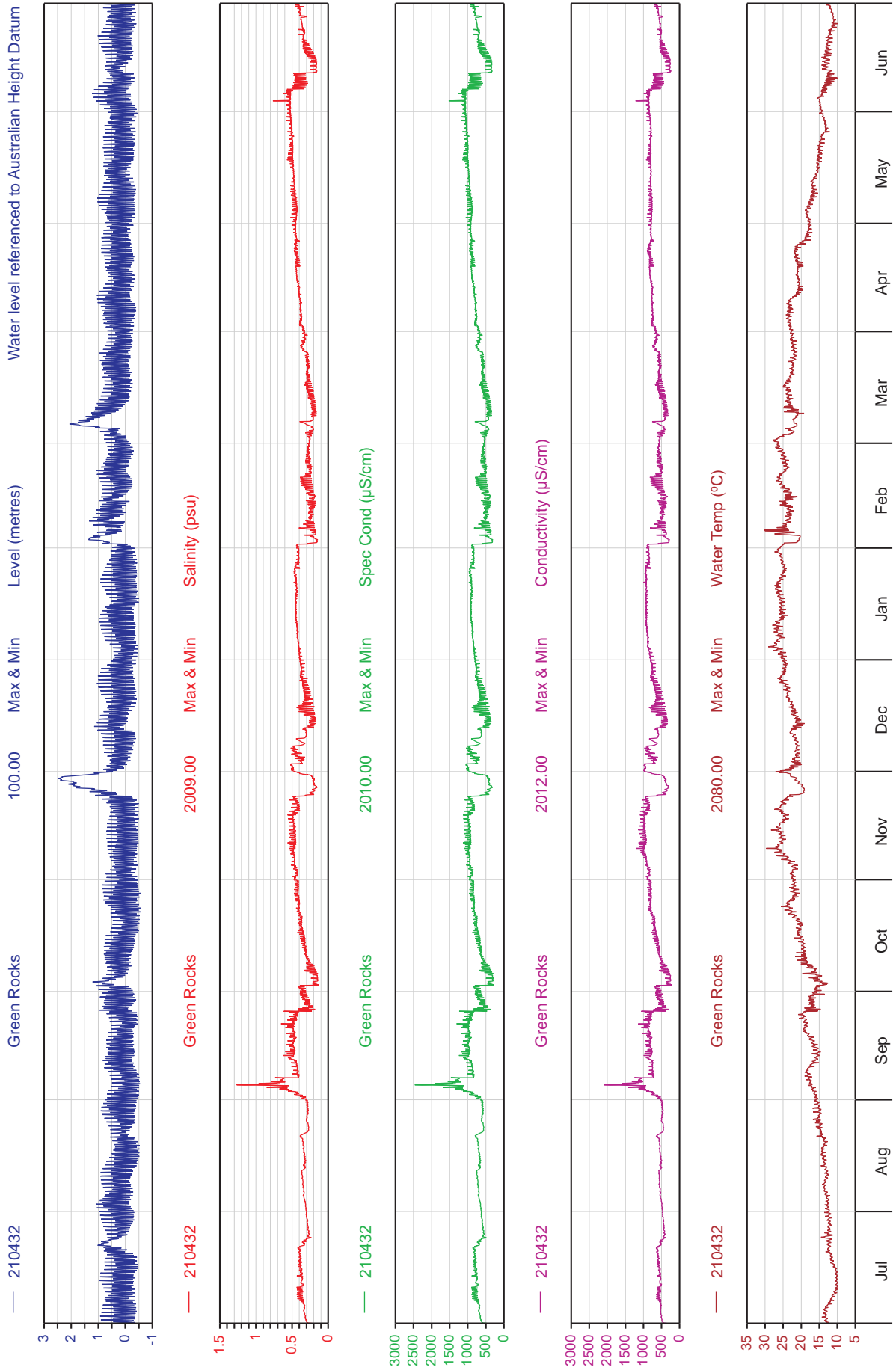


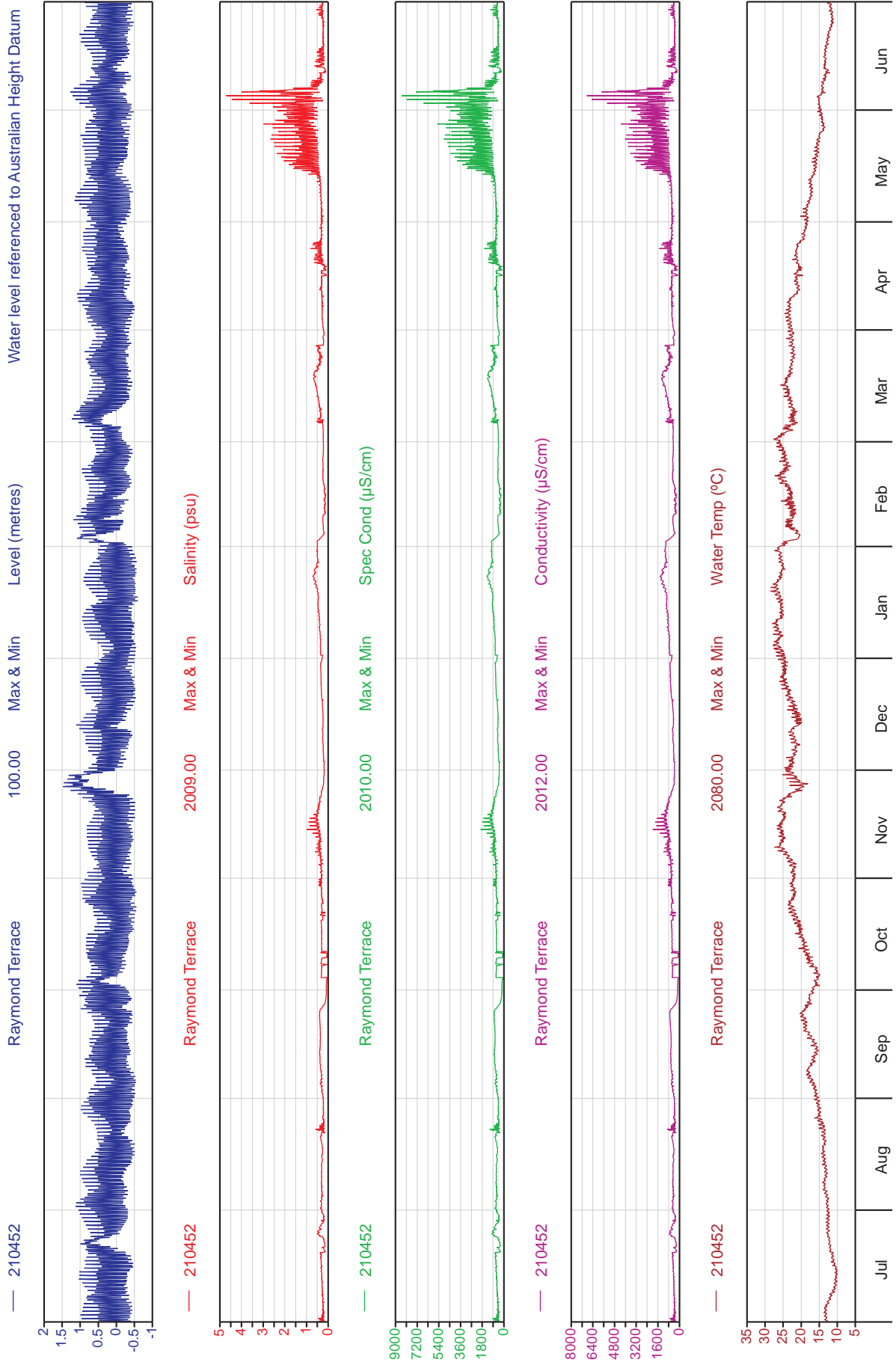
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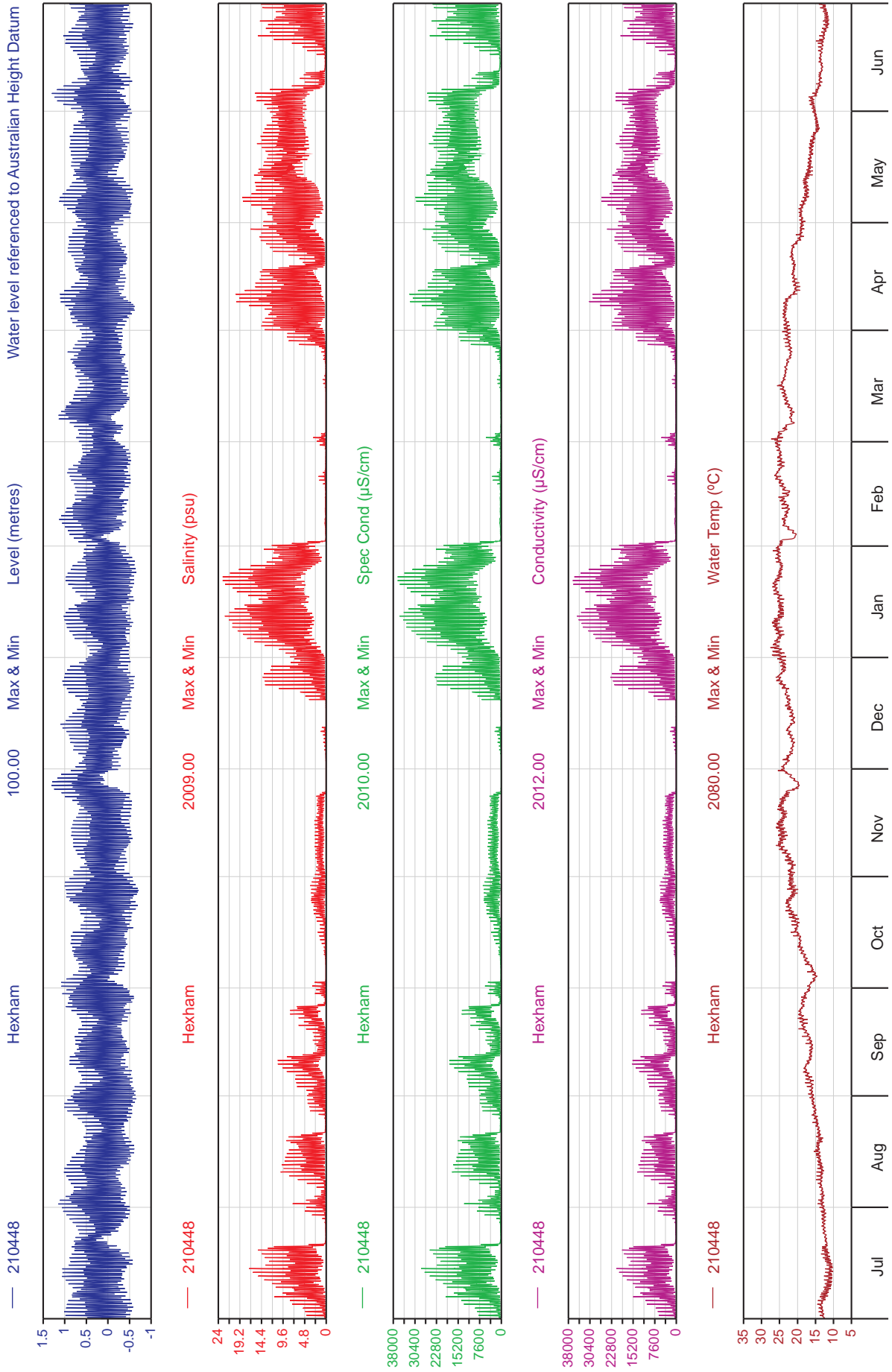
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2011-2012
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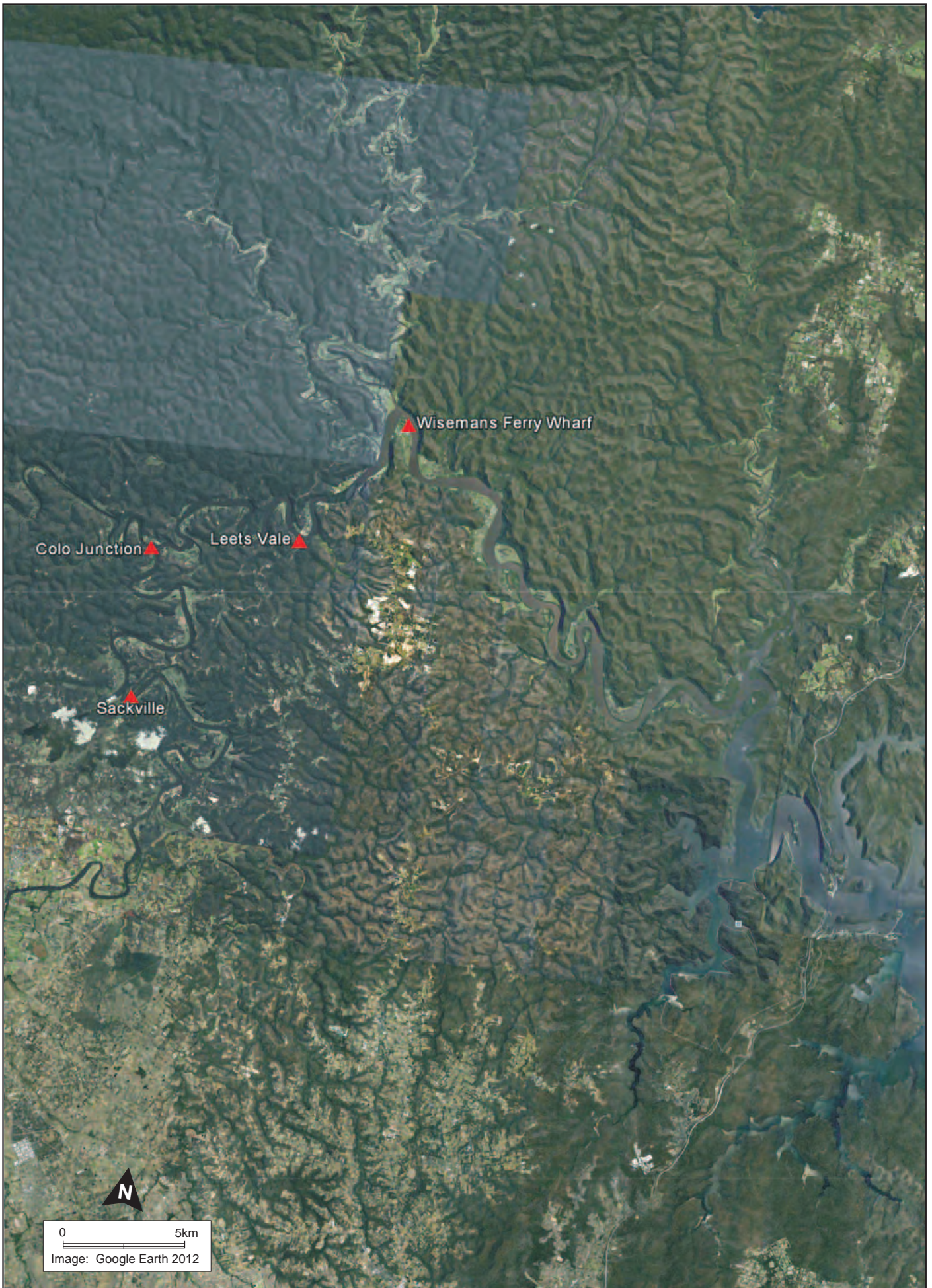
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Report 2161

Figure
23









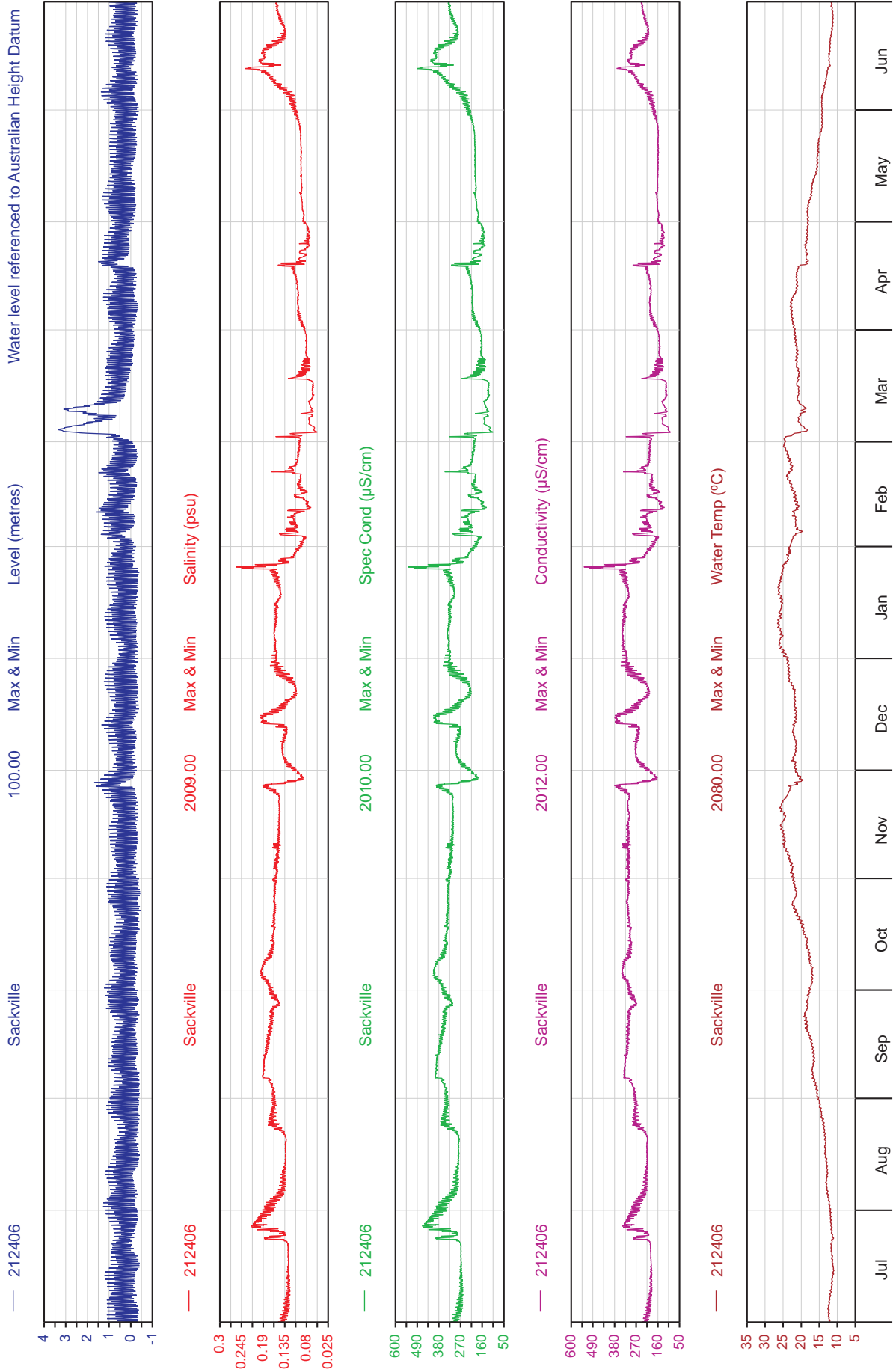
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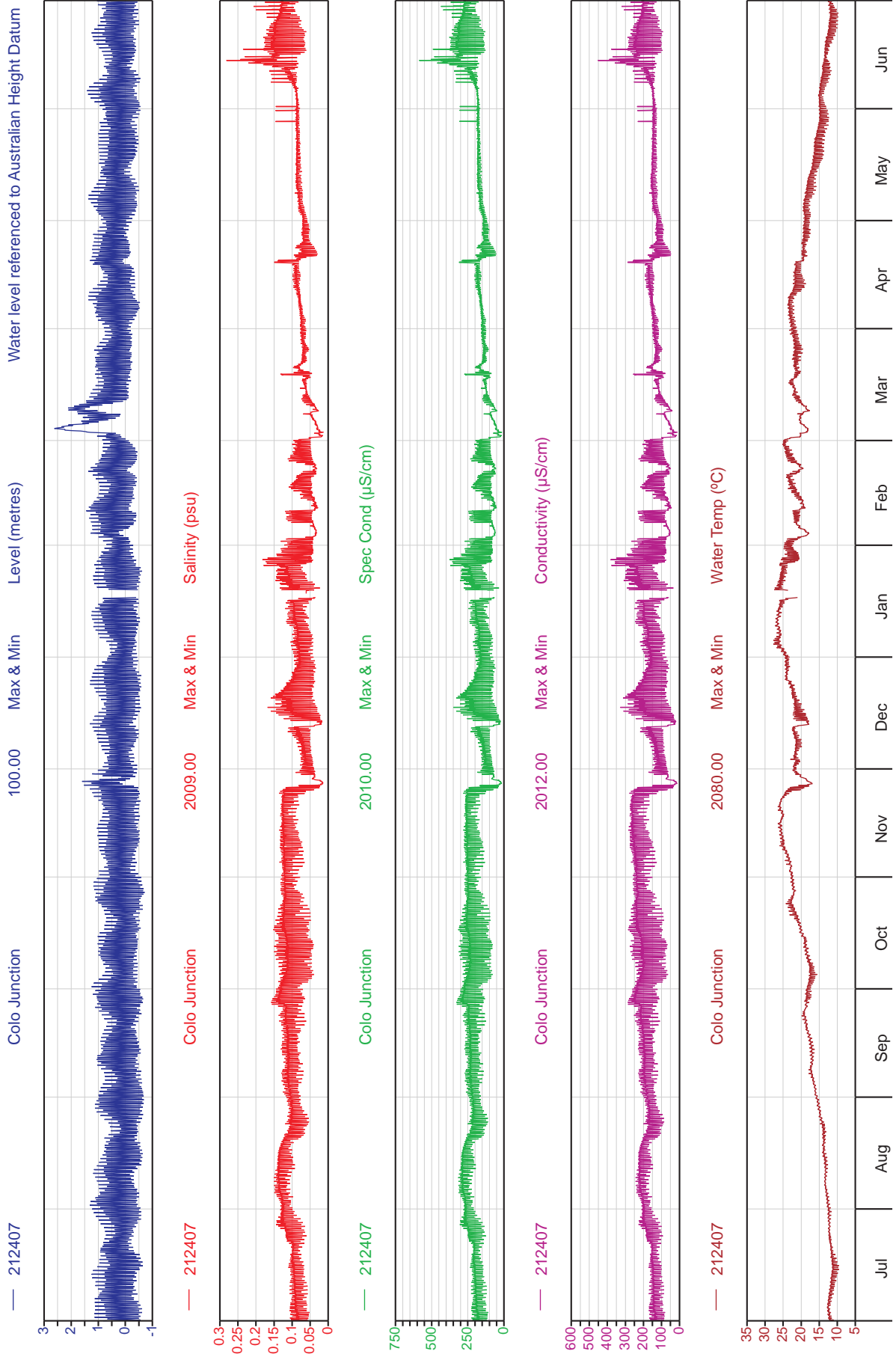
**STATION LOCATION
HAWKESBURY RIVER REGION**

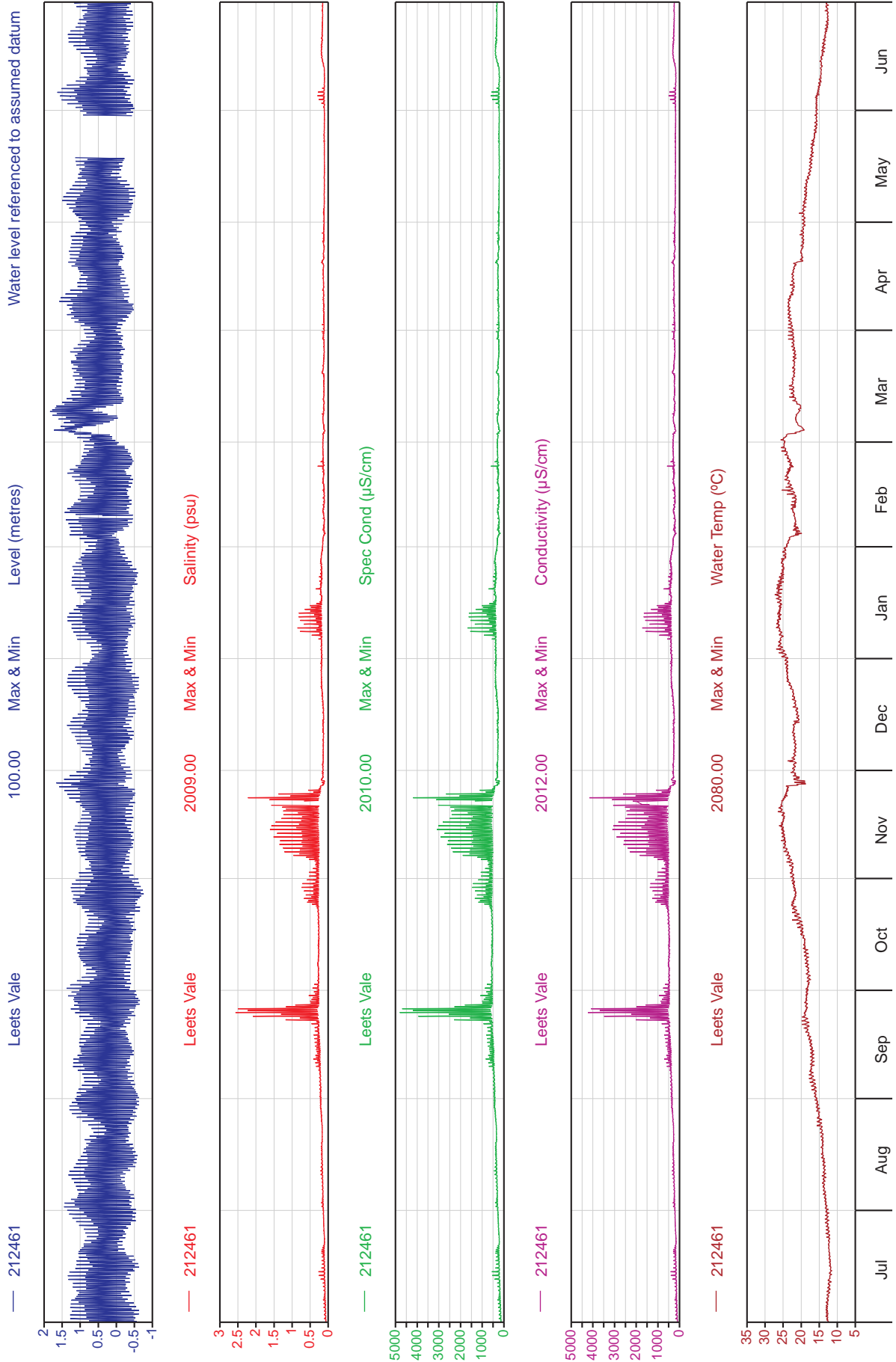
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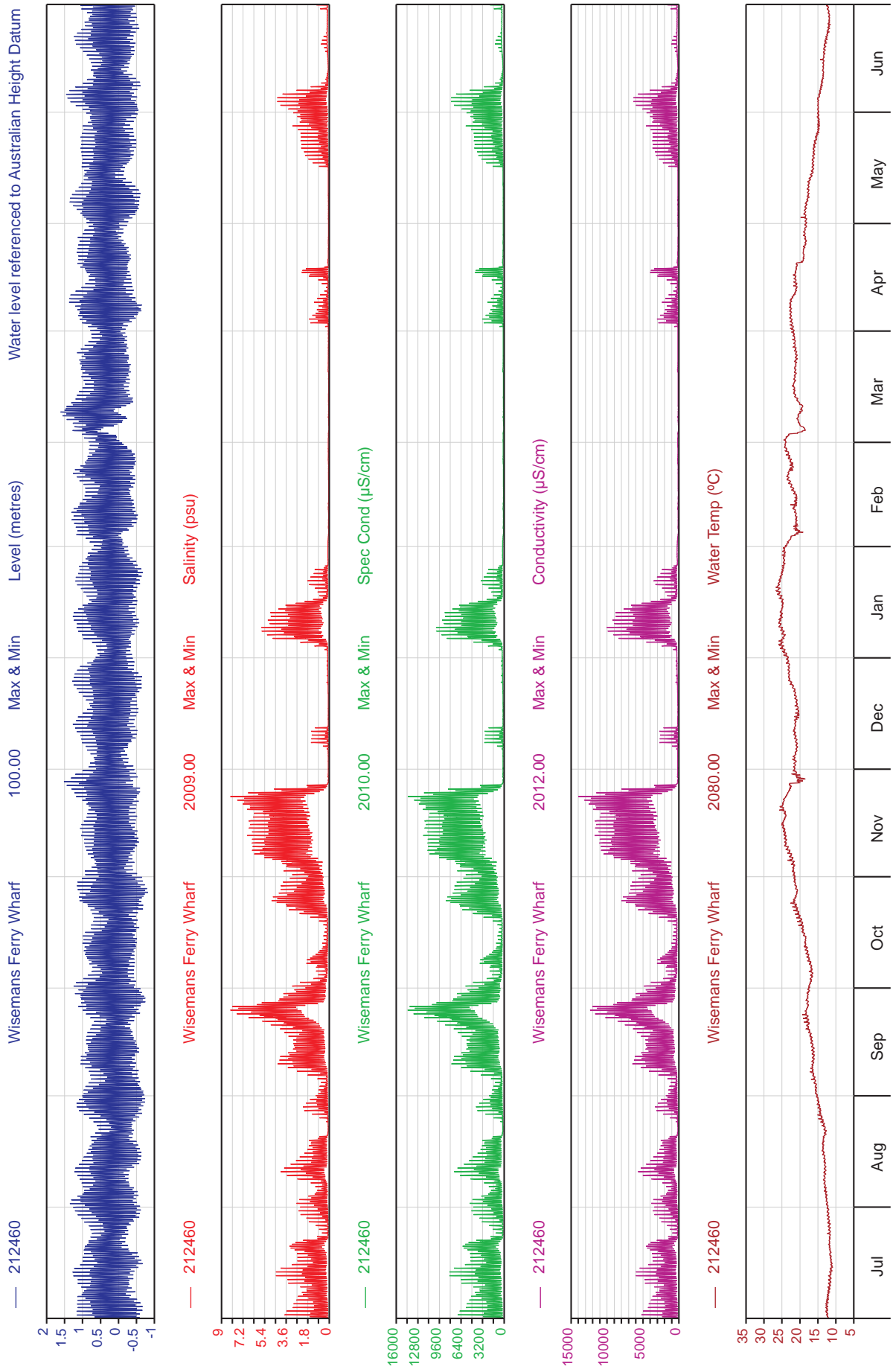
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27

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WATER LEVEL AND WATER QUALITY DATA
2011-2012
WISEMANS FERRY WHARF

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Figure
31

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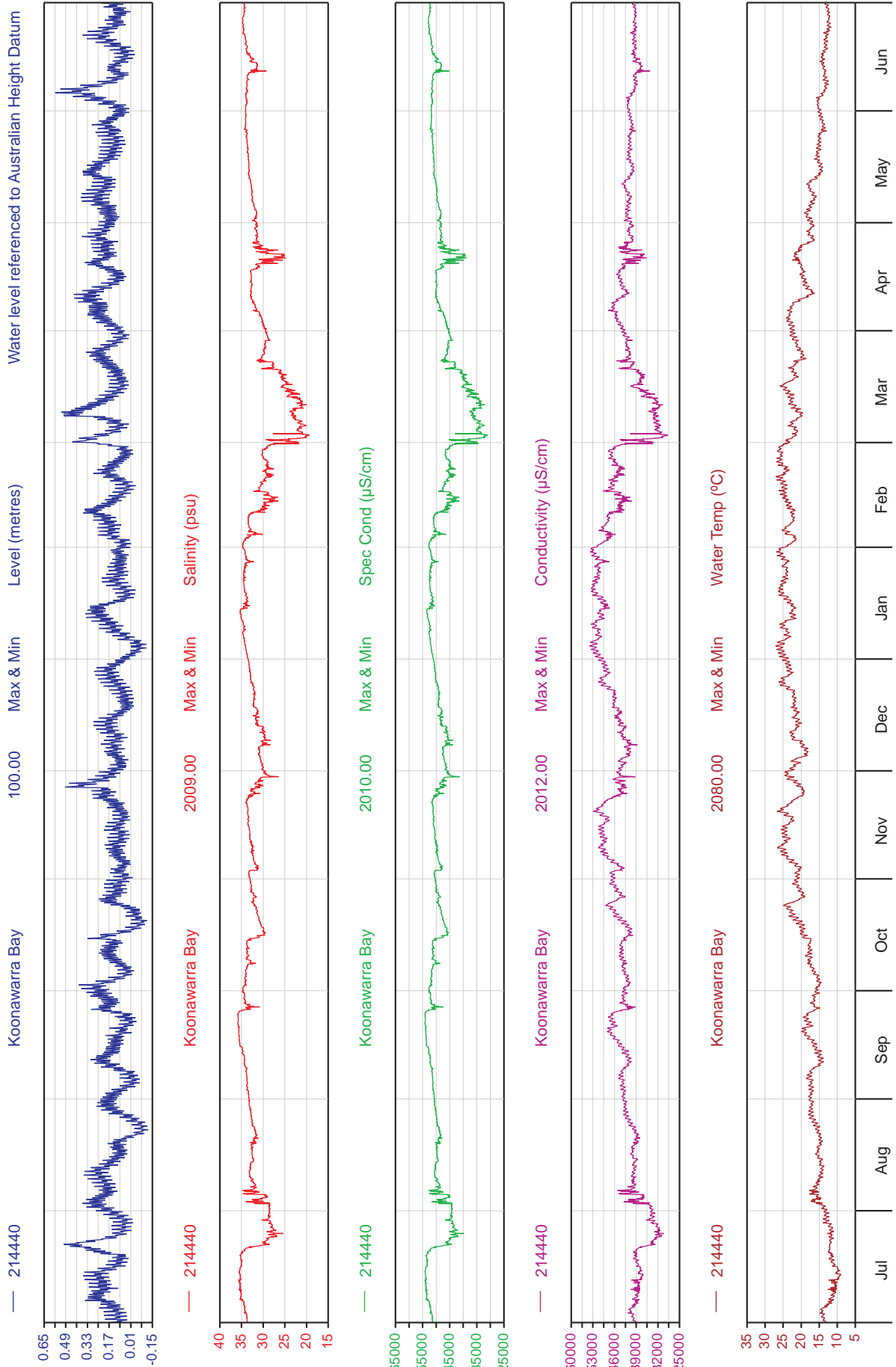
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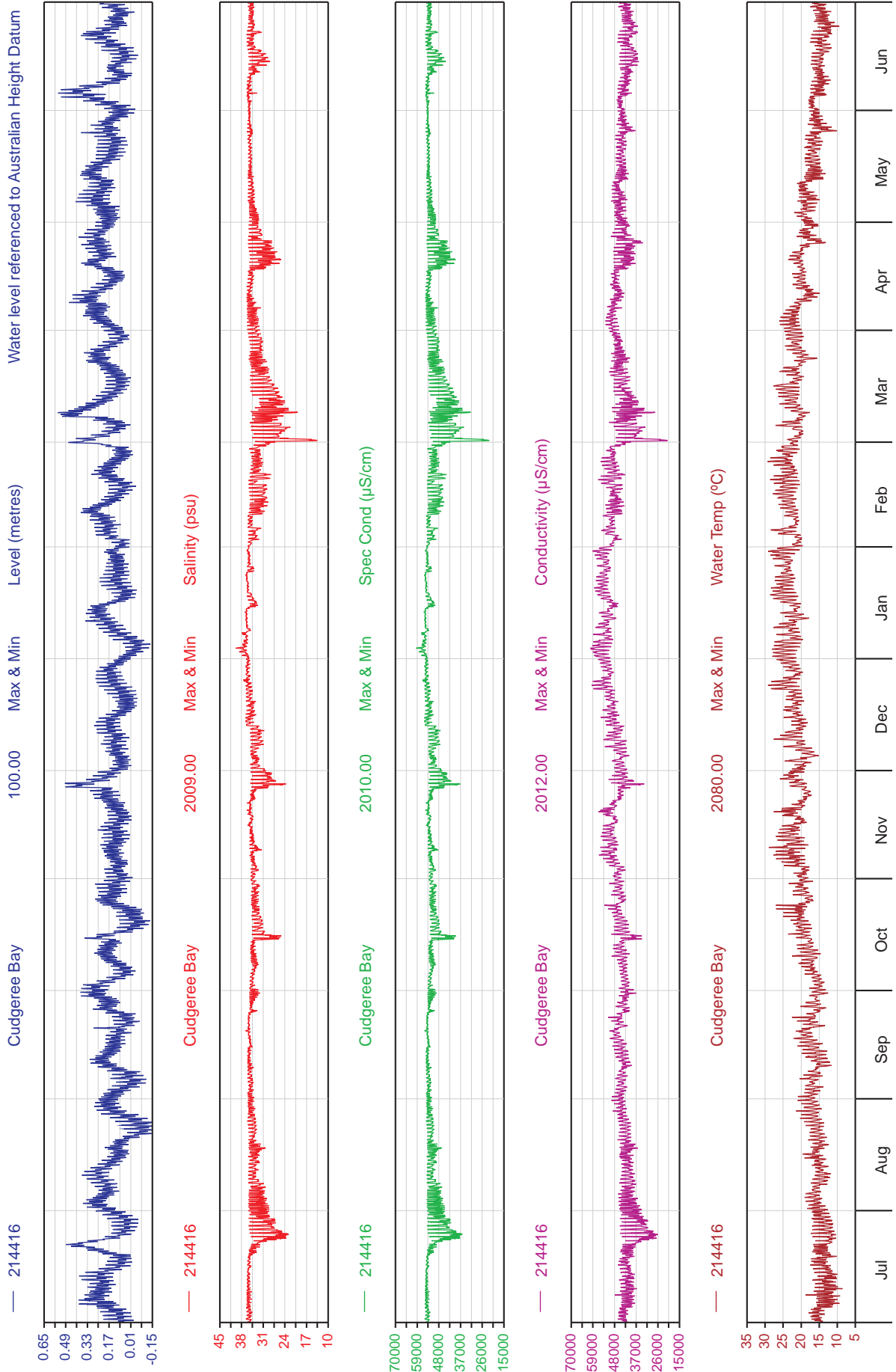
**STATION LOCATIONS
LAKE ILLAWARRA REGION**

MHL
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Figure
32

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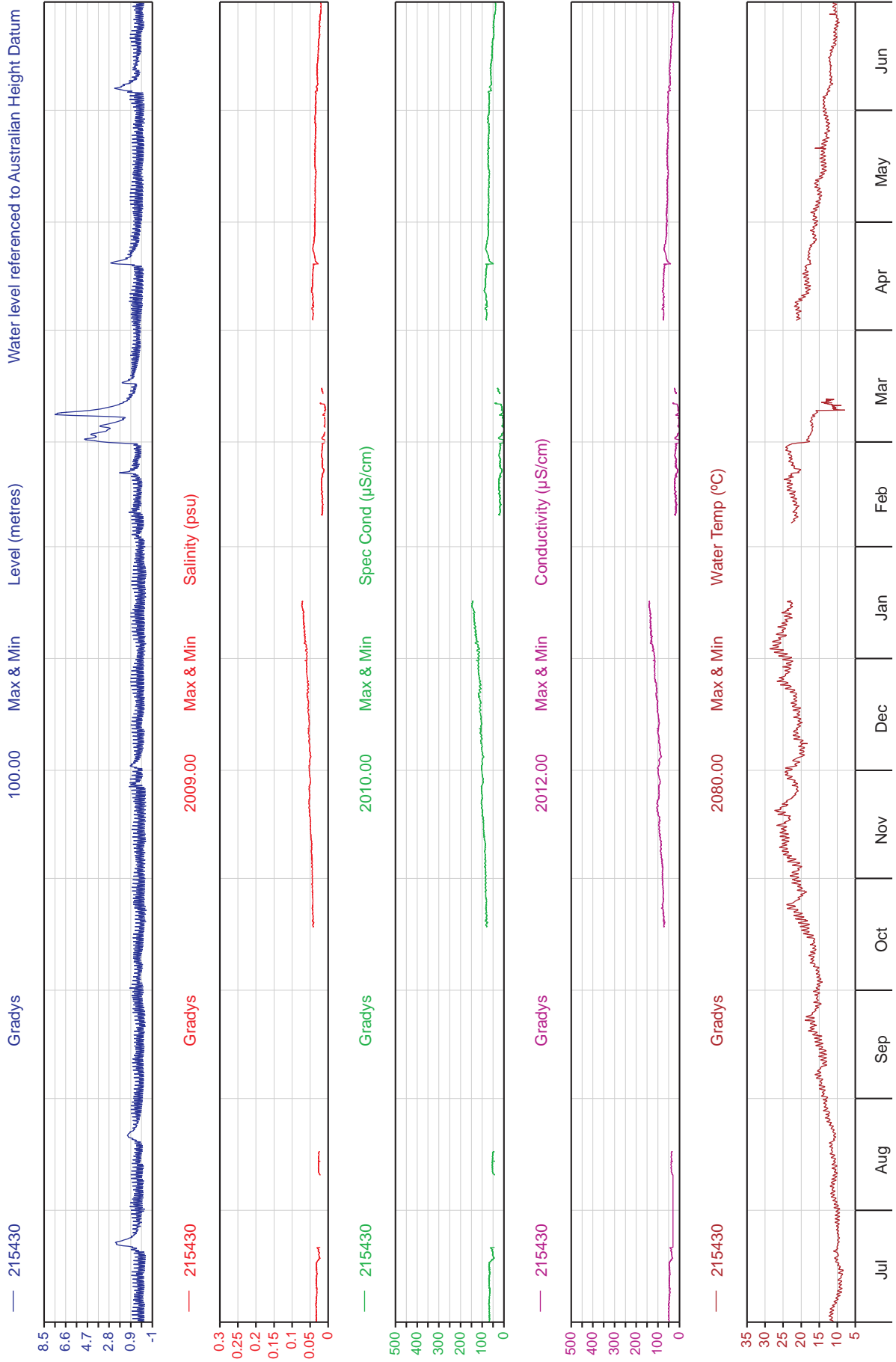
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STATION LOCATIONS SHOALHAVEN RIVER REGION

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Figure
35

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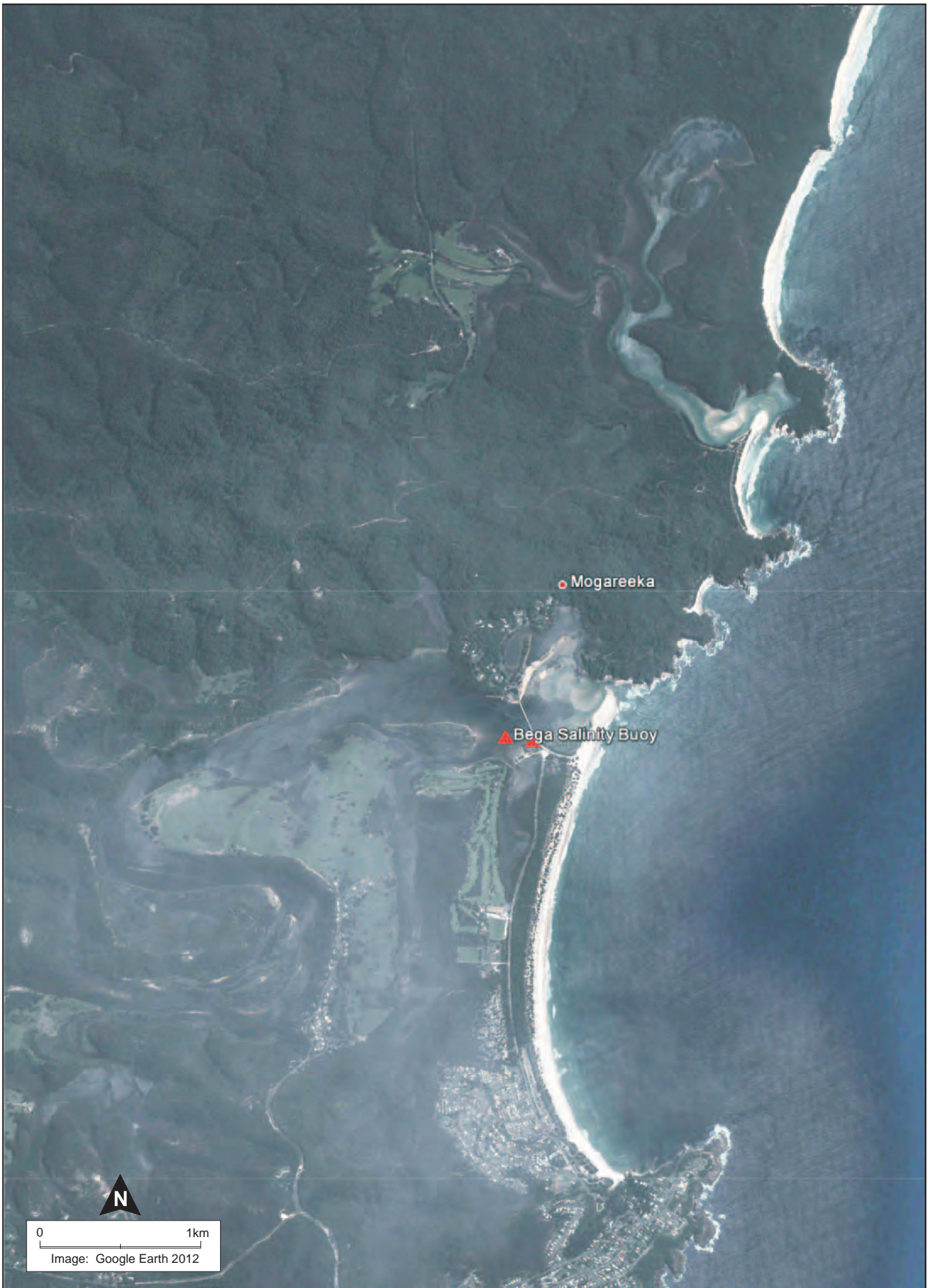
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WATER LEVEL AND WATER QUALITY DATA
2011-2012
GRADYS CARAVAN PARK

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Figure
36

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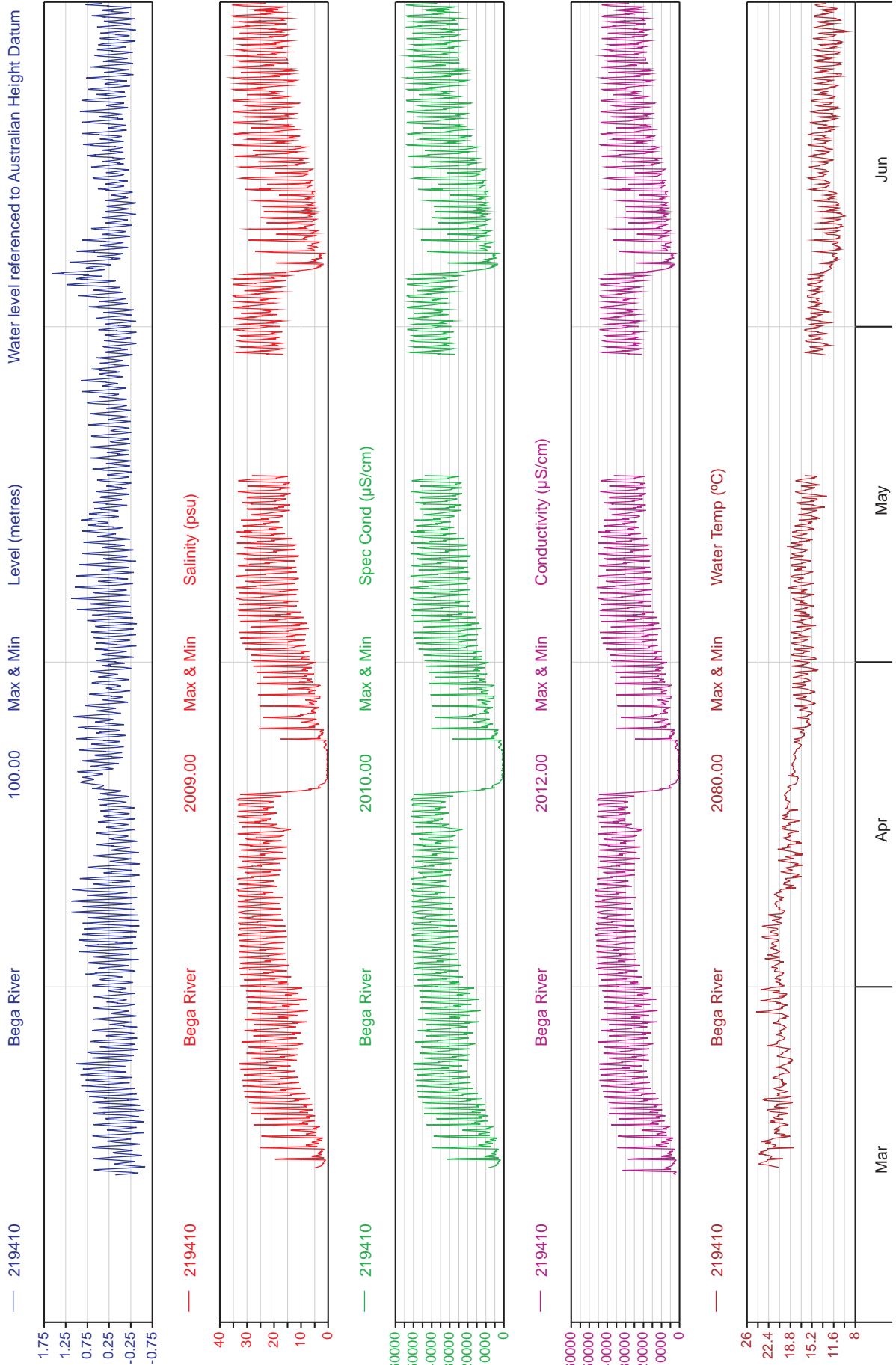
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STATION LOCATIONS BEGA RIVER REGION

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Figure
37

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Appendix A

Data On-line

Appendix A Data On-line

Station Longname	Station Name	Station Number	Start Date	End Date	MHL Report
Brunswick River at Mullumbimby	Mullumbimby	202402	08-Apr-98	18-Mar-99	1000
Richmond River at Coraki	Coraki	203403	20-Sep-94	ongoing	749
Tucombil Canal at Tucombil Highway Bridge	Tucombil Highway Bridge	203411	21-Aug-97	29-Aug-98	961
Rocky Mouth Creek at Rocky Mouth Creek	Rocky Mouth Creek	203432	06-Sep-94	21-Aug-96	794
Tucombil Canal at Tucombil Floodgate	Tucombil Floodgate	203434	09-Sep-94	29-Sep-95	961
Richmond River at Bungawalbin	Bungawalbin	203450	09-Sep-94	ongoing	
Lennox Head at Lake Ainsworth	Lake Ainsworth	203455	15-Nov-95	30-Nov-96	851
Clarence River at Grafton	Grafton	204400	02-Mar-99	ongoing	1065
Clarence River at Rogans Bridge	Rogans Bridge	204413	09-Mar-99	ongoing	1065
Clarence River at Mylneford	Mylneford	204460	21-May-10	ongoing	
Nambucca River at Macksville	Macksville	205416	17-Feb-99	22-Feb-00	1050
Coffs Creek at Coffs Creek Highway Bridge	Coffs Creek Highway Bridge	205439	14-Dec-92	23-Nov-96	
Bonville Creek at Bonville	Bonville	205480	08-Aug-97	15-Feb-99	985
Borirgala Creek at Borirgala Creek	Borirgala Creek	206450	06-Apr-01	26-Sep-01	1151
Macleay River at South West Rocks	South West Rocks	206456	01-Mar-96	01-Mar-99	986
Macleay River at Euroka Upstream	Euroka Upstream	206458	07-Dec-09	ongoing	
Macleay River at Kempsey	Kempsey	206468	09-Feb-10	ongoing	
Maria River at Green Valley	Green Valley	207406	30-Sep-94	01-Nov-95	760
Lake Cathie at Lake Cathie	Lake Cathie	207441	18-Aug-93	07-Sep-94	
Manning River at Wingham	Wingham	208400	08-Dec-09	ongoing	
Manning River at Taree	Taree	208410	16-Feb-10	ongoing	
Manning River at Taree West	Taree West	208420	30-Apr-10	ongoing	
Myall River at Bombah Point	Bombah Point	209475	09-Jul-96	ongoing	906
Myall River at Tea Gardens	Tea Gardens	209480	20-Oct-09	ongoing	
Paterson River at Dunmore	Dunmore	210409	15-Oct-09	ongoing	

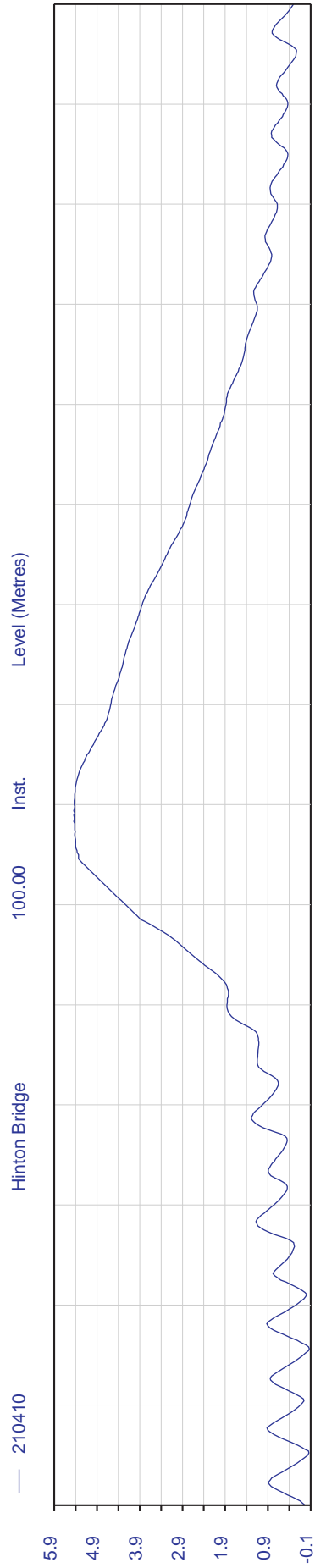
Station Longname	Station Name	Station Number	Start Date	End Date	MHL Report
Paterson River at Hinton Bridge	Hinton Bridge	210410	03-Dec-93	ongoing	750
Wallis Creek at Wallis Creek Downstream	Wallis Creek Downstream	210428	21-Sep-95	01-Oct-98	965
Hunter River at Green Rocks	Green Rocks	210432	03-Dec-93	ongoing	750
Hunter River at Hexham Bridge	Hexham Bridge	210448	17-Dec-93	ongoing	750
Hunter River at Hexham	Hexham	210448	13-Apr-11	ongoing	
Williams River at Raymond Terrace	Raymond Terrace	210452	15-Oct-09	ongoing	
Hunter River at McKimms Corner	McKimms Corner	210455	08-Oct-09	ongoing	
Hunter River at Belmore Bridge	Belmore Bridge	210458	01-Dec-93	ongoing	750
Nepean River at Castlereagh	Castlereagh	212404	01-Jul-94	01-Jul-98	
Hawkesbury River at Sackville	Sackville	212406	01-Jul-94	ongoing	
Hawkesbury River at Colo Junction	Colo Junction	212407	07-Nov-09	ongoing	
Hawkesbury River at Ebenezer	Ebenezer	212427	01-Jul-94	01-Jul-98	
Hawkesbury at Wisemans Ferry Wharf	Wisemans Ferry Wharf	212460	10-Jun-10	ongoing	
Hawkesbury at Leets Vale	Leets Vale	212461	22-Jun-10	ongoing	
Lake Illawarra at Cudgeree Bay	Cudgeree Bay	214416	09-Feb-93	ongoing	994
Lake Illawarra at Koonawarra Bay	Koonawarra Bay	214440	15-Jun-93	ongoing	994
Shoalhaven at Gradys Caravan Park	Gradys Caravan Park	215430	06-Oct-10	ongoing	
Wollumboola Lake at Wollumboola	Wollumboola	215454	01-Feb-99	06-Jan-11	1145
Crookhaven River at Crookhaven Heads	Crookhaven Heads	215471	06-Mar-95	07-Apr-95	
Currarong Creek at Currarong Creek	Currarong Creek	216405	04-Mar-96	04-Mar-97	858
Swan Lake at Swan Lake	Swan Lake	216425	02-Feb-99	02-Feb-00	
Clyde River at Nelligen	Nelligen	216453	17-Sep-96	17-Sep-97	889
Tomaga at George Bass Drive	George Bass Drive	216455	28-Aug-96	28-Aug-97	890
Tuross River at Coila Lake	Coila Lake	218405	08-Mar-96	21-Nov-96	848
Wagonga River at Barlows Bay	Barlows Bay	218415	30-Aug-96	30-Aug-97	888
Wallaga Lake at Regatta Point	Regatta Point	219405	06-Mar-95	07-Apr-95	
Bega River at Bega	Bega	219410	24-Feb-10	ongoing	
Back Lagoon at Back Lagoon	Back Lagoon	219415	25-Sep-97	25-Sep-98	963
Lake Curalo at Lake Curalo	Lake Curalo	220420	09-Mar-96	09-Mar-98	920
Wonboyn River at Agnew Wharf	Agnew Wharf	220425	20-Aug-97	20-Aug-98	964
Bartletts Creek at Bartletts Creek	Bartletts Creek	NA	06-Jun-95	19-Mar-96	780
Leddays Creek at Leddays Creek	Leddays Creek	NA	02-Jun-95	31-Jul-96	780
Officer Drain at Officer Drain	Officer Drain	NA	02-Jun-95	21-Mar-96	780

Station Longname	Station Name	Station Number	Start Date	End Date	MHL Report
McLeods Drain at McLeods Drain	McLeods Drain	NA	21-Mar-96	31-Jul-96	780
McLeods Drain Offshoot at McLeods Drain Offshoot	McLeods Drain Offshoot	NA	21-Mar-96	31/09/96	780
Cudgen Lake at Cudgen Lake	Cudgen Lake	NA	14-Dec-92	05-Nov-93	674
Cudgen Creek at Cudgen Lake West	Cudgen Lake West	NA	08-Oct-93	05-Nov-93	674
Cudgen Creek at Cudgen Creek	Cudgen Creek	NA	15-Dec-92	05-Nov-93	674
Simpsons Creek at Belongil	Belongil	NA	06-Dec-94	17-Dec-96	
Richmond River at Shaws Bay	Shaws Bay	NA	11-Mar-99	12-Apr-00	755, 849
Marshalls Creek at Capricornia Canal	Capricornia Canal	NA	24-Mar-97	31-Mar-11	1051
Marshalls Creek at New Brighton	New Brighton	NA	17-Mar-97	24-Apr-98	1000
Brunswick River at Pacific Highway Bridge	Pacific Highway Bridge	NA	18-Mar-97	18-Mar-99	1000
Simpsons Creek at Simpsons Creek	Simpsons Creek	NA	03-Apr-98	18-Mar-99	1000
Tuckean Broadwater at Tuckean	Tuckean	NA	30-Oct-95	29-Oct-96	850
Richmond River at Empire Vale Creek	Empire Vale Creek	NA	08-May-98	12-Oct-99	1032
Roberts creek at Roberts Creek	Roberts Creek	NA	20-May-94	24-May-96	784
Clarence River at Tarrent Bridge	Tarrent Bridge	NA	04-Mar-99	11-Apr-00	1065
Andersons Inlet at Middle Island MM1	Middle Island MM1	NA	06-Apr-01	15-Dec-06	986
Andersons Inlet at Middle Island MM2	Middle Island MM2	NA	19-Mar-96	03-Feb-99	986
Andersons Inlet at Double Island	Double Island	NA	19-Mar-96	03-Feb-99	986
Macleay River at Andersons Inlet	Andersons Inlet	NA	06-Apr-01	27-Sep-01	1151
Maria River at Connection Creek	Connection Creek	NA	22-Sep-94	26-Oct-95	760
Hastings River at Lake Innes	Lake Innes	NA	19-Aug-93	07-Sep-94	760
Scotts Creek at Scotts Creek	Scotts Creek	NA	20-Oct-98	22-Oct-99	1029
Wallis Lake at Peach Tree Point	Peach Tree Point	NA	30-Jul-97	09-Mar-99	987
Wallis Lake at Wallamba	Wallamba	NA	30-Jul-97	25-Aug-98	987
Wallis Lake at Booti Island	Booti Island	NA	31-Jul-97	25-Aug-98	987
Wallis Lake at Darawakh Creek	Darawakh Creek	NA	26-Aug-98	08-Mar-99	987
Smiths Lake at smiths Lake	Smiths Lake	NA	04-May-95	16-May-96	771
Myall Lake at Mayers Point	Mayers Point	NA	10-Jul-96	04-Mar-98	906
Myall River at Monkey Jacket	Monkey Jacket	NA	09-Jul-96	04-Mar-98	906
Lake Wollumboola at Lake Wollumboola	Lake Wollumboola Floating	NA	07-Dec-00	19-Jun-01	1145
Tuross Lake at Trunketabella	Trunketabella	NA	04-May-94	11-Mar-98	921
Wallaga Lake at Meads Bay	Meads Bay	NA	03-Feb-99	10-Feb-00	1048
Hexham Swamp at Ironbark Creek Downstream	Ironbark Creek Downstream	NA	08-Aug-02	30-Jun-09	

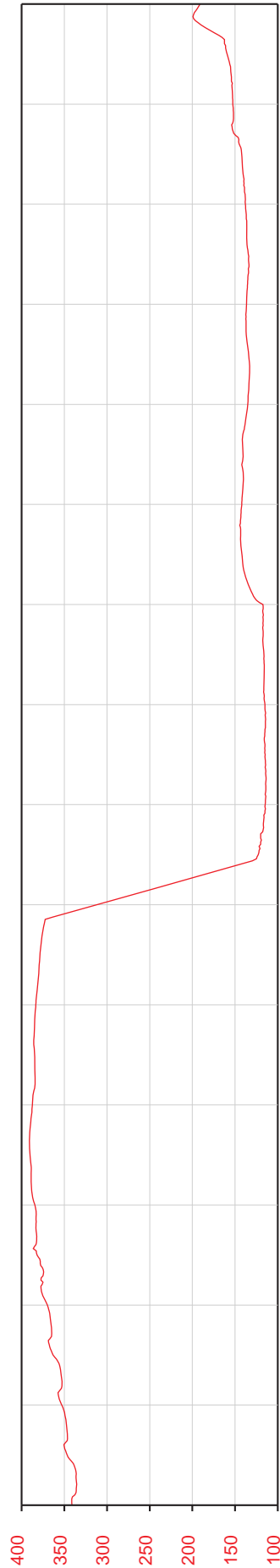
Station Longname	Station Name	Station Number	Start Date	End Date	MHL Report
Hexham Swamp at Ironbark Creek Upstream	Ironbark Creek Upstream	NA	09-Aug-02	27-Oct-04	
Hexham Swamp at Morris Jetty	Morris Jetty	NA	07-Aug-02	30-Jun-09	
Hunter River at Fishery Creek	Fishery Creek	NA	08-Aug-02	07-Mar-03	
Hunter River at Fishery Creek 2	Fishery Creek	NA	11-Jun-03	29-Aug-03	
Hexham Swamp at Shortland Wetland Centre	Shortland Wetland Centre	NA	10-Mar-99	04-Jul-00	1058
Hexham Swamp at SWC Canoe Trail	SWC Canoe Trail	NA	07-Aug-02	09-Jan-03	12,021,289
Lake Macquarie at Swansea Channel Site 4	Swansea Channel Site 4	NA	28-Mar-96	14-Jun-96	770
Lake Macquarie at Swansea Channel Site 5	Swansea Channel Site 5	NA	15-Apr-96	10-May-96	770
Orphan site at Berowra Water Quality	Berowra Creek Water Quality	NA	26-May-95	29-Nov-95	745
Berowra Creek at Berowra Waters Marina	Berowra Waters Marina	NA	22-Aug-01	23-Nov-01	
Narrabeen Lagoon at Pittwater Road Bridge	Pittwater Road Bridge	NA	23-Feb-96	15-Nov-05	
Manly Lagoon at Riverview Parade	Riverview Parade	NA	02-Feb-96	05-Jan-07	
Manly Lagoon at Manly Dam	Manly Dam	NA	29-Jan-96	22-Aug-01	
Shoalhaven River at Wharf Road	Wharf Road	NA	06-Mar-95	07-Apr-95	
Shoalhaven River at Nowra Bridge	Nowra Point	NA	07-Mar-95	07-Apr-95	
Clyde River at Clyde Site 7	Clyde River Site 7	NA	25-Sep-96	08-Oct-96	792
Clyde River at Clyde Site 16	Clyde River Site 16	NA	25-Sep-96	08-Oct-96	
Wonbyn River Upstream of Wonboyn Lake	Wonboyn River	NA	21-Aug-97	06-Sep-98	

Appendix B
Sample Outputs

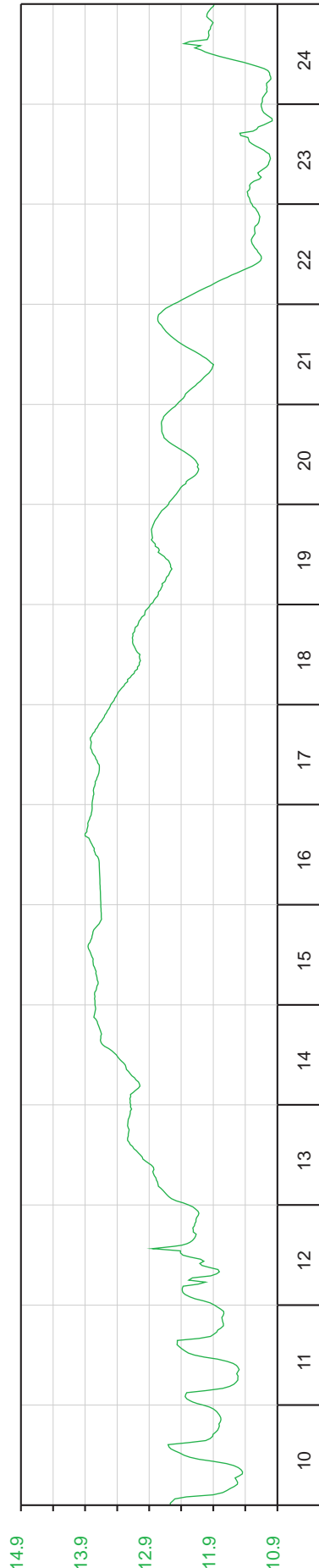
Period 15 Day Plot Start 00:00_10/06/2011
 Interval 30 Minute Plot End 00:00_25/06/2011
 — 210410 Hinton Bridge



— 210410 Hinton Bridge Inst. 2012.00 Conductivity ($\mu\text{S}/\text{cm}$)



— 210410 Hinton Bridge Inst. 2080.00 Water Temp ($^{\circ}\text{C}$)



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SAMPLE DATA PLOTS

MHL Report 2161

Figure B1

DRAWING 2161-B1.cdr

Station Name, Port Stephens (Live),,
Station Number,209471,,
Latitude,+152:10:56.06,,
Longitude,-32:42:53.57,,
Datum,PSHD,,

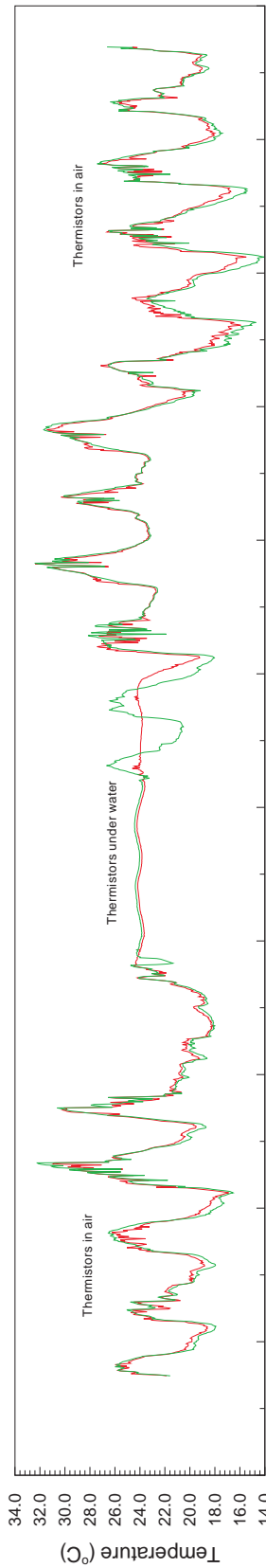
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date,time,value,value.status
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5/07/2011,0:45:00,1.39316,6 (Good)
5/07/2011,1:00:00,1.3186,6 (Good)
5/07/2011,1:15:00,1.22369,6 (Good)
5/07/2011,1:30:00,1.10246,6 (Good)
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5/07/2011,7:15:00,0.495641,6 (Good)



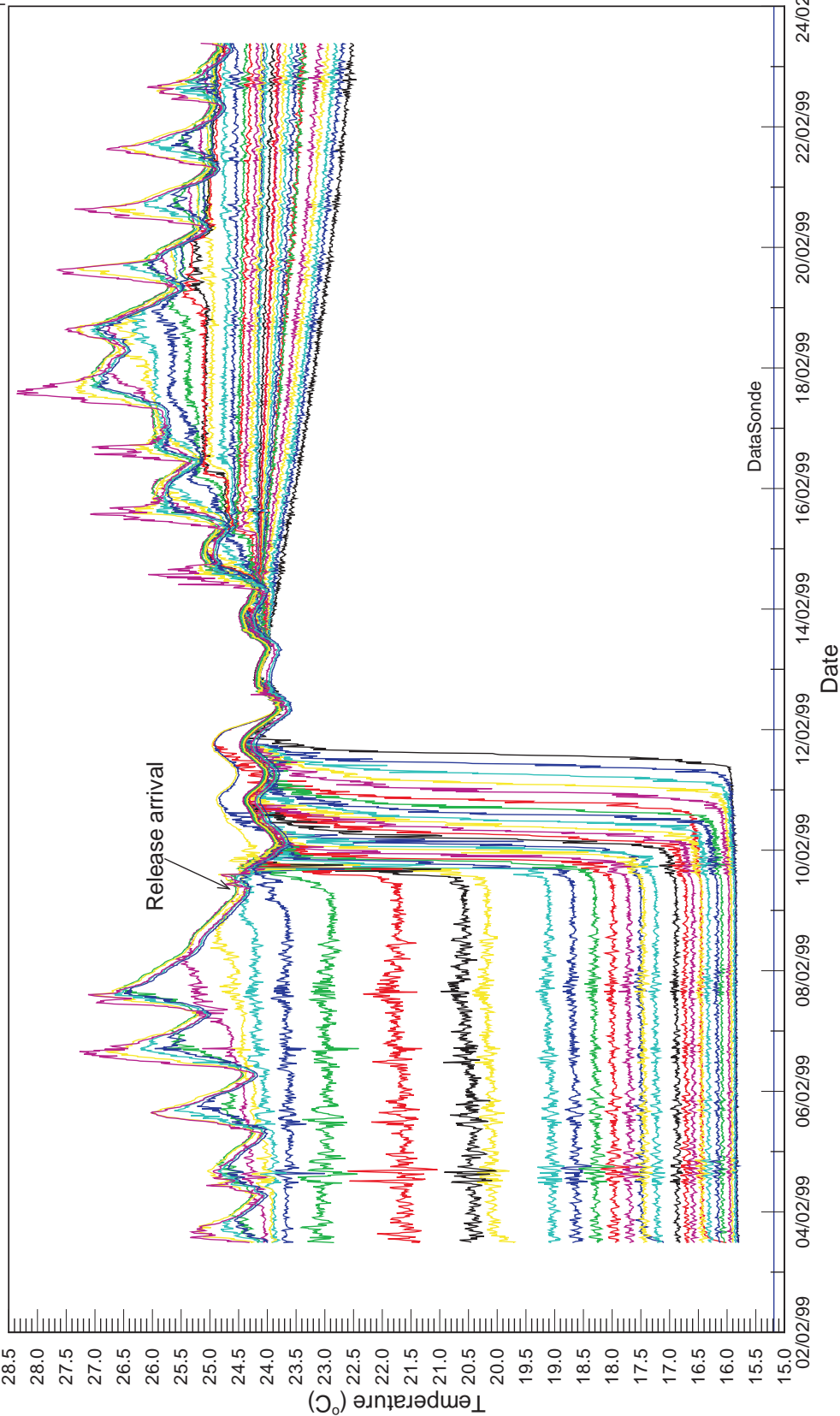


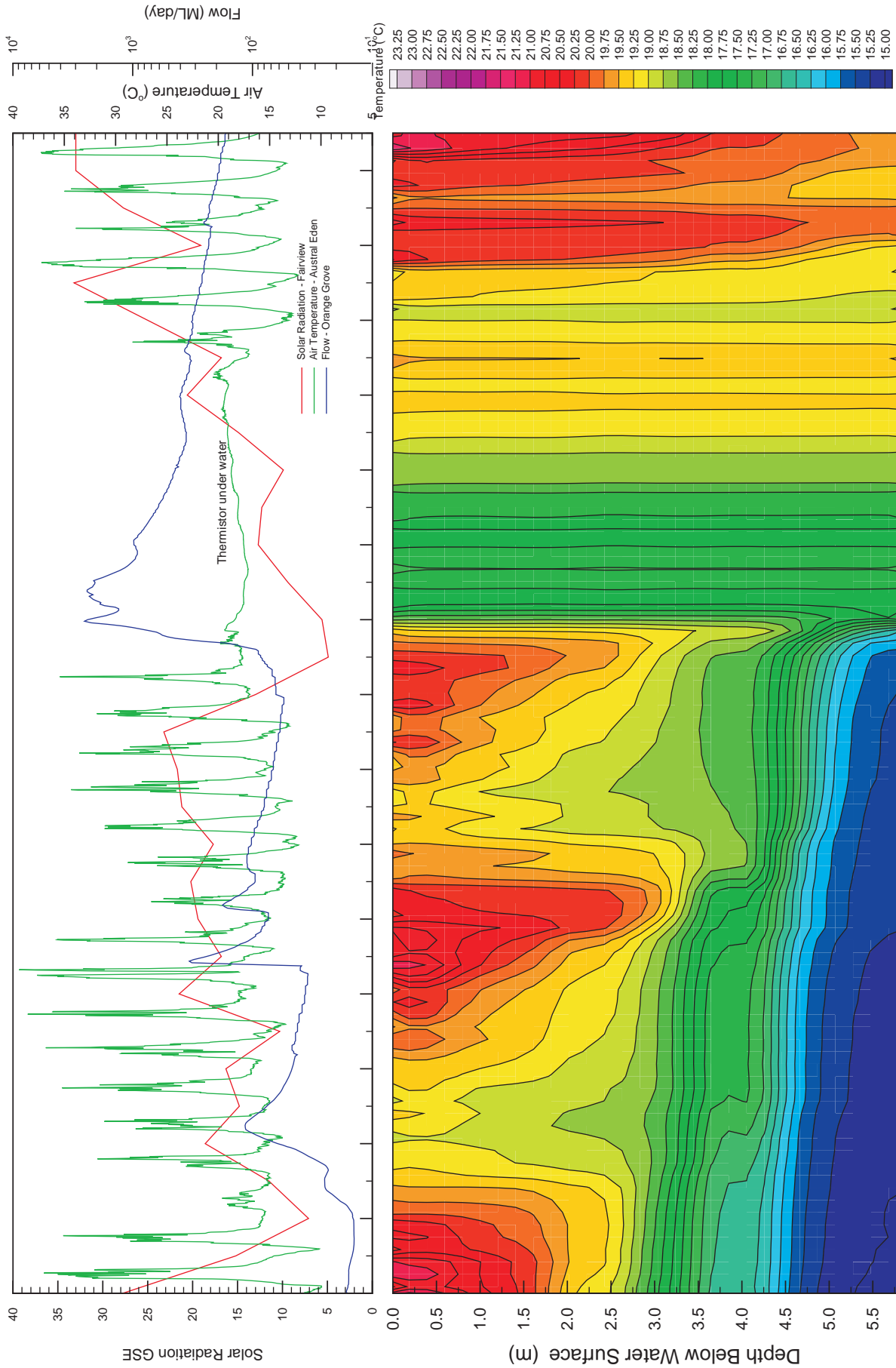
SAMPLE THERMISTOR CHAIN DATA TEMPERATURE DISTRIBUTION TIME SERIES

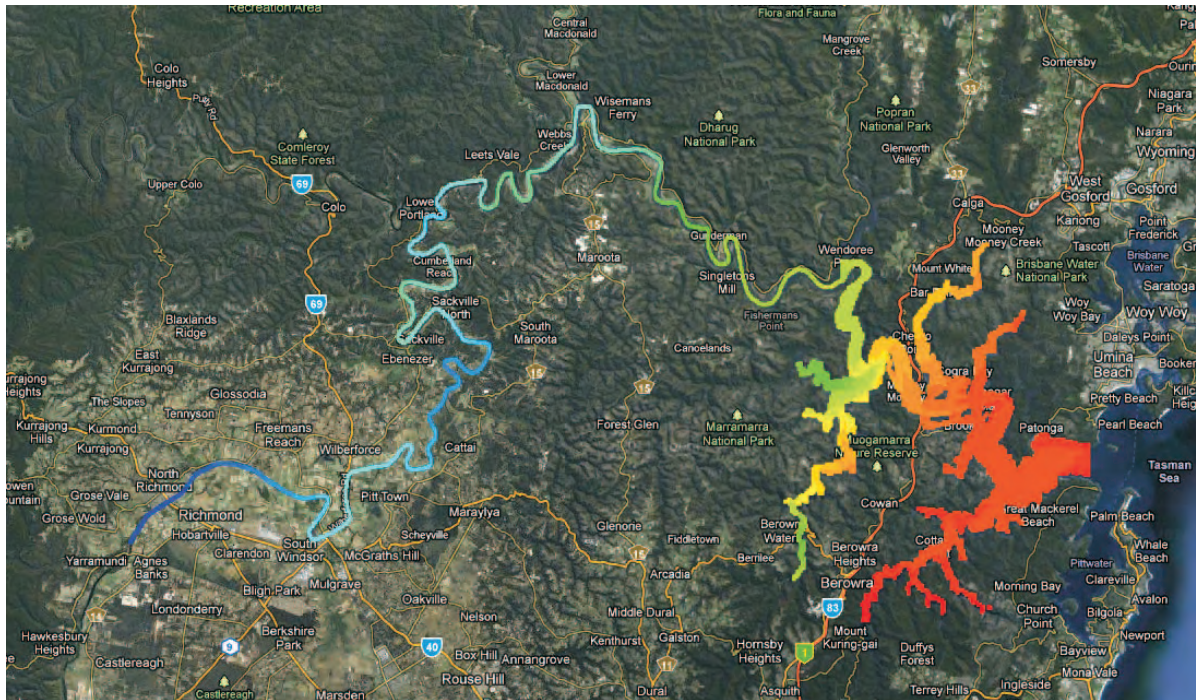
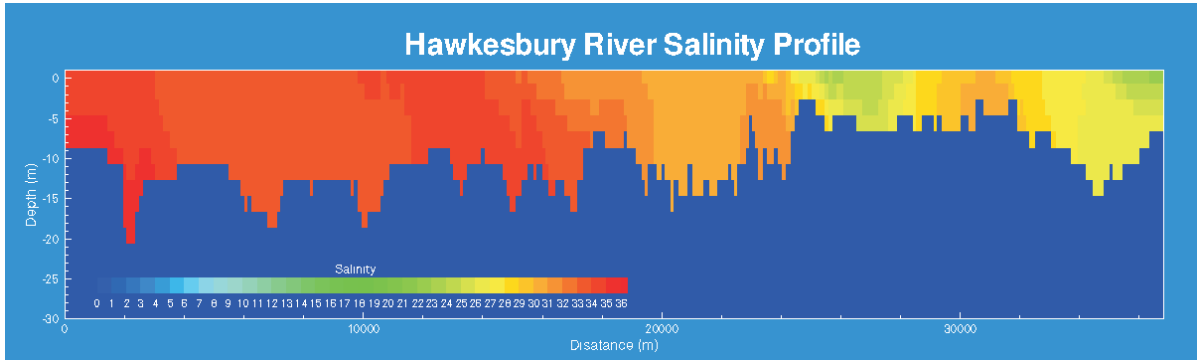
Thermistor and Depth
T37-0.25m
T38-0.75m



Thermistor and Depth
T1-17.64m
T2-17.15m
T3-16.65m
T4-16.15m
T5-15.67m
T6-15.20m
T7-14.70m
T8-14.23m
T9-13.80m
T10-13.24m
T11-12.75m
T12-12.25m
T13-11.75m
T14-11.24m
T15-10.73m
T16-10.23m
T17-9.73m
T18-9.24m
T19-8.73m
T20-8.23m
T21-7.93m
T22-7.93m
T23-6.75m
T24-6.24m
T25-5.74m
T26-5.44m
T27-4.78m
T28-4.28m
T29-3.75m
T30-3.20m
T32-2.20m
T33-1.70m
T34-1.20m
T35-0.73m
T36-0.22m







Appendix C

Other Publications of Interest

Appendix C Other Publications of Interest

Data Reports

MHL Annual Ocean Tide Levels Summaries available:

MHL Report Nos. 515 (86-87), 544 (87-88), 563 (88-89), 585 (89-90), 602 (90-91), 628 (91-92), 658 (92-93), 697 (93-94), 732 (94-95), 777 (95-96), 876 (96-97), 947 (97-98), 1013 (98-99), 1069 (99-00), 1129 (00-01), 1205 (01-02), 1277 (02-03), 1347 (03-04), 1423 (04-05), 1512 (05-06), 1764 (06-07), 1848 (07-08), 1933 (08-09), 2010 (09-10), 2089 (10-11).

MHL Annual Estuary and River Water Levels Summaries available:

MHL Report Nos. 555 (87-88), 564 (88-89), 582 (89-90), 601 (90-91), 625 (91-92), 659 (92-93), 698 (93-94), 731 (94-95), 778 (95-96), 875 (96-97), 947 (97-98), 1014 (98-99), 1070 (99-00), 1130 (00-01), 1206 (01-02), 1276 (02-03), 1346 (03-04), 1422 (04-05), 1511 (05-06), 1763 (06-07), 1847 (07-08), 1932 (08-09), 2009 (09-10), 2088 (10-11).

MHL Annual Coastal Rainfall Summaries available:

MHL Report Nos. 610 (90-91), 624 (91-92), 660 (92-93), 699 (93-94), 730 (94-95), 776 (95-96), 874 (96-97), 946 (97-98), 1015 (98-99), 1071 (99-00), 1131 (00-01), 1207 (01-02), 1278 (02-03), 1348 (03-04), 1424 (04-05), 1513 (05-06), 1765 (06-07), 1849 (07-08), 1934 (08-09), 2011 (09-10), 2090 (10-11).

MHL Annual Wave Climate and Coastal Air Pressure Summaries available:

MHL Report Nos. 547 (87-88), 560 (88-89), 581 (89-90), 600 (90-91), 627 (91-92), 655 (92-93), 695 (93-94), 733 (94-95), 779 (95-96), 877 (96-97), 948 (97-98), 1016 (98-99), 1072 (99-00), 1132 (00-01), 1208 (01-02), 1279 (02-03), 1349 (03-04), 1425 (04-05), 1514 (05-06), 1766 (06-07), 1850 (07-08), 1935 (08-09), 2012 (09-10), 2091 (10-11).

NSW Public Works 2011, *Monitoring of Estuaries for Water Sharing Plans Annual Summary 2009-2011*, Manly Hydraulics Laboratory, Report No. 2101, 2011 in prep.

Salinity Profiling

NSW Public Works 2010, *Bellinger and Kalang Rivers Data Collection July 2008–September 2009*, Manly Hydraulics Laboratory, Report No. 1951.

NSW Public Works 2012, *NSW Estuaries Salinity Data Compilation*, Manly Hydraulics Laboratory, Report No. 1812.

Appendix D
Station Location Maps

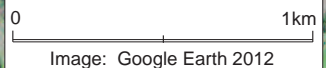


Image: Google Earth 2012



0 1km
Image: Google Earth 2012



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**STATION LOCATION
OAKLAND ROAD**

MHL
Report 2161

**Figure
D2**

DRAWING 2161-D2.cdr



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STATION LOCATION BUNGAWALBIN

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Figure
D3

DRAWING 2161-D3.cdr



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STATION LOCATION MYLNEFORD

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Figure
D4

DRAWING 2161-D4.cdr



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STATION LOCATION ROGANS BRIDGE

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Figure
D5

DRAWING 2161-D5.cdr



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STATION LOCATION GRAFTON

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Figure
D6

DRAWING 2161-D6.cdr



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**STATION LOCATION
KEMPSEY**

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**Figure
D7**

DRAWING 2161-D7.cdr



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STATION LOCATION WINGHAM

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Figure
D8

DRAWING_2161-D8.cdr



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STATION LOCATION TAREE WEST

MHL
Report 2161

Figure
D9

DRAWING 2161-D9.cdr



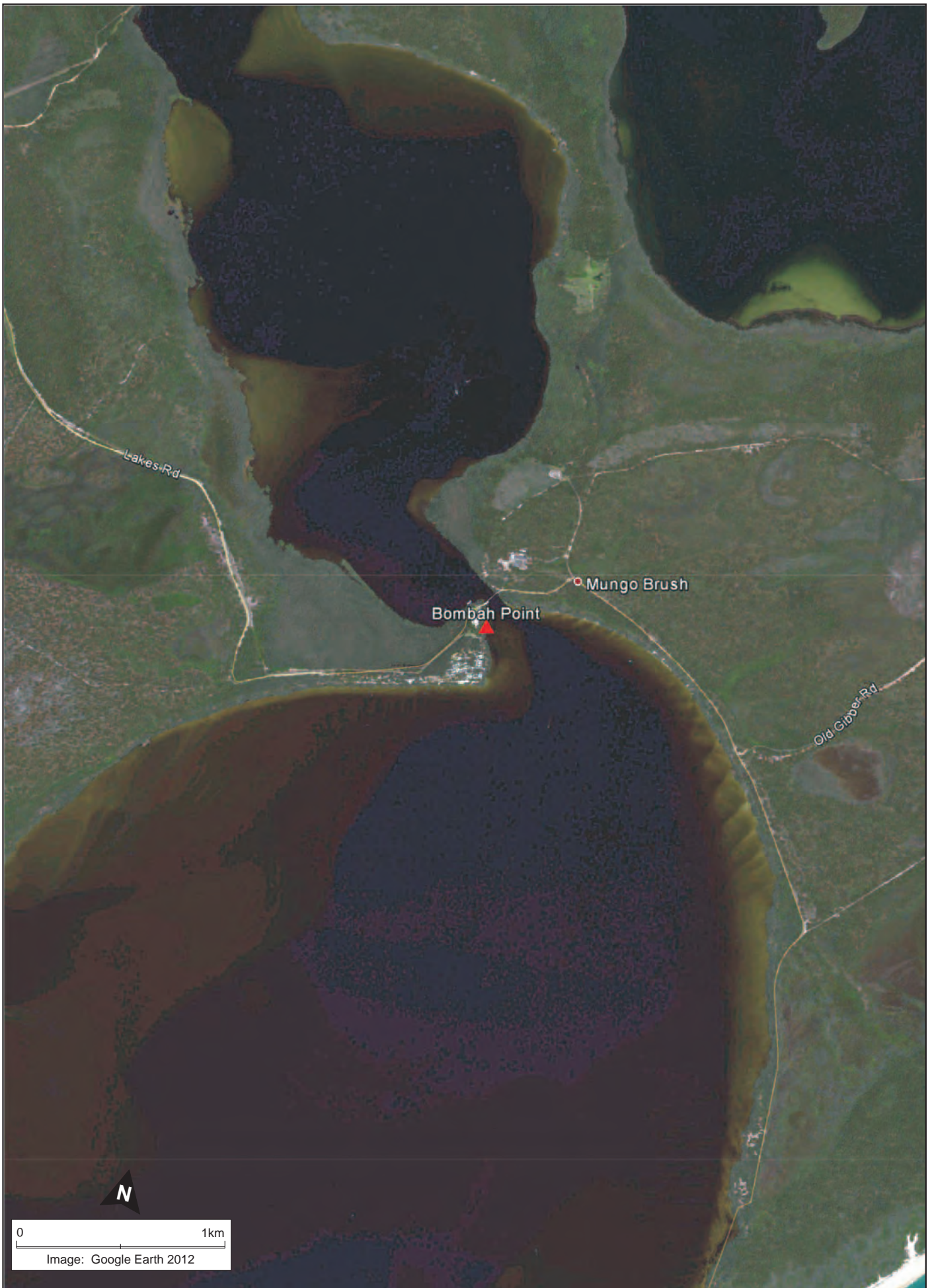
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Manly Hydraulics Laboratory

**STATION LOCATION
TAREE**

MHL
Report 2161

Figure
D10

DRAWING 2161-D10.cdr





0 1km
Image: Google Earth 2012



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STATION LOCATION TEA GARDENS

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Figure
D12

DRAWING 2161-D121.cdr



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STATION LOCATION DUNMORE

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Report 2161

Figure
D13

DRAWING 2161-D13.cdr



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STATION LOCATION HINTON BRIDGE

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Figure
D14

DRAWING 2161-D14.cdr



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STATION LOCATION McKIMMS CORNER

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Figure
D15

DRAWING 2161-D15.cdr



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STATION LOCATION GREEN ROCKS

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Figure
D16

DRAWING 2161-D16.cdr



0 500m
Image: Google Earth 2012



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**STATION LOCATION
RAYMOND TERRACE**

MHL
Report 2161
**Figure
D17**
DRAWING 2161-D17.cdf



0 500m
Image: Google Earth 2012



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STATION LOCATION HEXHAM BRIDGE

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Report 2161

Figure
D18

DRAWING 2161-D18.cdr



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STATION LOCATION SACKVILLE

MHL
Report 2161

Figure
D19

DRAWING 2161-D19.cdr



0 500m
Image: Google Earth 2012



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STATION LOCATION COLO JUNCTION

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Figure
D20

DRAWING 2161-D20.cdr



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STATION LOCATION LEETS VALE

MHL
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Figure
D21

DRAWING 2161-D21.cdf



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STATION LOCATION WISEMANS FERRY WHARF

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Figure
D22

DRAWING 2161-D22.cdf



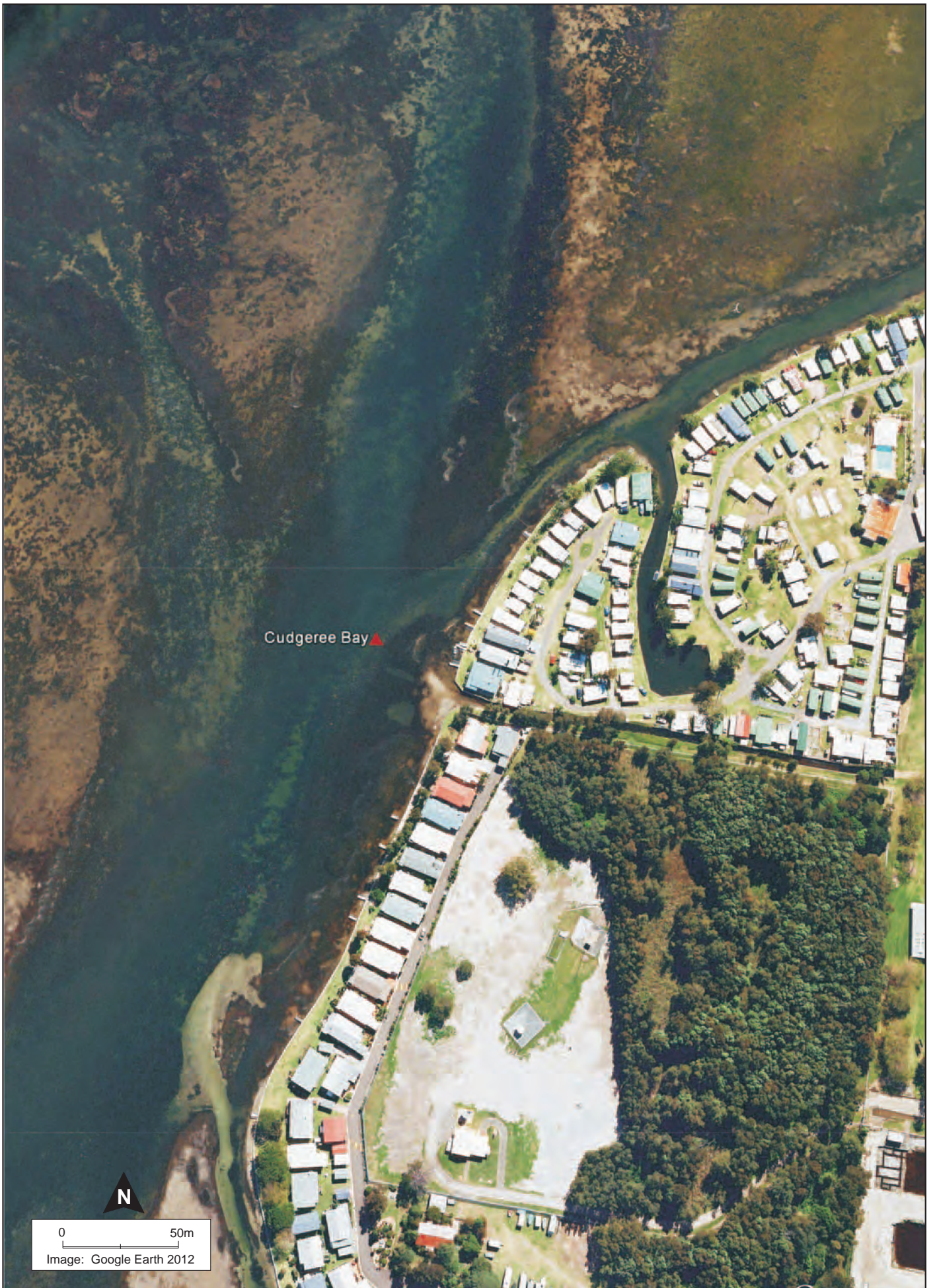
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Manly Hydraulics Laboratory

STATION LOCATION KONAWARRA BAY

MHL
Report 2161

Figure
D23

DRAWING 2161-D23.cdr



Cudgerie Bay ▲



0 50m

Image: Google Earth 2012



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STATION LOCATION CUDGEREE BAY

MHL
Report 2161

Figure
D24

DRAWING 2161-D24.cdr



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STATION LOCATION GRADYS CARAVAN PARK

MHL
Report 2161

Figure
D25

DRAWING 2161-D25.cdr



0 100m
Image: Google Earth 2012



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STATION LOCATION BEGA RIVER

MHL
Report 2161

Figure
D26

DRAWING 2161-D26.cdf



Public Works
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