APPENDIX C

6 WHARF DEVELOPMENT 3D GEOLOGICAL MODEL AND DREDGE VOLUMES

NAPIER PORT

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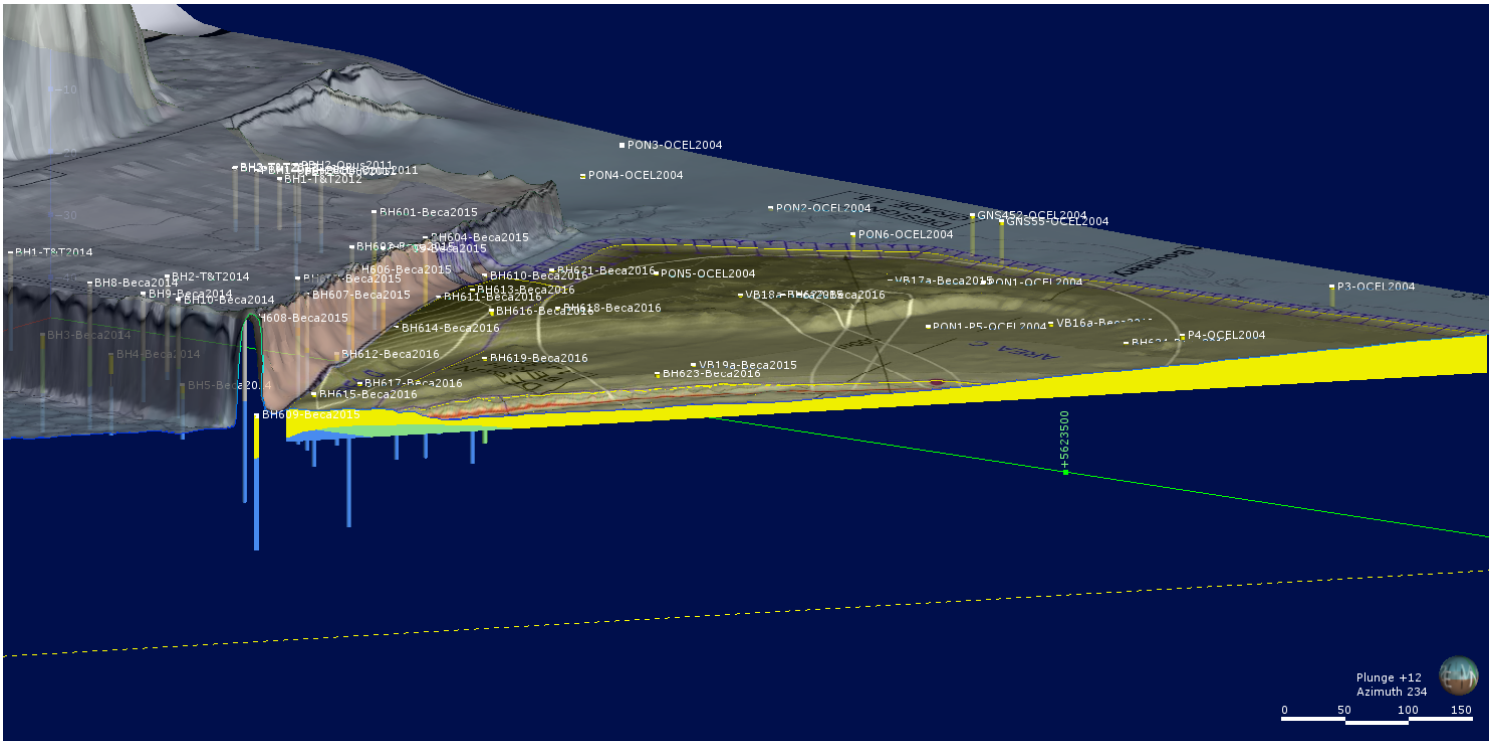
Report

6 Wharf Development: 3D Geological Model and Dredge Volumes

Prepared for Napier Port

Prepared by (Beca)

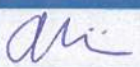
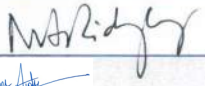
15 May 2017



Revision History

Revision N°	Prepared By	Description	Date
A	Nicola Ridgley	Draft for comment	May 2016
B	Nicola Ridgley	Updated with NP Comments	5 July 2016
C	Alicia Newton	Updated for revised dredge plan	23 September 2016
D	Nicola Ridgley	Final	19 October 2016
E	Nicola Ridgley	For Consent	15 May 2017

Document Acceptance

Action	Name	Signed	Date
Prepared by	Alicia Newton		16/5/17
Reviewed by	Nicola Ridgley		16/05/17
Approved by	Connon Andrews		16/05/17
on behalf of	Beca Ltd		

Executive Summary

Beca Ltd (Beca) was commissioned by Napier Port to undertake geotechnical investigations, development of 3D geological model, geotechnical interpretation and developed design of the proposed 6 Wharf to support Resource Consent application to undertake the proposed works. (Refer Napier Port - RFP 6 Wharf Development Preliminary Design of Wharf and Structure CONT-IS-2015-7571 dated September 2015).

The proposed development includes the construction of a new wharf (6 Wharf) structure approximately 350m long by 34m wide to increase capacity at the port for larger vessels and cargo volumes. 6 Wharf will be constructed adjacent to the northern end of the existing container terminal. The proposed development also involves increasing maximum dredging level at the port from the existing level (approximately -12.8m CD) to -14.5m CD.

The 3D geological model has been developed from the data provided by Napier Port using the software Leapfrog Geo v.3.1. The geotechnical data was reviewed by an engineering geologist and a geological layering system developed based on geology, material strength and material type. The extent and quality of data varies across the site, as such some interpretation of the data has been undertaken.

The following units have been modelled:

- Reclamation Fill - Loose to medium dense, fine to medium gravel and some cobbles, typically the outer bund edge and loose to medium dense, fine to medium sand. All reclamation fill has been combined into one layer.
- Recent Marine Sediment (outer harbour) – this unit represents the upper layer of marine sediment in Area A, the outer length of the shipping channel. The majority of this material in this area is expected to be very loose to loose fine to medium sand. No strength testing was completed in this unit however vibrocores were successful, indicating low strength (SPT-N <10 blows /300mm) material.
- Recent Marine Sediment (transition zone and inner harbour) – this unit represents the upper layer of marine sediment in Areas A1, B, C and D. This material is predominantly a soft to firm clayey silt; however lenses of sandy silt and stiffer silt are present within this layer. This unit is defined by strengths of SPT-N typically less than 10 blows/300mm.
- Quaternary Marine Sediment - this material predominantly comprises a firm to stiff clayey silt, with SPT-N typically greater than 10 blows/300mm. However zones of medium dense sands and silty sands are also present within this layer.
- Residual Mangaheia Group – This unit represents sandstone and siltstone of the underlying Mangaheia Group rock that has been residually weathered to very stiff to hard fine sandy silt with some clay. The SPT-N values for this unit are typically between 20 and 50 blows/300mm
- Mangaheia Group – this rock comprises bedded sandstone, siltstone and limestone with SPT-N typically greater than 50 blows/300mm.

Dredge volumes have been calculated from the geological model. This was achieved be defining both the horizontal and vertical boundaries of the proposed dredge area. The volumes provided are separated into the following areas: outer channel (Area A); transition between Area A and B (Area A1); inner channel (Area B); swing basin (Area C); Wharf No.6 berthing pocket (Area D).

Contents

Appendices

1 Introduction

Beca Ltd (Beca) was commissioned by Napier Port to undertake geotechnical investigations and interpretation, development of a 3D geological model and design of the proposed 6 Wharf to support Resource Consent applications to undertake the proposed work. (Refer Napier Port - RFP 6 Wharf Development Preliminary Design of Wharf and Structure CONT-IS-2015-7571 dated September 2015).

This report documents development of the 3D geological model and presents dredge volumes for staged removal of material.

2 Project Description

The proposed development includes the construction of a new wharf (6 Wharf) structure, approximately 350m long and 34m wide (with a 50m future extension also designated), to increase capacity at the port for larger vessels and cargo volumes. 6 Wharf will be constructed adjacent to the northern end of the existing container terminal. The proposed development includes increasing the maximum dredged level at the port from the existing level (approximately -12.8m CD) to -14.5m CD.

The proposed development includes dredging to form a berth pocket adjacent to 6 Wharf, and to extend and deepen both the turning basin and channel into the port. The proposed dredging works, designed by Napier Port, is shown on Drawing – Wharf 6 Proposed Dredging Works Stage 2 -14.5m (5341 404 & 405 Rev F) and are provided in Appendix A.

3 Sources of Information

Geotechnical data from historical investigations across the port area was provided by Napier Port. This was supplemented with 25 geotechnical boreholes and 27 vibrocores undertaken by Beca between December 2015 and January 2016. Information used to build the geological model is summarised below, with some additional detail provided in Appendix A, Table A.1:

- Wharf 6 Proposed Dredging Works Stage 2 -14.5m (Drawing 5341 404 & 405 Rev F dated 31/08/2016).
- Napier Port survey and bathymetric data (provided 13/11/2015)
- Seismic survey of offshore sediment thickness (provided 15/11/2015)
- Geotechnical Investigations (provided 28/10/2015)
  - Breakwater Harbour Dredging Borehole Logs, 1977
  - Napier Port Wharf No. 1 Development – Geotechnical Report for Dredging Work, 1994
  - Wharf No. 1 Borehole Logs, Pro-Drill, 1995
  - Geotechnical Report on the Proposed Reclamation to the West of the Port behind the Proposed No. 6 Berth, OCEL, 2004
  - Wharf No. 4 CPTs, Geomil / Opus, 2008
  - Liqueo Tanks Borehole Logs, T&T, 2010
  - Port Central Building Borehole Logs, Opus, 2011
  - Port Central Building Borehole Logs, T&T, 2012
  - Shed 9 Borehole Logs, T&T, 2012
  - Reefer Towers Borehole Logs, T&T, 2014
  - Kimahia Basin Dredge, Opus, 2015

  - Wharf No. 1B Borehole Logs, Golder Associates, 2015
  - Napier Port Conveyor Borehole Log, T&T, 2015
  - Wharf No. 6 Proposed Dredging Vibrocore Logs, 2015
- Beca geotechnical investigations
  - Wharf No. 5 Upgrade Borehole Logs, Beca, 2014
  - Wharf No. 6 Borehole Logs, Beca, 2015-2016

4 Geological Model Development

The 3D geological model has been developed from the data provided by Napier Port and recent investigations using the software Leapfrog Geo v.3.1[1].

The geotechnical data was reviewed by an engineering geologist and a simplified geological layering system has been developed based on geology, material strength and material type. The extent and quality of data varies across the site, as such some re-interpretation and extrapolation of the data has been undertaken.

The following units have been modelled:

- Reclamation Fill - Loose to medium dense, fine to medium gravel and some cobbles, typically the outer bund edge and loose to medium dense, fine to medium sand. All reclamation fill has been combined into one layer.
- Recent Marine Sediment (outer harbour) – this unit represents the upper layer of marine sediment in Area A, the outer length of the shipping channel. The majority of this material in this area is expected to be very loose to loose fine to medium sand. No strength testing was completed in this unit however vibrocores were successful, indicating low strength (SPT-N <10 blows /300mm) material.
- Recent Marine Sediment (transition zone and inner harbour) – this unit represents the upper layer of marine sediment in Areas A1, B, C and D. This material is predominantly a soft to firm clayey silt; however lenses of sandy silt and stiffer silt are present within this layer. This unit is defined by strengths of SPT-N typically less than 10 blows/300mm.
- Quaternary Marine Sediment - this material predominantly comprises a firm to stiff clayey silt, with SPT-N typically greater than 10 blows/300mm. However zones of medium dense sands and silty sands are also present within this layer.
- Residual Mangaheia Formation – This unit represents sandstone and siltstone of the underlying Mangaheia Formation rock that has been residually weathered to very stiff to hard fine sandy silt with some clay. The SPT-N values for this unit are typically between 20 and 50 blows/300mm
- Mangaheia Formation – this rock comprises bedded sandstone, siltstone and limestone with SPT-N typically greater than 50 blows/300mm.

The geological model was developed by bringing together various datasets. The Leapfrog software requires a specific workflow process which ensures models are developed in a consistent and logical way. The following steps were undertaken to create the final geological model:

- A topographic surface, defining the upper boundary of the geological model, was created from XYZ points, derived from topographic survey and bathymetric data.

[1] Leapfrog Geo is a workflow solution for geological modelling. ARANZ Geo Limited is the developer of the 3D geological modelling software Leapfrog.

- Aerial imagery was draped on the topographic surface to aid with visualisation
- Model layers have been characterised from interpretation of investigation data including boreholes, cone penetration tests, water jet probes, seismic survey data and vibrocores.
- The location and interpreted geological data was then imported into Leapfrog.
- Geological contact surfaces were modelled using the interval data taken from the boreholes and seismic survey data.
- A chronological order was assigned to each unit, and each surface defined as either an erosional or depositional contact, which determines how each surface interacts and ultimately how each unit is displayed.
- These surfaces were then manually modified by the engineering geologist/modeller to reflect conceptual variability not captured by the available investigation data.
- The dredging plan was added to guide division of the model into discrete areas and dredging stages. Unit volumes are automatically calculated.
- The final geological model can be updated as new data becomes available.

The model in its entirety has been delivered to Napier Port. The full version of the model requires a licence to update or modify. Should Napier Port obtain a licence, cross sections can be easily created within Leapfrog to present useful visualisations of the data and a series of images can be combined to create movies to highlight specific areas of importance within the model. Data created within the model can also be exported in various formats for use in other programs such as ArcGIS, CAD and Surfer.

The geological model has also been provided in the form of a Leapfrog Viewer file, which can be viewed and manipulated, but not modified. The Leapfrog Viewer is a visualisation tool specifically designed to allow presentation and distribution of the model without requiring licenced software to operate or interrogate. To use it will require installation of free software, available to download from the developer's website (http://www.leapfrog3d.com/products/Leapfrog-Viewer).

5 Dredge Volumes

5.1 Dredge Volumes

Dredge volumes have been calculated from the geological model and are provided in Table 5.1. This was achieved by defining both the horizontal and vertical boundaries of the proposed dredge area. The vertical boundaries of the dredge areas were defined using the proposed dredging plan provided by Napier Port. The upper horizontal boundary is defined using the topographic surface and the lower horizontal boundary is defined by the design dredge level. At the request of Napier Port dredge volumes were divided into 0.5m intervals from -12.5m CD to -14.5m CD.

Each dredge stage/interval was also split into the areas listed below and shown on Drawing 5341 404 & 405 Rev F (Refer to Appendix A):

- Area A: Outer channel
- Area A1: Transition between Area A and B
- Area B: Inner channel
- Area C: Swing basin
- Area D: 6 Wharf berthing pocket

Volume estimates have been determined based on the following simplifications and assumptions:

- Dredge slope angles have been not been modelled. Vertical sides have been extended to provide an equivalent area and therefore volume. This may result in a slightly greater volume of residual soil and rock and lower volume of sediment.
- The volumes are incremental for each 0.5m depth of dredging, up to -14.5m CD by area and material type.
- Localised dredging beneath the proposed wharf, the shear key and scour protection for the berth has not been included in Table 5.1. Estimated additional volume is 100,000m^3 and is included in total volumes in Table 5.2.
- Over dredge allowance has been added to the total volume in each dredge area at a particular dredge level. An over dredge allowance of 0.2m at design dredge -14.5m is shown in Table 5.1.

Table 5.1 - Napier Port Approximate Dredging Volumes

Area	Depth Interval (m CD)	Unit Volume (m^3)						
		Recent Marine Sediment	Quaternary Marine Sediment	Residual Mangaheia Group	Mangaheia Group	Total (excl. over dredge)	Over Dredge	Total (incl. Over Dredge)
A	-12.5	27,100[a]	0	0	0	27,100		
	-13.0	92,100[a]	0	0	0	92,100		
	-13.5	176,200[a]	0	0	0	176,200		
	-14.0	220,300[a]	0	0	0	220,300		
	-14.5	252,800[a]	0	0	0	252,800		
	A Total	768,500	0	0	0	768,500	106,000	874,500
A1	-12.5	6,000	0	0	0	6,000		
	-13.0	33,900	0	0	0	33,900		
	-13.5	85,600	0	0	0	85,600		
	-14.0	89,800	0	0	0	89,800		
	-14.5	89,900	0	0	0	89,900		
	A1 Total	305,200	0	0	0	305,200	37,000	342,200
B	-12.5	19,900	0	4,400	0	24,300		
	-13.0	15,000	0	12,400	0	27,400		
	-13.5	12,400	0	18,800	300	31,500		
	-14.0	7,900	0	21,500	2,900	32,300		
	-14.5	3,900	0	20,600	8,300	32,800		
	B Total	59,100	0	77,700	11,500	148,300	13,500	161,800
C	-12.5	967,400	0	2,900	0	970,300		
	-13.0	154,900	0	2,900	0	157,800		
	-13.5	153,300	0	4,500	0	157,800		
	-14.0	151,800	0	6,000	0	157,800		
	-14.5	150,900	0	7,000	0	157,900		
	C Total	1,578,300	0	23,300	0	1,601,600	65,000	1,666,600
D	-12.5	88,200	6,500	26,500	3,200	124,400		
	-13.0	3,400	900	5,600	1,600	11,500		
	-13.5	2,300	900	6,200	2,200	11,600		
	-14.0	1,700	1,100	6,100	2,800	11,700		
	-14.5	1,400	1,200	5,600	3,500	11,700		
	D Total	97,000	10,600	50,000	13,300	170,900	6,000	176,900
Total (-14.5mCD)		2,808,100	10,600	151,000	24,800	2,994,500	227,500	3,222,000

Note: a) Refer Section 4. RMS in Area A predominantly very loose to loose sand.
b) Excludes scour protection

Table 5.2 - Summary Total Dredge Volume by Dredge Interval

Dredge Level (m CD)	Total Excluding Overdredge (m^3)	Total Including Overdredge and Scour Protection (m^3)
-12.5	1,152,100	1,479,600
-13	1,474,800	1,802,300
-13.5	1,937,500	2,265,000
-14	2,449,400	2,776,900
-14.5	2,994,500	3,322,000

5.2 Cross Sections

5.2.1 Vertical Sections

Vertical sections have been created at approximately 500m intervals extending from the outer edge of the proposed dredge area and along the length of the proposed dredge channel. The cross sections display the geological units present within the dredge area.

Vertical sections are attached in Appendix B, along with a location plan.

5.2.2 Horizontal Sections

Sections sliced horizontally at dredge levels of -12.5m, -13m, -13.5m, -14m, and -14.5m have been created to show the geology expected to be encountered at that dredge level.

Horizontal sections are attached in Appendix B.

5.3 Isopach Maps

Isopach maps have been created using Surfer v.11, a contouring and surface modelling program, using outputs from the Leapfrog model. These maps show the thickness of each naturally occurring material type to dredge levels of -12.5m, -13m, -13.5m, -14m, and -14.5m, as specified by Napier Port. This allows areas with particularly thick layers of sediment or rock to be quickly identified, facilitating the development of area specific and economic dredging solutions.

Isopach maps are attached in Appendix C.

6 Software Used

Leapfrog Geo version: 3.1.1, 2016. ARANZ Geo Limited.

Surfer version: 11.4.958, 2013. Golden Software, Inc.

7 Applicability Statement

This report has been prepared by Beca on the specific instructions of our Client. It is solely for our Client's use for the purpose for which it is intended in accordance with the agreed scope of work. Any use or reliance by any person contrary to the above, to which Beca has not given its prior written consent, is at that person's own risk.

Should you be in any doubt as to the applicability of this report and/or its recommendations for the proposed development as described herein, and/or encounter materials on site that differ from those described herein, it is essential that you discuss these issues with the authors before proceeding with any work based on this document.

Appendix A

Sources of Information

Table A.1 - Napier Port Existing Geotechnical Investigations

Project	Date	Type of Investigation					
		BH	CPT	Vibrocore	Shear Wave Survey	Surface Sample	Water Jet Probe
Breakwater Harbour Dredging	1977					21	
Napier Port Wharf No. 1 Development	1994	25	1				
Wharf No. 1, Pro-Drill	1995	15					
Proposed Western Reclamation, OCEL	2004						25
Wharf No. 4, GeoMil / Opus	2008		10				
Liqueo Tanks, T&T	2010	4					
Port Central Building, Opus	2011	4	3				
Port Central Building, T&T	2012	3	3				
Shed 9, T&T	2012	3	10				
Reefer Towers, T&T	2014	2	10				
Wharf No. 5 Upgrade, Beca	2014	10			3		
Kimahia Basin Dredge, Opus	2015					74	
Wharf No. 1B, Golder	2015	6			3		
Napier Port Conveyor, T&T	2015	1					
Wharf No. 6 Development, Beca	2015-2016	25					
Wharf No. 6 Proposed Dredging	2016			27			

NOTES:

1. *All survey and GPS positions are in terms of HAWKES BAY CIRCUIT 2000 (HAWKTM2000) datum.*
2. *All sounding depths are in terms of chart datum, 4.837m below BM (H40). Stainless steel pin in concrete block near south west corner of PONL Admin Building.*
3. *Major Isobaths are at 1.0m intervals. Minor Isobaths are at 0.5m intervals.*
4. *Shaded areas are areas to be dredged (cut).*
5. *Volume to be dredged 3,000,000m3*

REFERENCES
Existing ground contours from surveys:
2015 Multibeam White Pointer Survey
CZM F151202S.ASC

Colour Banding - Cut Depths (m)

Number	Minimum Elevation	Maximum Elevation	Color
1	-12.000	-11.000	
2	-11.000	-10.000	
3	-10.000	-9.000	
4	-9.000	-8.000	
5	-8.000	-7.000	
6	-7.000	-6.000	
7	-6.000	-5.000	
8	-5.000	-4.000	
9	-4.000	-3.000	
10	-3.000	-2.000	
11	-2.000	-1.000	
12	-1.000	0.000	
13	0.000	1.000	

420500 mE
421000 mE
421500 mE
820500 mN
820000 mN
-12.0
-11.5
-11.0
-10.5
-10.0
-9.5
-9.0
-8.5
-8.0
-7.5
-7.0
-6.5
-6.0
-5.5
-5.0
-4.5
-4.0
AREA A1
AREA C
AREA B
AREA D
DESIGN -14.5m
DESIGN GRADE 1:3,2
DESIGN GRADE 1:5
500m
BERTH POCKET 350M
Model Ship LOA 300m / Beam = 42.8m / D = -12.5m
50M FUTURE EXT
DESIGN BERTH -14.5m
AREA TO BE DETAILED DURING DESIGN PHASE
AREA TO BE DETAILED DURING DESIGN PHASE
CONCEPT DESIGN
NOTE: SCALES SHOWN ARE FOR A1 DRAWING

ISS	DATE	AMENDMENTS	APPD
F	31/8/16	Layout modifications	
E	9/05/16	New channel layout as requested by pilots	
D	28/4/16	New channel layout post simulation study	

REFERENCE DRGS | No.

NAPIER PORT

WHARF 6
PROPOSED DREDGING WORKS
STAGE 2 -14.5M

FILE	5341	CHECK	DATE	SCALE
CADFILE				1:2000
SURVEY				
DESIGN	CPV	MdV	2/10/15	
DRAWN	CPV	MdV	2/10/15	
APPROVED				

5341 | SHEET 404 | REV F

Colour Banding - Cut Depths (m)

Number	Minimum Elevation	Maximum Elevation	Color
1	-12.000	-11.000	
2	-11.000	-10.000	
3	-10.000	-9.000	
4	-9.000	-8.000	
5	-8.000	-7.000	
6	-7.000	-6.000	
7	-6.000	-5.000	
8	-5.000	-4.000	
9	-4.000	-3.000	
10	-3.000	-2.000	
11	-2.000	-1.000	
12	-1.000	0.000	
13	0.000	1.000	

NOTES:

1. *All survey and GPS positions are in terms of HAWKES BAY CIRCUIT 2000 (HAWKTM2000) datum.*
2. *All sounding depths are in terms of chart datum, 4.837m below BM (H40). Stainless steel pin in concrete block near south west corner of PONL Admin Building.*
3. *Major Isobaths are at 1.0m intervals. Minor Isobaths are at 0.5m intervals.*
4. *Shaded areas are areas to be dredged (cut).*
5. *Volume to be dredged 3,000,000m3*

REFERENCES

Existing ground contours from surveys:
2015 Multibeam White Pointer Survey
CZM F151202S.ASC

822500 mN | 822000 mN | 821500 mN | 821000 mN | 820500 mN | 820000 mN | 819500 mN

422000 mE | 421500 mE | 421000 mE | 420500 mE | 420000 mE

PORT MANAGEMENT AREA
SPECIAL CONSERVATION AREA
EXISTING JOSCO CHANNEL DUKC TRACK
EXISTING SOUTH CHANNEL DUKC TRACK
EXISTING DEEP WATER CHANNEL DUKC TRACK

DESIGN -14.5m
AREA A
AREA A1
AREA B
AREA C
AREA D
DESIGN GRADE 1:3.2
DESIGN GRADE 1:5
DESIGN BERTH -14.5m
DESIGN -14.5m
500m
Port Boundary

CONCEPT DESIGN

NOTE: SCALES SHOWN ARE FOR A1 DRAWING

ISS	DATE	AMENDMENTS	APPD
F	31/8/16	Layout modifications	
E	9/05/16	New channel layout as requested by pilots	
D	28/4/16	New channel layout post simulation study	

NAPIER PORT

WHARF 6
PROPOSED DREDGING WORKS
STAGE 2 -14.5M

REFERENCE DRGS				No.
FILE	5341	CHECK	DATE	SCALE
CADFILE				1:5000
SURVEY				
DESIGN	CPV	MdV	2/10/15	
DRAWN	CPV	MdV	2/10/15	
APPROVED				

5341 | SHEET 405 | REV F

Appendix B

Cross Sections

Colour Banding - Cut Depths (m)			
Number	*Minimum Elevation*	*Maximum Elevation*	*Color*
1	-12.000	-11.000	
2	-11.000	-10.000	
3	-10.000	-9.000	
4	-9.000	-8.000	
5	-8.000	-7.000	
6	-7.000	-6.000	
7	-6.000	-5.000	
8	-5.000	-4.000	
9	-4.000	-3.000	
10	-3.000	-2.000	
11	-2.000	-1.000	
12	-1.000	0.000	
13	0.000	1.000	

NOTES:

1. *All survey and GPS positions are in terms of HAWKES BAY CIRCUIT 2000 (HAWKTM2000) datum.*
2. *All sounding depths are in terms of chart datum, 4.837m below BM (H40). Stainless steel pin in concrete block near south west corner of PONL Admin Building.*
3. *Major Isobaths are at 1.0m intervals. Minor Isobaths are at 0.5m intervals.*
4. *Shaded areas are areas to be dredged (cut).*
5. *Volume to be dredged 3,000,000m3*

REFERENCES
Existing ground contours from surveys:
2015 Multibeam White Pointer Survey
CZM F151202S.ASC

822500 mN | 822000 mN | 821500 mN | 821000 mN | 820500 mN | 820000 mN | 819500 mN

422000 mE | 421500 mE | 421000 mE | 420500 mE | 420000 mE

PORT MANAGEMENT AREA
SPECIAL CONSERVATION AREA
EXISTING JOSCO CHANNEL DUKC TRACK
EXISTING SOUTH CHANNEL DUKC TRACK
EXISTING DEEP WATER CHANNEL DUKC TRACK

A | A' | B | B' | C | C' | D | D' | E | E' | F | F' | G | G' | H | H' | I | I' | J | J'

DESIGN -14.5m AREA A
AREA A1
AREA B
AREA C
AREA D
DESIGN GRADE 1:3.2
DESIGN GRADE 1:5
DESIGN BERTH -14.5m
500m
Port Boundary

CONCEPT DESIGN

NOTE: SCALES SHOWN ARE FOR A1 DRAWING

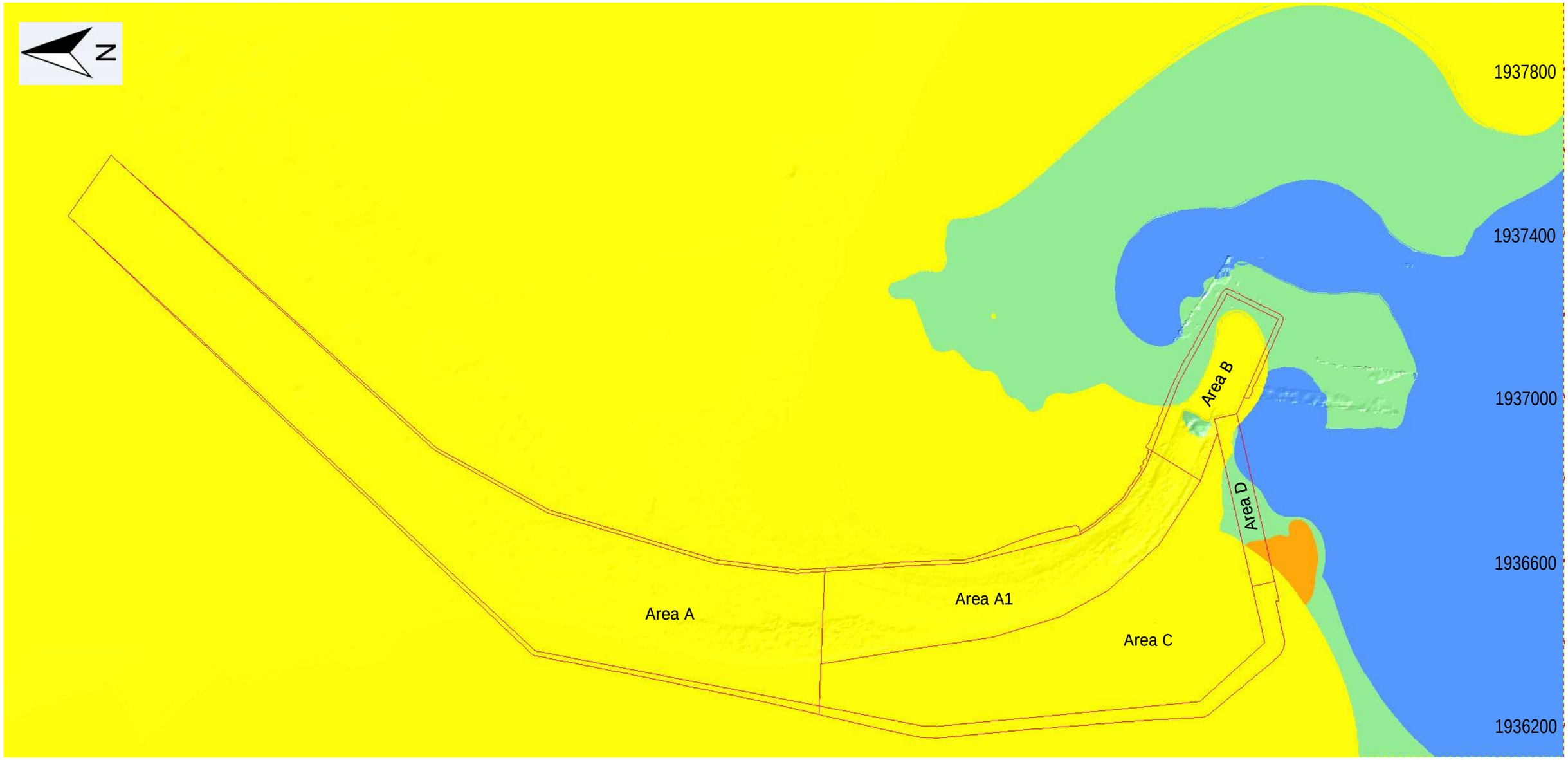
ISS	DATE	AMENDMENTS	APPD
F	31/8/16	Layout modifications	
E	9/05/16	New channel layout as requested by pilots	
D	28/4/16	New channel layout post simulation study	

NAPIER PORT

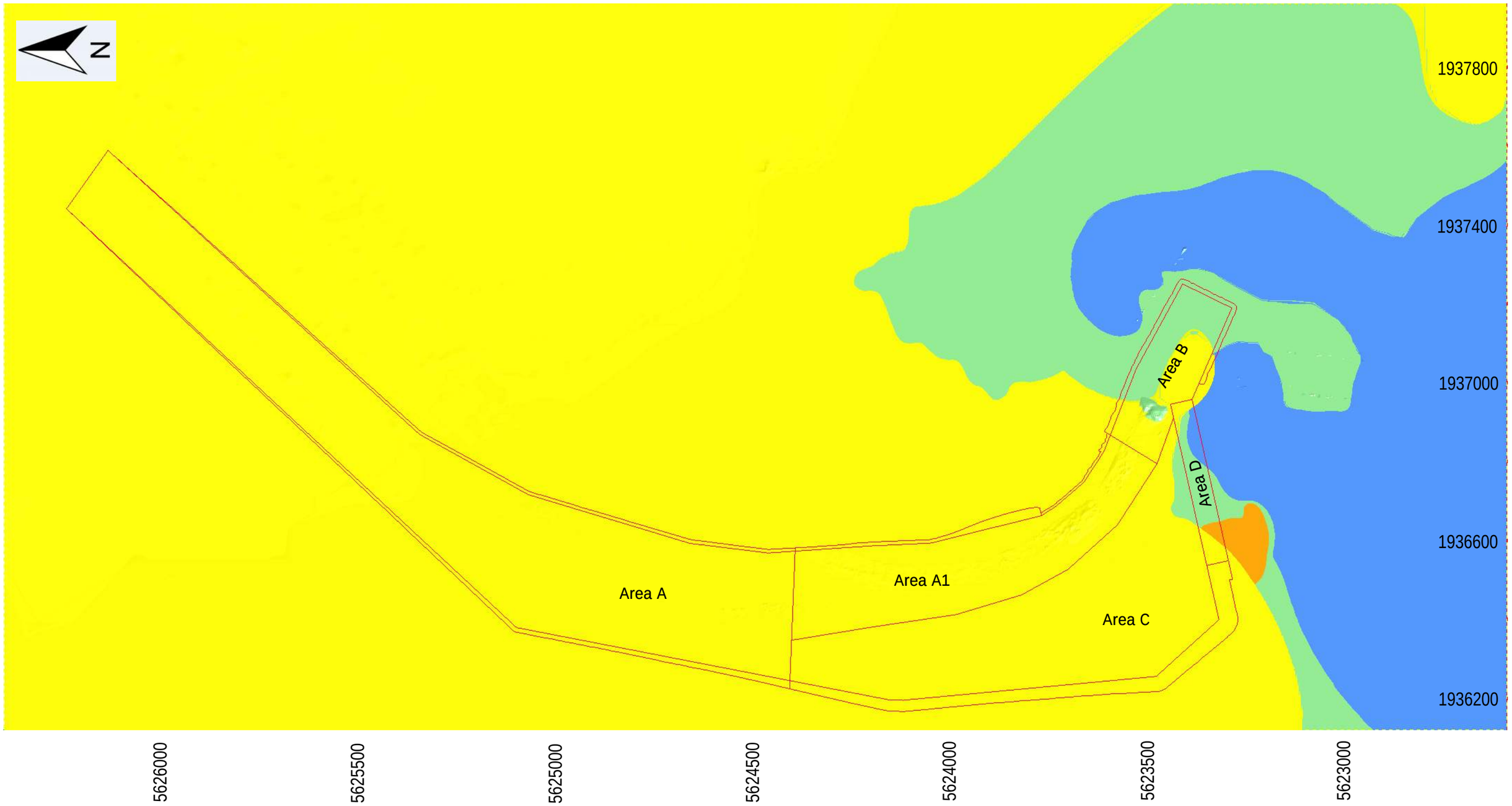
WHARF 6
PROPOSED DREDGING WORKS
STAGE 2 -14.5M

REFERENCE DRGS				No.
FILE	5341	CHECK	DATE	SCALE
CADFILE				1:5000
SURVEY				
DESIGN	CPV	MdV	2/10/15	
DRAWN	CPV	MdV	2/10/15	
APPROVED				

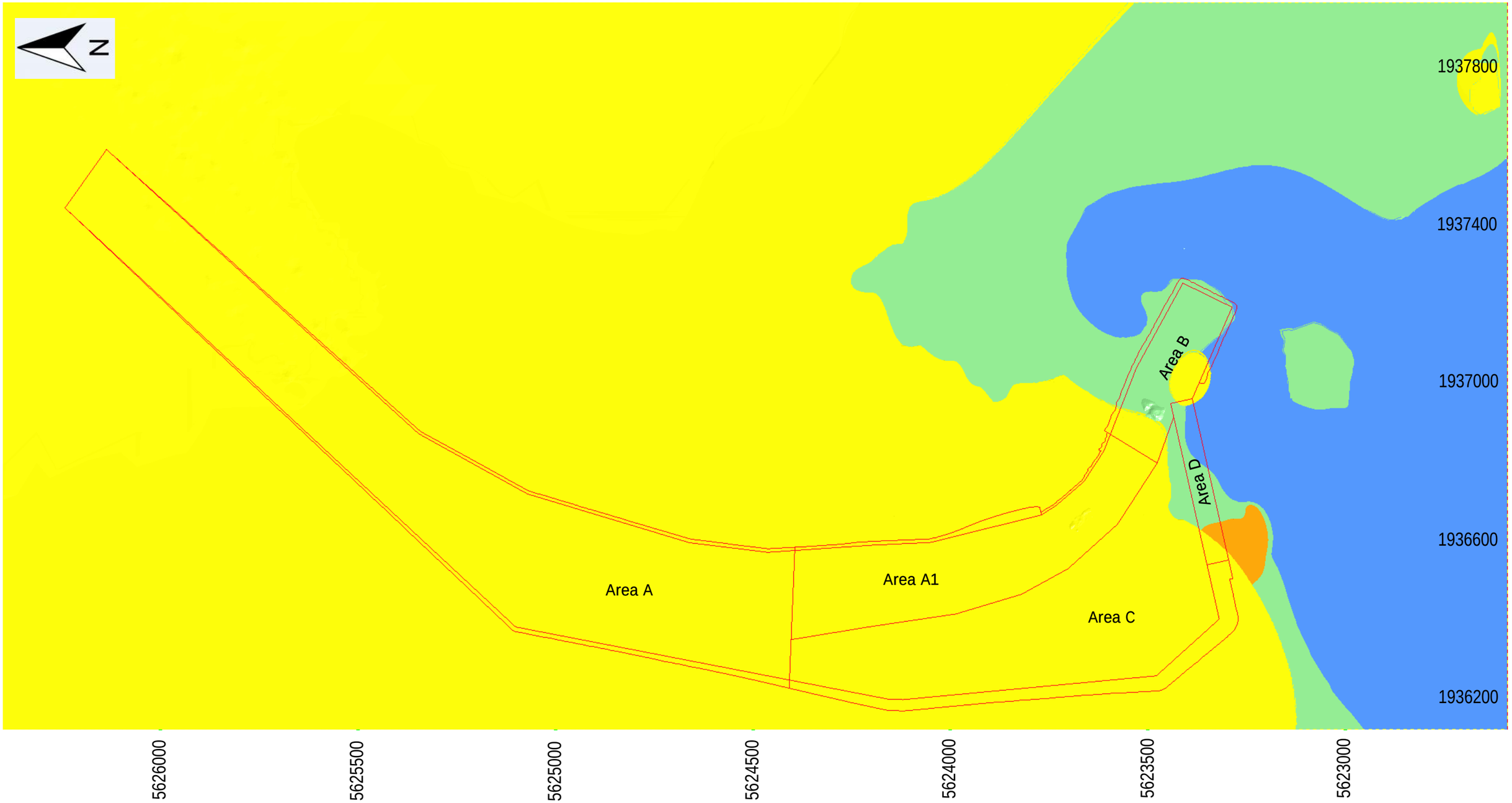
5341 | SHEET 405 | REV F



Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	HORIZONTAL SECTION DREDGE LEVEL -12.5m	HORIZONTAL SECTION 1 23 - 09 - 2016 | Rev 2



Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	HORIZONTAL SECTION DREDGE LEVEL -13.0m	HORIZONTAL SECTION 2 23 - 09 - 2016 | Rev 2



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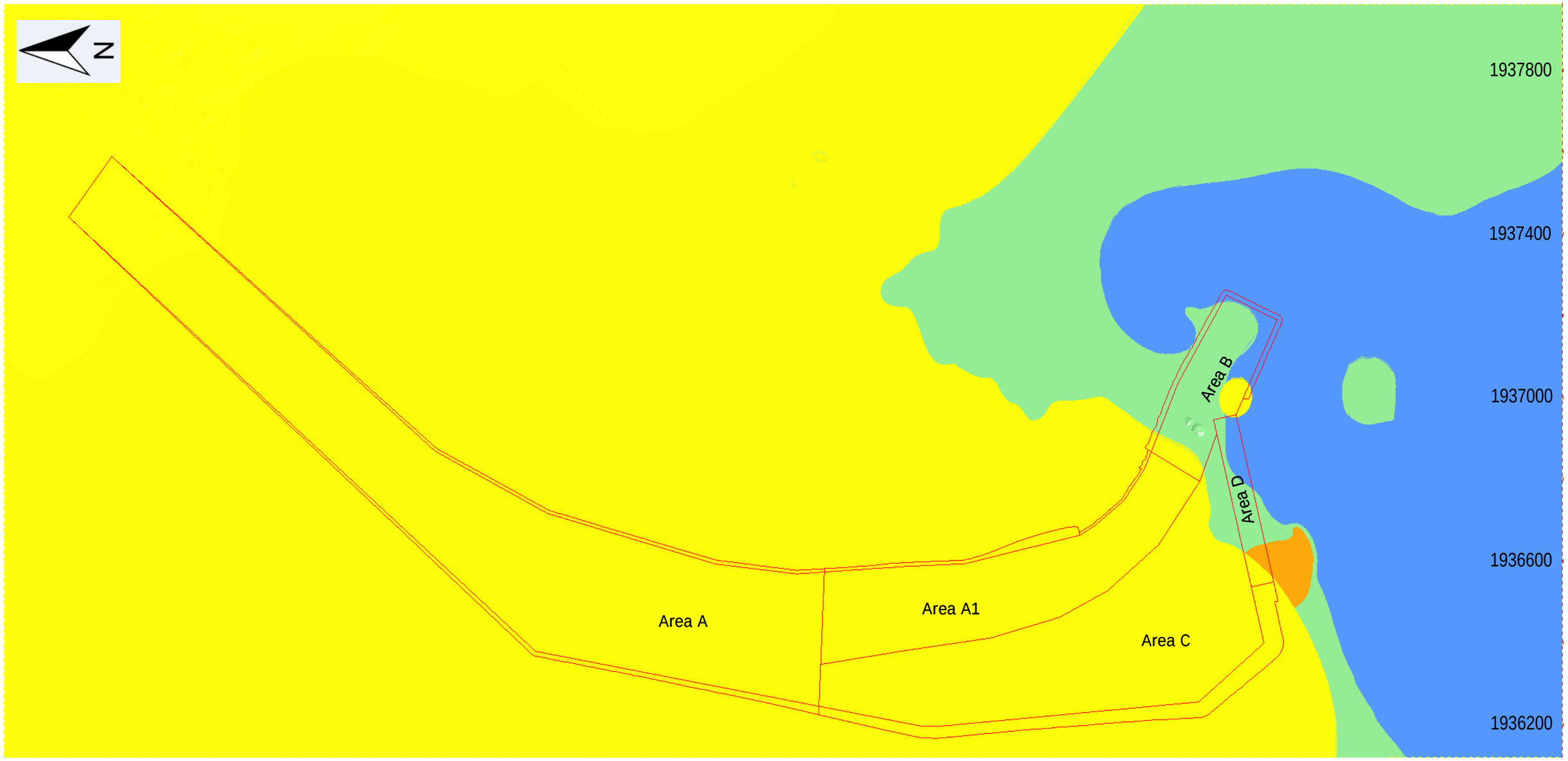
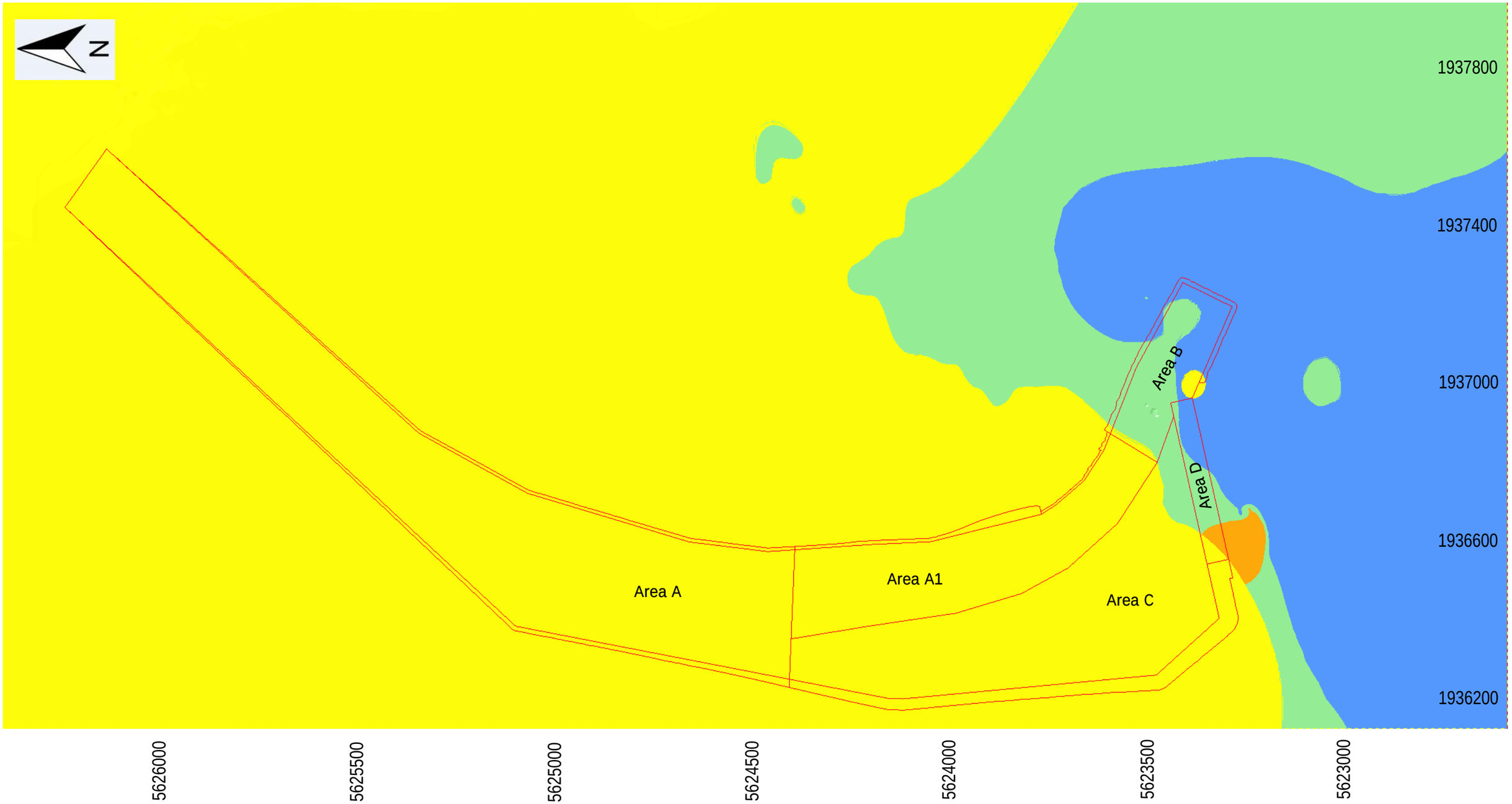
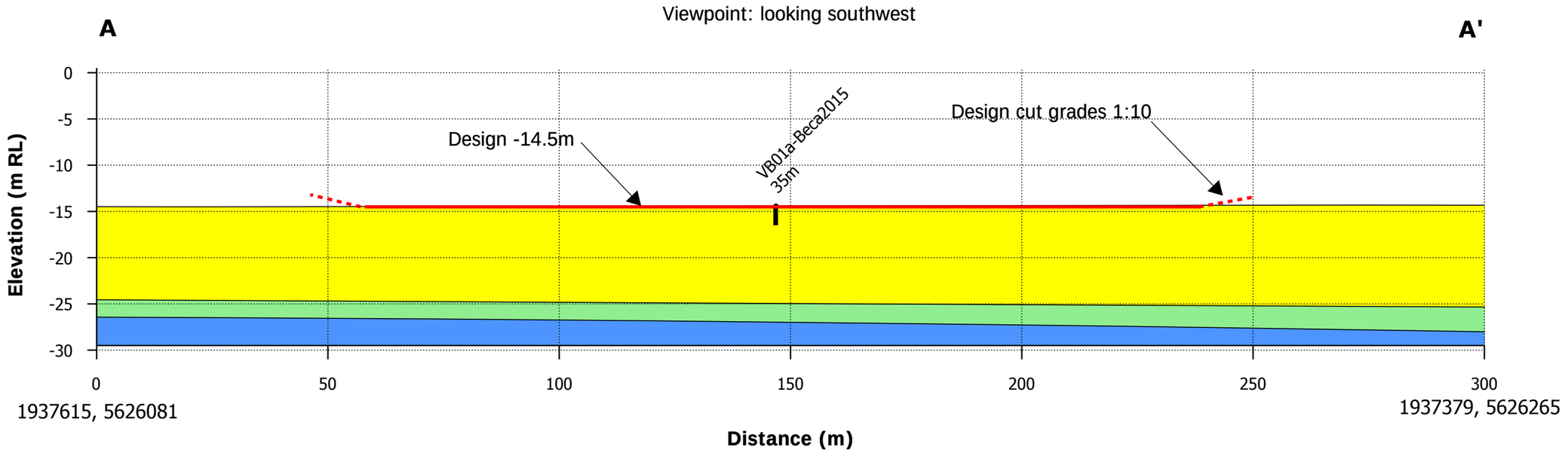


Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	HORIZONTAL SECTION DREDGE LEVEL -14.0m	HORIZONTAL SECTION 4 23 - 09 - 2016 | Rev 2



Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	HORIZONTAL SECTION DREDGE LEVEL -14.5m	HORIZONTAL SECTION 5 23 - 09 - 2016 | Rev 2



Legend

- Mangaheia Fm (N = 50+)
- Quaternary Marine Sediments
- Recent Marine Sediments
- Reclamation Fill
- Residual Mangaheia Fm

Scale: 1:1,000

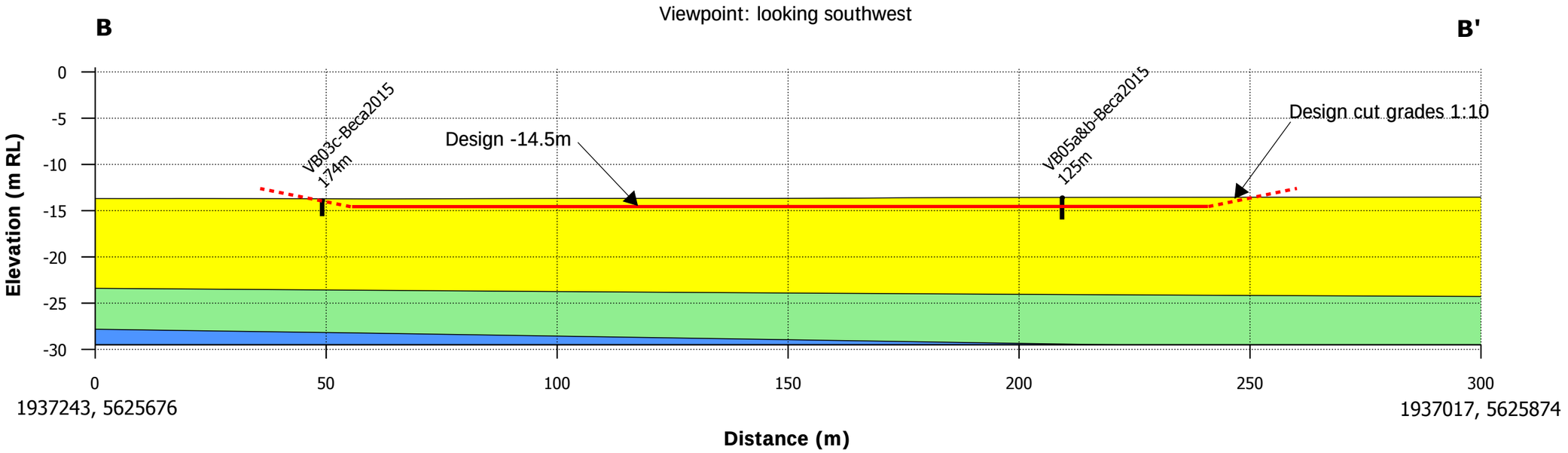
Vertical exaggeration: 2x

0m 50m

ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	VERTICAL SECTION A-A'	VERTICAL SECTION 1 23 - 09 - 2016 | Rev 2



Legend

- Mangaheia Fm (N = 50+)
- Quaternary Marine Sediments
- Recent Marine Sediments
- Reclamation Fill
- Residual Mangaheia Fm

Scale: 1:1,000

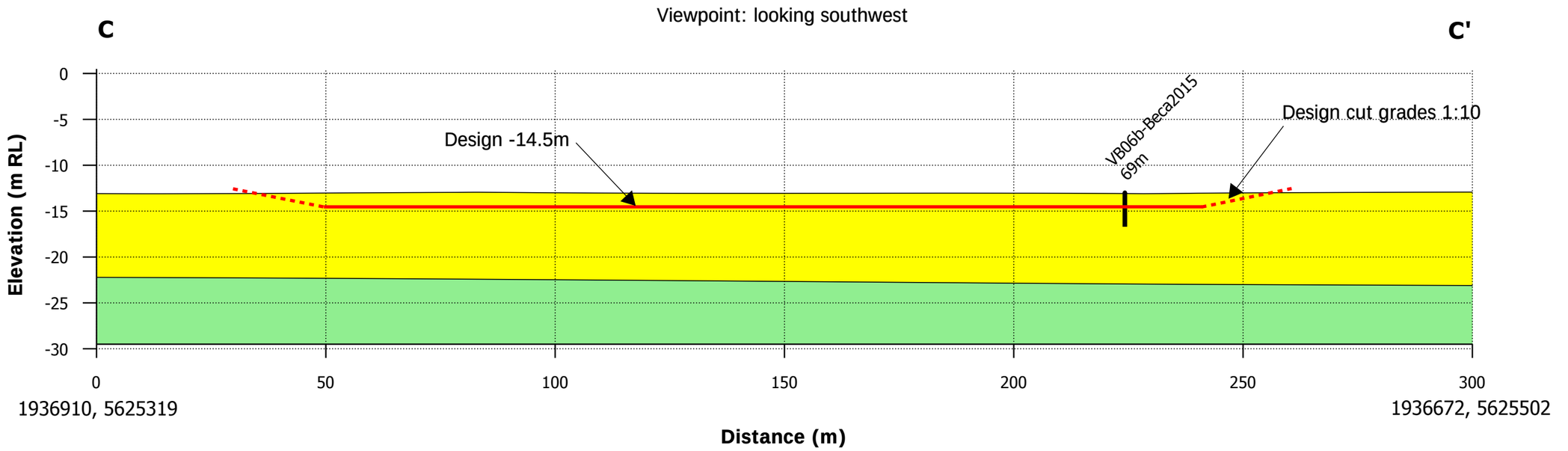
Vertical exaggeration: 2x

0m 50m

ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	VERTICAL SECTION B-B'	VERTICAL SECTION 2 23 - 09 - 2016 | Rev 2



Legend

- Mangaheia Fm (N = 50+)
- Quaternary Marine Sediments
- Recent Marine Sediments
- Reclamation Fill
- Residual Mangaheia Fm

Scale: 1:1,000

Vertical exaggeration: 2x

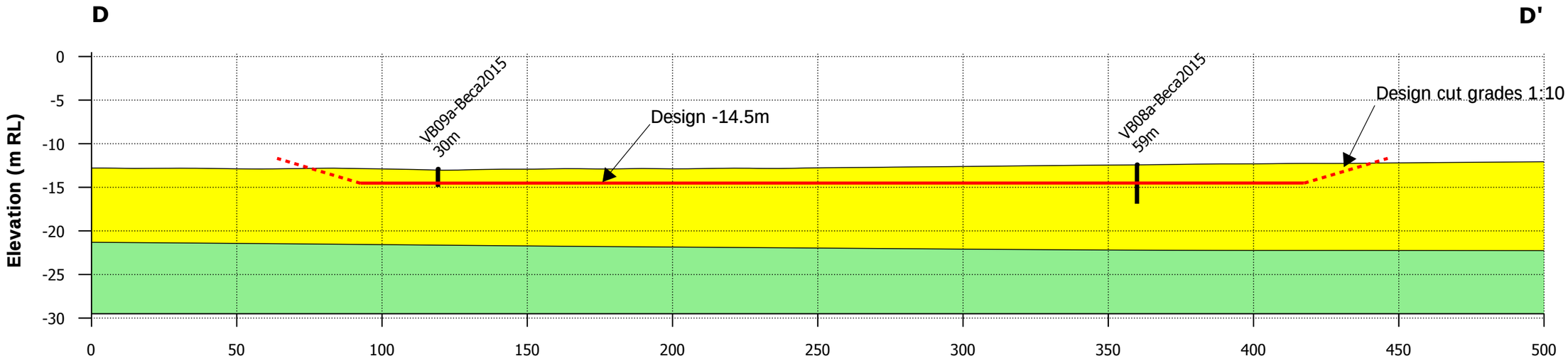
0m 50m

ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	VERTICAL SECTION C-C'	VERTICAL SECTION 3 23 - 09 - 2016 | Rev 2

Viewpoint: looking southwest



Legend

- Mangaheia Fm (N = 50+)
- Quaternary Marine Sediments
- Recent Marine Sediments
- Reclamation Fill
- Residual Mangaheia Fm

Scale: 1:1,500

Vertical exaggeration: 3x

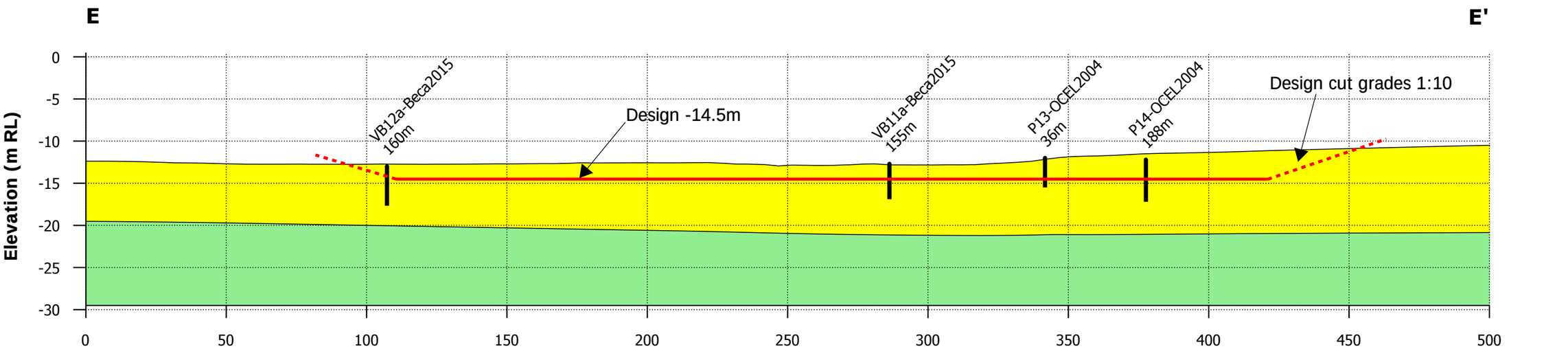
0m 50m

ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	VERTICAL SECTION D-D'	VERTICAL SECTION 4 23 - 09 - 2016 | Rev 2

Viewpoint: looking south



Legend

- Mangaheia Fm (N = 50+)
- Quaternary Marine Sediments
- Recent Marine Sediments
- Reclamation Fill
- Residual Mangaheia Fm

Scale: 1:1,500

Vertical exaggeration: 3x

0m 50m

ORIGINAL DRAWING IN COLOUR

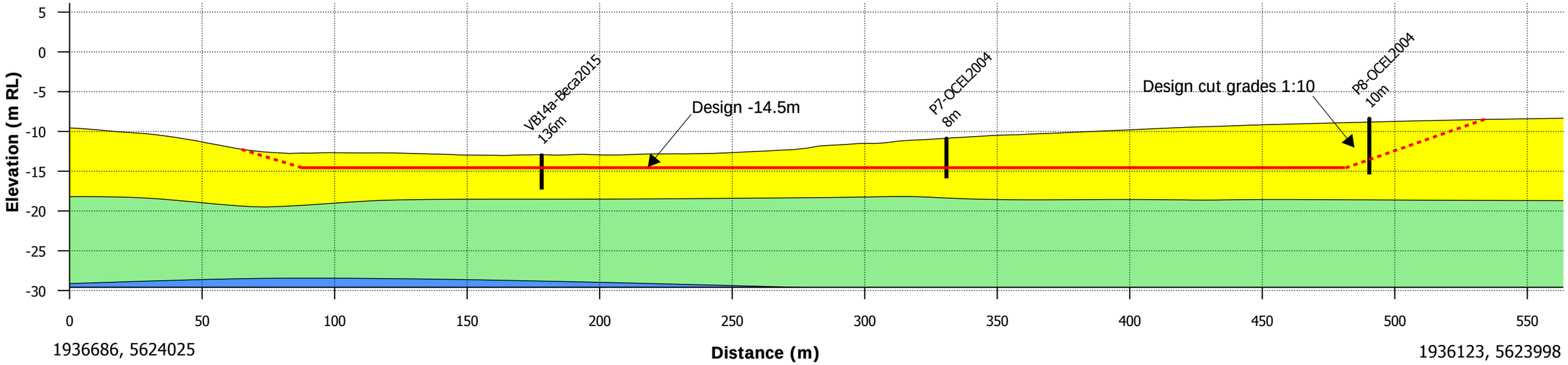
PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	VERTICAL SECTION E-E'	VERTICAL SECTION 5 23 - 09 - 2016 | Rev 2

F

Viewpoint: looking south

F'



1936686, 5624025

1936123, 5623998

Legend

- Mangaheia Fm (N = 50+)
- Quaternary Marine Sediments
- Recent Marine Sediments
- Reclamation Fill
- Residual Mangaheia Fm

Scale: 1:1,500

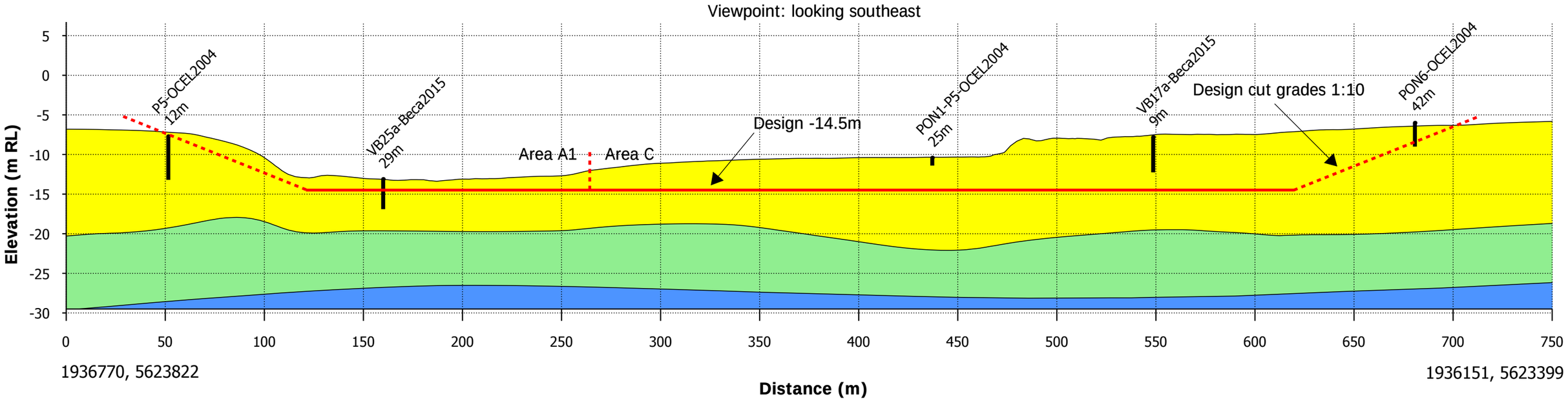
Vertical exaggeration: 3x

0m 50m

ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	VERTICAL SECTION F-F'	VERTICAL SECTION 6 23 - 09 - 2016 | Rev 2



Legend

- Mangaheia Fm (N = 50+)
- Quaternary Marine Sediments
- Recent Marine Sediments
- Reclamation Fill
- Residual Mangaheia Fm

Scale: 1:2,000

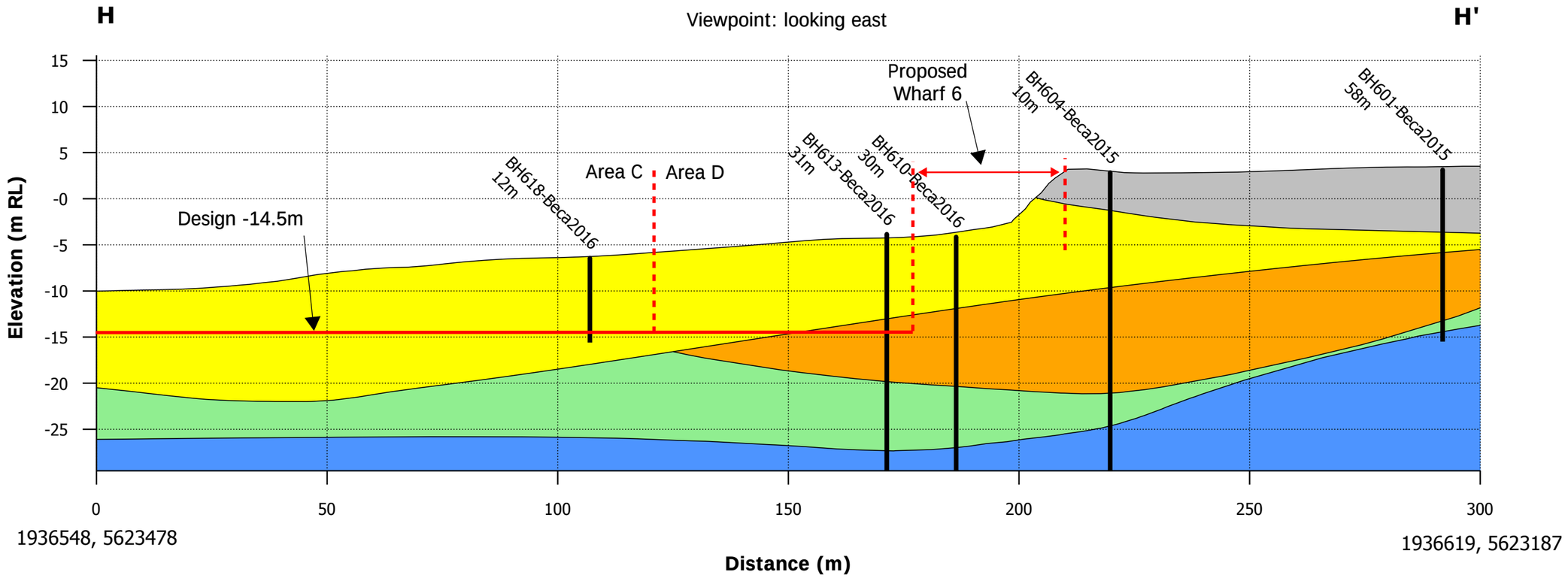
Vertical exaggeration: 4x

0m — 200m

ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	VERTICAL SECTION G-G'	VERTICAL SECTION 7 23 - 09 - 2016 | Rev 2



Legend

- Mangaheia Fm (N = 50+)
- Quaternary Marine Sediments
- Recent Marine Sediments
- Reclamation Fill
- Residual Mangaheia Fm

Scale: 1:1,000

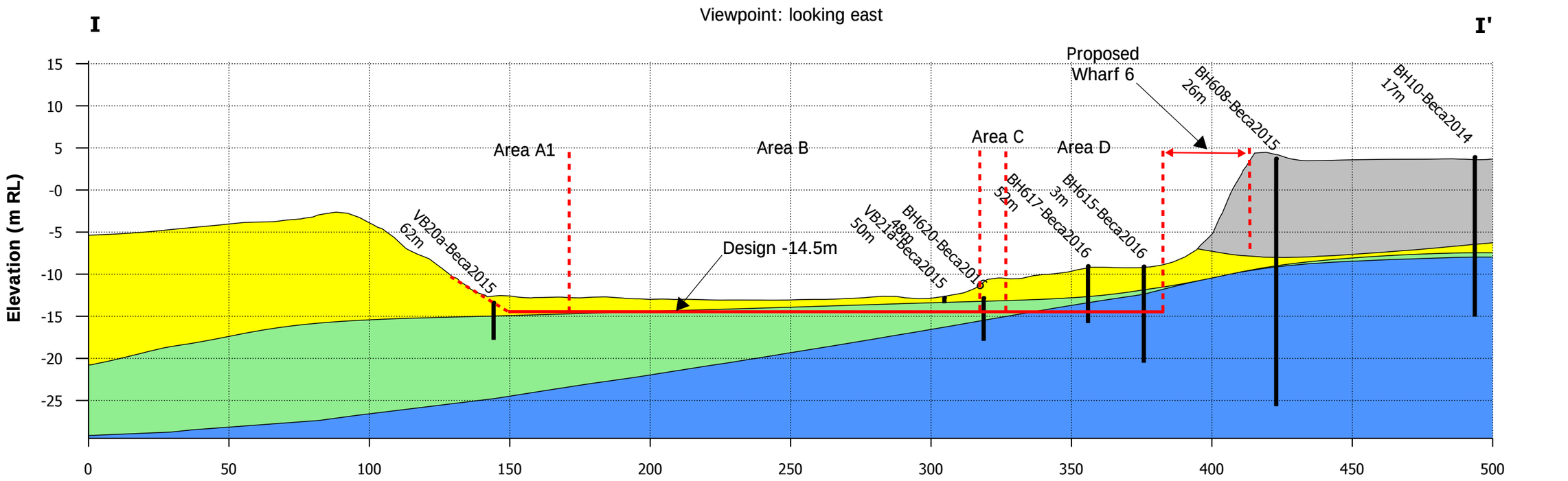
Vertical exaggeration: 2x

0m 50m

ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	VERTICAL SECTION H-H'	VERTICAL SECTION 8 23 - 09 - 2016 | Rev 2



Legend

- Mangaheia Fm (N = 50+)
- Quaternary Marine Sediments
- Recent Marine Sediments
- Reclamation Fill
- Residual Mangaheia Fm

Scale: 1:1,500

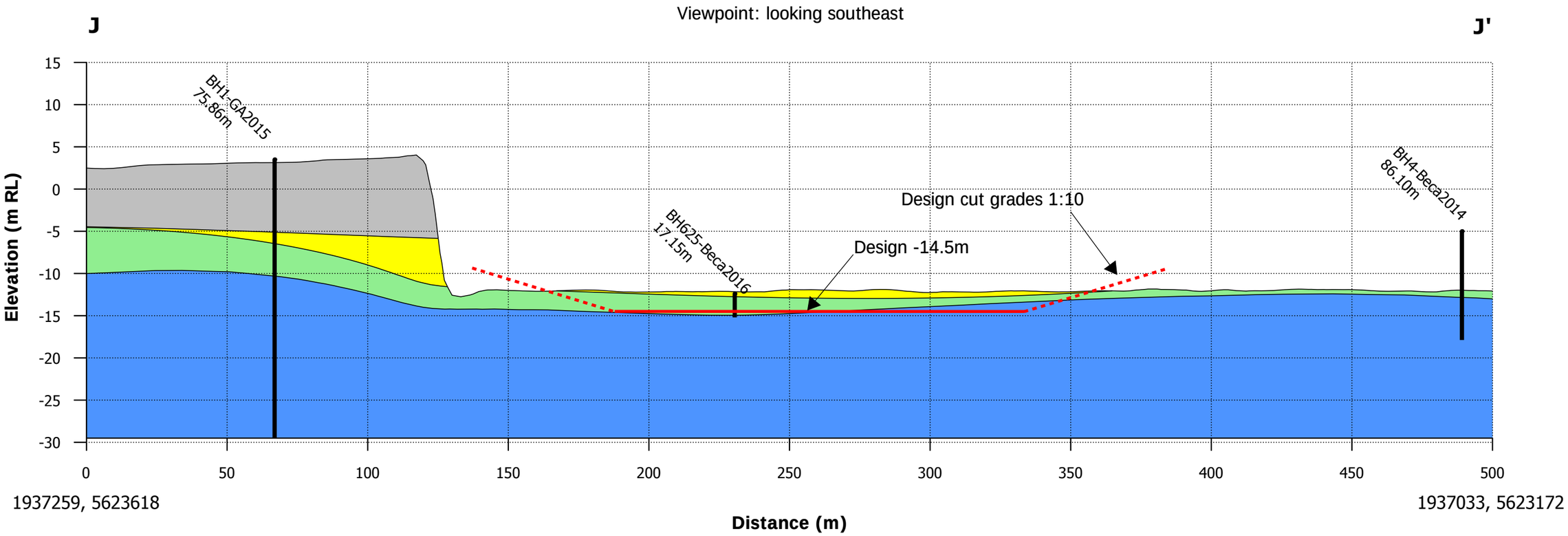
Vertical exaggeration: 3x

0m 50m

ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	VERTICAL SECTION I-I'	VERTICAL SECTION 9 23 - 09 - 2016 | Rev 2



Legend

- Mangaheia Fm (N = 50+)
- Quaternary Marine Sediments
- Recent Marine Sediments
- Reclamation Fill
- Residual Mangaheia Fm

Scale: 1:1,500

Vertical exaggeration: 3x

0m 50m

ORIGINAL DRAWING IN COLOUR

PDF ONLY
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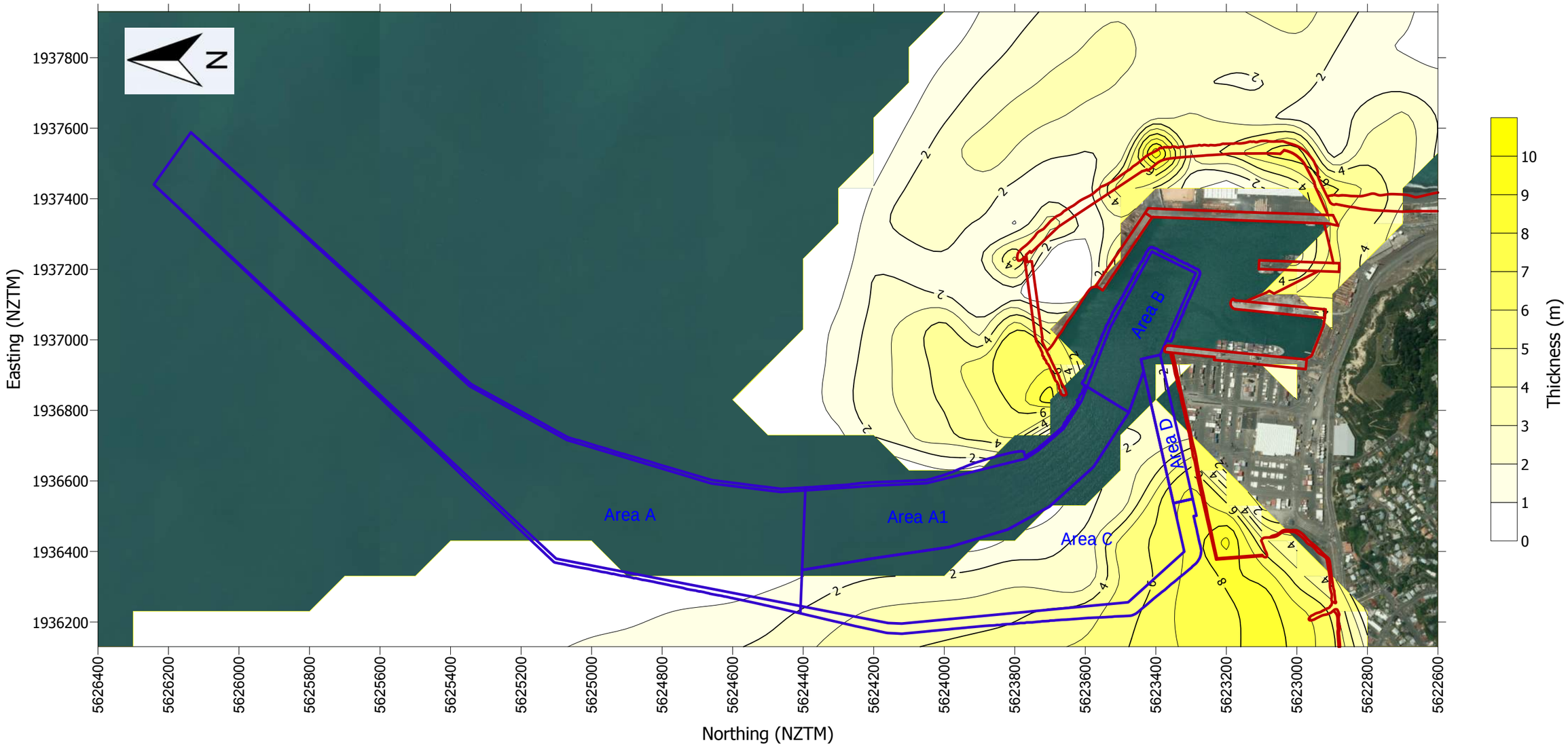
Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	VERTICAL SECTION J-J'	VERTICAL SECTION 10 23 - 09 - 2016 | Rev 2

Appendix C

Isopach Maps



ORIGINAL DRAWING IN COLOUR

PDF ONLY
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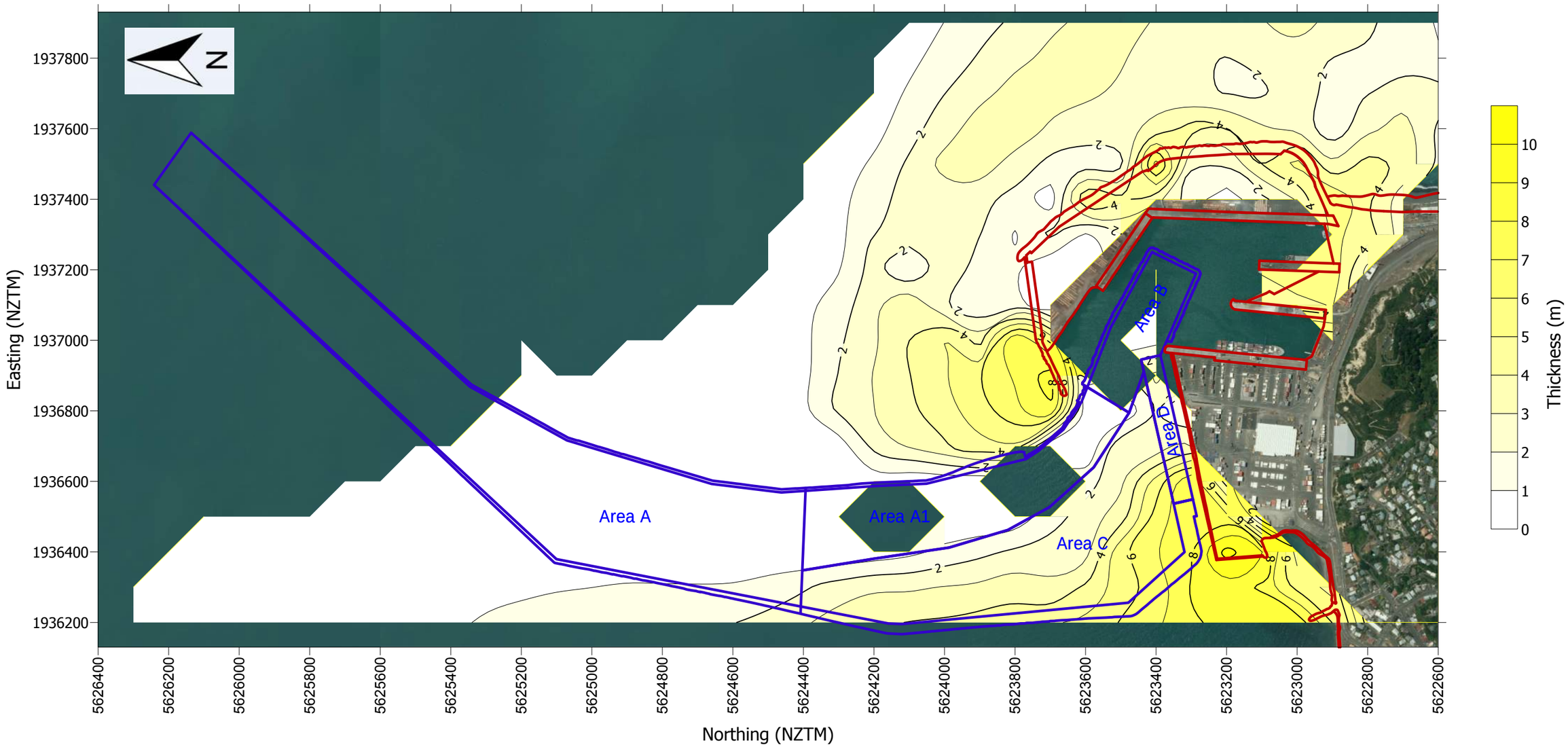
Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP RECENT MARINE SEDIMENT TO -12.5m	ISOPACH MAP 1 23 - 09 - 2016 | Rev 3



ORIGINAL DRAWING IN COLOUR

PDF ONLY
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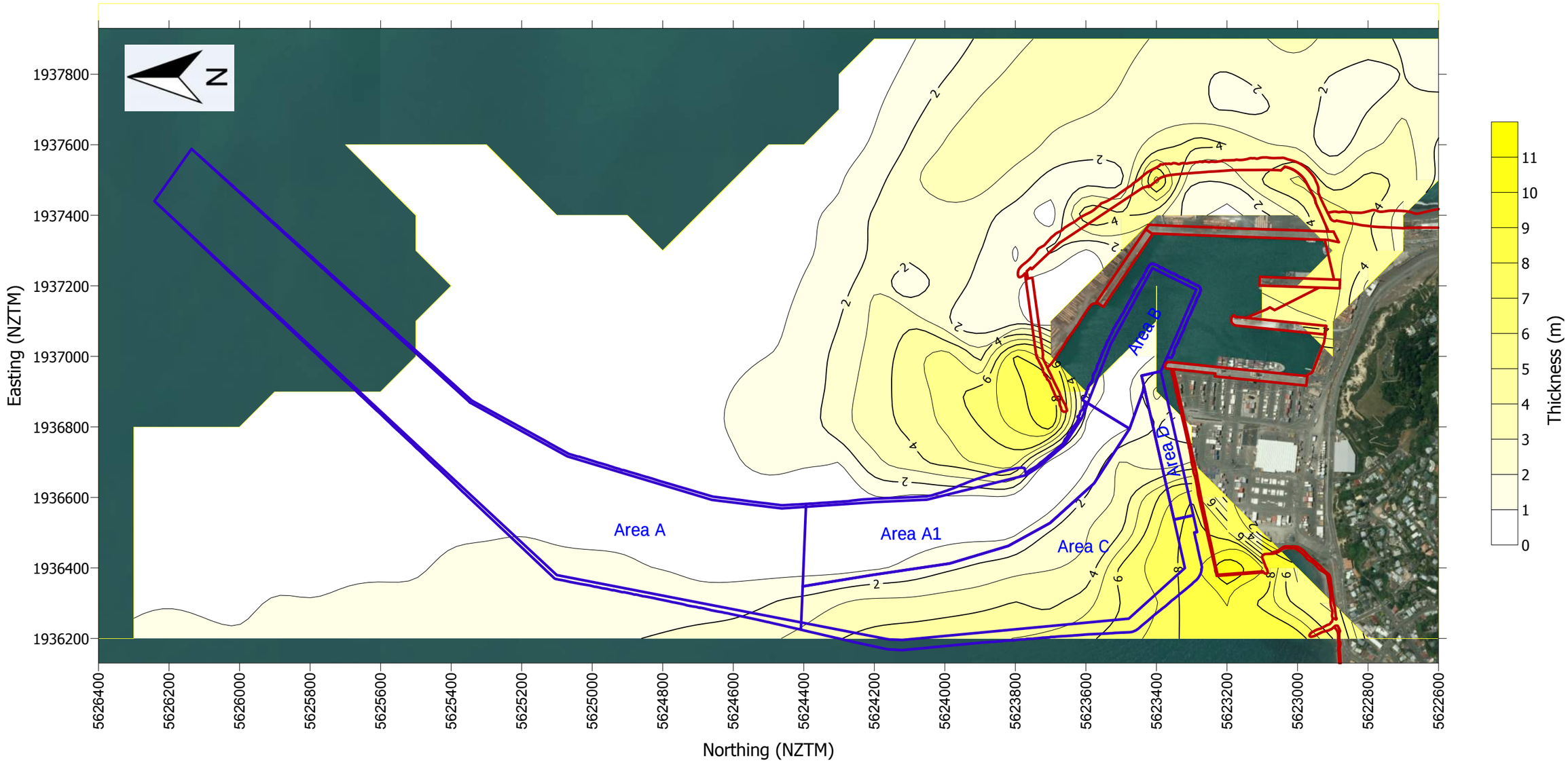
Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP RECENT MARINE SEDIMENT TO -13.0m	ISOPACH MAP 2 01 - 06 - 2016 | Rev 2



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PDF ONLY
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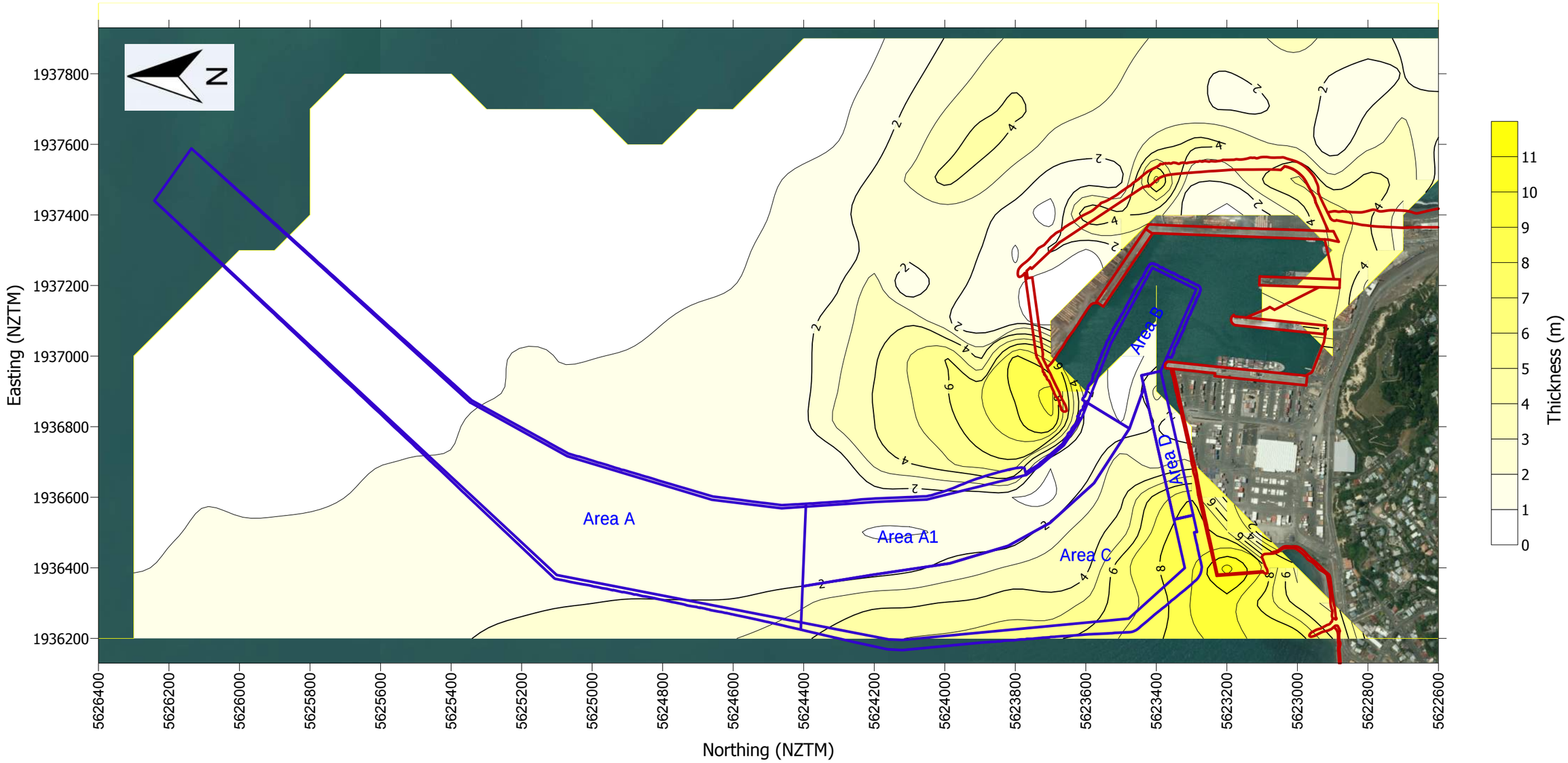
Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP RECENT MARINE SEDIMENT TO -13.5m	ISOPACH MAP 3 23 - 09 - 2016 | Rev 3



ORIGINAL DRAWING IN COLOUR

PDF ONLY
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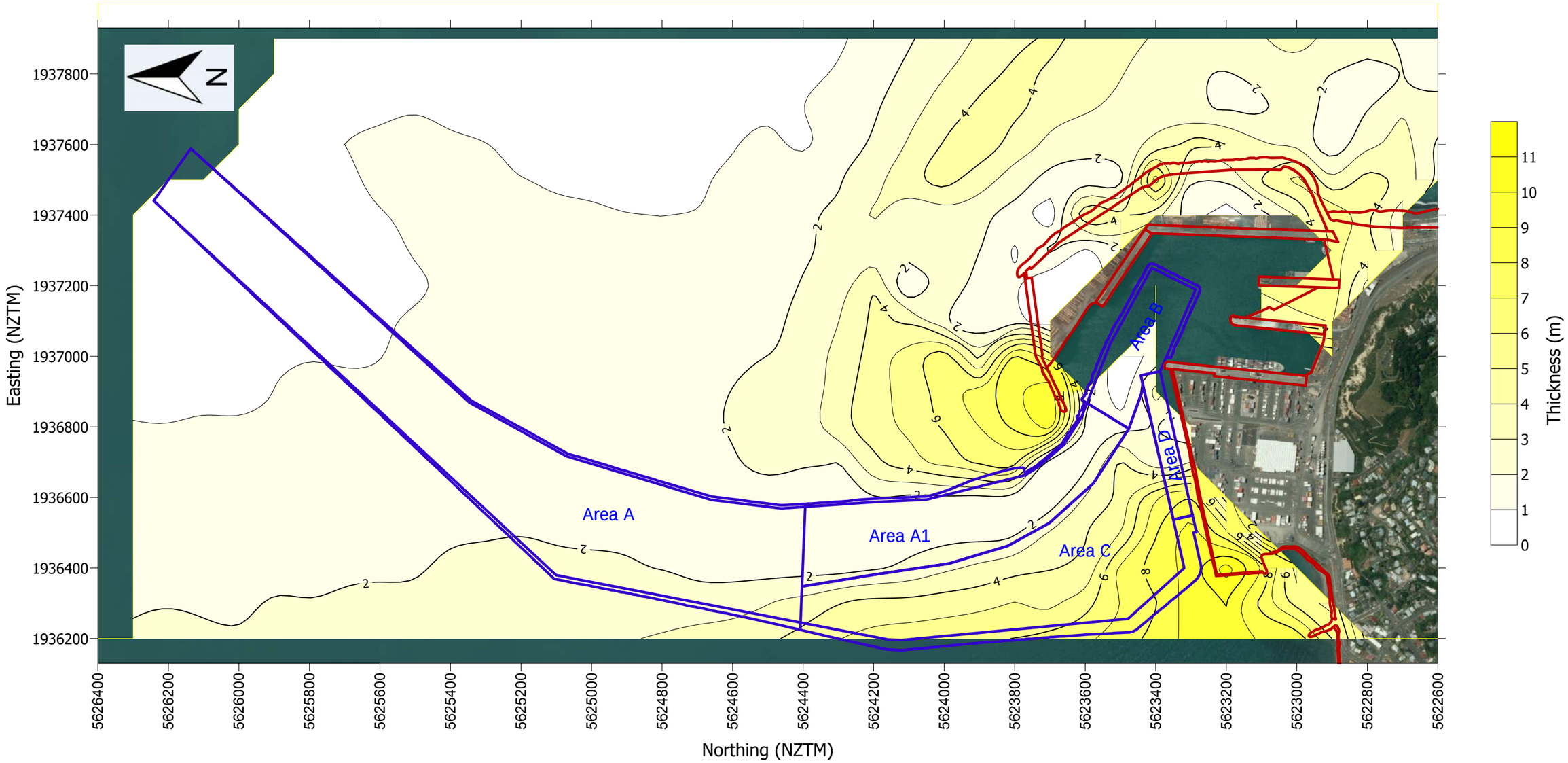
Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP RECENT MARINE SEDIMENT TO -14.0m	ISOPACH MAP 4 23 - 09 - 2016 | Rev 3



ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP RECENT MARINE SEDIMENT TO -14.5m	ISOPACH MAP 5 23 - 09 - 2016 | Rev 3

ORIGINAL DRAWING IN COLOUR

PDF ONLY
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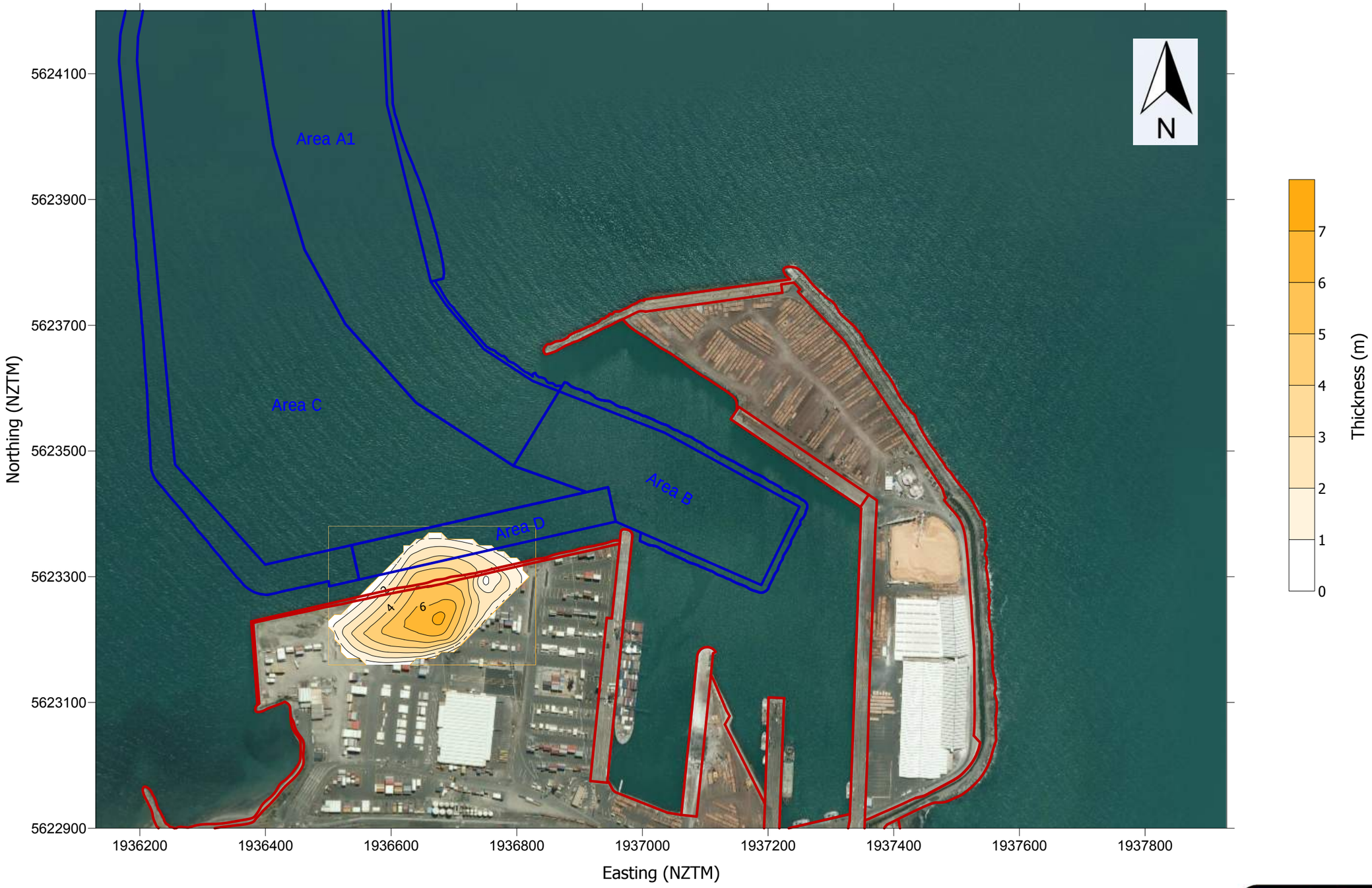
Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP QUATERNARY MARINE SEDIMENT TO -12.5m	ISOPACH MAP 6 23 - 09 - 2016 | Rev 3



ORIGINAL DRAWING IN COLOUR

PDF ONLY
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Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP QUATERNARY MARINE SEDIMENT TO -13.0m	ISOPACH MAP 7 23 - 09 - 2016 | Rev 3

ORIGINAL DRAWING IN COLOUR

PDF ONLY
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Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP QUATERNARY MARINE SEDIMENT TO -13.5m	ISOPACH MAP 8 23 - 09 - 2016 | Rev 3

ORIGINAL DRAWING IN COLOUR

PDF ONLY
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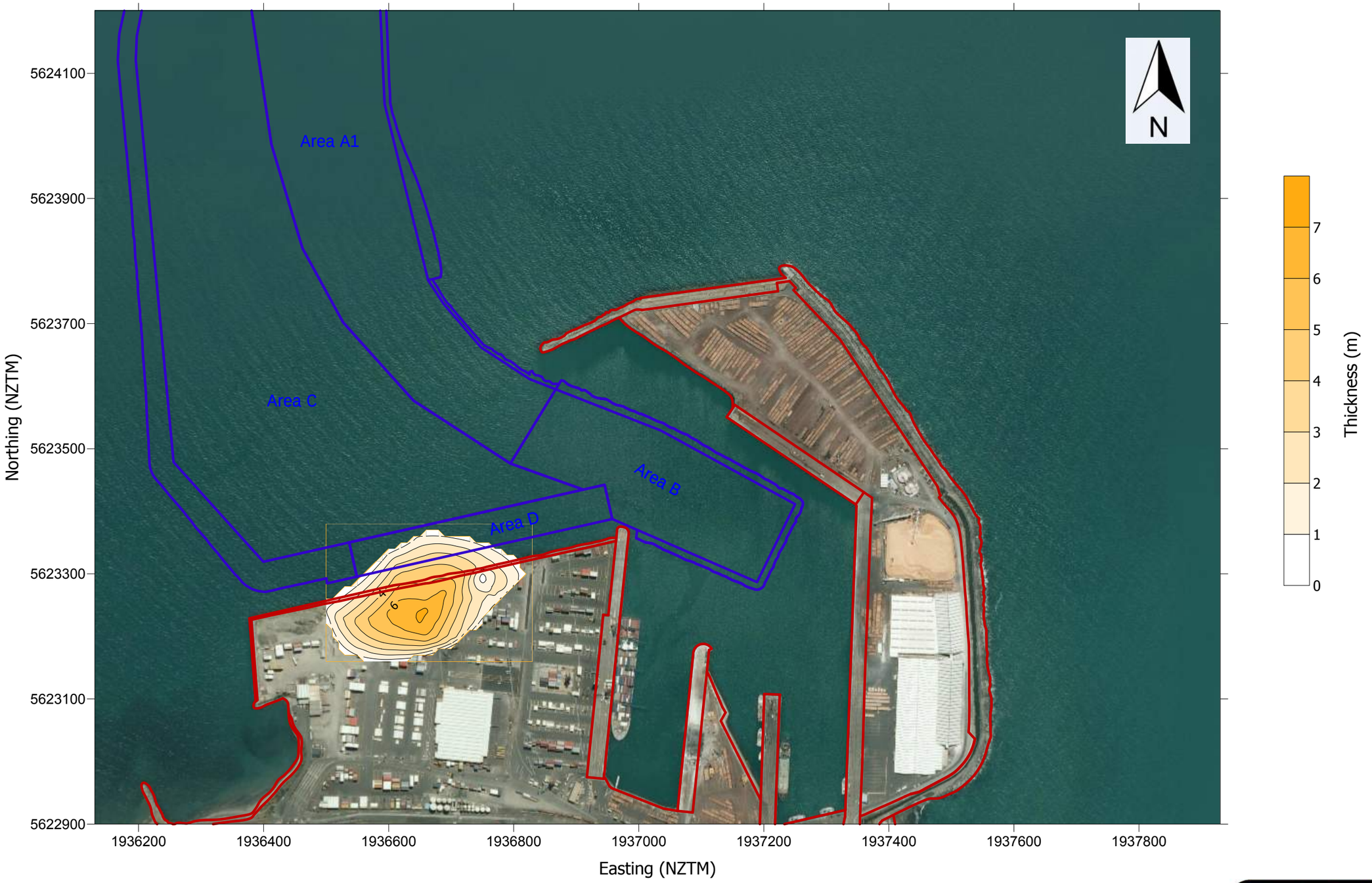
Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP QUATERNARY MARINE SEDIMENT TO -14.0m	ISOPACH MAP 9 23 - 09 - 2016 | Rev 3



ORIGINAL DRAWING IN COLOUR

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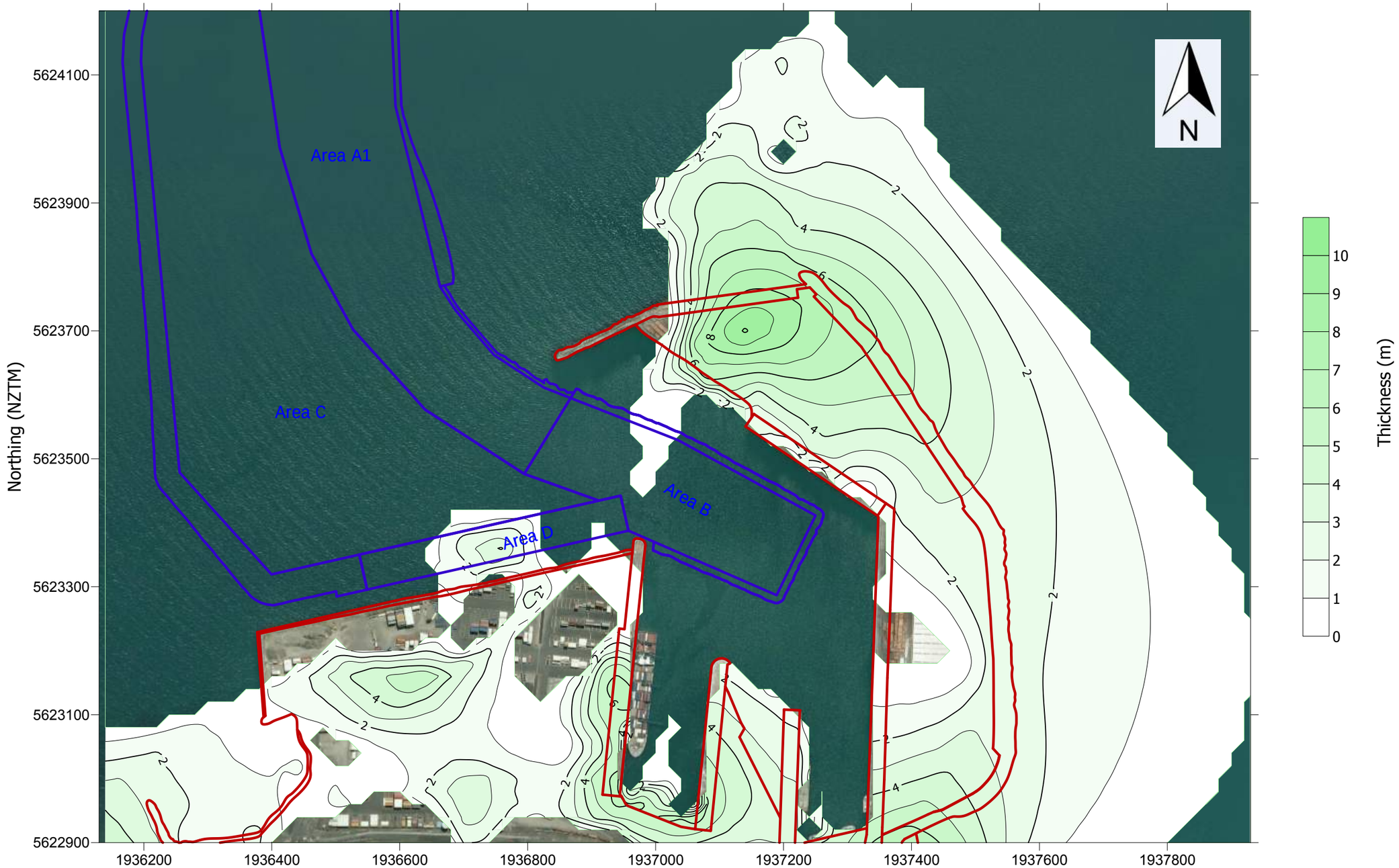
Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP QUATERNARY MARINE SEDIMENT TO -14.5m	ISOPACH MAP 10 23 - 09 - 2016 | Rev 3



ORIGINAL DRAWING IN COLOUR

PDF ONLY
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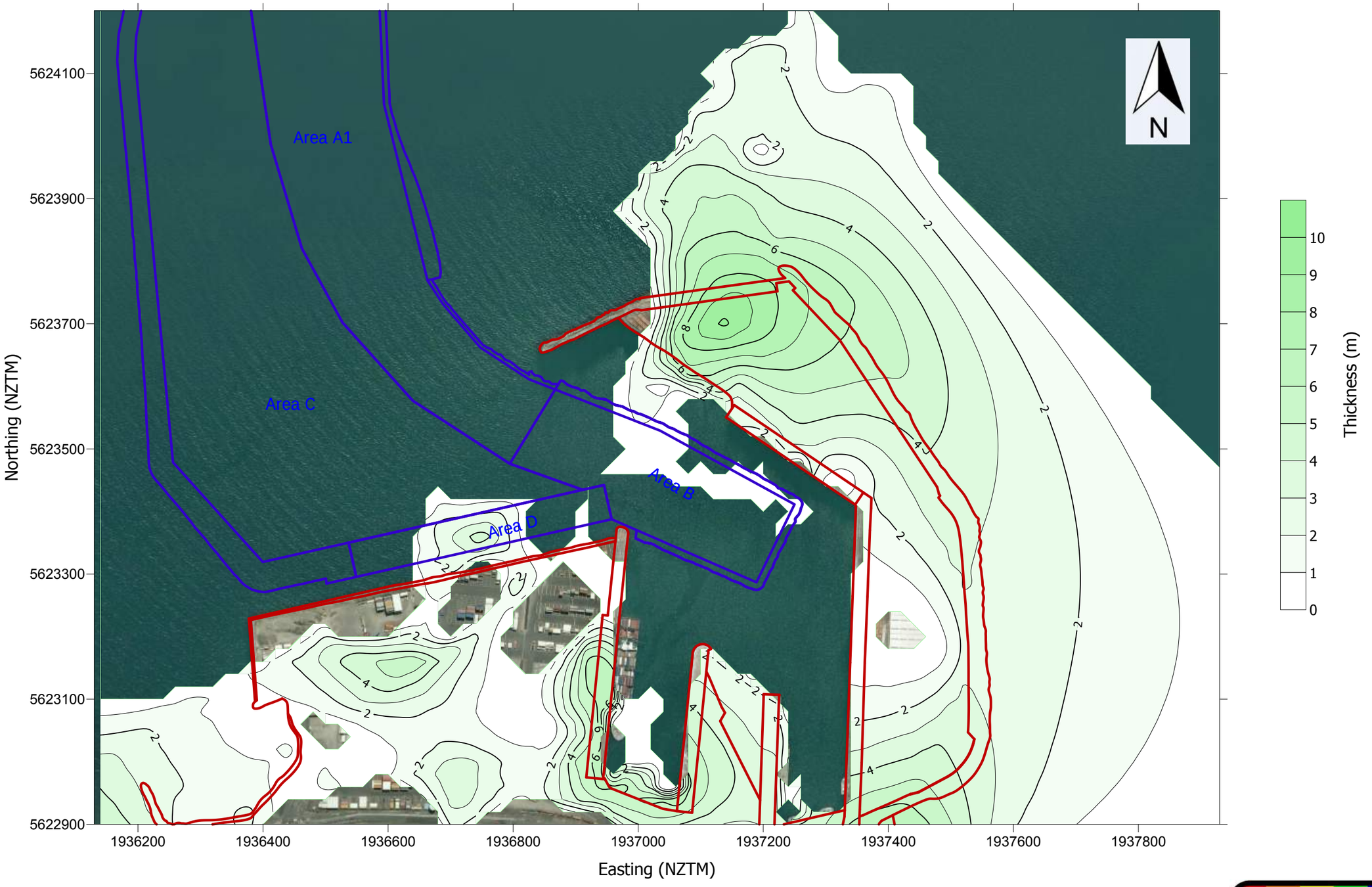
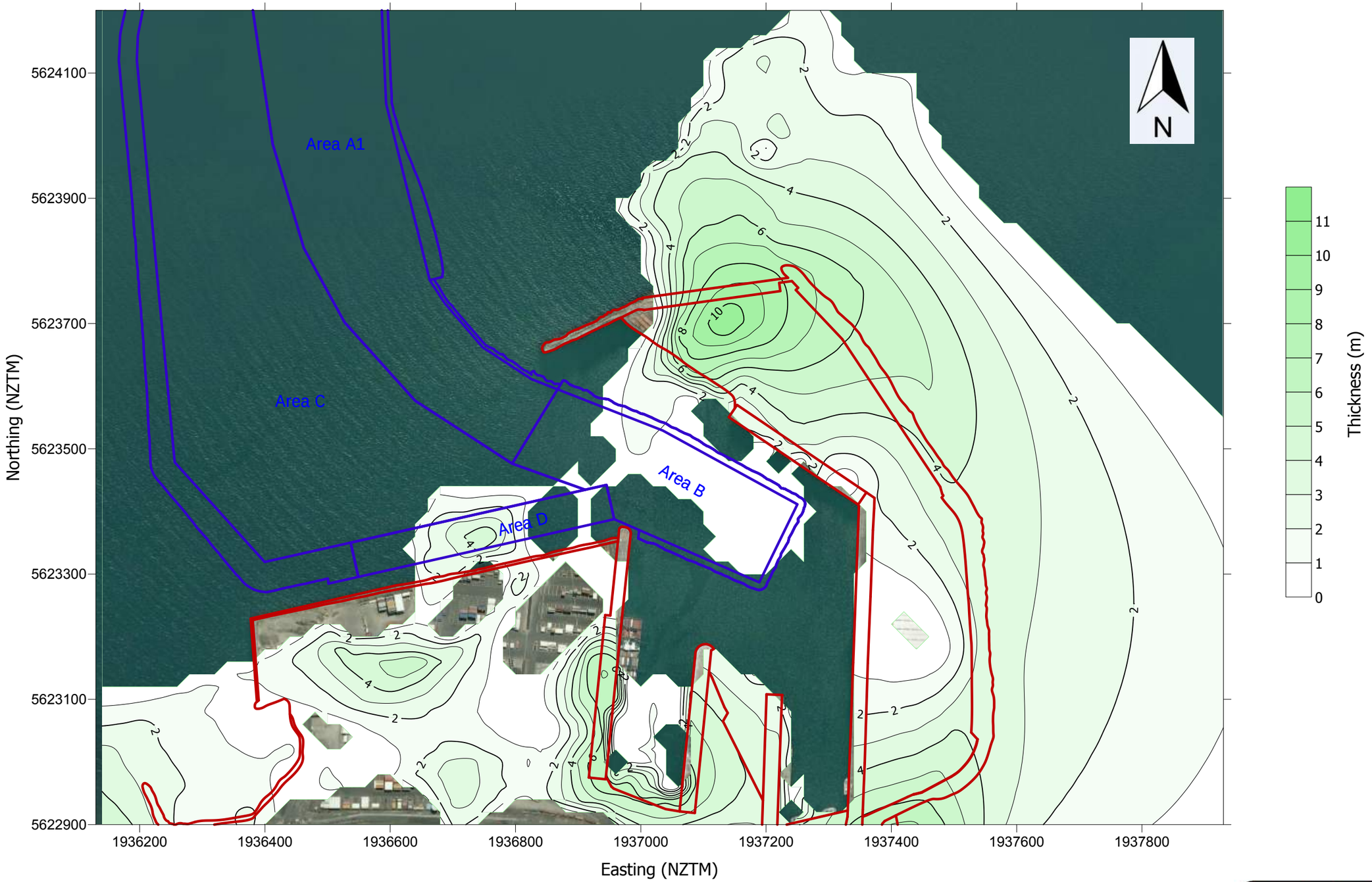
Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP RESIDUAL MANGAHEIA FORMATION TO -12.5m	ISOPACH MAP 11 23 - 09 - 2016 | Rev 3



ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

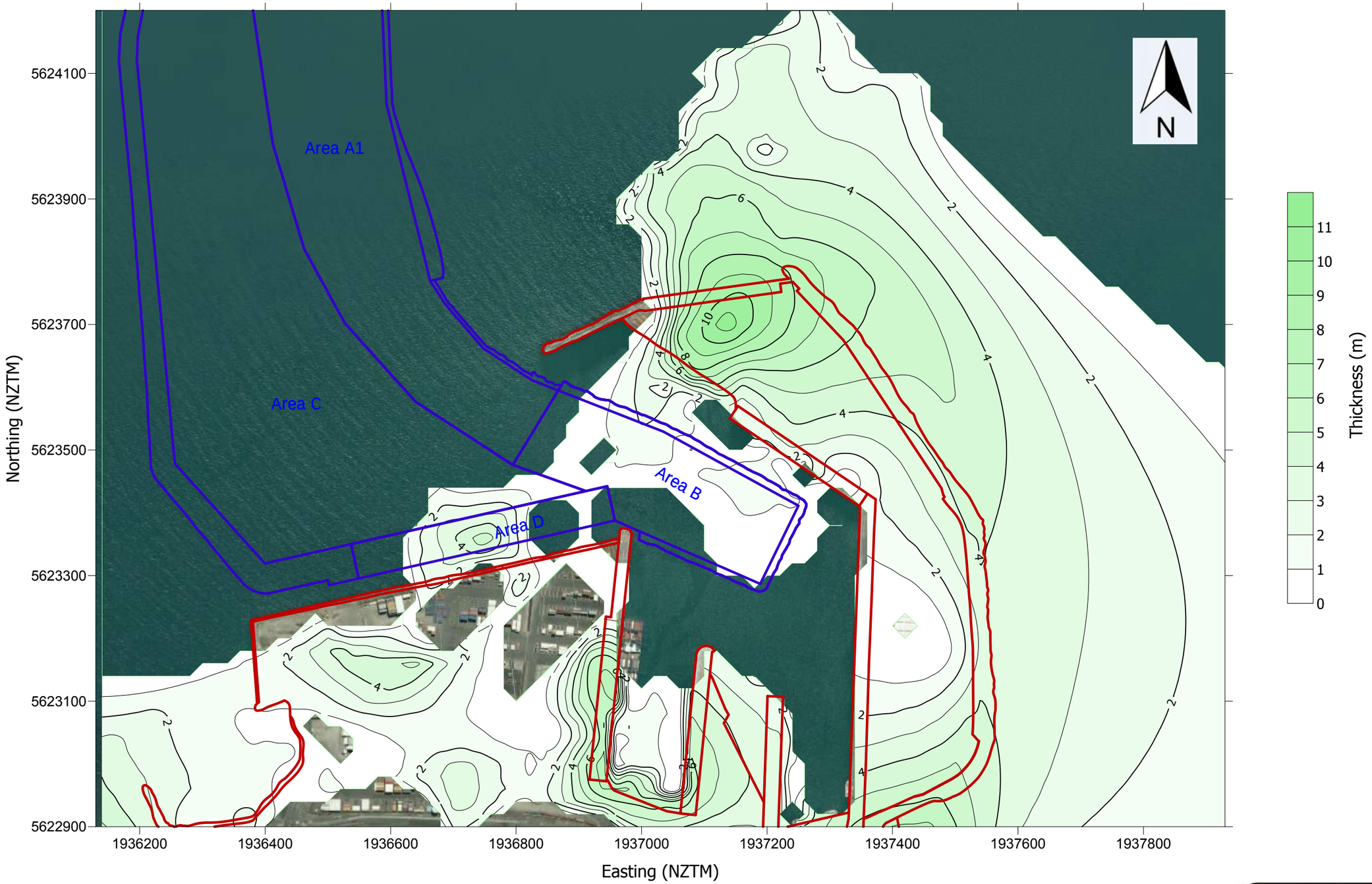
Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP RESIDUAL MANGAHEIA FORMATION TO -13.0m	ISOPACH MAP 12 23 - 09 - 2016 | Rev 3



ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

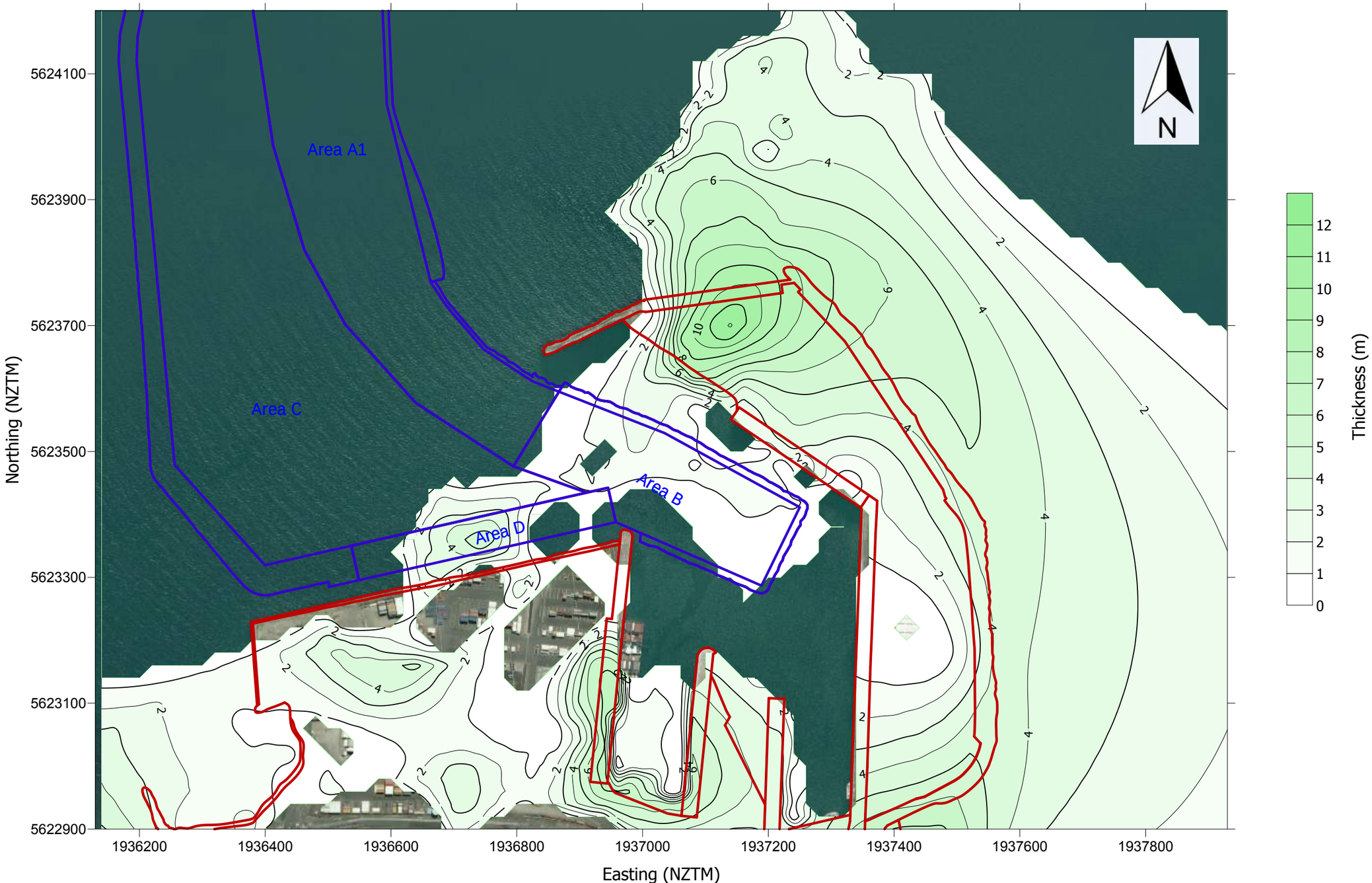
Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP RESIDUAL MANGAHEIA FORMATION TO -13.5m	ISOPACH MAP 13 23 - 09 - 2016 | Rev 3



ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP RESIDUAL MANGAHEIA FORMATION TO -14.0m	ISOPACH MAP 14 23 - 09 - 2016 | Rev 3



ORIGINAL DRAWING IN COLOUR

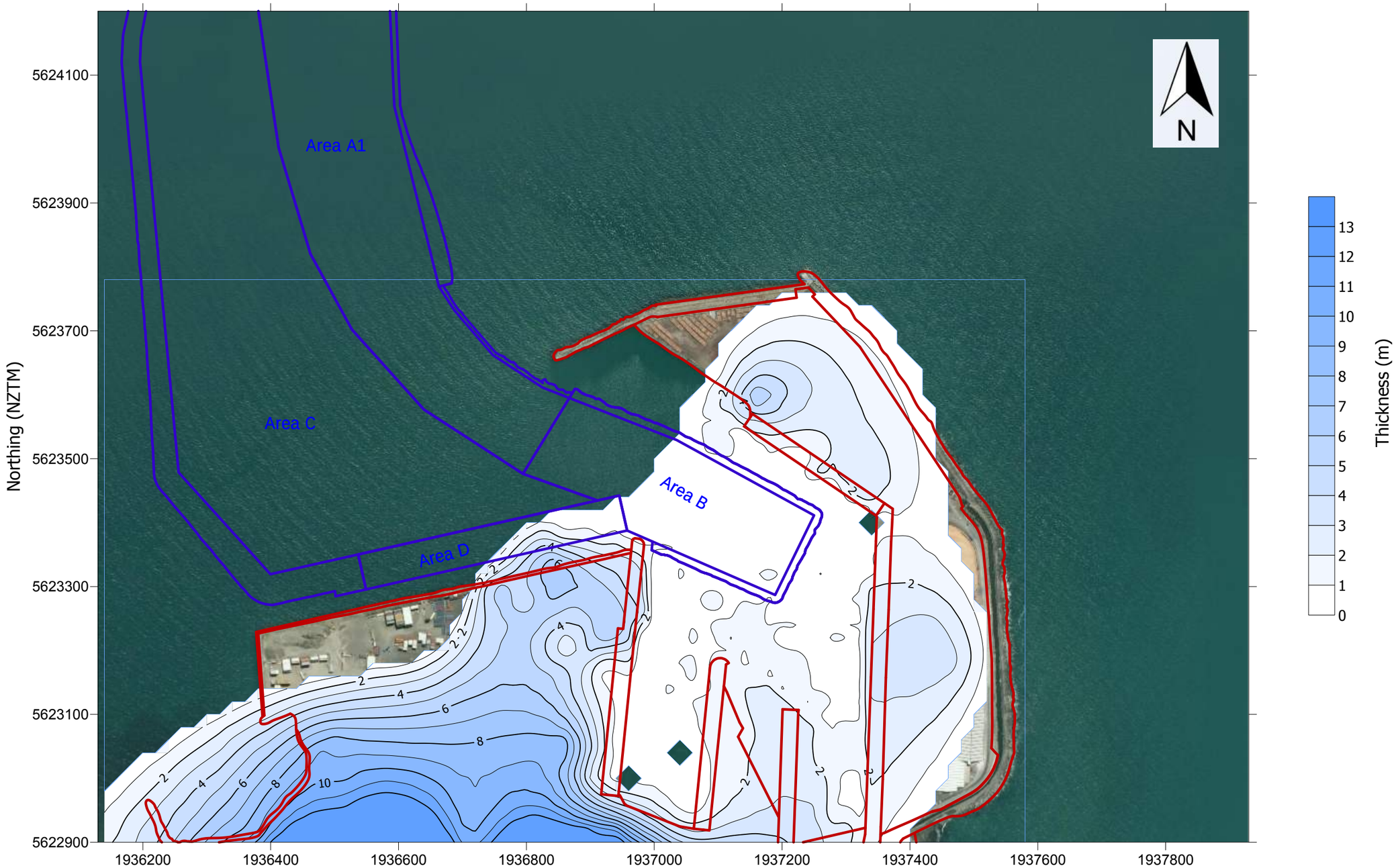
PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP RESIDUAL MANGAHEIA FORMATION TO -14.5m	ISOPACH MAP 15 23 - 09 - 2016 | Rev 3

ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP MANGAHEIA FORMATION TO -12.5m	ISOPACH MAP 16 23 - 09 - 2016 | Rev 3



ORIGINAL DRAWING IN COLOUR

PDF ONLY
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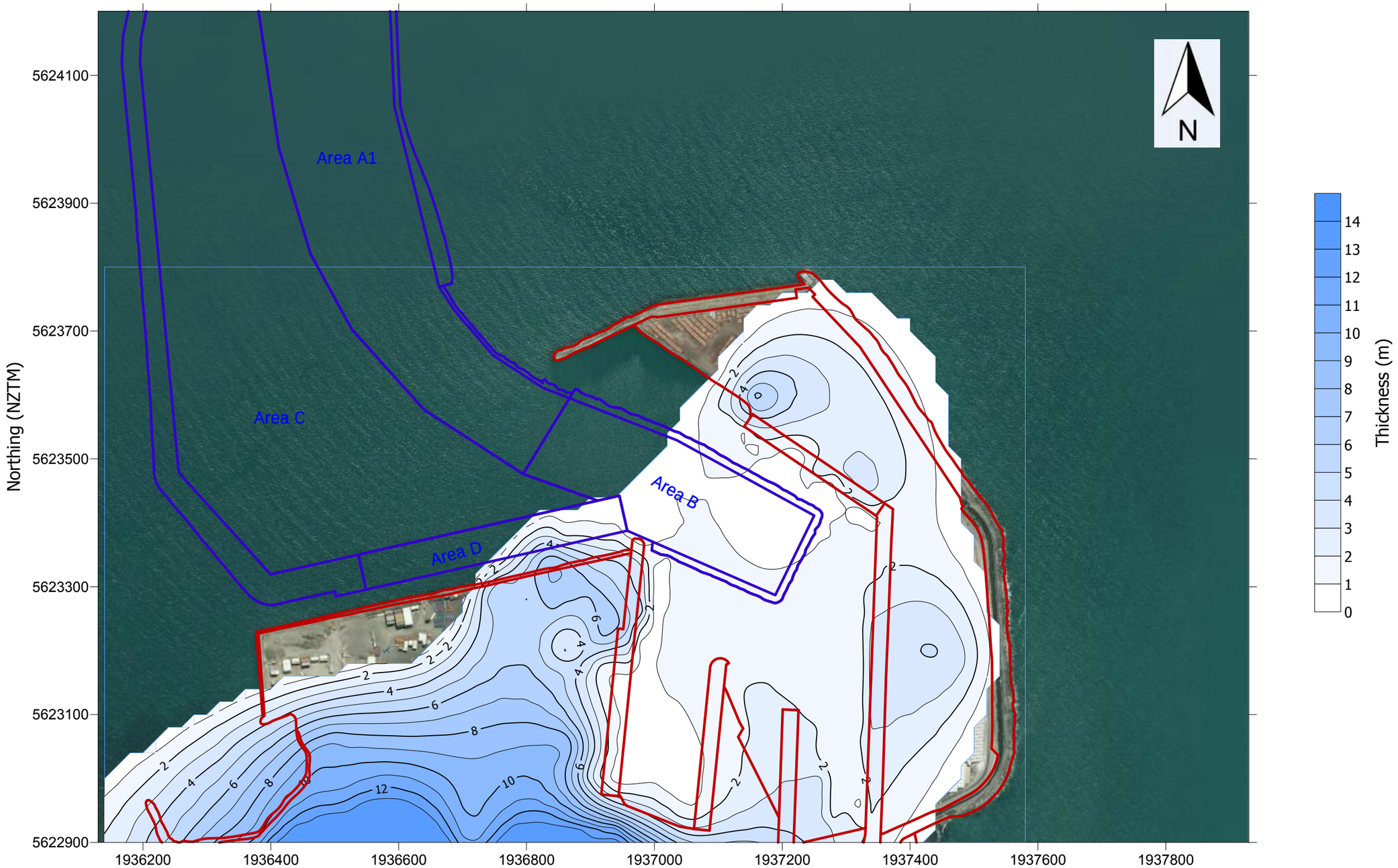
Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP MANGAHEIA FORMATION TO -13.0m	ISOPACH MAP 17 23 - 09 - 2016 | Rev 3



ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP MANGAHEIA FORMATION TO -13.5m	ISOPACH MAP 18 23 - 09 - 2016 | Rev 3

ORIGINAL DRAWING IN COLOUR

PDF ONLY
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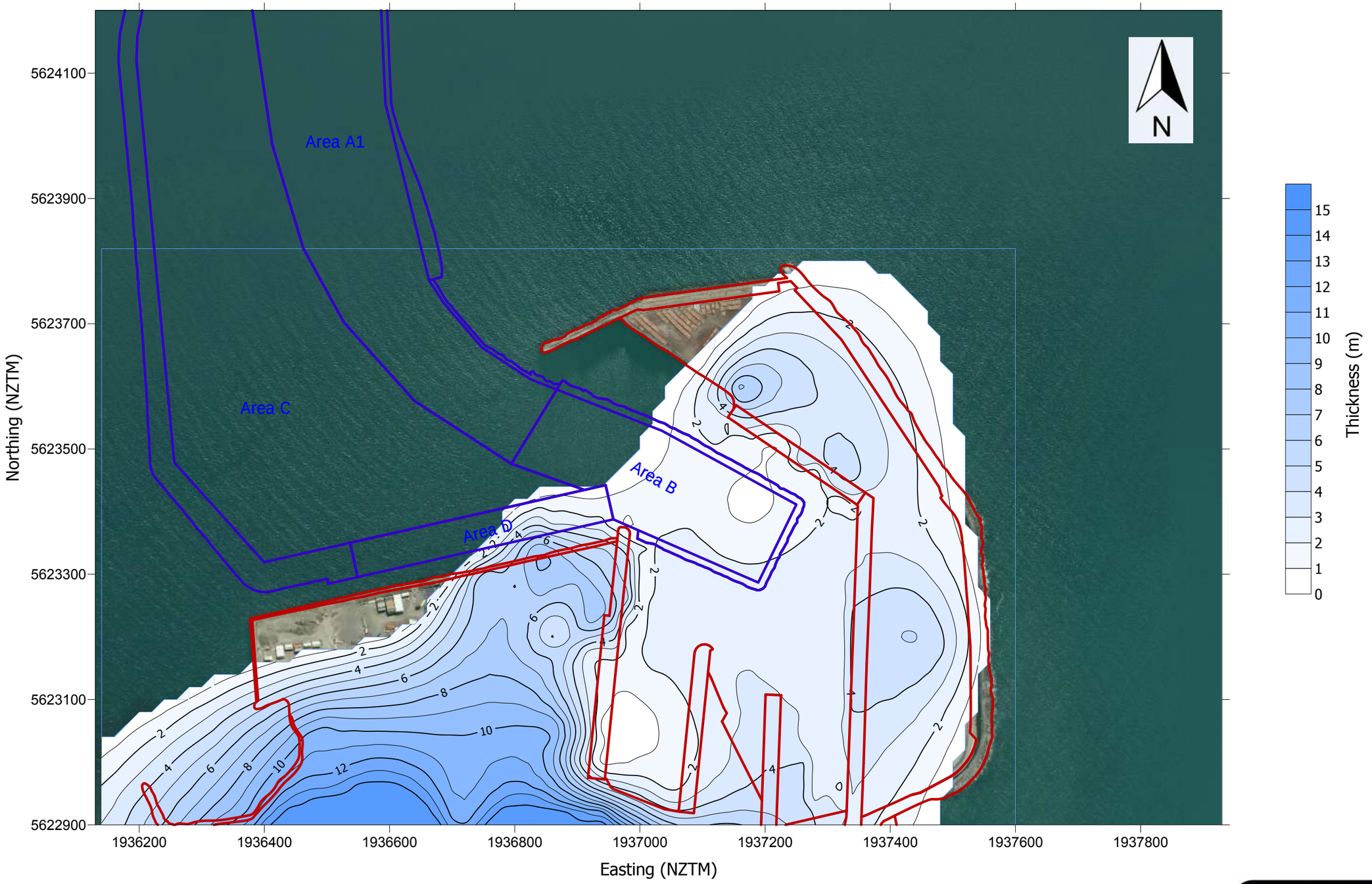
Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP MANGAHEIA FORMATION TO -14.0m	ISOPACH MAP 19 23- 09 - 2016 | Rev 3



ORIGINAL DRAWING IN COLOUR

PDF ONLY
NO DWG FILE

Beca	PORT OF NAPIER WHARF 6 DEVELOPMENT	ISOPACH MAP MANGAHEIA FORMATION TO -14.5m	ISOPACH MAP 20 23 - 09 - 2016 | Rev 3