



# **Wollongong City Council Coastal Zone Study**

## **Volume 2 - Appendices**

### **FINAL**

**LJ2822/R2564v2**

**Prepared for Wollongong City Council\***

**Appendix A**

# **WCC Geotechnical Data**



PLEASE QUOTE  
Ref: KB  
Ext: 4590  
File No: W10284

Memo to be Filed □

Tuesday, 17 November 2009

To: ENVIRONMENTAL STRATEGY AND PLANNING DIVISION  
Ms Philomena Gangaiya

Re: **WOLLONGONG COASTAL HAZARDS STUDY  
GEOTECHNICAL INVESTIGATION**

I refer to a request from your office for a geotechnical investigation to be conducted at twelve beach locations within the Wollongong LGA from Stanwell Park Beach in the north to Windang Beach in the south as per the email brief sent by your consultant Cardno Lawson Treloar P/L on 15<sup>th</sup> October 2009.

A geotechnical investigation was undertaken on the 3<sup>rd</sup> to 9<sup>th</sup> of November, 2009

### **GEOLOGY**

Reference to 1:100,000 scale geological maps supplied by The Department of Mineral Resources indicate that the beach areas are typically underlain by Quaternary deposits of medium to coarse grained marine quartz sand with shelly fragments. The foredune areas are typically underlain by fine to medium grained marine quartz sands. Some interdune silts and sands may also be found behind the foredune areas.

The bedrock geology of the beaches in the Wollongong LGA is complicated by a general dip in bedrock strata to the north. The geology of the seacliffs and rock platforms at the beaches consist of interbedded sandstones with some claystone, siltstone and coal layers evident in the north of the study area (Stanwell Park to Fairy Creek at Wollongong). The rock quality underlying the northern beaches can be variable and in places deep weathered residual profiles consisting of sandy clays are observed (Sandon point Beach for example).

The rock quality increases toward the south beyond Fairy Creek at Wollongong where Budgong Sandstone is prevalent. This lithic sandstone is intruded by various igneous flows of basalt that emerge at the beach (at Port Kembla North Beach for example).

### **METHOD**

Twenty - three (23) test pits were excavated on twelve beaches as nominated in the consultant brief located as close as possible to the nominated test locations using a 3-tonne mini excavator equipped with a 1200mm gummy bucket. The maximum reach of

this equipment was around 3.5 metres. Each test pit was excavated as far as possible and was limited either by presence of rock or collapse of sand due to groundwater inflow. The depth of test pits varied between 1.0m to 3.1m depth.

The test pit information was further substantiated by Perth Sand Penetrometer (PSP) testing conducted at the most seaward test pit location on each beach. The PSP tests were taken to virtual refusal at between 1.8m to 3.6m depth.

A GPS easting and northing were recorded at each test pit location along with other pertinent site information where required.

The location of the test pits and PSP's are shown on the attached drawings

## **RESULTS**

The test pit and PSP logs are attached.

## **CONCLUSION**

### *General Profile and Rock Intercept*

Test pit analysis revealed that the foreshore area of beaches contain essentially single sized (poorly graded) beach sands to between 1.0m to 2.8m depth. Typically, excavation was discontinued due to water ingress and collapse of sands making further headway impossible. The foreshore areas were then further investigated by Perth Sand Penetrometer (PSP) in order to extend the investigation depth below the groundwater line.

Test pits 4 and 8 were located toward the rear of Wombarra and Sharkies Beaches respectively. These test pits located well nested boulder armour layers close to the rock cliffs at between 2.5 to 2.8m depth from surface. Bedrock was not found.

Test Pit 11 located on Sandon Point Beach intercepted the underlying natural residual clay soils at 1.0m beneath the beach boulder armour at 0.6m depth. This sandy clay is a residual of sandstone and previous drilling at a site 50m south of this location shows that it can be in excess of 7m deep with some gravelly / rocky bands. This material is also prone to undercutting and collapse due wave run up during storm events, a consideration which led to the construction of a boulder armour seawall structure for the support of the cycleway to the south.

Test Pit 15 located on Bellambi Point beach uncovered lithic sandstone bedrock at 1.0m depth located immediately beneath the beach sands which is consistent with the visual assessment of other outcrops at that beach.

All other Test Pits were excavated to maximum reach or practical refusal due to progressive collapse of the pit walls.

Perth Sand Penetrometer testing was used to extend the information from each seaward test pit location. Bouncing refusal to PSP is indicative of intercept with either bedrock or a well nested boulder layer. Virtual refusal occurs where penetration is still possible but

very slow and damaging to equipment and is indicative of very dense sand, pebbles or soft rock. A summary is included in Table 2 of this report

### *Particle Grading Analysis*

One sample from each beach was retrieved for laboratory testing. These were tested according to AS1289.3.6.1 particle grading analysis allowing various characteristics<sup>1</sup> to be determined. These are summarised into the following table.

<b>Location</b>	<b>Test Pit</b>	<b>D10</b>	<b>D30</b>	<b>D50</b>	<b>D60</b>	<b>Cc</b>	<b>Cu</b>
stanwell park	1	0.33	0.40	0.47	0.50	1.0	1.5
wombarra	3	0.26	0.34	0.39	0.42	1.1	1.7
coledale	5	0.20	0.31	0.36	0.39	1.3	1.9
sharkies	7	0.19	0.28	0.34	0.36	1.2	1.9
austinmer	9	0.22	0.32	0.36	0.38	1.2	1.8
sandon pt beach	11	0.19	0.30	0.35	0.37	1.3	2.0
bulli	12	0.21	0.32	0.36	0.39	1.2	1.8
woonona	13	0.18	0.28	0.33	0.35	1.2	2.0
bellambi	14	0.18	0.24	0.32	0.34	1.0	1.9
bellambi pt	15	0.17	0.24	0.31	0.34	0.9	2.0
east corrimal	16	0.18	0.27	0.35	0.39	1.1	2.1
towradgi	18	0.28	0.33	0.38	0.40	1.0	1.4
puckeys	19	0.31	0.35	0.40	0.43	0.9	1.4
south beach	20	0.31	0.35	0.41	0.44	0.9	1.4
coniston	21	0.22	0.32	0.36	0.38	1.2	1.8
port kembla	22	0.17	0.20	0.24	0.27	0.9	1.6
windang	23	0.17	0.21	0.27	0.30	0.9	1.8
<b>averages</b>		<b>0.22</b>	<b>0.30</b>	<b>0.35</b>	<b>0.38</b>	<b>1.1</b>	<b>1.8</b>

*Table 1 Particle Grading Analysis*

In general the coarsest grained sands were located in the north at Stanwell Park Beach. The more finely grained sands were located to the south at Bellambi Point, Port Kembla Beach and Windang Beaches.

Any further investigation to extend this information particularly with regard to location of deep bedrock will require the use of a drill rig employing either cased push tube or auger drilling methods.

For further information, please contact the undersigned,

Yours Sincerely

Kevin Bogie  
Geotechnical Officer  
Infrastructure Division

Digitally signed by Kevin Bogie  
DN: cn=Kevin Bogie,  
o=Wollongong City Council,  
ou=Geotechnical Officer, c=US  
Date: 2009.11.18 15:31:55 +11'00'

Reviewed By

Peter Tobin  
Senior Geotechnical Engineer  
Infrastructure Division

<sup>1</sup> Cc = Coefficient of Curvature. Cu = Coefficient of Uniformity.

Location	Test Pit	depth of test pit	depth to groundwater	position on beach	presence of armour	location of rock	Refusal to PSP
stanwell park	1	2.60	2.50	mid tide area	^	^	3.10 (term V ref)
	2	2.80	^	back of beach	^	^	
wombarra	3	2.50	2.20	mid tide area	^	^	2.80 (bouncing)
	4	2.90	^	back of beach	2.5 (400 dia boulders)	^	
coledale	5	2.00	1.70	high tide line	^	^	2.30 (bouncing)
	6	2.60	^	back of beach	^	^	
sharkies	7	2.00	0.70	mid tide area	^	^	2.42 (bouncing)
	8	3.10	^	back of beach	2.8 (500 dia boulders)	^	
austinner	9	2.80	2.10	high tide line	^	^	3.00 (term V ref)
	10	2.60	2.20	back of beach	^	^	
sandon pt beach	11	1.40	^	above high tide line	0.6 (400 dia boulders)	1.0 (clay)	
	12	2.60	2.40	above high tide line	^	^	3.60 (term V ref)
woonona	13	2.80	2.60	above high tide line	^	^	3.05 (bouncing)
bellambi	14	2.30	1.30	mid tide area	^	^	3.60 (term V ref)
bellambi pt	15	1.00	0.80	mid tide area	none	1.0 (sandstone)	
east corral	16	1.80	0.70	mid tide area	^	^	2.70 (terminated)
	17	2.60	1.50	above high tide line	^	^	
towradgi	18	2.70	2.60	above high tide line	^	^	3.60 (term V ref)
puckeys	19	2.30	^	above high tide line	^	^	3.60 (terminated)
south beach	20	2.10	1.70	mid tide area	^	^	2.20 (term V ref)
coniston	21	2.40	1.10	mid tide area	^	^	3.30 (term V ref)
port kembala	22	2.00	1.80	high tide line	^	^	1.70 (term V ref)
windang	23	2.40	2.10	high tide line	^	^	3.50 (term V ref)

Bouncing : refusal on hard material either bedrock or floater / boulder armour layer

Terminated : test terminated without refusal

Term V ref : test terminated at virtual refusal. Persistence could lead to loss of equipment / breakage

Table 2 : Test Pit and PSP Summary Sheet



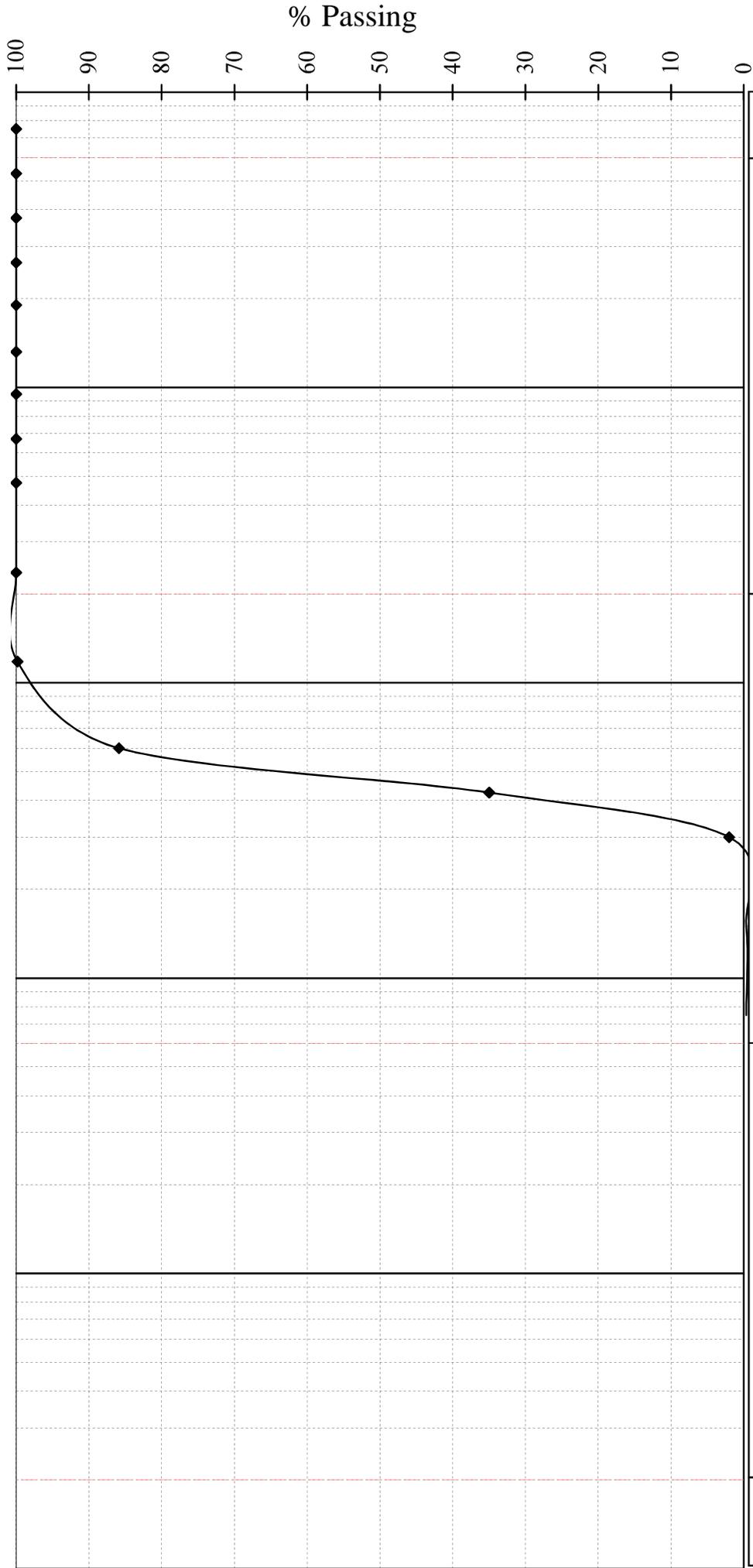
# Wollongong City Council Geotechnical Services

Job/Location ..... Stanwell Park Beach

Client ..... WCC  
.....Environment.....

Lab No. .... W10284

Sample No. .... TP1



CLAY	SILT		SAND			GRAVEL			COBBLES
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	
0.001 mm		0.01 mm	0.1 mm	1 mm	10 mm	100 mm			

Classification: *uniform sand*     $D_{10}$  (mm): 0.33     $D_{30}$  (mm): 0.40     $D_{50}$  (mm): 0.47     $D_{60}$  (mm): 0.50     $C_c = 1.0$      $C_u = 1.5$

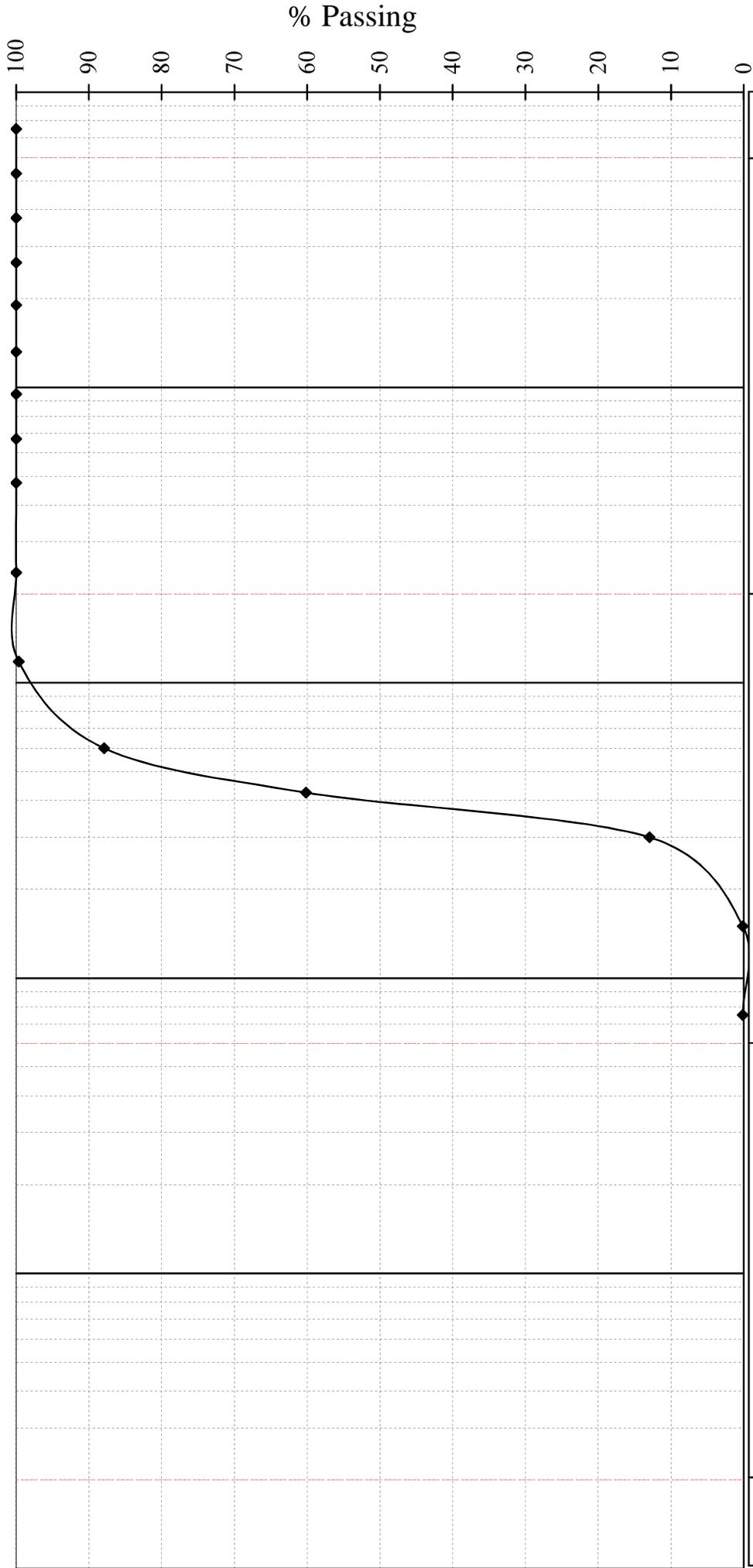
Form No. S04

Jan 2007



# Wollongong City Council Geotechnical Services

Job/Location ..... Wombarra Beach ..... Client WCC ..... Lab No. W10284 ..... Sample No. TP3 .....  
 ..... Environment.....



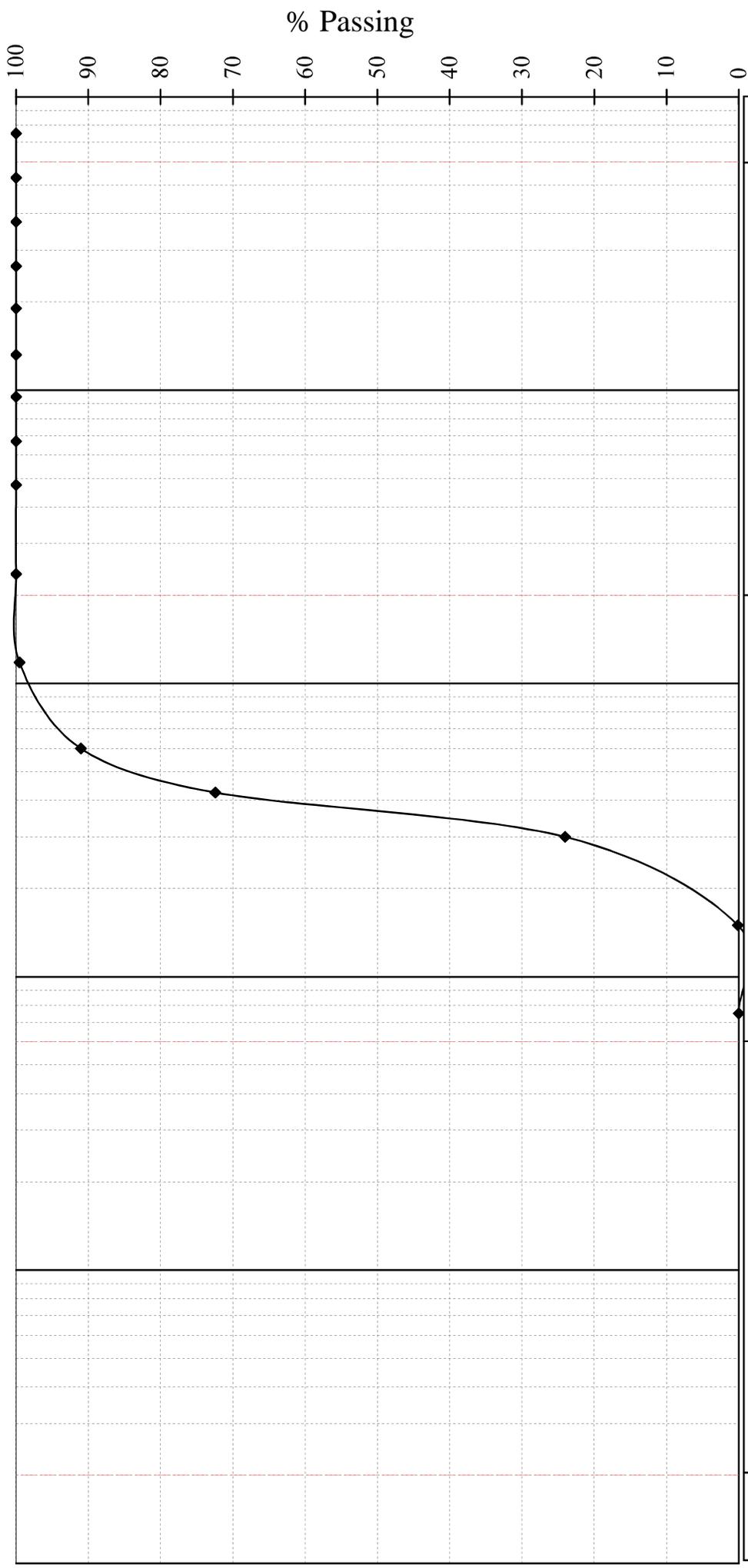
CLAY	SILT		SAND		GRAVEL			COBBLES
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		
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Classification: *uniform sand*     $D_{10}$  (mm): 0.26     $D_{30}$  (mm): 0.34     $D_{50}$  (mm): 0.39     $D_{60}$  (mm): 0.42     $C_c = 1.1$      $C_u = 1.7$   
 Form No. S04    Jan 2007



# Wollongong City Council Geotechnical Services

Job/Location ..... Coledale Beach ..... Client WCC ..... Lab No. W10284 ..... Sample No. TP5



CLAY	SILT		SAND		GRAVEL			COBBLES
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	COARSE	
0.001 mm	0.01 mm		0.1 mm	1 mm	10 mm			100 mm

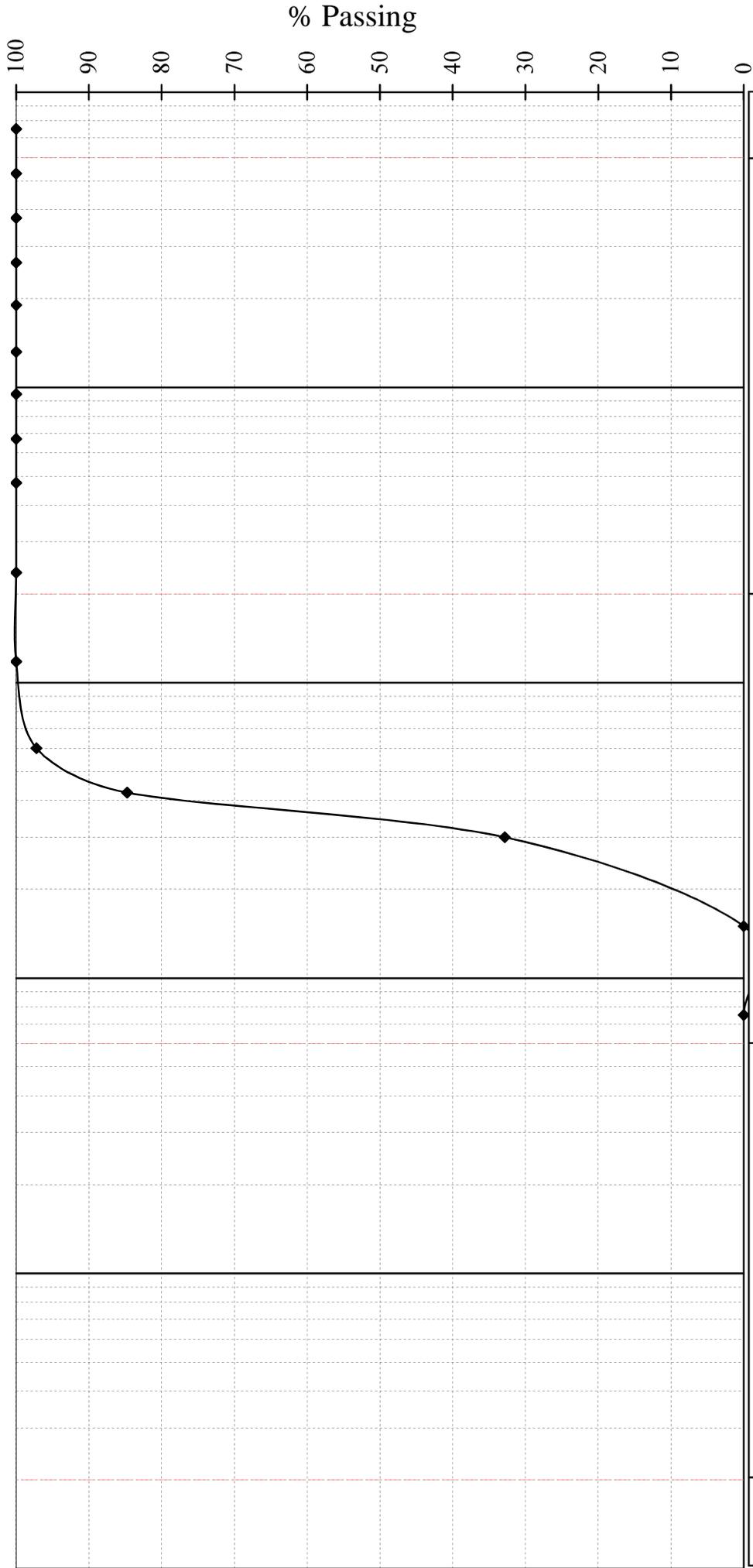
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**Wollongong City Council**  
**Geotechnical Services**

Job/Location: Sharkies Beach  
 Client: WCC Environment  
 Lab No.: W10284  
 Sample No.: TP7



CLAY	SILT		SAND		GRAVEL		COBBLES
0.001 mm	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	100 mm
	0.01 mm		0.1 mm		1 mm		10 mm

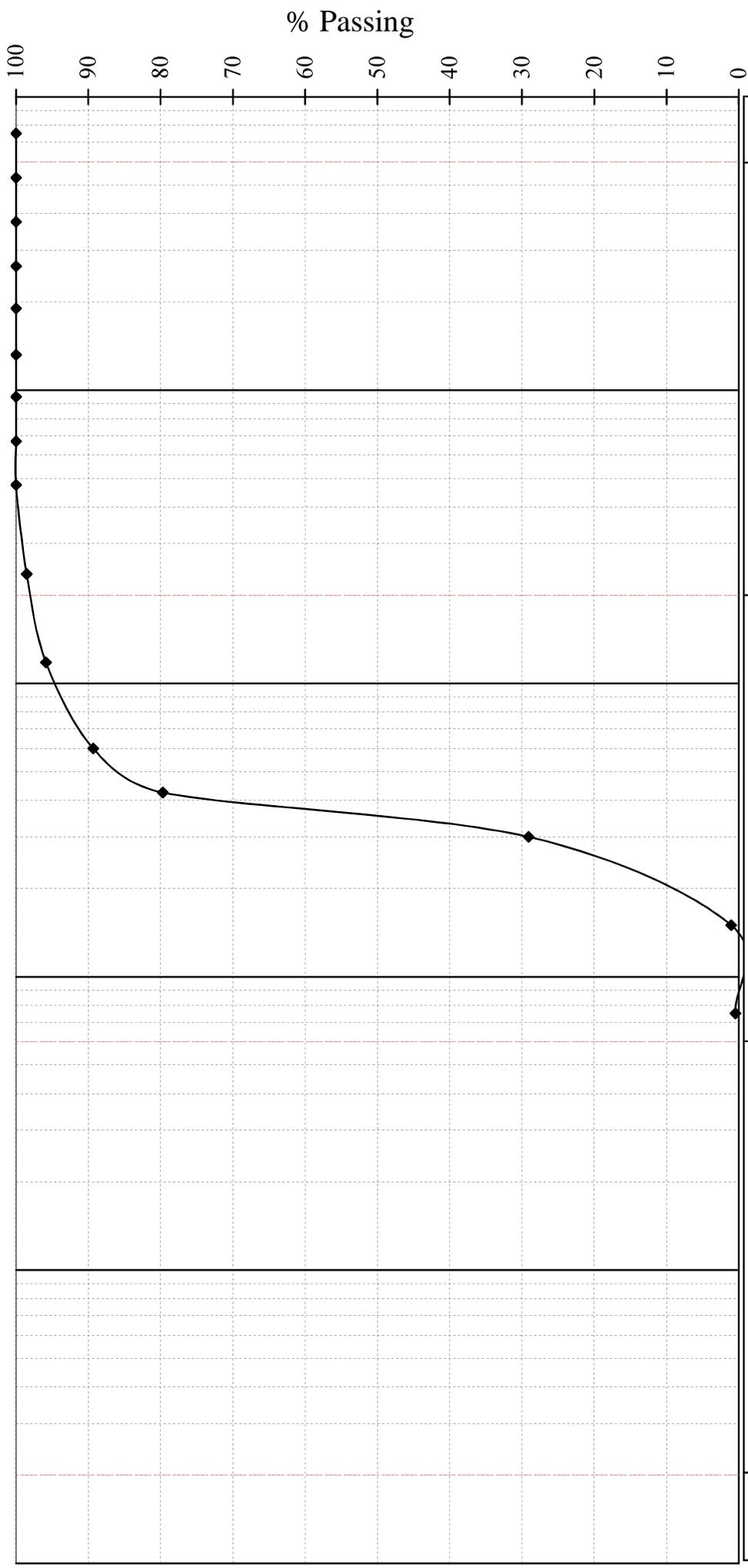
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**Wollongong City Council**  
**Geotechnical Services**

Job/Location ..... Sandon Point Beach ..... Client WCC ..... Lab No. W10284 ..... Sample No. TP11



CLAY	SILT		SAND			GRAVEL			COBBLES	
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	
0.001 mm	0.01 mm		0.1 mm	1 mm			10 mm			100 mm

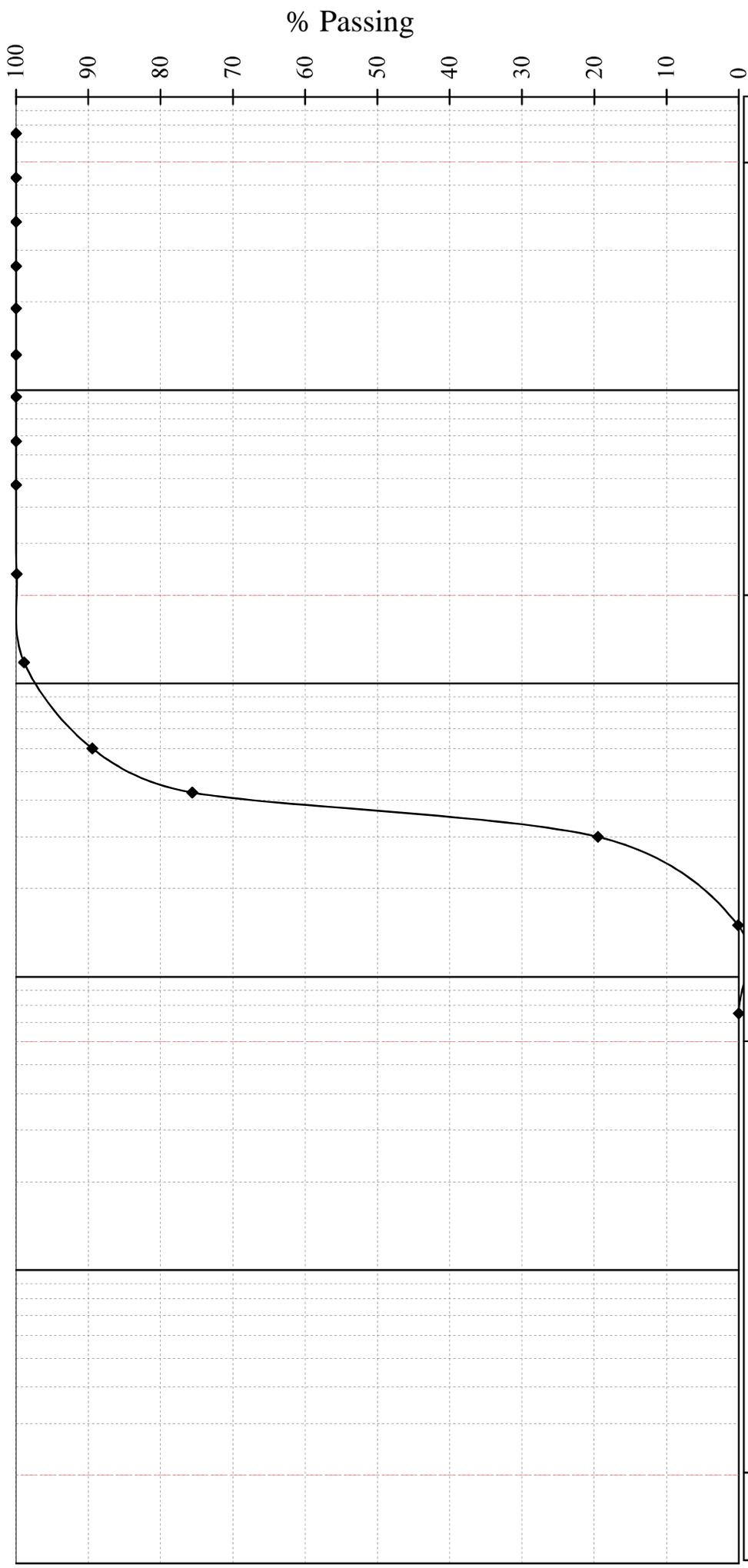
Classification: *uniform sand*     $D_{10}$  (mm): 0.19     $D_{30}$  (mm): 0.30     $D_{50}$  (mm): 0.35     $D_{60}$  (mm): 0.37     $C_c = 1.3$      $C_u = 2.0$

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# Wollongong City Council Geotechnical Services

Job/Location ..... Bulli Beach ..... Client WCC ..... Lab No. W10284 ..... Sample No. .... TPI2 .....



CLAY	SILT			SAND			GRAVEL			COBBLES
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	
<b>0.001 mm</b>	<b>0.01 mm</b>			<b>0.1 mm</b>			<b>1 mm</b>			<b>10 mm</b>

Classification: *uniform sand*     $D_{10}$  (mm): 0.21     $D_{30}$  (mm): 0.32     $D_{50}$  (mm): 0.36     $D_{60}$  (mm): 0.39     $C_c = 1.2$      $C_u = 1.8$

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# Wollongong City Council Geotechnical Services

Job/Location

Woonona Beach

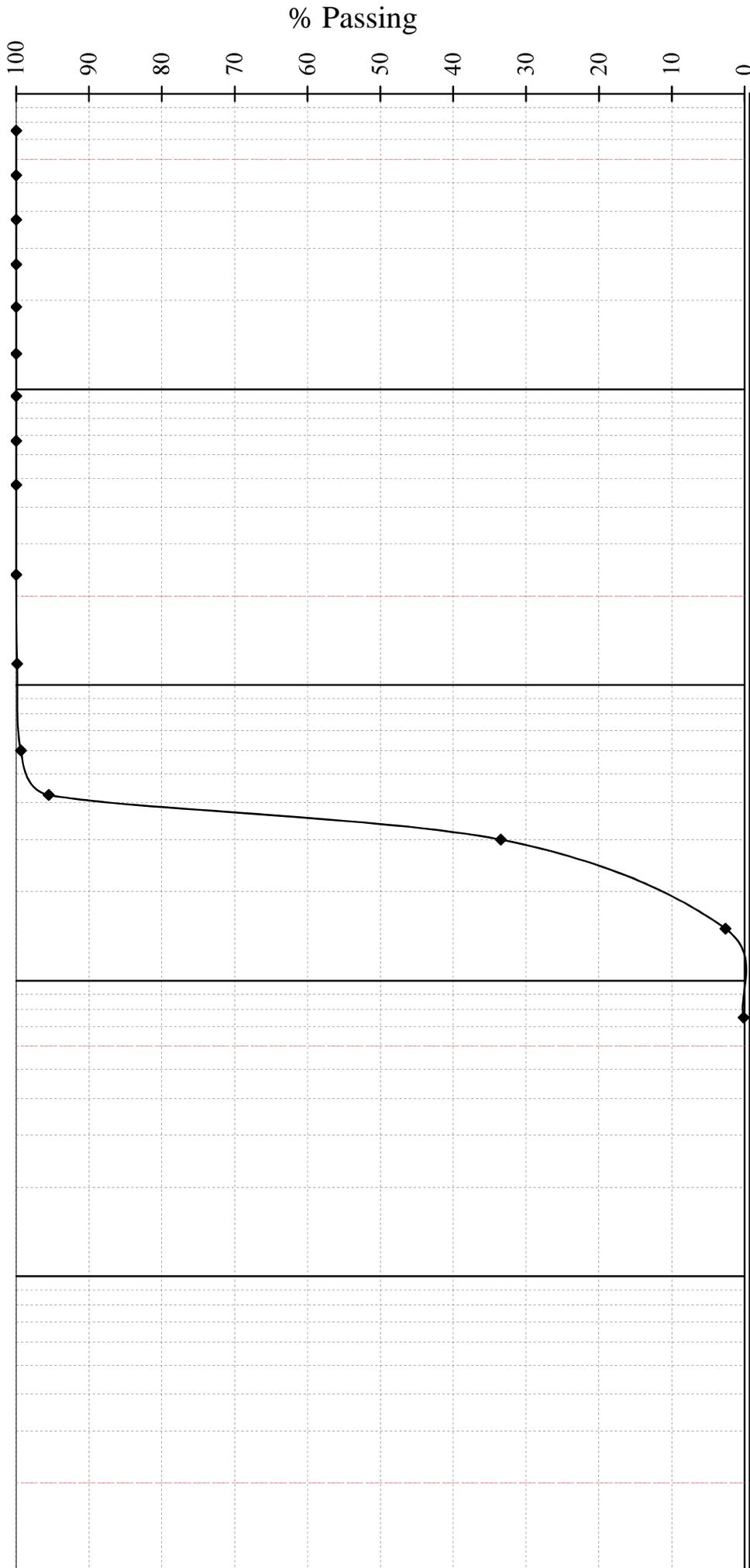
Client  
WCC  
Environment

Lab No.

W10284

Sample No.

TPI13



CLAY	SILT		SAND		GRAVEL		COBBLES
0.001 mm	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	100 mm
	0.01 mm		0.1 mm		1 mm		10 mm

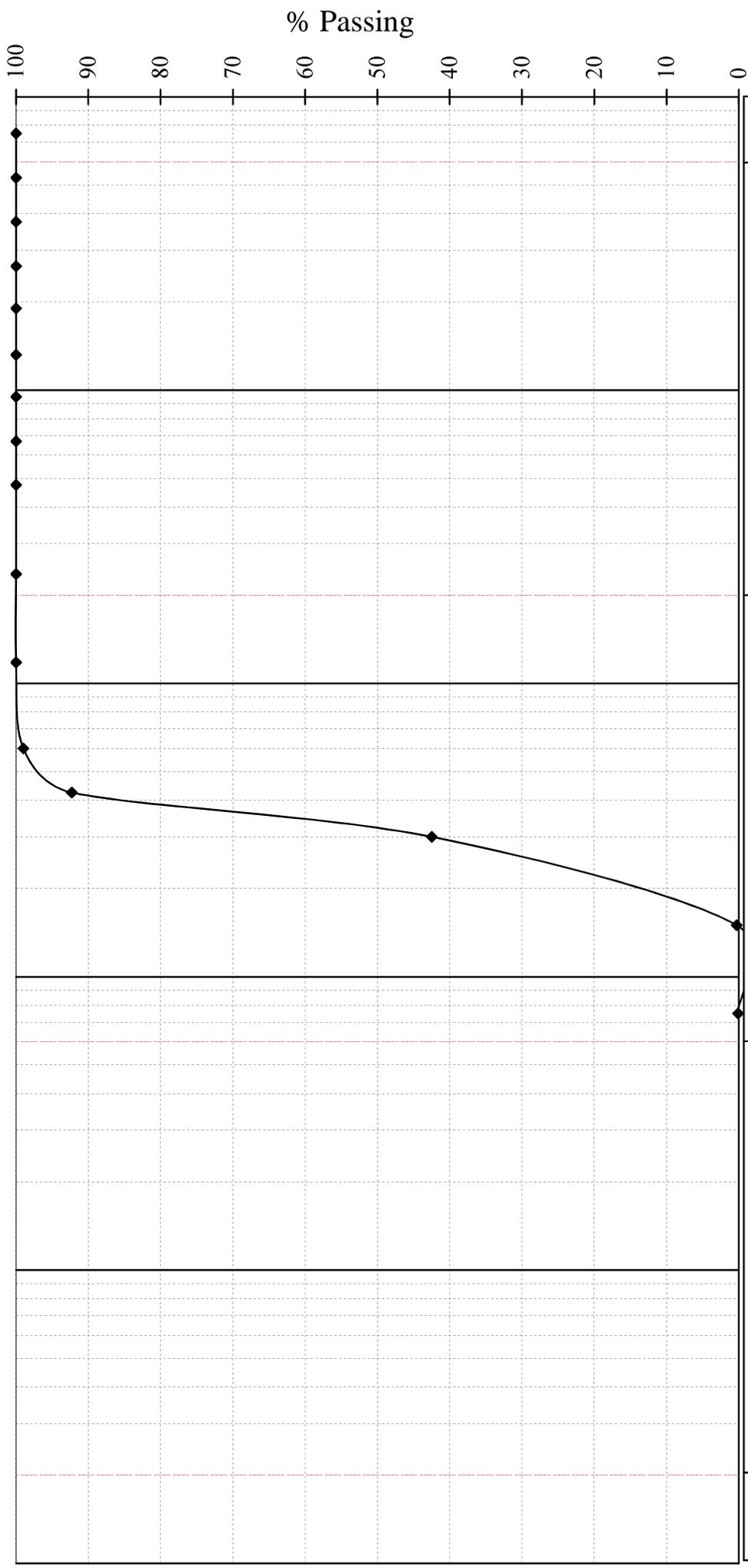
Classification: *uniform sand*     $D_{10}$  (mm): 0.18     $D_{30}$  (mm): 0.28     $D_{50}$  (mm): 0.33     $D_{60}$  (mm): 0.35     $C_c = 1.2$      $C_u = 2.0$

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# Wollongong City Council Geotechnical Services

Job/Location: Bellambi Beach  
 Client: WCC Environment  
 Lab No.: W10284  
 Sample No.: TP14



CLAY	SILT		SAND		GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	

**0.001 mm**      **0.01 mm**      **0.1 mm**      **1 mm**      **10 mm**      **100 mm**

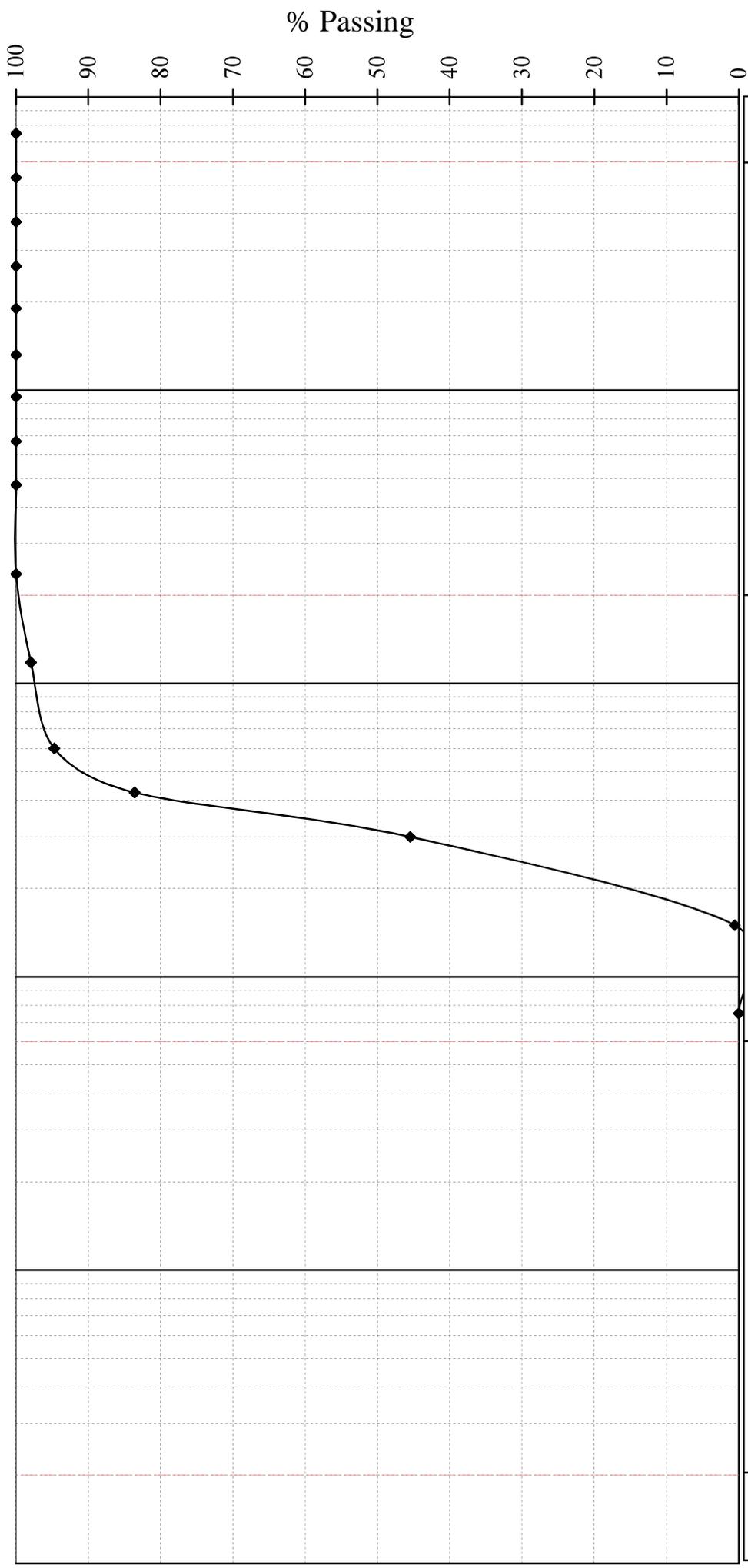
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# Wollongong City Council Geotechnical Services

Job/Location: Bellambi Point  
 Client: WCC Environment  
 Lab No.: W10284  
 Sample No.: TPI5



CLAY	SILT		SAND		GRAVEL			COBBLES
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		
0.001 mm	0.01 mm		0.1 mm	1 mm	10 mm		100 mm	

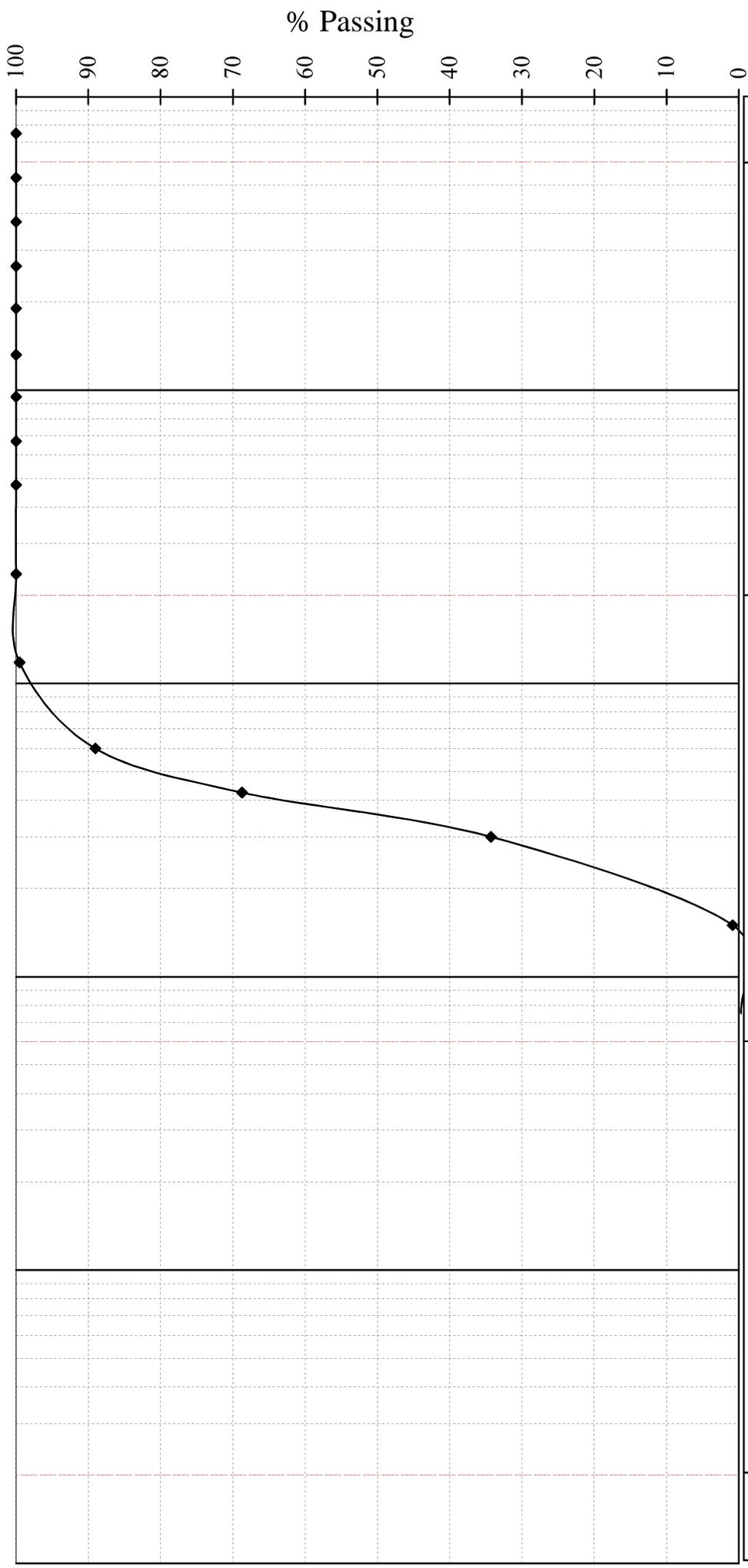
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**Wollongong City Council**  
**Geotechnical Services**

Job/Location: ..... East Corrimal Beach ..... Client: WCC ..... Environment: ..... Lab No.: W10284 ..... Sample No.: ..... TPI6: .....



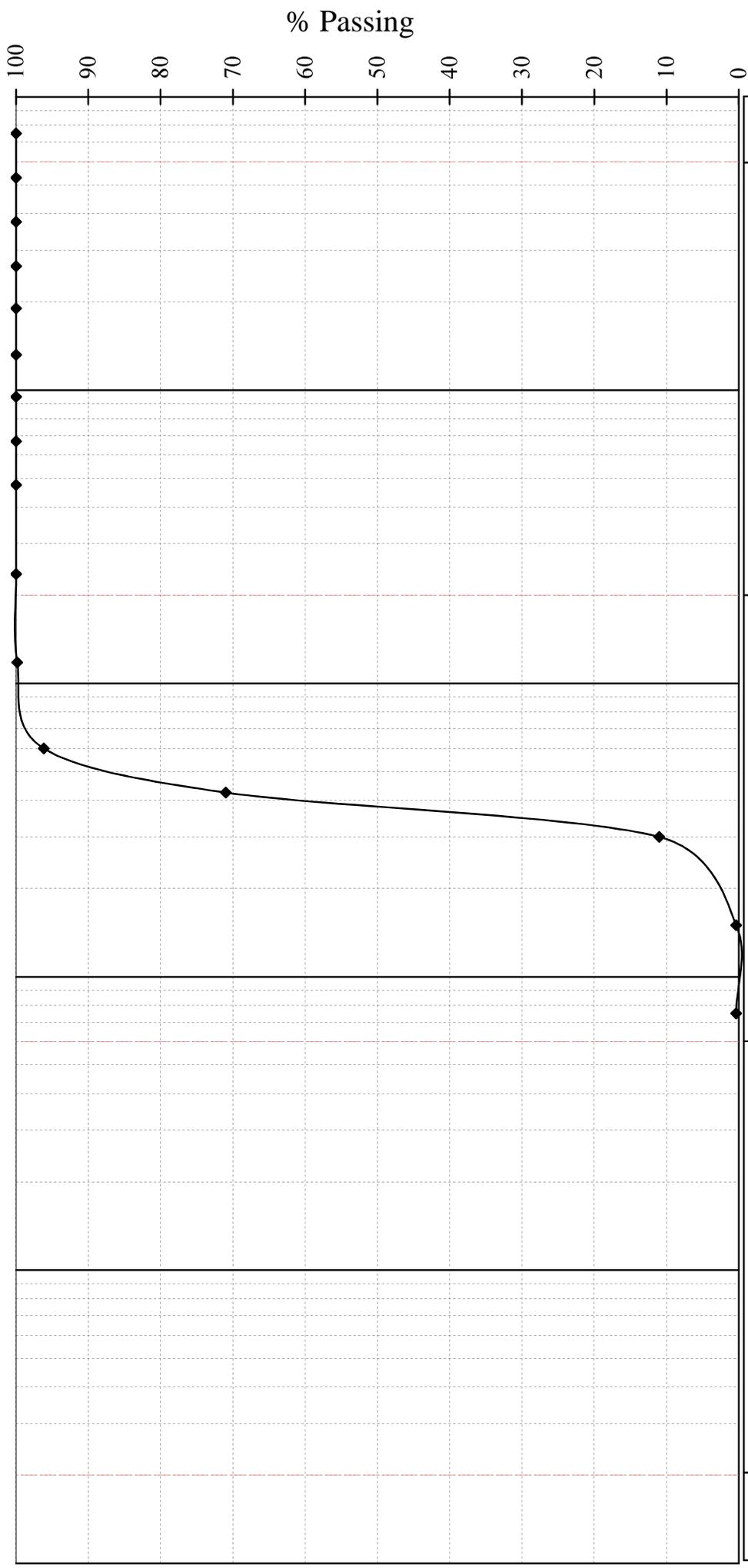
CLAY	SILT		SAND		GRAVEL			COBBLES
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		

**0.001 mm**      **0.01 mm**      **0.1 mm**      **1 mm**      **10 mm**      **100 mm**  
 Classification: *uniform sand*       $D_{10}$  (mm): 0.18       $D_{30}$  (mm): 0.27       $D_{50}$  (mm): 0.35       $D_{60}$  (mm): 0.39       $C_c = 1.1$        $C_u = 2.1$   
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**Wollongong City Council**  
**Geotechnical Services**

Job/Location: Towradgi Beach (van park)      Client: WCC Environment      Lab No.: W10284      Sample No.: TPI8



CLAY	SILT		SAND			GRAVEL			COBBLES	
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM		COARSE
<b>0.001 mm</b>	<b>0.01 mm</b>		<b>0.1 mm</b>			<b>1 mm</b>			<b>10 mm</b>	<b>100 mm</b>

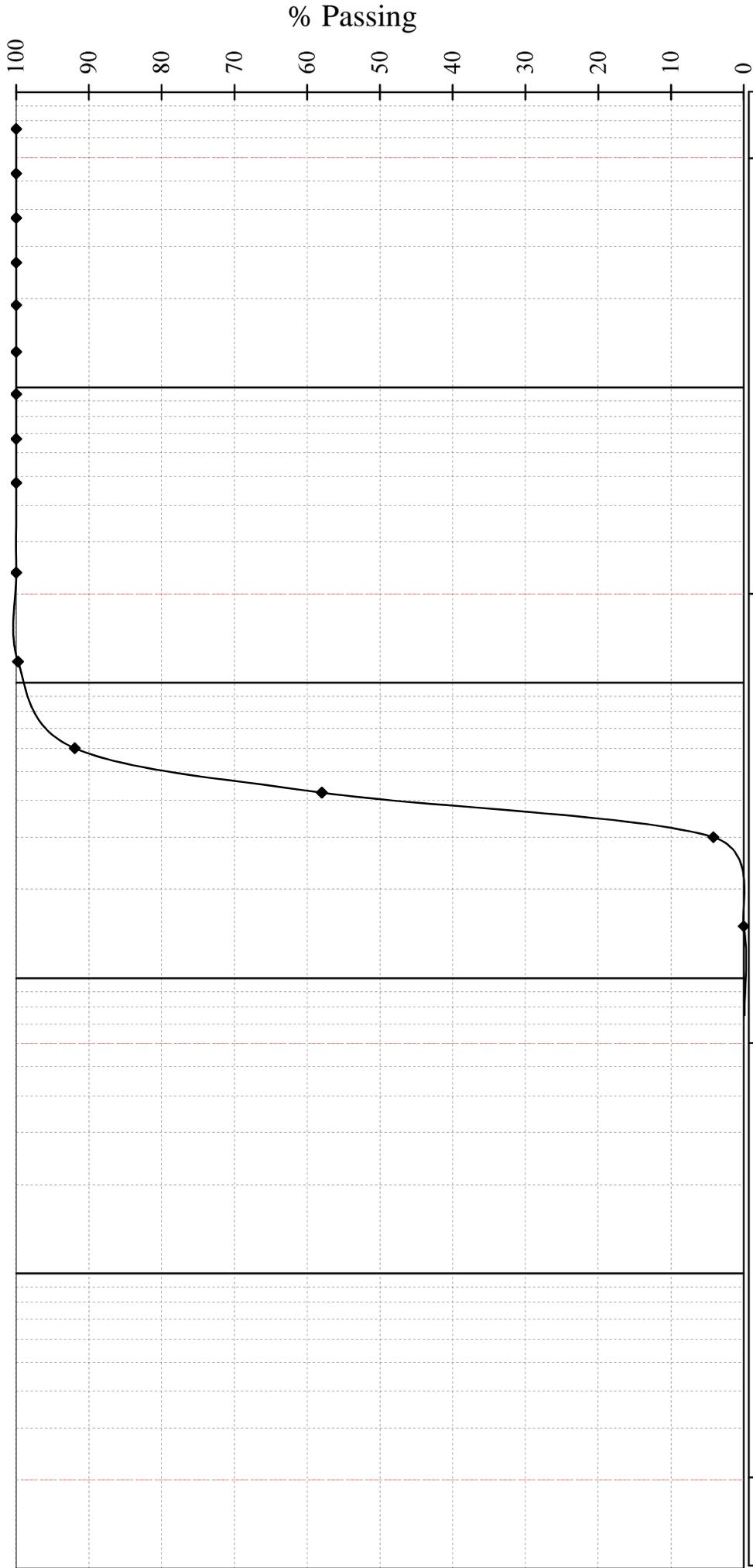
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# Wollongong City Council Geotechnical Services

Job/Location: Puckey's Beach (Fairy Meadow)      Client: WCC Environment      Lab No.: W10284      Sample No.: TPI9



CLAY	SILT		SAND		GRAVEL			COBBLES
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	COARSE	100 mm
0.001 mm	0.01 mm		0.1 mm	1 mm	10 mm			100 mm

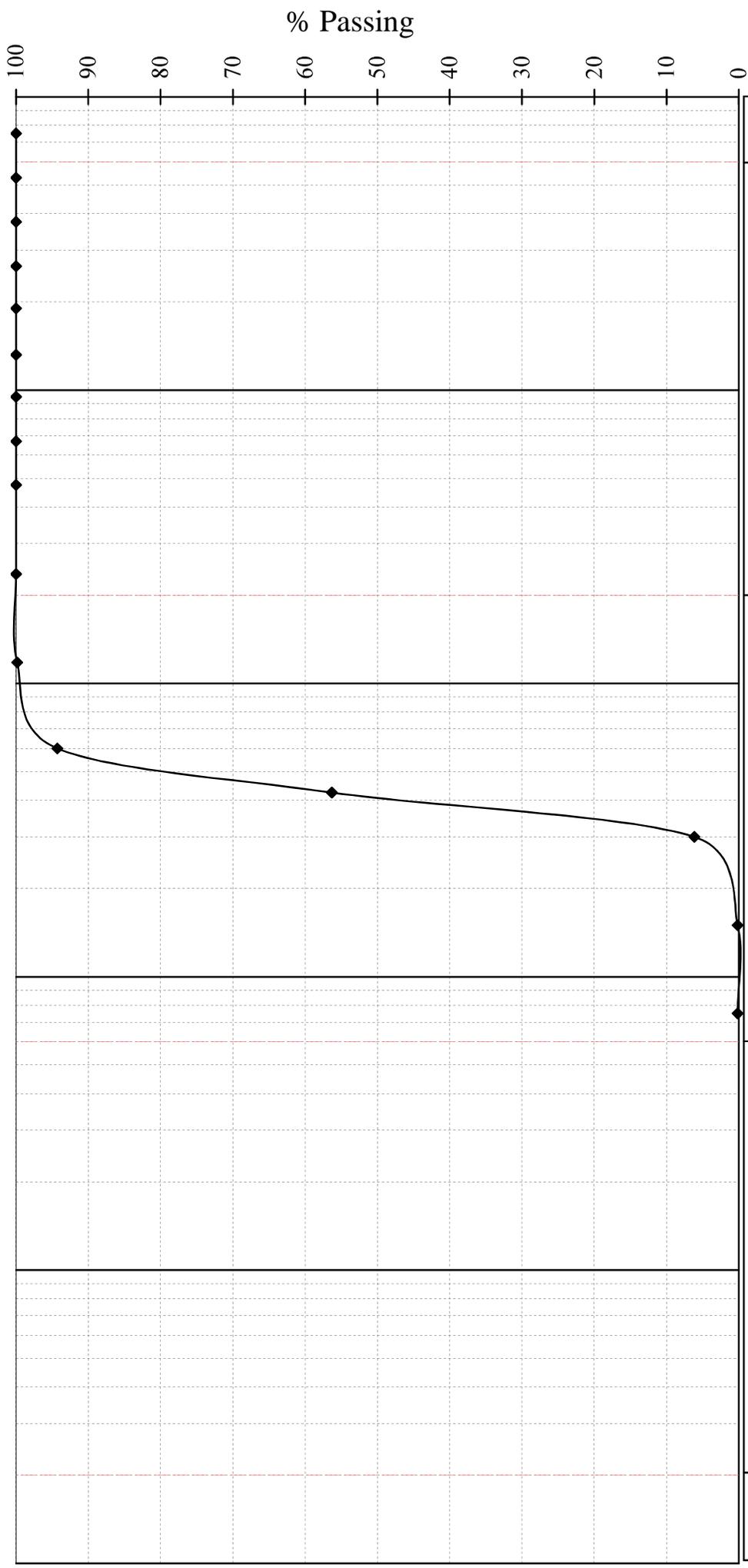
Classification: *uniform sand*       $D_{10}$  (mm): 0.31       $D_{30}$  (mm): 0.35       $D_{50}$  (mm): 0.40       $D_{60}$  (mm): 0.43       $C_c = 0.9$        $C_u = 1.4$

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# Wollongong City Council Geotechnical Services

Job/Location: Wollongong (South) Beach  
 Client: WCC Environment  
 Lab No.: W10284  
 Sample No.: TP20



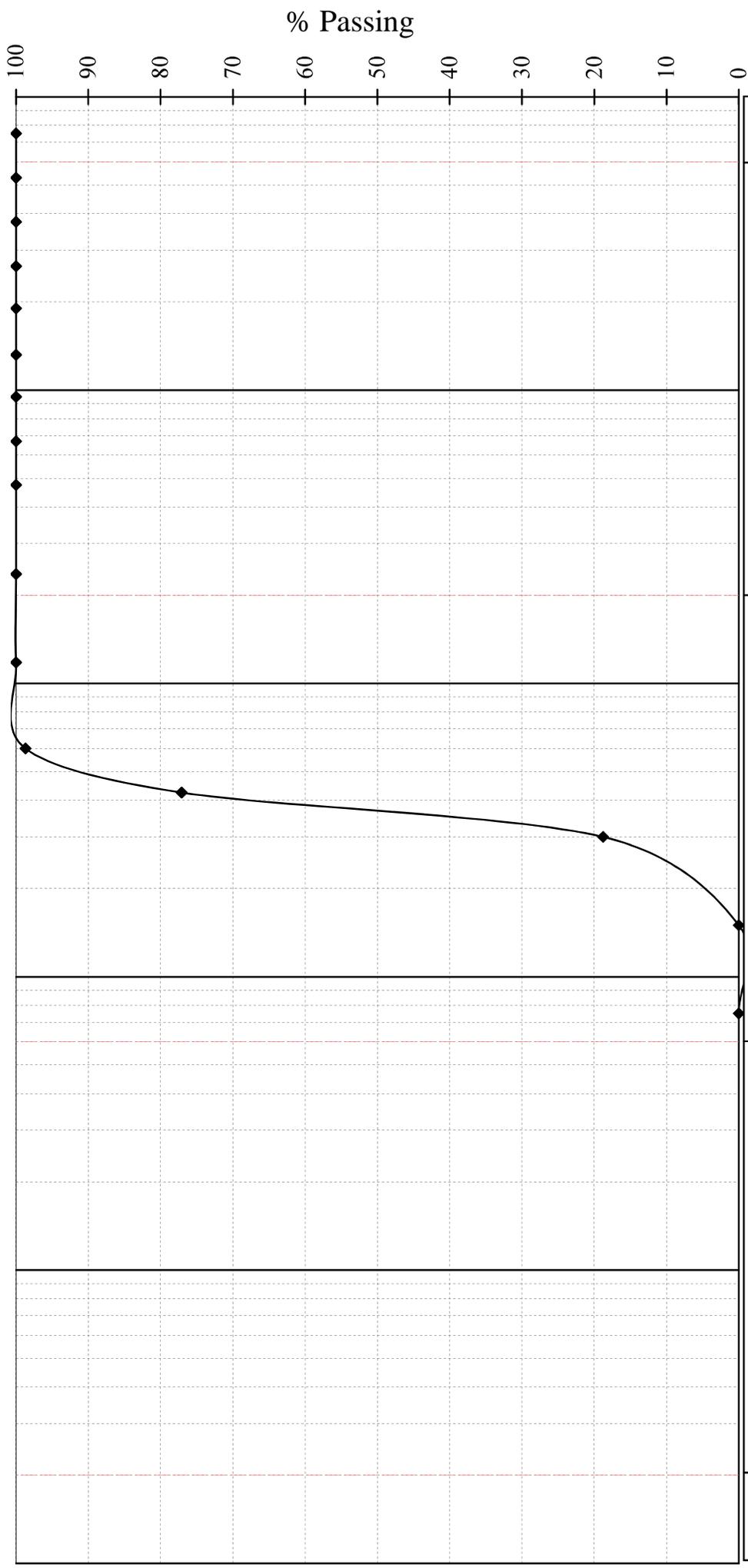
CLAY	SILT			SAND			GRAVEL			COBBLES	
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		
0.001 mm	0.01 mm			0.1 mm			1 mm			10 mm	100 mm

Classification: *uniform sand*  
 $D_{10}$  (mm): 0.31     $D_{30}$  (mm): 0.35     $D_{50}$  (mm): 0.41     $D_{60}$  (mm): 0.44  
 $C_c = 0.9$      $C_u = 1.4$   
 Form No. S04    Jan 2007



# Wollongong City Council Geotechnical Services

Job/Location ..... Coniston Beach ..... Client **WCC** ..... Lab No. **W10284** ..... Sample No. **TP21** .....  
 ..... Environment .....





# Wollongong City Council Geotechnical Services

Job/Location

Port Kembla Beach

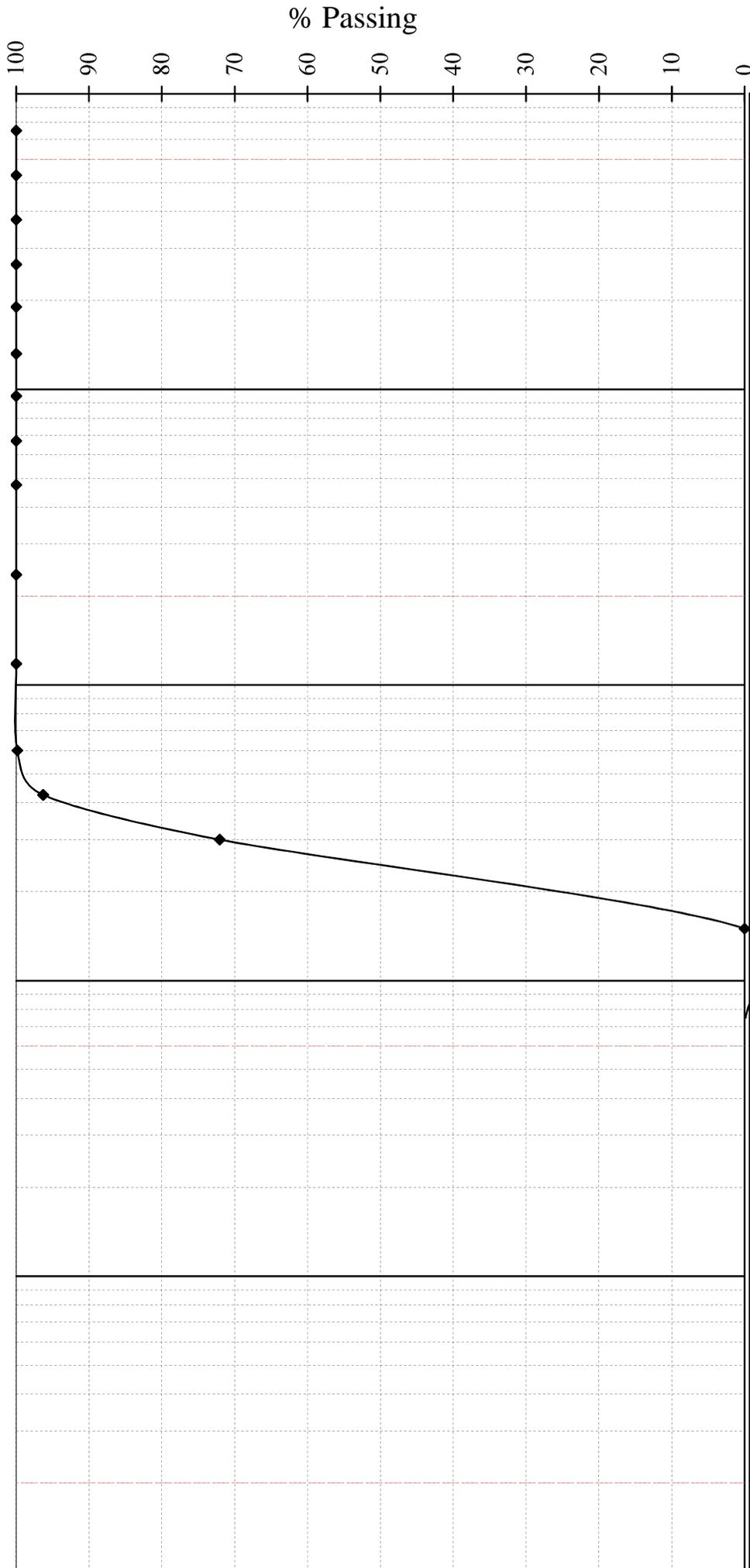
Client  
WCC  
Environment

Lab No.

W10284

Sample No.

TP22



CLAY	SILT			SAND			GRAVEL			COBBLES
0.001 mm	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	100 mm
	0.01 mm			0.1 mm			1 mm			10 mm

Classification: *uniform sand*

$D_{10}$  (mm): 0.17

$D_{30}$  (mm): 0.20

$D_{50}$  (mm): 0.24

$D_{60}$  (mm): 0.27

$C_c = 0.9$

$C_u = 1.6$

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# Wollongong City Council Geotechnical Services

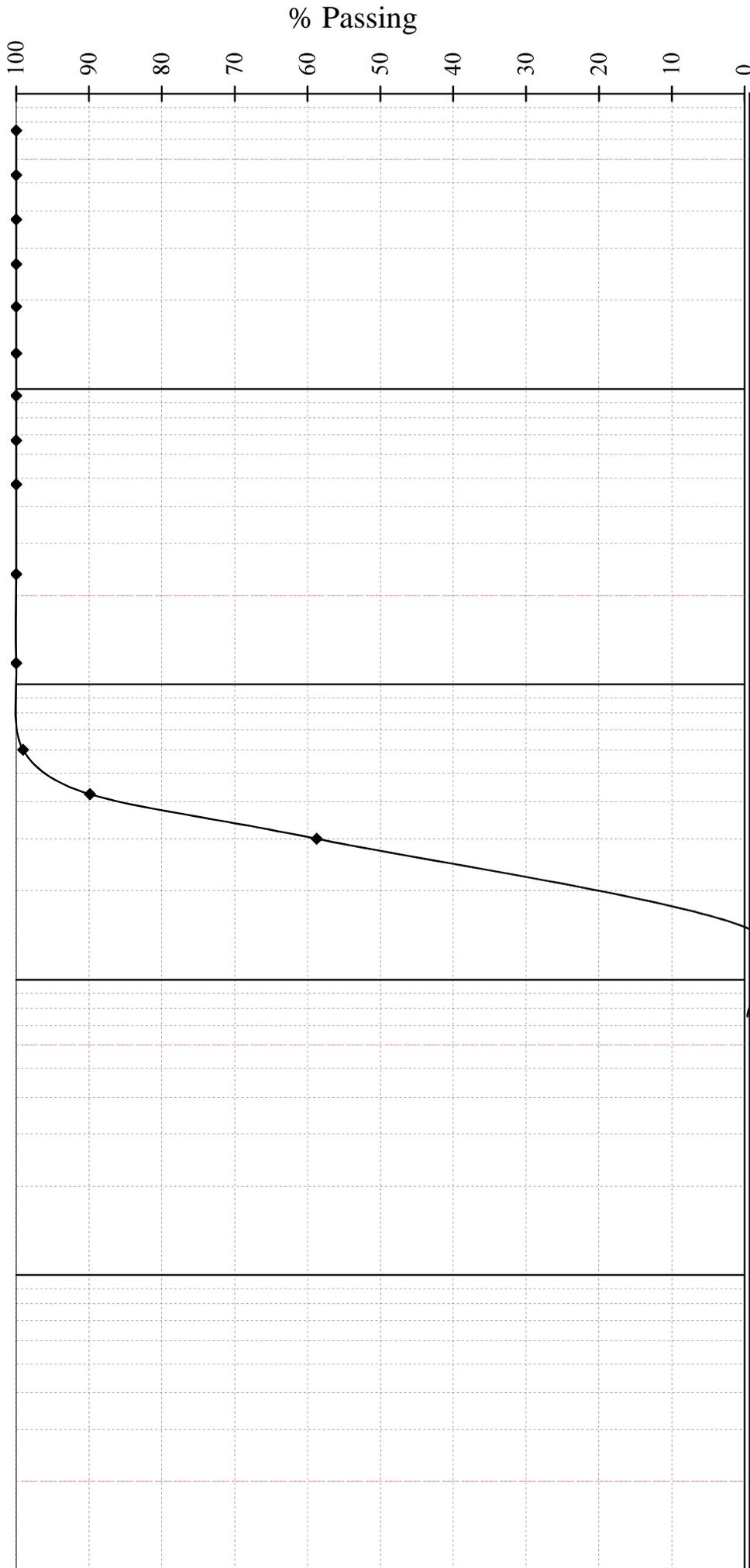
Job/Location

Windang Beach

Client  
WCC  
Environment

Lab No. W10284

Sample No. TP23



CLAY	SILT		SAND		GRAVEL		COBBLES
0.001 mm	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	100 mm
	0.01 mm		1 mm	10 mm		100 mm	

Classification: *uniform sand*     $D_{10}$  (mm): 0.17     $D_{30}$  (mm): 0.21     $D_{50}$  (mm): 0.27     $D_{60}$  (mm): 0.30     $C_c = 0.9$      $C_u = 1.8$

Form No. S04    Jan 2007



# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284																						
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 1																						
Location : Stanwell Park Beach – E 0314804, N 6210388						Date : 3/11/2009																						
						Logged/Checked by: KB & TH																						
Equipment type- 3t Excavator			Slope: deg.			R.L. surface:																						
Hole Diameter			Bearing: deg.			Datum: <i>AHD</i>																						
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION Soil type, plasticity or particle characteristic, colour secondary and minor components	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations																	
1200mm gummy bucket / 3t excavator			PSP1 start @ 0.00	0		SP	Beach SAND, poorly graded, light brown, grey, medium – coarse grained, with some quartz and shell fragments ~ 600µm	M	L																			
			0.6m	0.1								0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
		TP1		2.6			TP1 terminated at 2.6m (hole collapsing)																					
		0.8m		3.0																								
			PSP1 term @ 3.1	3.1																								
				3.5																								



# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 2					
Location : Stanwell Park Beach – E 0314784, N 6210401						Date : 3/11/2009					
						Logged/Checked by: KB & TH					
Equipment type- 3t Excavator			Slope: deg.		R.L. surface:						
Hole Diameter			Bearing: deg.		Datum: AHD						
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION Soil type, plasticity or particle characteristic, colour secondary and minor components	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator	none detected	0.6m	none	0.5		SP	Beach SAND, poorly graded, light brown, grey, medium – coarse grained, with quartz and trace of shell ~ 600µm	M	L		
		TP2		1.0							
		0.8m					TP2 terminated at 2.8m (hole collapsing)				Silty streaks appearing.



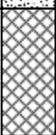
# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 3					
Location : Wombarra Beach – E 0312045, N 6205465						Date : 3/11/2009					
						Logged/Checked by: KB & TH					
Equipment type- 3t Excavator			Slope:           deg.		R.L. surface:						
Hole Diameter			Bearing:       deg.		Datum:           AHD						
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator			PSP2 start @ 0.00			SP	Beach SAND, poorly graded, light brown, grey, medium-coarse grained, with some quartz and shell fragments ~ 600µm	M	L		
			SW SW 0.65m TP3 0.85m	0.5 1 0 2 1 1 1 2 2 3 4 5 8 9 11 13 17 16 14 21 17 21 29 13 14 15 24 B.ref							
			PSP2 term @ 2.80				TP3 terminated at 2.5m				

# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284						
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 4						
Location : Wombarra Beach – E 0312021, N 6205479						Date : 3/11/2009						
Location : Wombarra Beach – E 0312021, N 6205479						Logged/Checked by: KB & TH						
Equipment type- 3t Excavator			Slope: deg.			R.L. surface:						
Hole Diameter			Bearing: deg.			Datum: AHD						
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations	
1200mm gummy bucket / 3t excavator				0.70m		SP	Beach SAND, poorly graded, light brown, grey, medium-coarse grained, with some quartz and shell fragments ~ 600µm	M	L			
		TP4A	0.90m									
		TP4B	1.50m									
			2.50m			F	FILL: rounded cobbles & boulders to 400mm, coalwash, sandstone cobbles & gravels, sand & sandy clay.	M			Appears to be fills & regraded natural material. Appears moderate-well compacted (well nested)	
				3.0			TP4 terminated at 2.9m					
				3.5								



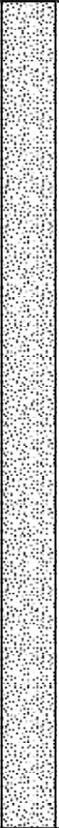
# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 5					
Location : Coledale Beach – E 0311250, N 6204093						Date : 3/11/2009					
						Logged/Checked by: KB & TH					
Equipment type- 3t Excavator			Slope:           deg.		R.L. surface:						
Hole Diameter			Bearing:       deg.		Datum:						
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator			PSP3 start @ 0.00			SP	Beach SAND, poorly graded, light brown, grey, coarse grained, with some quartz and shell fragments ~ 600µm – 2.36mm	M	L		
			SW SW 1 1 1 1 2 3 4 5 6 7 10 11 14 17 21 22 26 29 28 23 21 B.ref	0.50m 0.70m							
			PSP3 term @ 2.3				TP5 terminated at 2.0m				

# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 6					
Location : Coledale Beach – E 0311222, N 6204095						Date : 3/11/2009					
						Logged/Checked by: KB & TH					
Equipment type- 3t Excavator			Slope:           deg.		R.L. surface:						
Hole Diameter			Bearing:       deg.		Datum:						
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator	none detected	TP6	none	0.50m		SP	Beach SAND, poorly graded, light brown, grey, fine-medium grained, with some quartz and shell fragments ~ 600µm becoming coarser with depth with some shell fragments to 5mm).	M	L		
				0.70m							
							TP6 terminated at 2.6m				



# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 7					
Location : Sharky's – E 0310678, N 6203111						Date : 3/11/2009					
						Logged/Checked by: KB & TH					
Equipment type- 3t Excavator			Slope:           deg.		R.L. surface:						
Hole Diameter			Bearing:       deg.		Datum:						
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION Soil type, plasticity or particle characteristic, colour secondary and minor components	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator			PSP4 start @ 0.00			SP	Beach SAND, poorly graded, light brown, grey, fine-medium grained, with trace of shell fragments.	M	L		
			PSP4 SW 1 SW 2 TP7 PSP4 term @ 2.42								



# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 8					
Location : Sharky's – E 0310641, N 6203135						Date : 3/11/2009					
Equipment type- 3t Excavator						Slope: deg.		R.L. surface:			
Hole Diameter						Bearing: deg.		Datum:			
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION Soil type, plasticity or particle characteristic, colour secondary and minor components	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator	none detected	TP8	none	0.60m		SP	Beach SAND, poorly graded, light brown, grey, fine-medium grained, with trace of shell fragments.	M	L		
				0.80m							
				2.9m							
				3.0m			FILL: Sandstone boulders & sand matrix, boulders to 500mm diameter				
				3.1m			TP8 terminated at 3.1m				



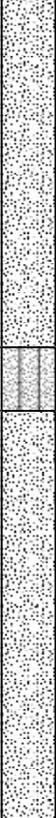
# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 9					
Location : Austinmer Beach – E 0310035, N 6201953						Date : 4/11/2009					
						Logged/Checked by: KB & TH					
Equipment type- 3t Excavator			Slope:           deg.		R.L. surface:						
Hole Diameter			Bearing:       deg.		Datum:						
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION Soil type, plasticity or particle characteristic, colour secondary and minor components	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator			PSP5 start @ 0.00	0.00		SP	Beach SAND, poorly graded, light brown, grey, fine-medium grained, with a trace of shell fragments.	M	L		
			TP9	0.50m							
			SW	1.00							
			1	1.10							
			2	1.20							
			1	1.30							
			2	1.40							
			2	1.50							
			3	1.60							
			4	1.70							
			5	1.80							
			4	1.90							
			5	2.00							
			5	2.10							
			6	2.20							
			9	2.30							
			10	2.40							
			10	2.50							
			16	2.60							
			16	2.70							
			17	2.80							
			19	2.90							
			24	3.00							
			26	3.10							
			31	3.20							
			31	3.30							
			30	3.40							
			30	3.50							
			30	3.60							
				3.00			TP9 terminated at 2.8m (hole collapsing)				PSP – tip dented when removed.
			PSP5 term @ 3.0	3.00							
				3.50							

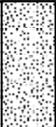
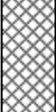
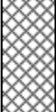
# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284												
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 10												
Location : Austinmer Beach – E 0310002, N 6201974						Date : 4/11/2009												
						Logged/Checked by: KB & TH												
Equipment type- 3t Excavator			Slope:           deg.			R.L. surface:												
Hole Diameter			Bearing:       deg.			Datum:												
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION Soil type, plasticity or particle characteristic, colour secondary and minor components	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations							
1200mm gummy bucket / 3t excavator			none	0.50m		SP	Beach SAND, poorly graded, light brown, grey, fine-medium grained, with trace of shell fragments and some black silty lenses.	M	L		Plastic bottle piece found @ 1100							
		TP10																
		0.70m																
				1.0		SM	Silty sand layer, black.											
				1.5		SP	Beach SAND, poorly graded, light brown, grey, coarse grained, with shell fragments to 5mm.	W	L									
				2.0														
				2.5														
				2.2m			TP10 terminated at 2.6m											
				3.0														
				3.5														

# Engineering Log - Excavation

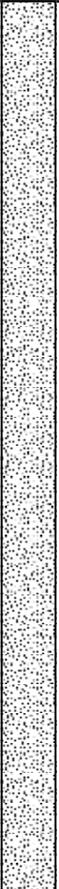
Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 11					
Location : Sandon Point Beach – E 0309118, N 6198498						Date : 4/11/2009					
						Logged/Checked by: KB & TH					
Equipment type- 3t Excavator			Slope:           deg.			R.L. surface:					
Hole Diameter			Bearing:       deg.			Datum:					
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION Soil type, plasticity or particle characteristic, colour secondary and minor components	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator	none detected	TP11	none	0.40m		SP	Beach SAND, poorly graded, light brown, grey, fine-medium grained, with a trace of shell fragments.	M	L		
				0.60m		F	FILL: beach sand, dark brown, silty sand, boulders & cobbles to 400mm (beach armour layer), grey-brown, brown, well nested.	M			
				1.0m		CI/ CL	Gravelly sandy CLAY, medium-low plasticity, grey, orange-brown, red-brown, with XW ironstone gravel & sandstone to 15mm.	M > PL	St		
				1.5m			TP11 terminated at 1.4m (in natural material).				
				2.0m							
				2.5m							
				3.0m							
				3.5m							



# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 13					
Location : Woonona Beach – E 0308674, N 6196764						Date : 4/11/2009					
						Logged/Checked by: KB & TH					
Equipment type- 3t Excavator			Slope: deg.			R.L. surface:					
Hole Diameter			Bearing: deg.			Datum:					
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION Soil type, plasticity or particle characteristic, colour secondary and minor components	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator			PSP7 start @ 0.00			SP	Beach SAND, poorly graded, light brown, grey, fine-medium grained, with fine quartz and shell fragments and some black silty bands.	M	L		Becoming coarser with depth.
		0.40m TP13	SW SW	0.5 1 0 0 1 1 1 2 2 2 2 4 4 7 9 11 13 15 16 18 21 24 25 28 23 25 25							
			PSP7 term @ 3.05				TP13 terminated at 2.8m				





# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 15					
Location : Bellambi Point – E 0309487, N 6194632						Date : 4/11/2009					
Logged/Checked by: KB & TH											
Equipment type- 3t Excavator			Slope: deg.			R.L. surface:					
Hole Diameter			Bearing: deg.			Datum:					
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator	none detected	0.30m	none	0.5		SP	Beach SAND, poorly graded, light brown, grey, medium-coarse grained, with quartz and trace of shell fragments ~ 600µm and some brown-black silty bands.	M / W	L		Rock outcrops noted throughout beach. Test Pit @ approx. mid tide level.
		TP15									
		0.50m		1.0			TP15 terminated at 1.0m (on rock shelf)				
				1.5							
				2.0							
				2.5							
				3.0							
				3.5							



# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 16					
Location : East Corrimal Beach – E 0308825, N 6193974						Date : 4/11/2009					
						Logged/Checked by: KB & TH					
Equipment type- 3t Excavator			Slope: deg.		R.L. surface:						
Hole Diameter			Bearing: deg.		Datum:						
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator			PSP9 start @ 0.00			SP	Beach SAND, poorly graded, light brown, grey, medium grained, with quartz and shell fragments ~ 600µm.	M / W	L		
			PSP9 SW 1 1 2 4 4 5 6 7 9 10 10 12 13 13 16 16 20 21 18 15 14 14 17 16 15 PSP9 term @ 2.70								
							TP16 terminated at 1.8m (hole collapsing)				



# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 17					
Location : East Corrimal Beach – E 0308794, N 6193993						Date : 4/11/2009					
						Logged/Checked by: KB & TH					
Equipment type- 3t Excavator			Slope:           deg.		R.L. surface:						
Hole Diameter			Bearing:       deg.		Datum:						
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION Soil type, plasticity or particle characteristic, colour secondary and minor components	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator			none	0.50m		SP	Beach SAND, poorly graded, light brown, grey, medium grained, with fine quartz and shell fragments ~ 600µm.	M	L		
		TP17		0.70m							
				1.5m							
				2.0m							
				2.5m							
				3.0m							
				3.5m							
							TP17 terminated at 2.6m				



# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment				Lab Number : W10284								
Project : Wollongong Coastal Hazards Study (WCHS)				Test Pit No: TP 18								
Location : Towradgi Beach – E 0307817, N 6192532				Date : 5/11/2009								
				Logged/Checked by: KB & TH								
Equipment type- 3t Excavator		Slope:           deg.		R.L. surface:								
Hole Diameter		Bearing:       deg.		Datum:								
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations	
1200mm gummy bucket / 3t excavator			PSP10 start @ 0.00		[Graphic Log: Stippled pattern representing sand]	SP	Beach SAND, poorly graded, light brown, grey, medium-coarse grained, with some fine quartz and some shell fragments to 5mm.	M	L			
			0.50m	PSP10								0.5
			TP18	SW								
			0.70m	SW								
				1								
				3								
				1								
				2								
				1								
				1								
				2								
				1								
				2								
				3								
				4								
			6									
			5									
			5									
			7									
			10									
			12									
			15									
			20									
			20									
			21									
			25									
			26									
			24									
			25									
			26									
			26									
			26									
			26									
			26									
			3.0									
			26									
			26									
			26									
			3.5									
			PSP10 term @ 3.60									



# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 19					
Location : Fairy Meadow Beach – E 0307537, N 6191981						Date : 5/11/2009					
						Logged/Checked by: KB & TH					
Equipment type- 3t Excavator			Slope: deg.		R.L. surface:						
Hole Diameter			Bearing: deg.		Datum:						
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator	none detected		PSP11 start @ 0.00			SP	Beach SAND, poorly graded, light brown, grey, medium-coarse grained, with some quartz and some shell fragments to 5mm.	M	L		
		0.50m	PSP11	0.5							
		TP19	SW	1							
		0.70m	SW	2							
				2							
				2							
				2							
				3							
				2							
				5							
				5							
				4							
				5							
				6							
				7							
				8							
				7							
				6							
				7							
				9							
				10							
				11							
				13							
				17							
				22			TP19 terminated at 2.3m				PSP – feels gravelly when removed near full depth
				19							
				26							
				23							
				21							
				18							
				17							
				18							
				20							
				19							
			PSP11 term @ 3.6	3.5							



# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284													
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 20													
Location : Wollongong City Beach – E 0307439, N 6188425						Date : 9/11/2009													
Equipment type- 3t Excavator						Slope: deg.						R.L. surface:							
Hole Diameter						Bearing: deg.						Datum:							
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION Soil type, plasticity or particle characteristic, colour secondary and minor components	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations								
1200mm gummy bucket / 3t excavator	▼ 1.7m	PSP12 start @ 0.00	PSP12	0.50m		SP	Beach SAND, poorly graded, light brown, grey, fine grained.	M	L	D	Pebbles present on the surface @ shore line.								
				TP20								0.70m	1	2	3	4	6	9	11
PSP12 term @ 2.20							TP20 terminated at 2.1m												
				2.5															
				3.0															
				3.5															



# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 21					
Location : Coniston Beach (Swan St) – E 0307236, N 6187613						Date : 9/11/2009					
Equipment type- 3t Excavator						Slope: deg.		R.L. surface:			
Hole Diameter						Bearing: deg.		Datum:			
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION Soil type, plasticity or particle characteristic, colour secondary and minor components	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator	▼ 1.1m		PSP13 start @ 0.00	0.00		SP	Beach SAND, poorly graded, light brown, grey, fine grained, with some shell fragments to 5mm.	M	L		Trace of pebbles @ shore line.
		0.50m	PSP13	0.50							
		TP21	SW	1.00							
			SW	1.10							
				1.20							
				1.30							
				1.40							
				1.50							
				1.60							
				1.70							
				1.80							
				1.90							
				2.00							
				2.10							
				2.20							
				2.30							
				2.40							
				2.50			TP21 terminated at 2.4m				
				2.60							
				2.70							
				2.80							
				2.90							
				3.00							
				3.10							
				3.20							
				3.30							
			PSP13 term @ 3.30	3.30							
				3.40							
				3.50							

# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

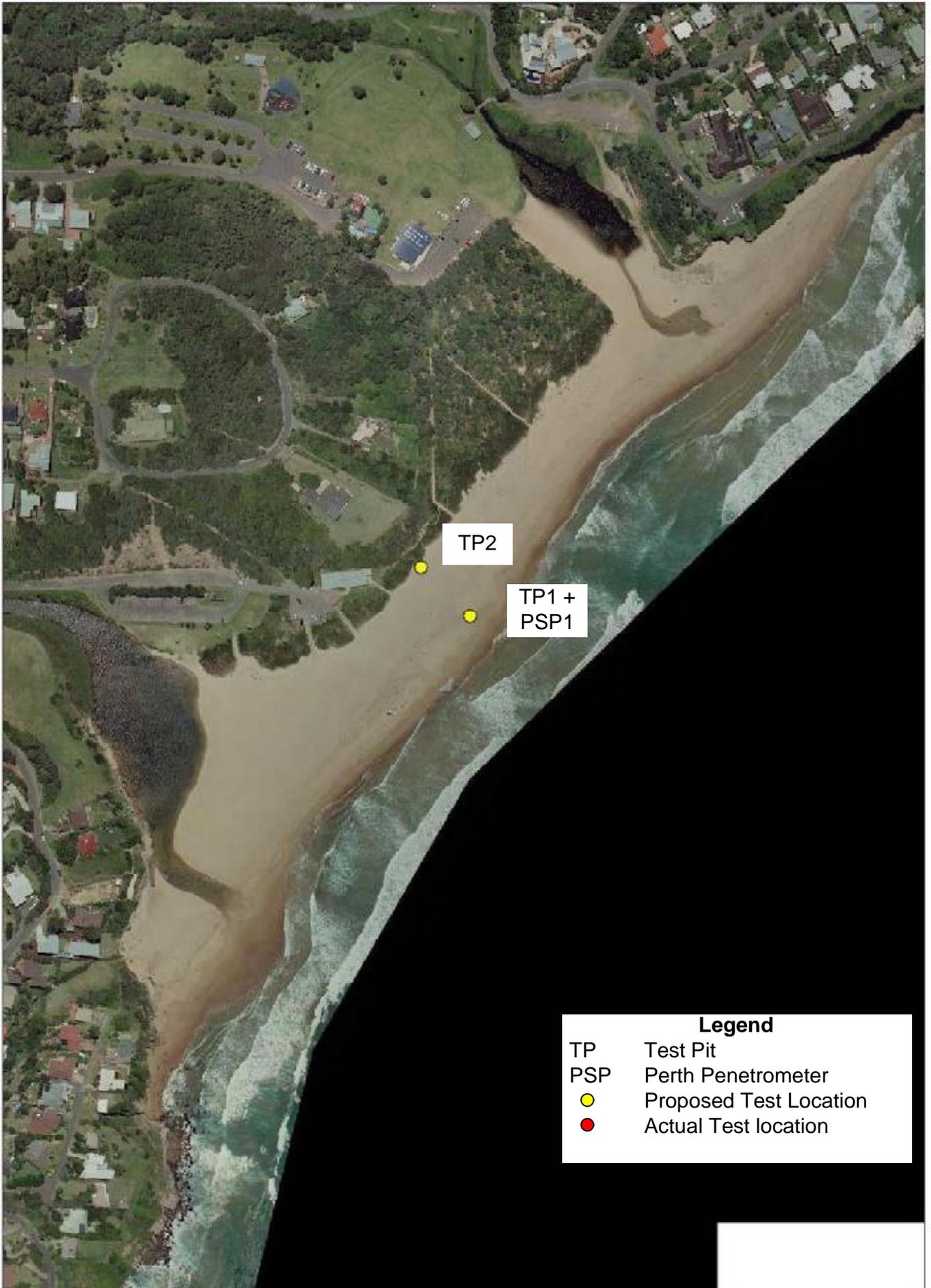
Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 22					
Location : Port Kembla Beach – E 0307914, N 6181127						Date : 9/11/2009					
Equipment type- 3t Excavator						Slope: deg.					
Hole Diameter						Bearing: deg.					
						R.L. surface:					
						Datum:					
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator			PSP14 start @ 0.00			SP	Beach SAND, poorly graded, light brown, grey, fine grained, with some shell fragments to 5mm.	M			Becoming coarser with depth.
			PSP14 SW	0.5							
		0.50m	1								
			2								
		TP22	2								
			2								
		0.70m	2								
			6								
			9								
			11								
			12	1.0							
			14								
		21									
		25									
		26									
		26									
		24									
		39	1.5								
		PSP14 term @ 1.70									
	1.8m			2.0			TP22 terminated at 2.0m				
				2.5							
				3.0							
				3.5							



# Engineering Log - Excavation

Wollongong City Council - Geotechnical Services

Client: WCC - Environment						Lab Number : W10284					
Project : Wollongong Coastal Hazards Study (WCHS)						Test Pit No: TP 23					
Location : Windang Beach – E 0304906, N 6176157						Date : 9/11/2009					
						Logged/Checked by: KB & TH					
Equipment type- 3t Excavator			Slope: deg.		R.L. surface:						
Hole Diameter			Bearing: deg.		Datum:						
method	groundwater	samples	field tests	Depth or R.L. in meters	Graphic Log	Classification Symbol	MATERIAL DESCRIPTION Soil type, plasticity or particle characteristic, colour secondary and minor components	Moisture Condition	Consistency density Index	Hand penetrometer kPa	Remarks & additional observations
1200mm gummy bucket / 3t excavator	▼ 2.1m		PSP15 start @ 0.00	0.00		SP	Beach SAND, poorly graded, light brown, grey, fine grained with shell fragments near surface to 10mm.	M	L		Becoming coarser with depth.
		0.50m	PSP15	0.50							
		TP23	SW	1.00							
		0.70m	1 0 2 2 4 4 4 5 6 6 4 5 8 8 10 12 15 17 19 23 20 17 17 20 20 19 19 19 22 24 26 33	1.50							
				2.00						D	
				2.50			TP23 terminated at 2.4m				
				3.00							
				3.50							
			PSP15 term @ 3.50								



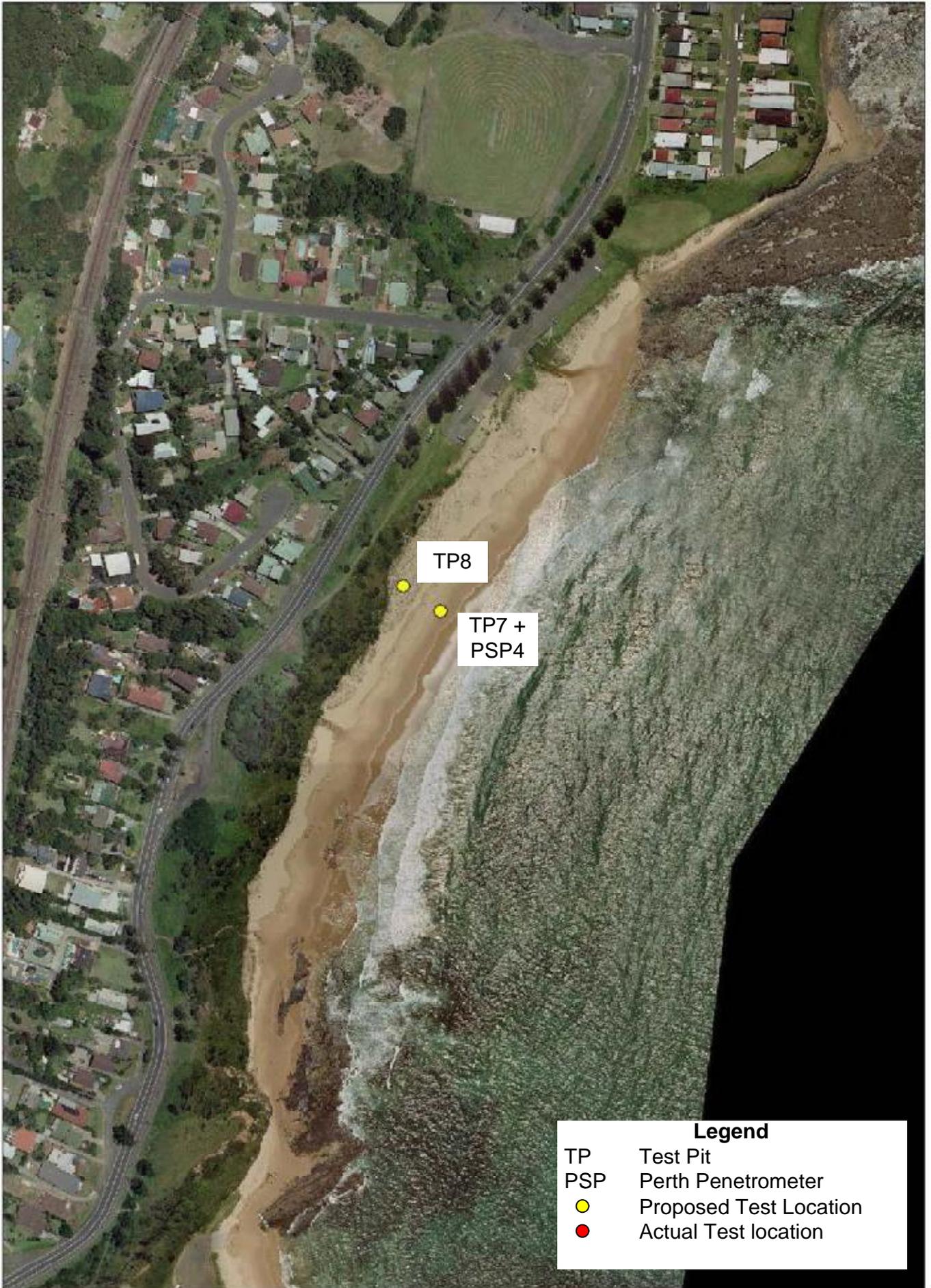




TP6

TP5 +  
PSP3

Legend	
TP	Test Pit
PSP	Perth Penetrometer
●	Proposed Test Location
●	Actual Test location











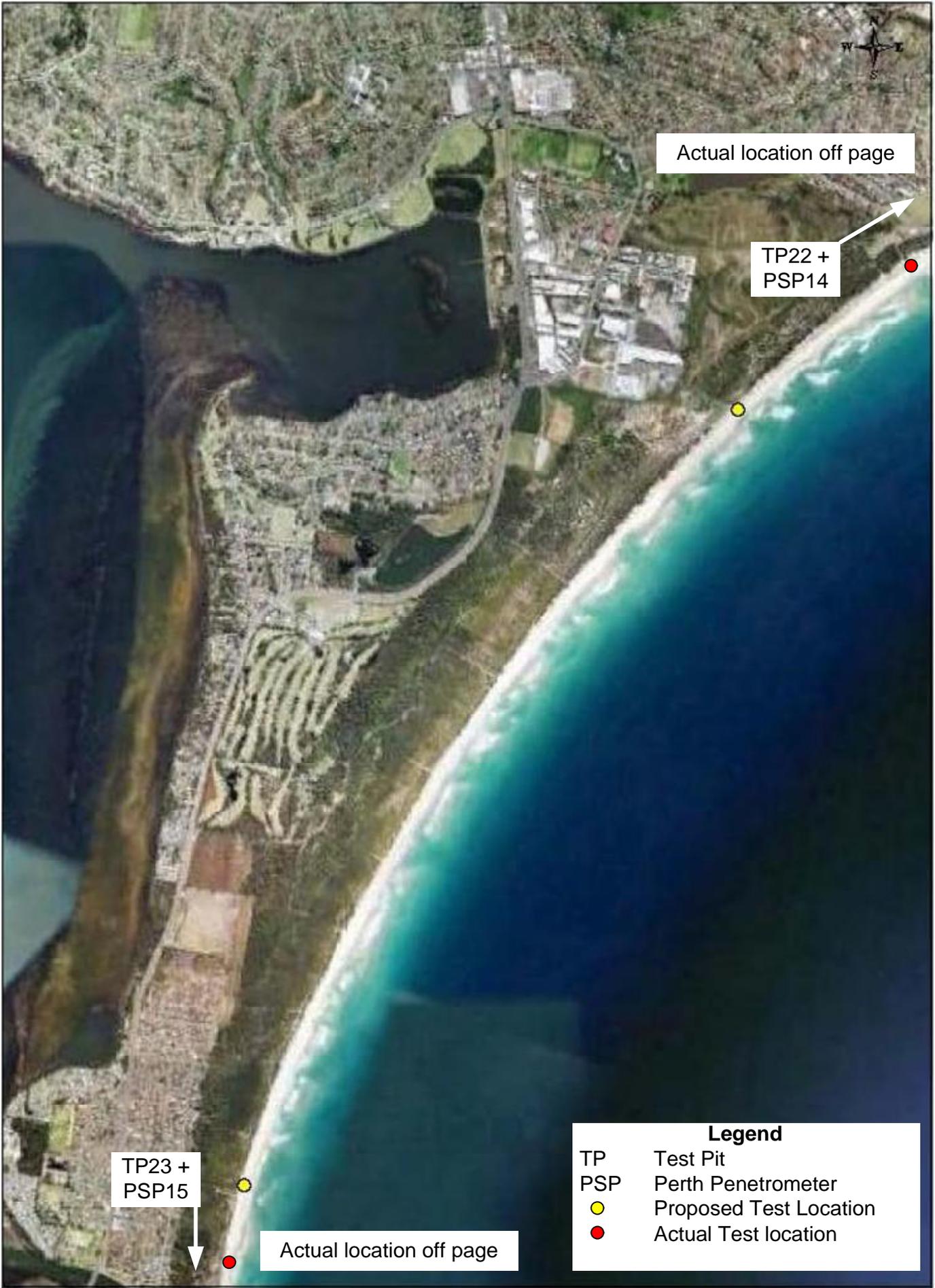
**Legend**

TP	Test Pit
PSP	Perth Penetrometer
● (yellow)	Proposed Test Location
● (red)	Actual Test location









Actual location off page

TP22 +  
PSP14

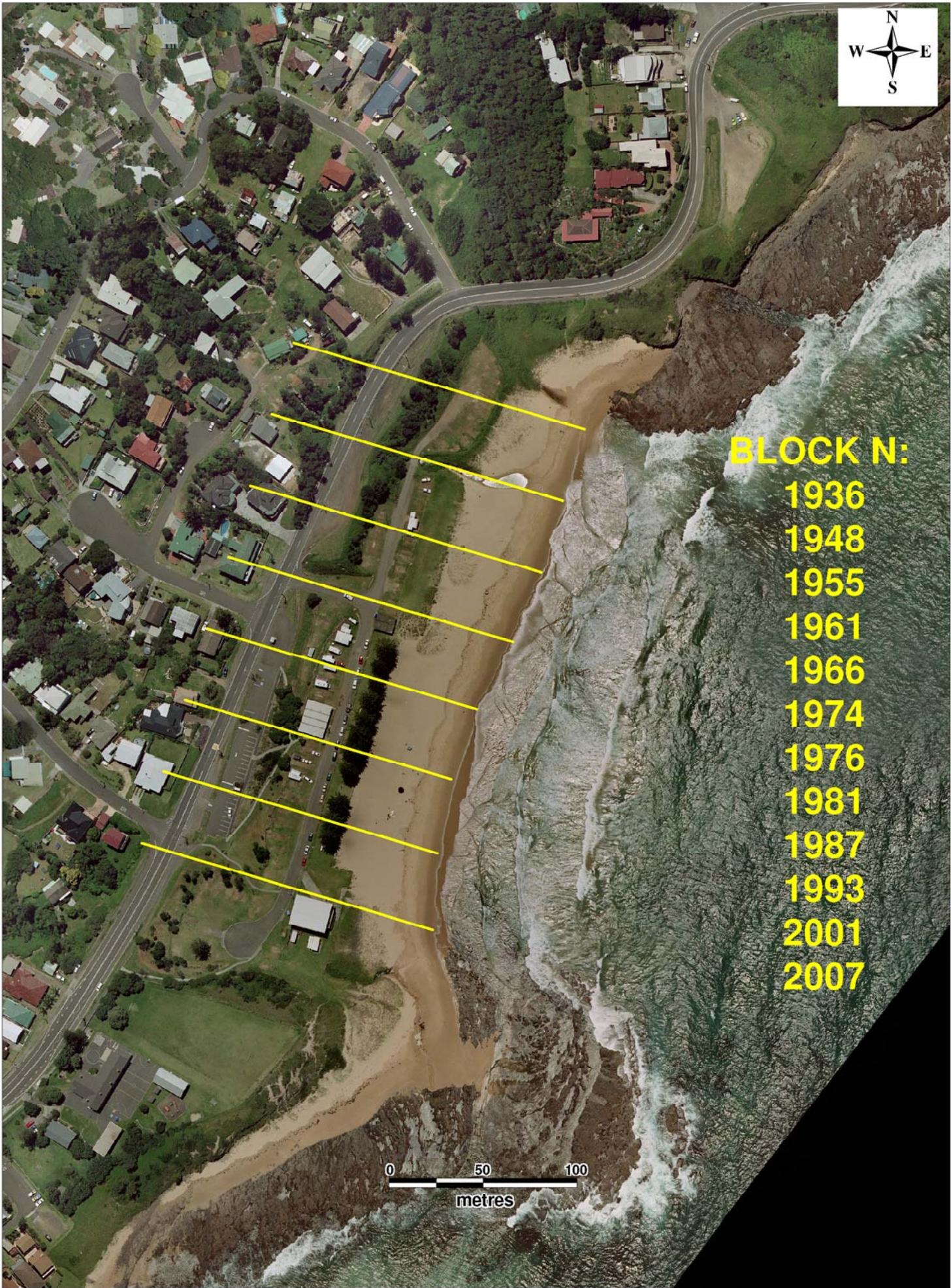
TP23 +  
PSP15

Actual location off page

Legend	
TP	Test Pit
PSP	Perth Penetrometer
● (Yellow)	Proposed Test Location
● (Red)	Actual Test location

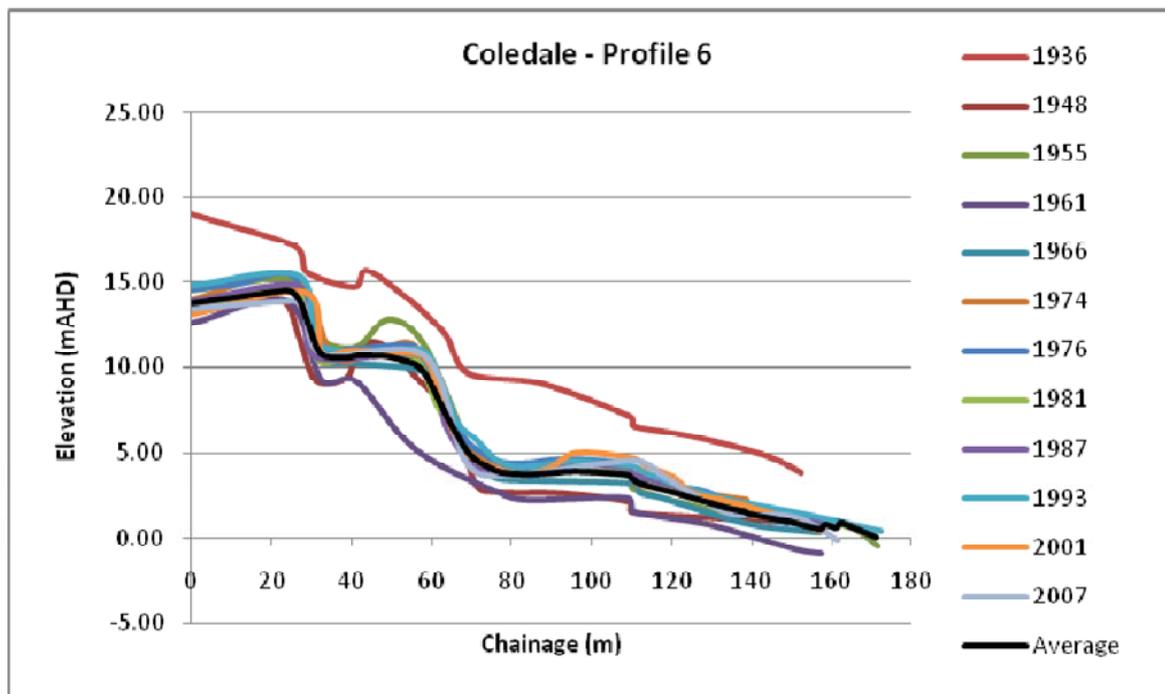
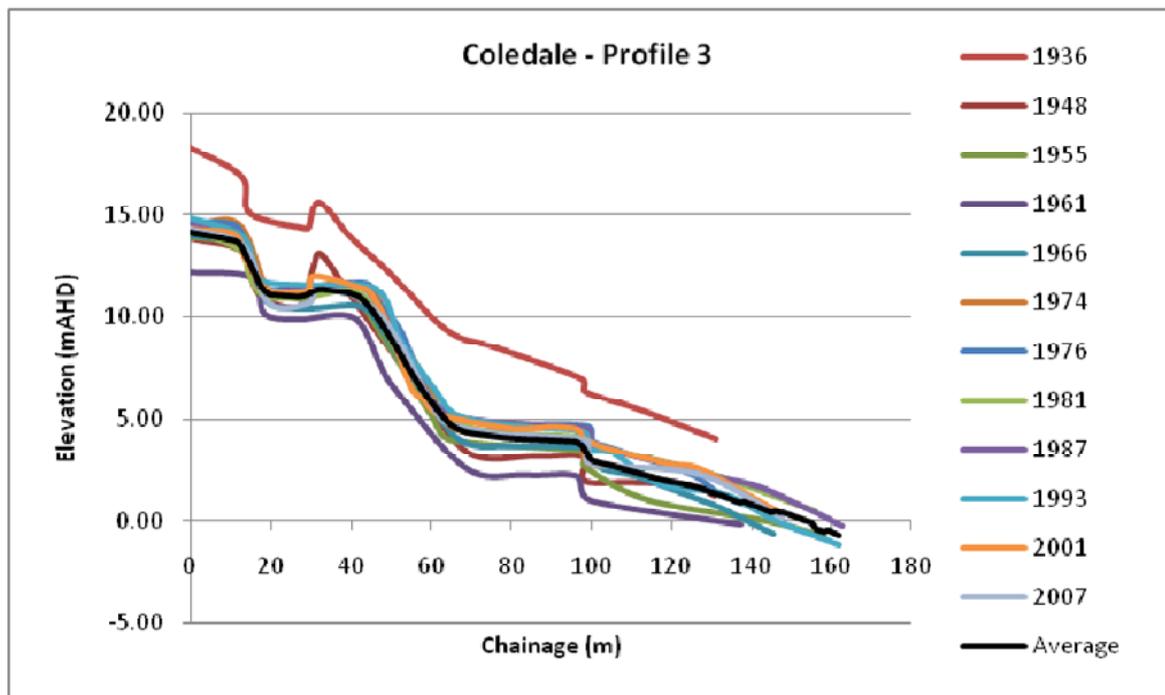
**Appendix B**

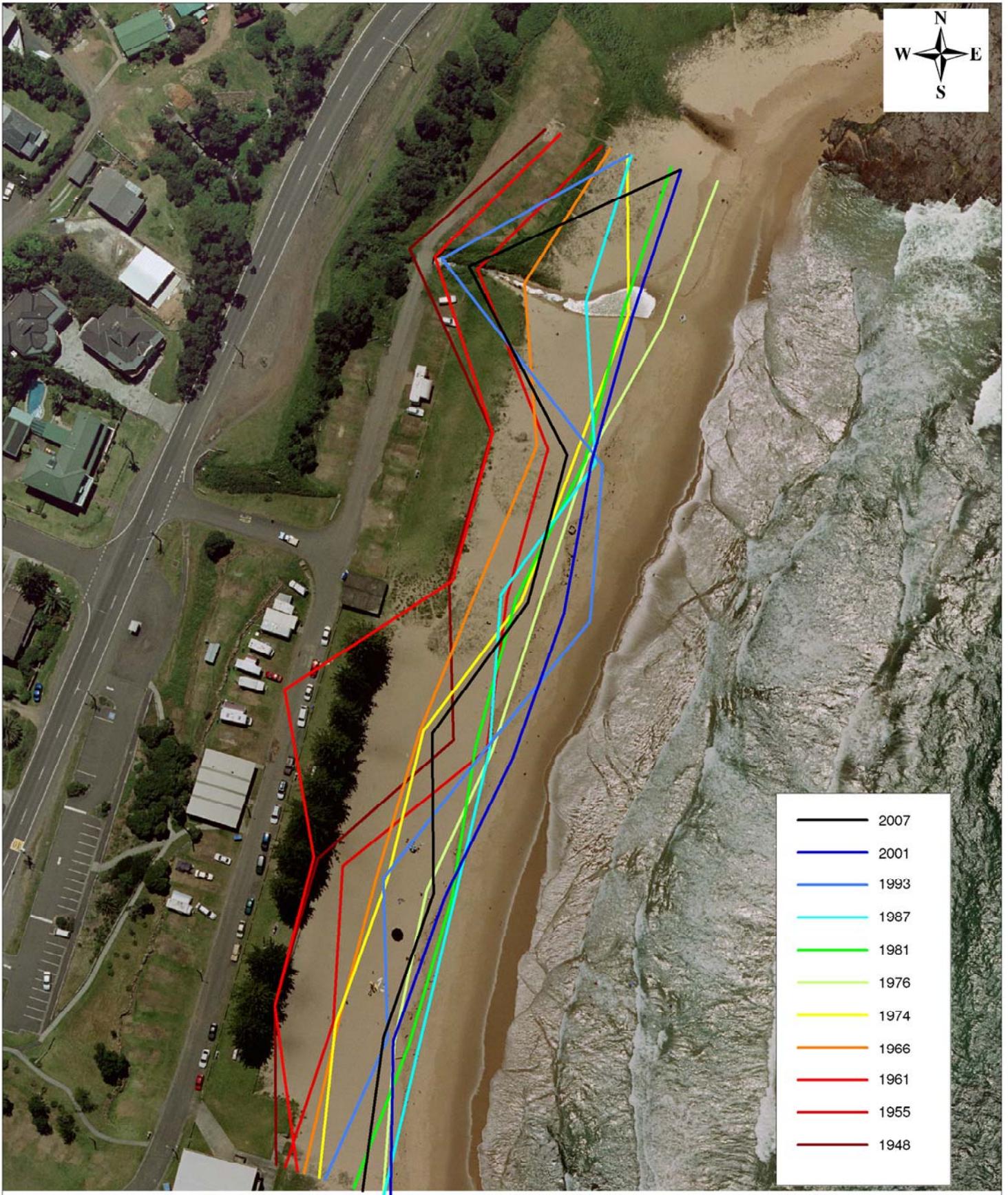
# **Photogrammetric Data**



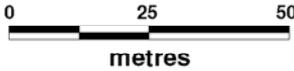
**BLOCK N:**  
1936  
1948  
1955  
1961  
1966  
1974  
1976  
1981  
1987  
1993  
2001  
2007

0 50 100  
metres

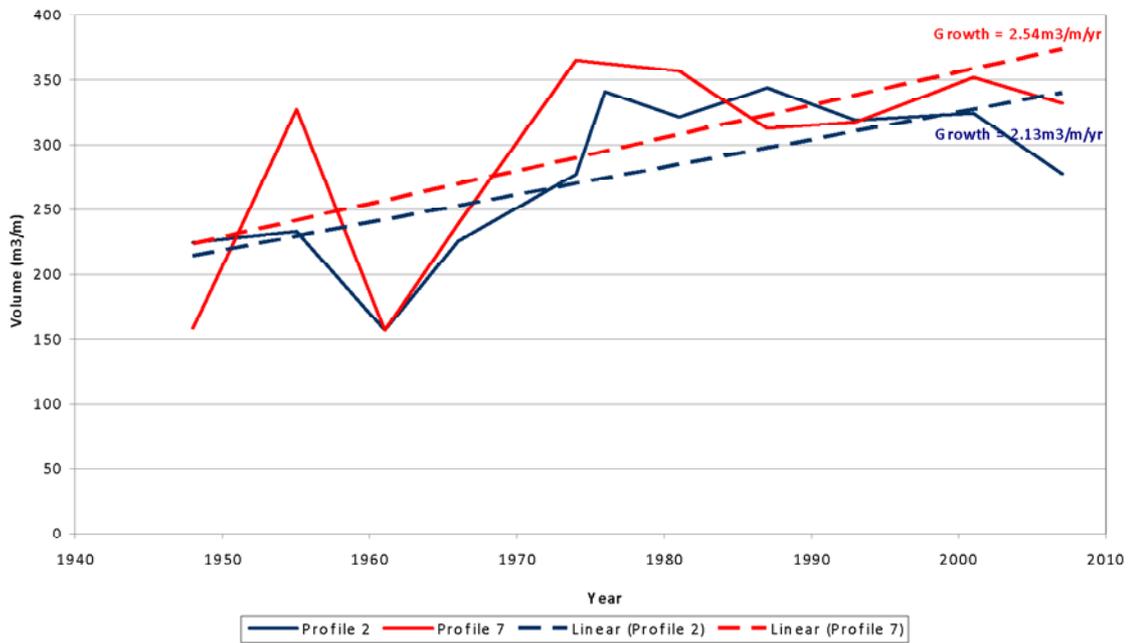




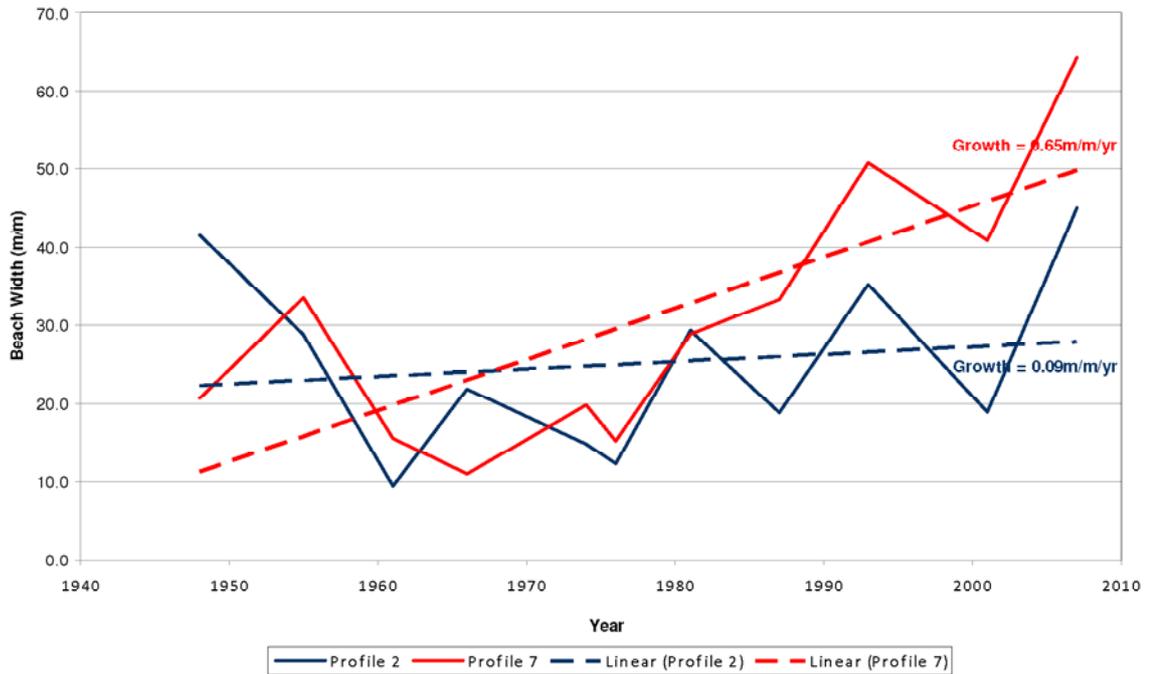
- 2007
- 2001
- 1993
- 1987
- 1981
- 1976
- 1974
- 1966
- 1961
- 1955
- 1948

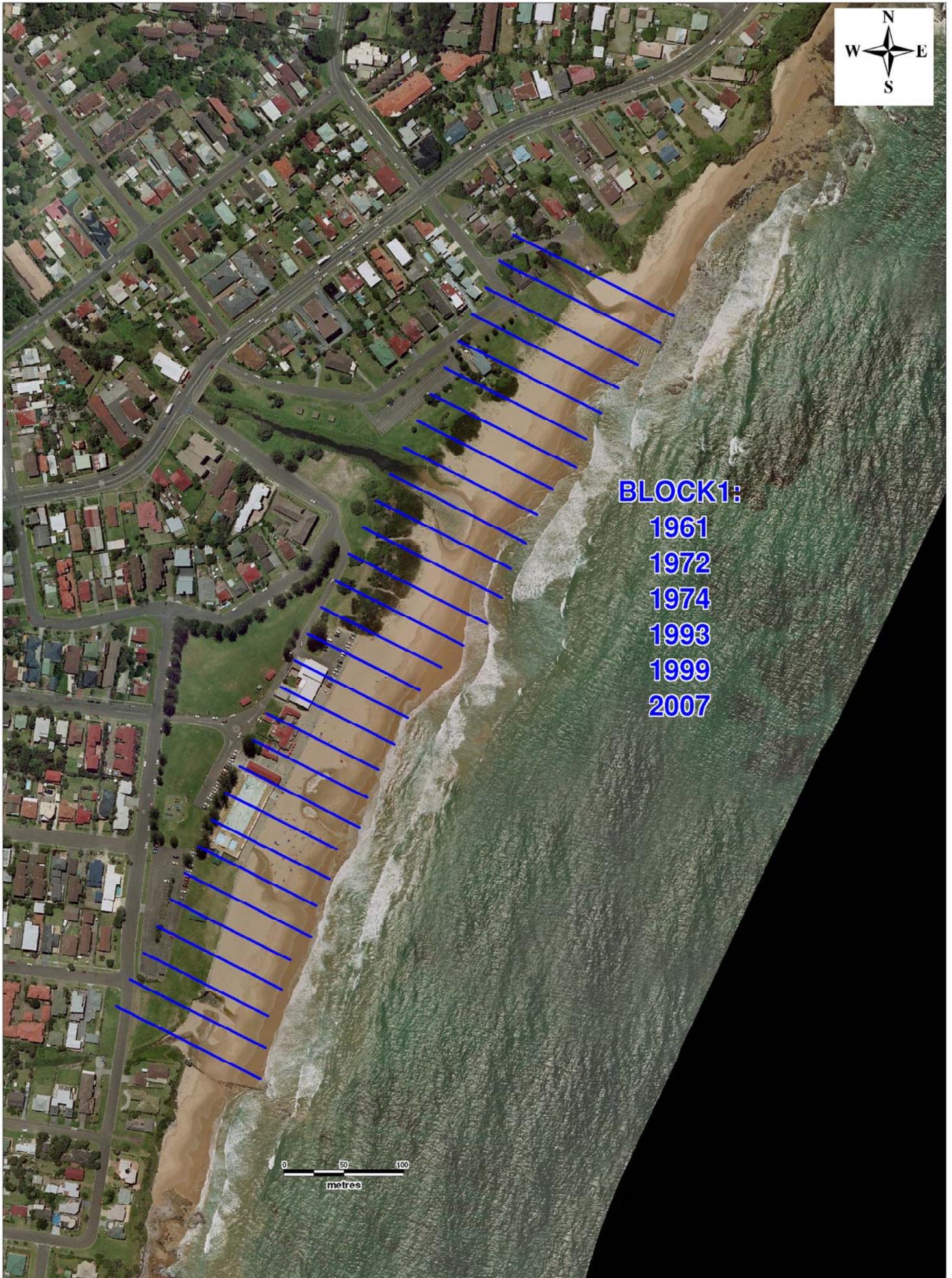


Coledale - Beach Volume History

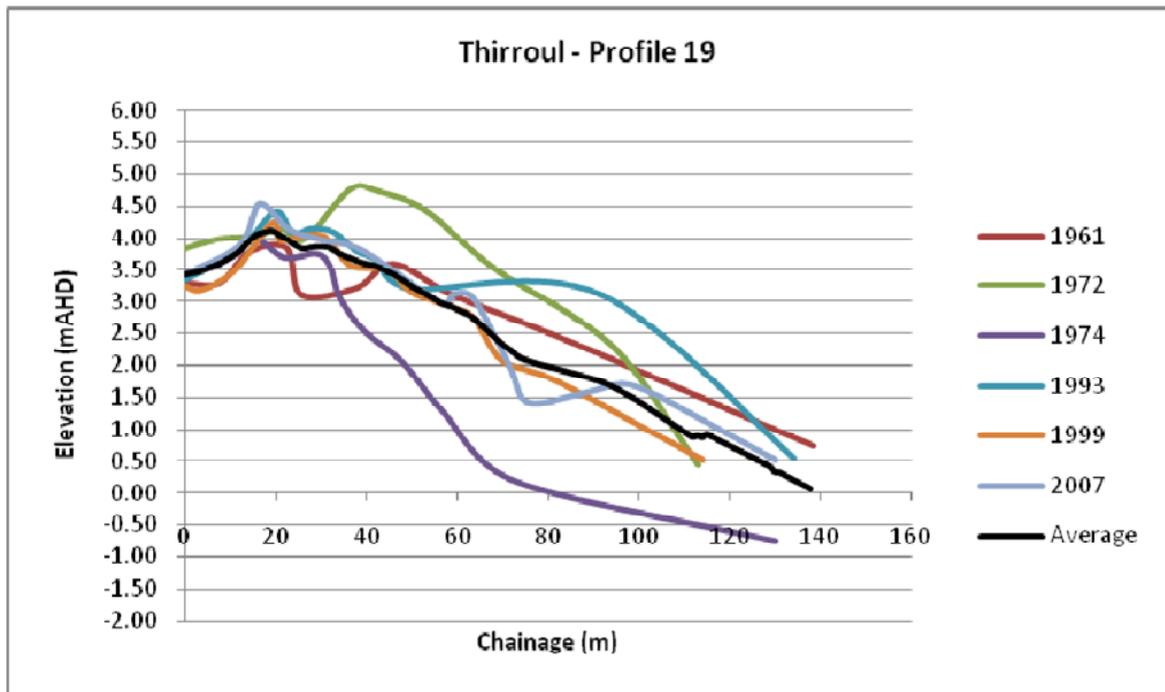
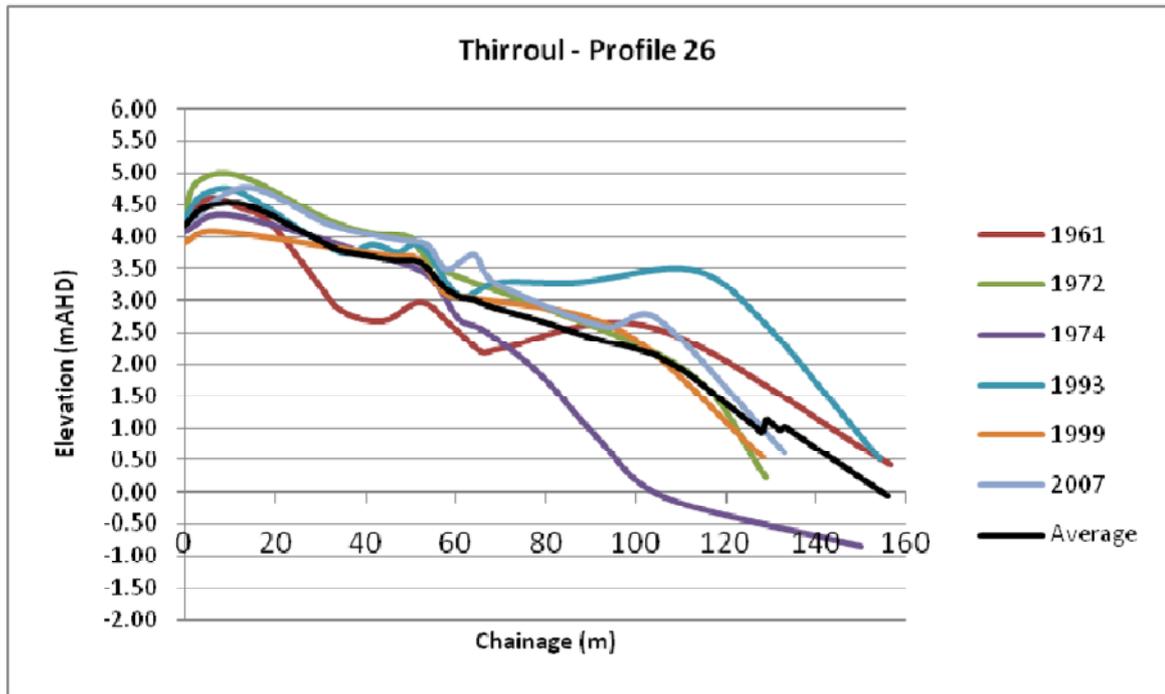


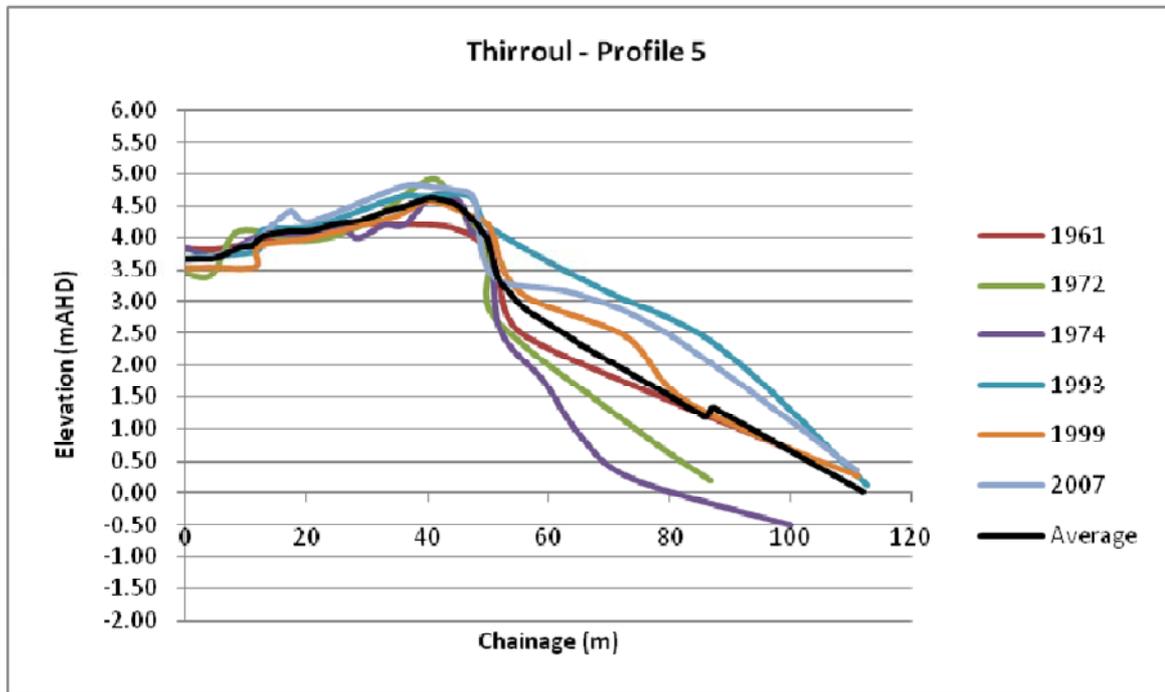
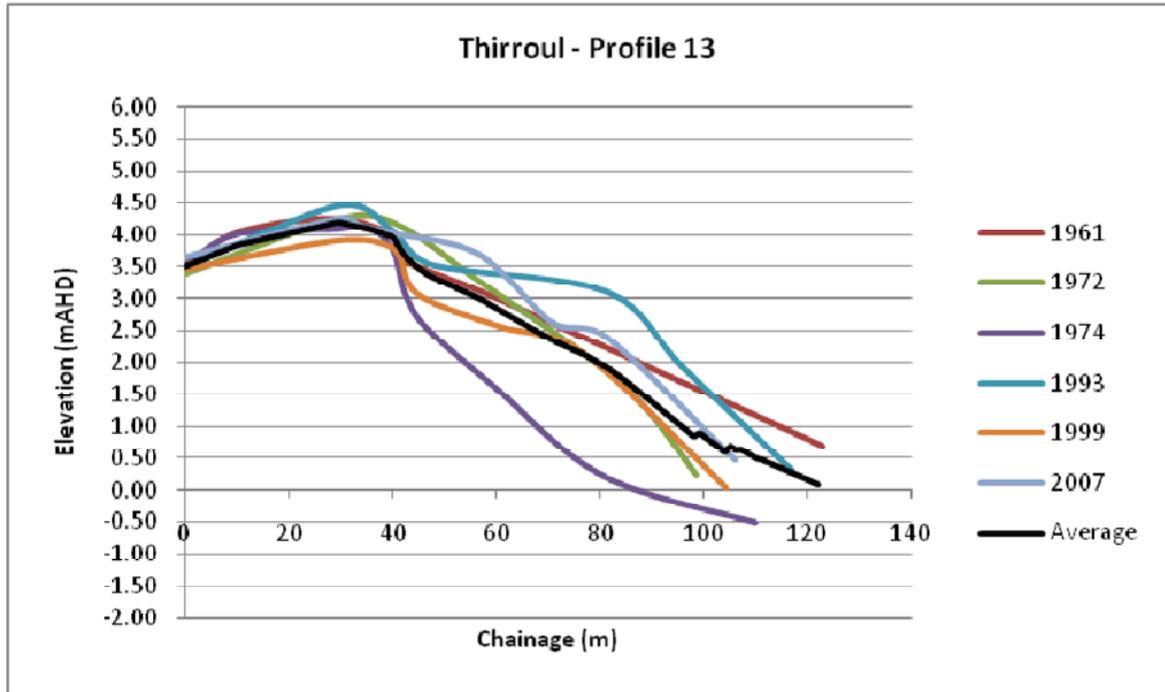
Coledale - Beach Width History

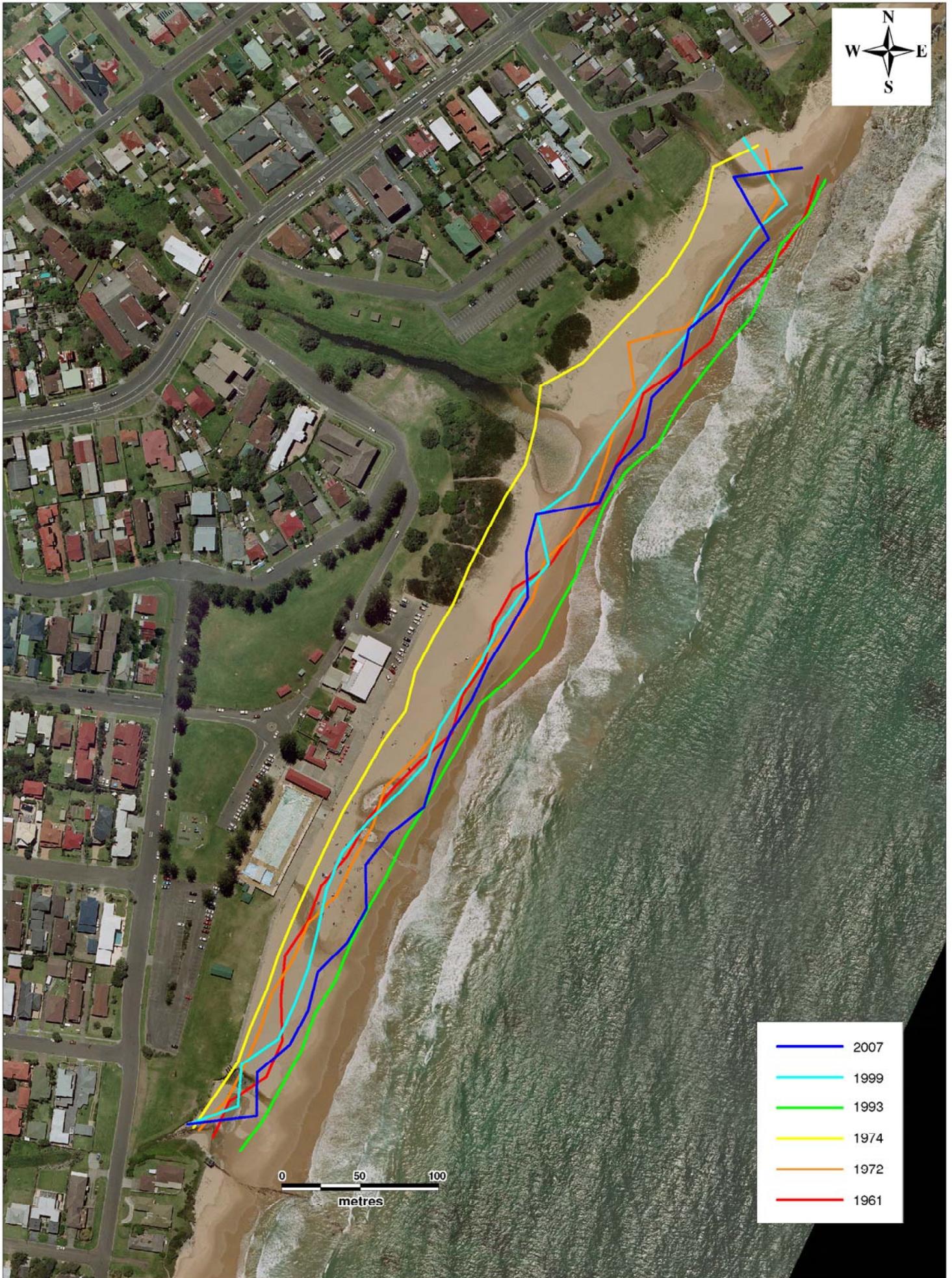




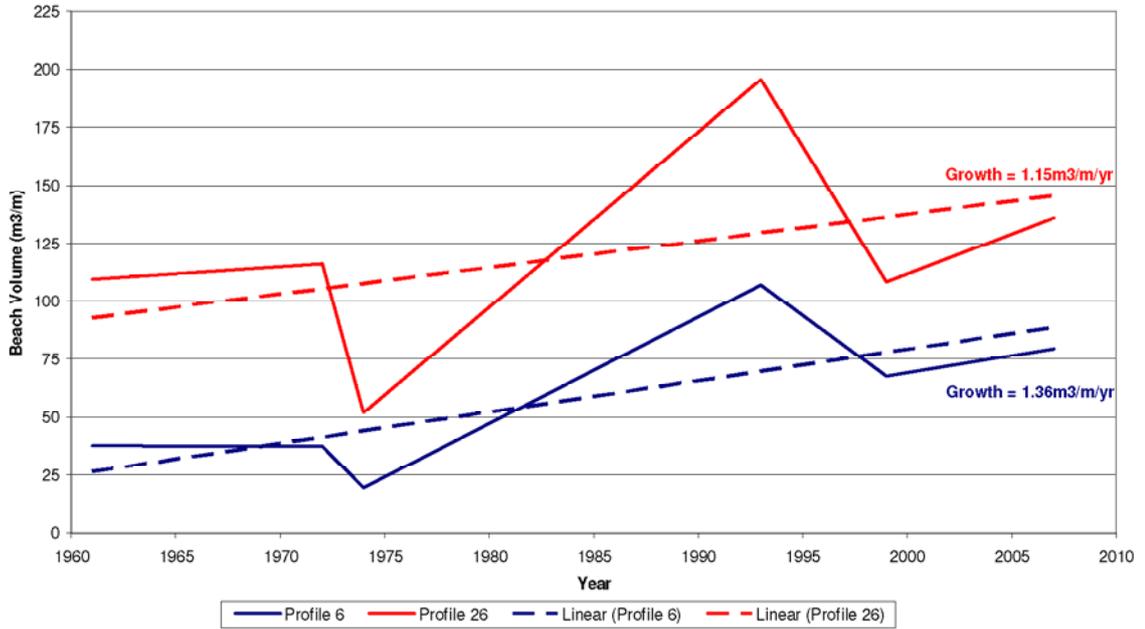
**BLOCK1:**  
1961  
1972  
1974  
1993  
1999  
2007



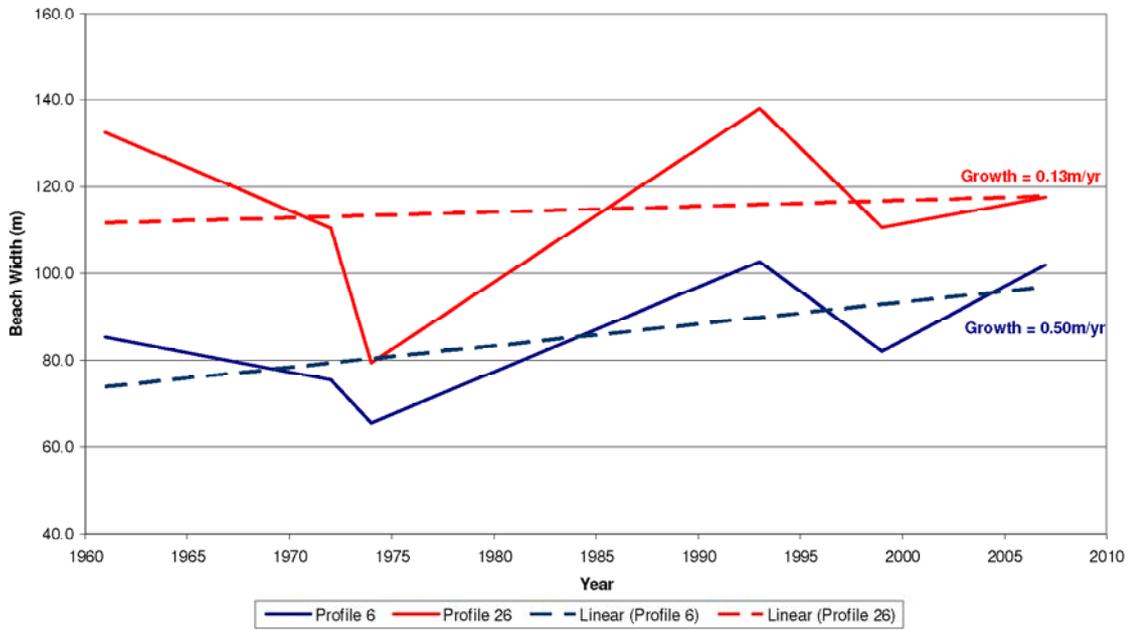


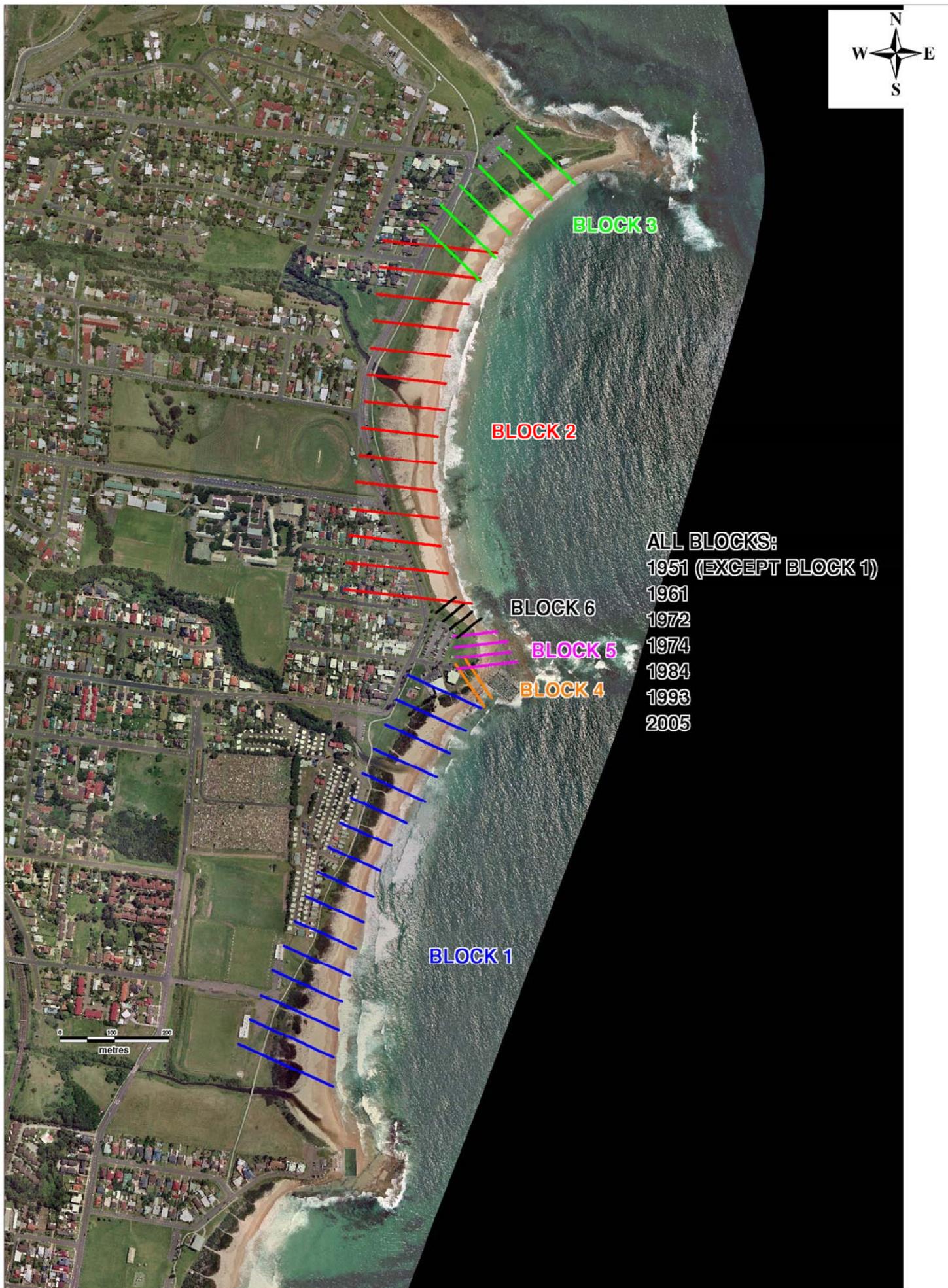


Thirroul - Beach Volume History

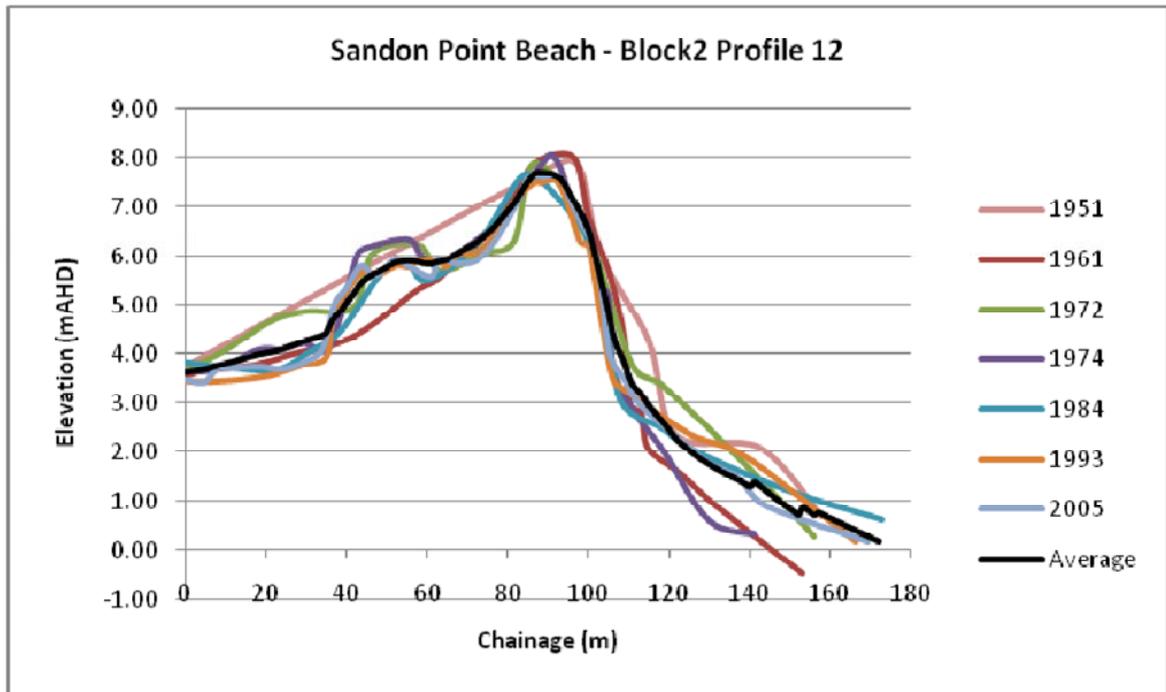
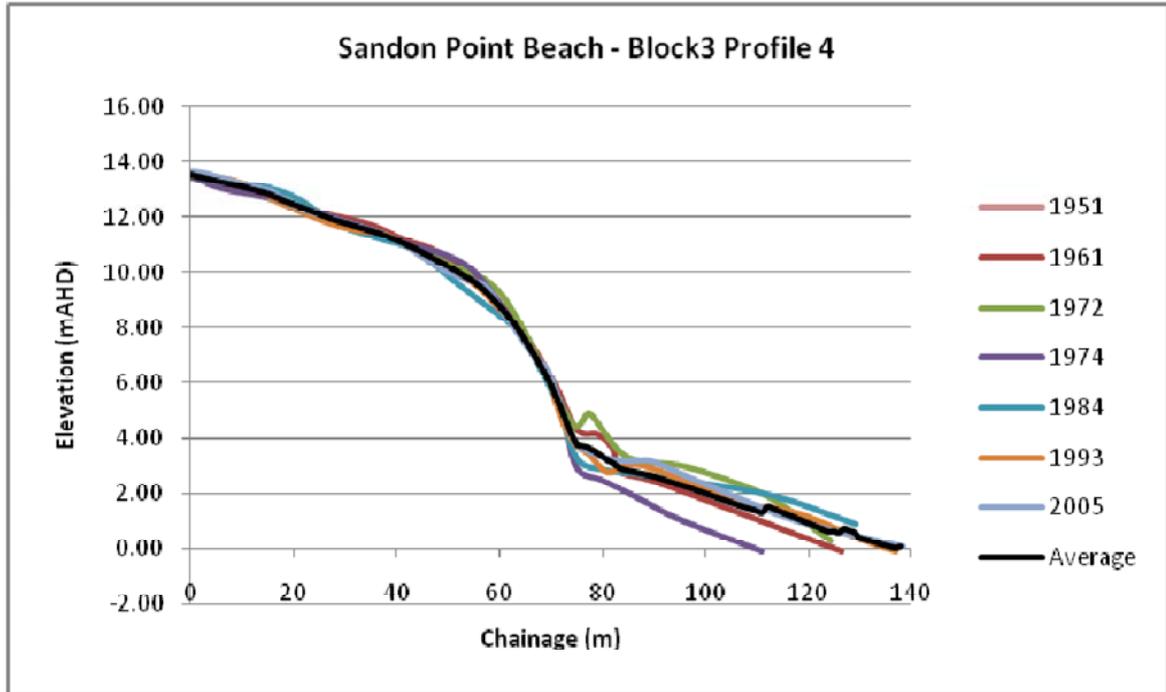


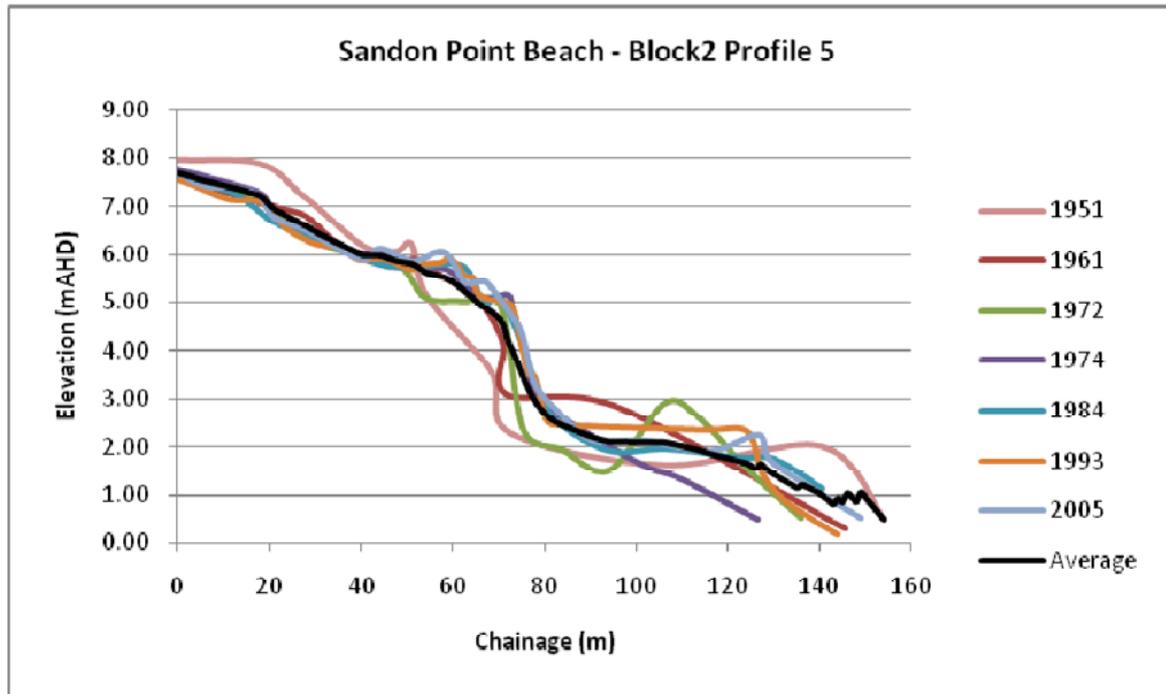
Thirroul - Beach Width History

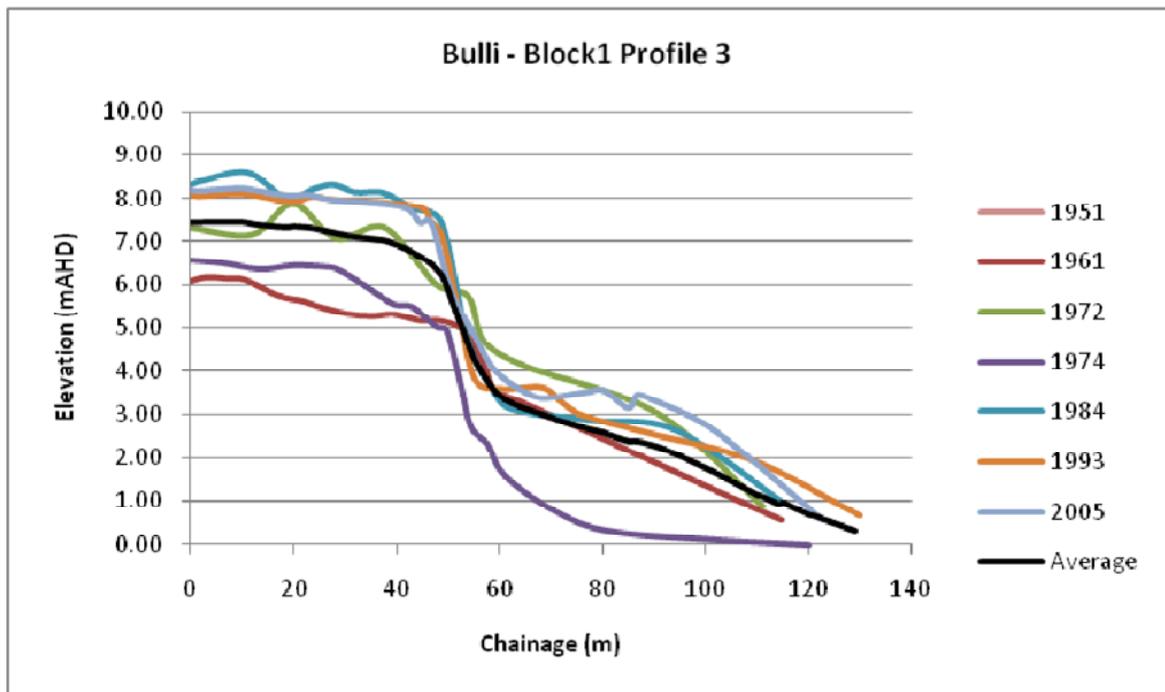
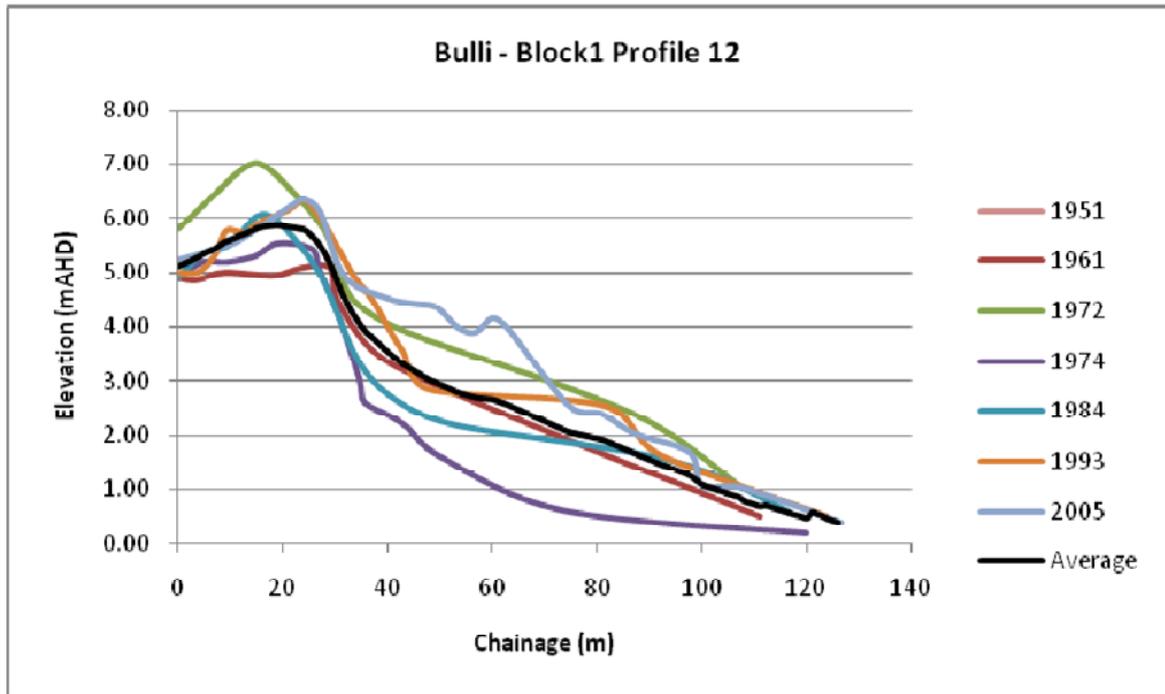


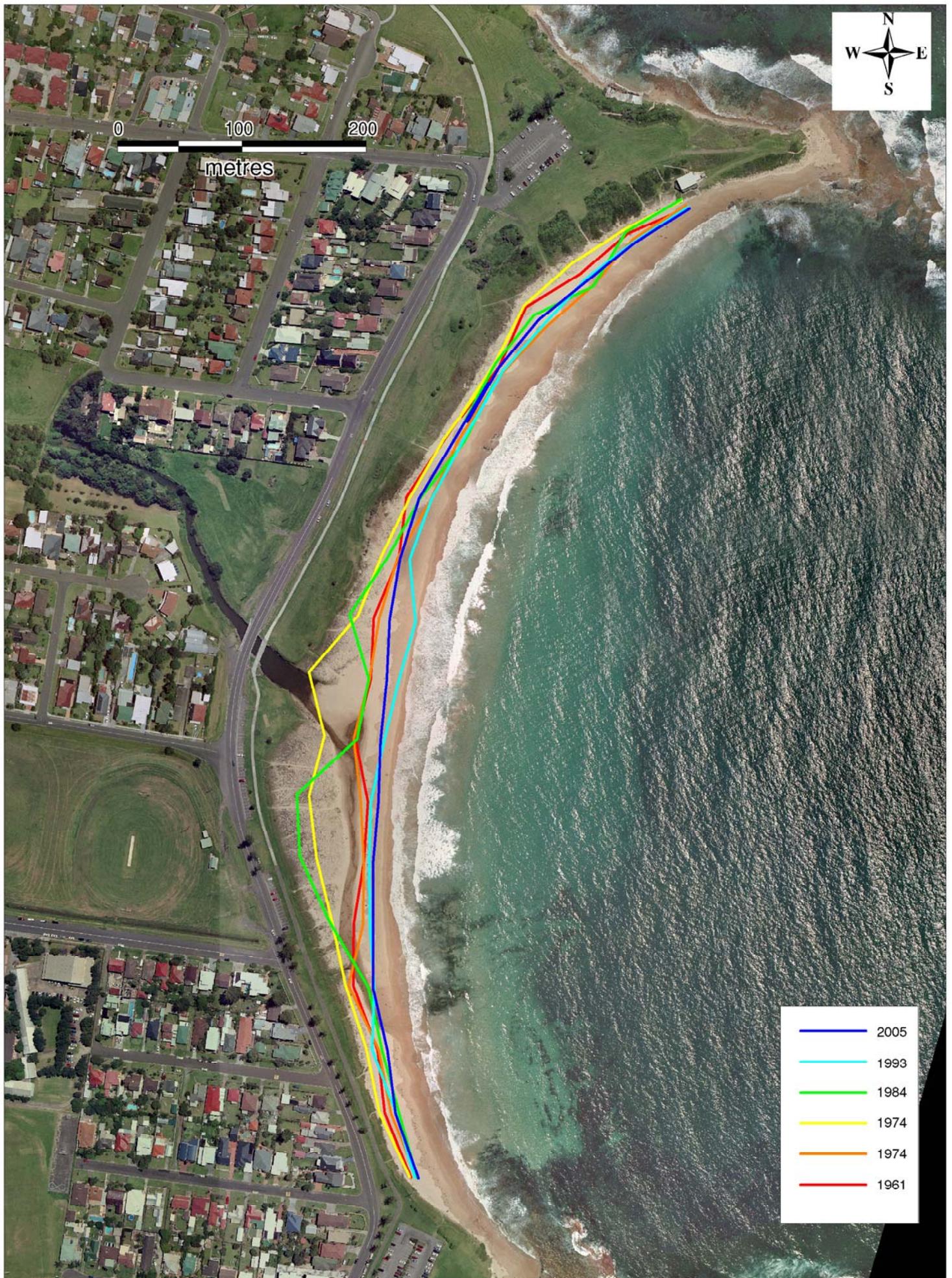


ALL BLOCKS:  
1951 (EXCEPT BLOCK 1)  
1961  
1972  
1974  
1984  
1993  
2005





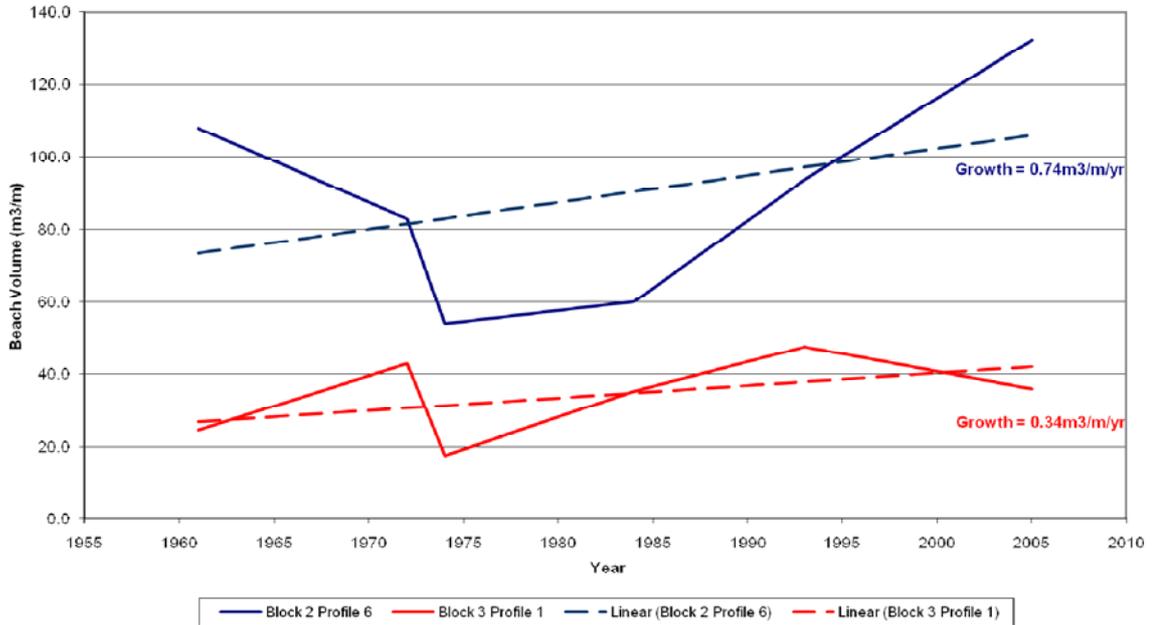




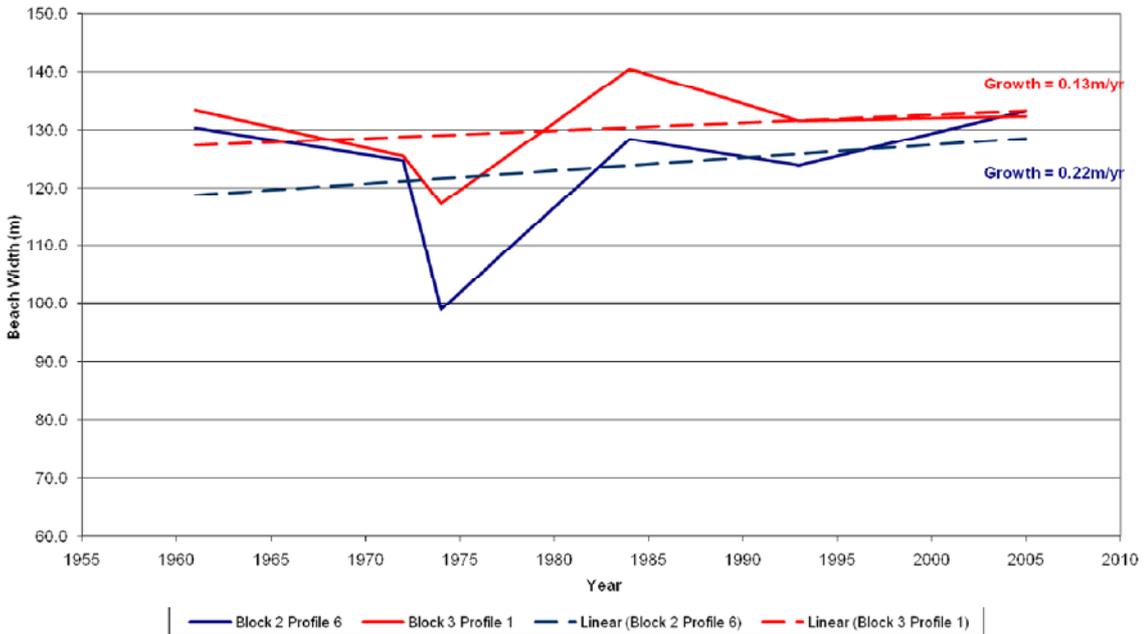


- 2005
- 1993
- 1984
- 1974
- 1972
- 1961

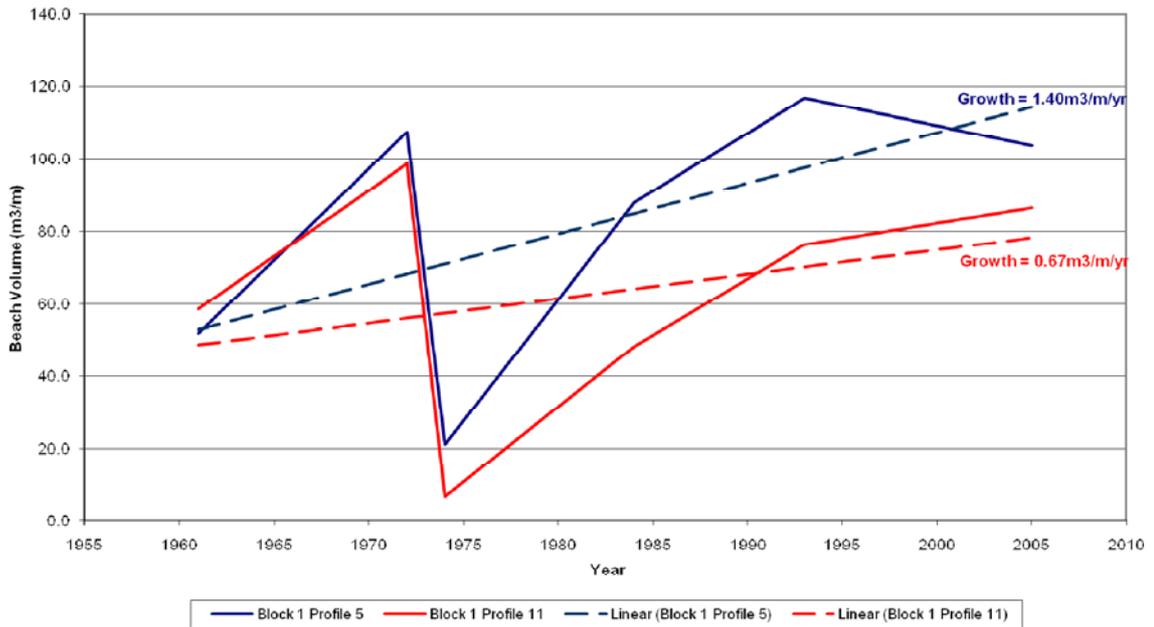
Sandon Pt Beach- Beach Volume History



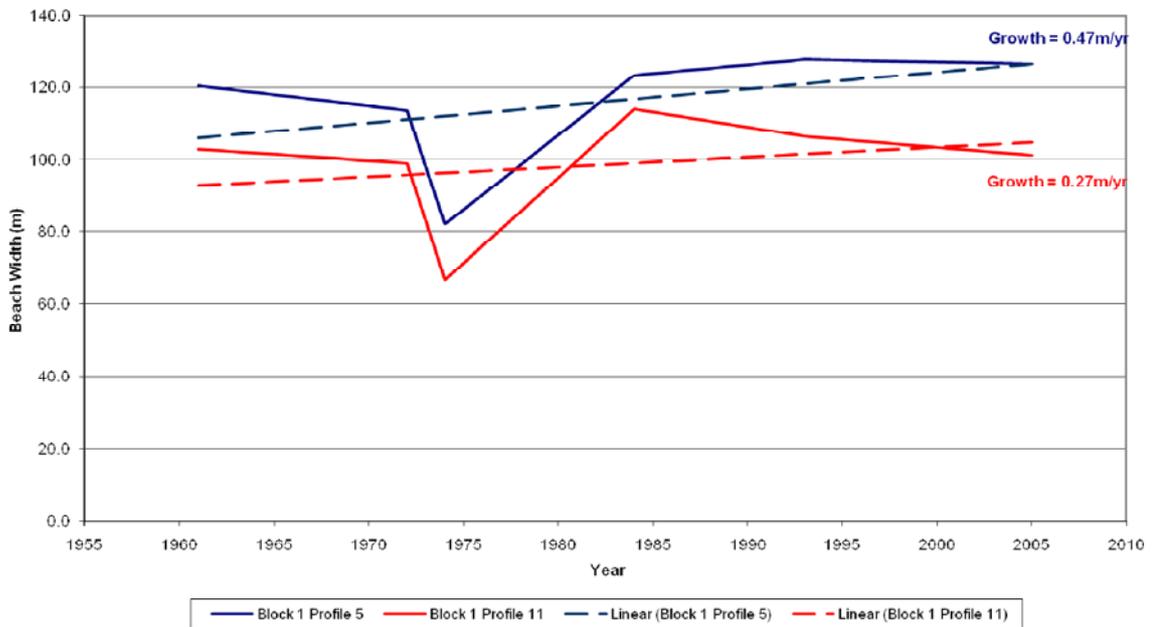
Sandon Pt Beach - Beach Width History

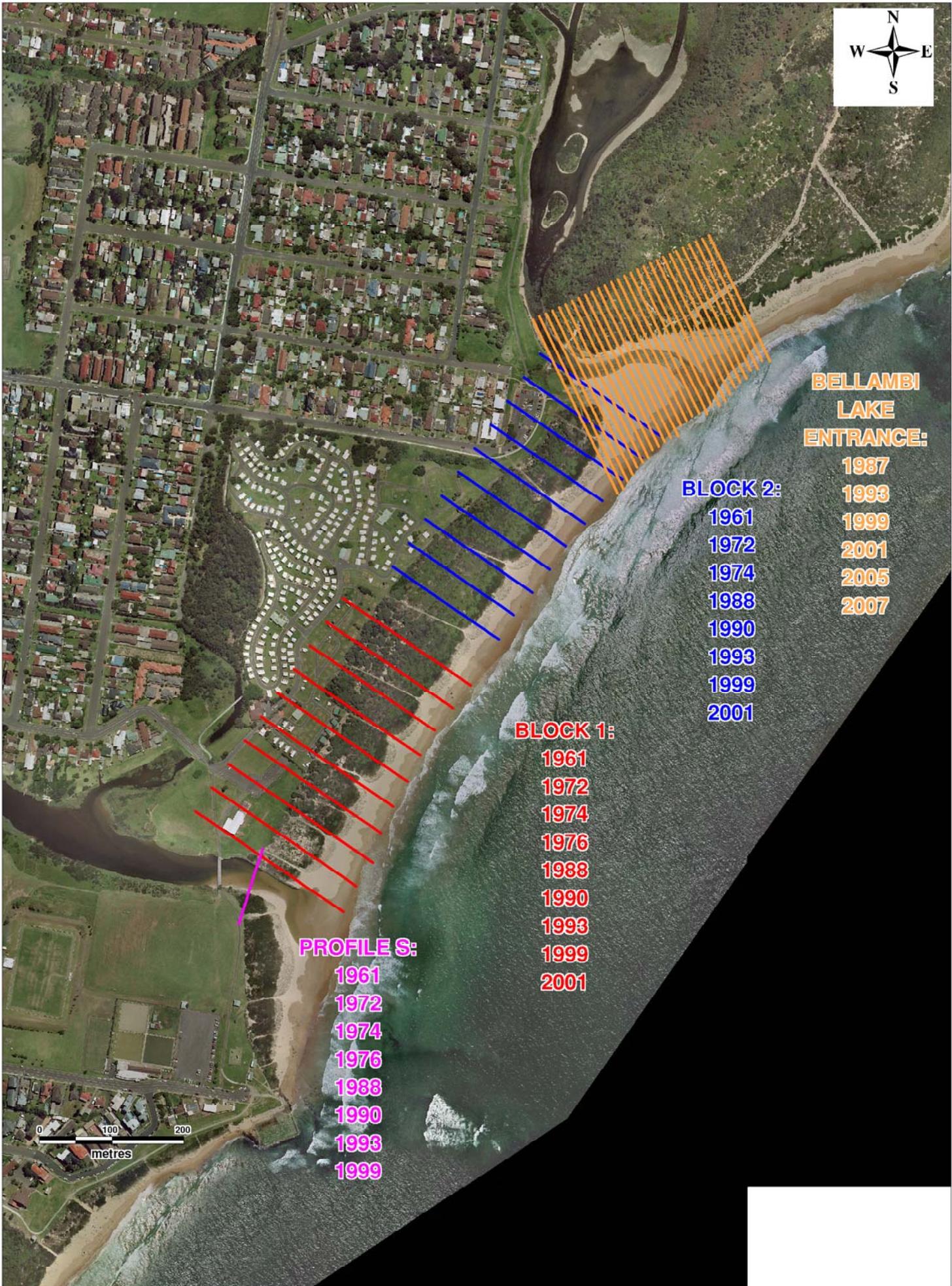


Bulli Beach - Beach Volume History



Bulli Beach - Beach Width History





**BELLAMBI  
LAKE  
ENTRANCE:**

- 1987
- 1993
- 1999
- 2001
- 2005
- 2007

**BLOCK 2:**

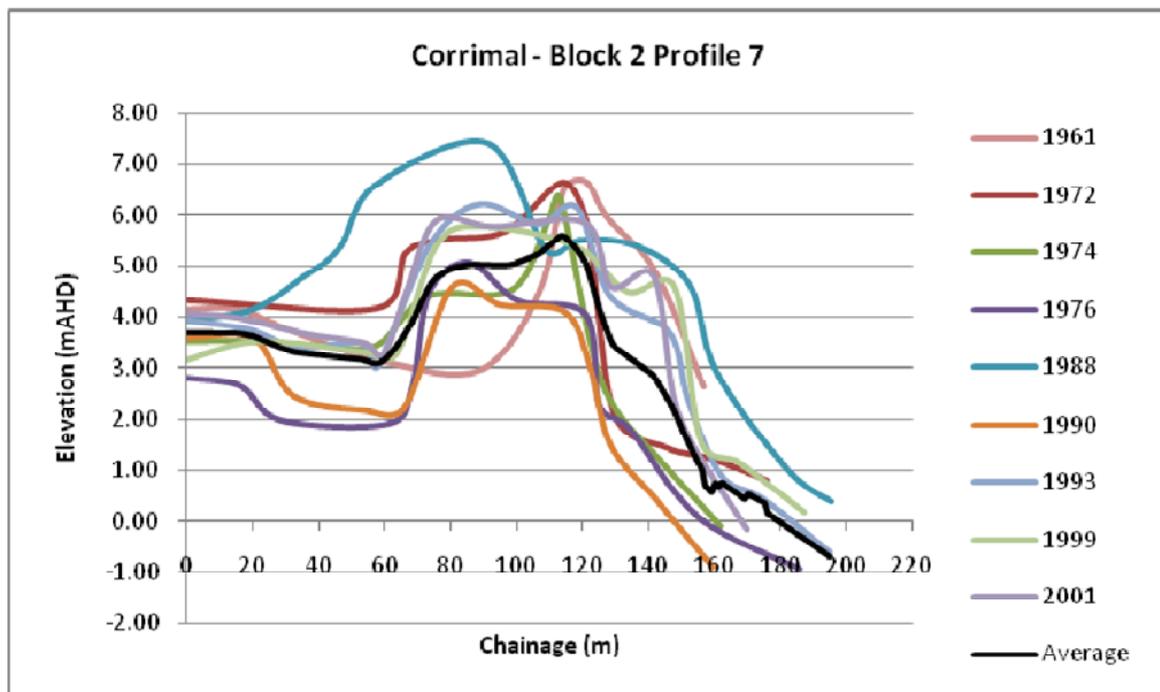
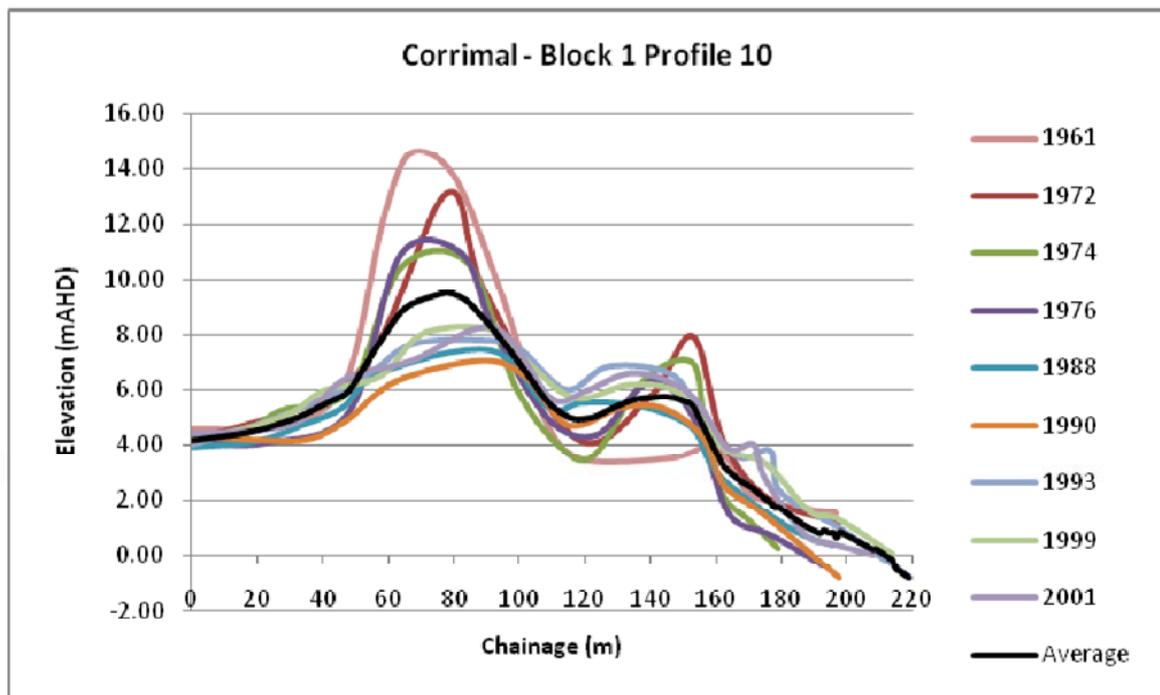
- 1961
- 1972
- 1974
- 1988
- 1990
- 1993
- 1999
- 2001

**BLOCK 1:**

- 1961
- 1972
- 1974
- 1976
- 1988
- 1990
- 1993
- 1999
- 2001

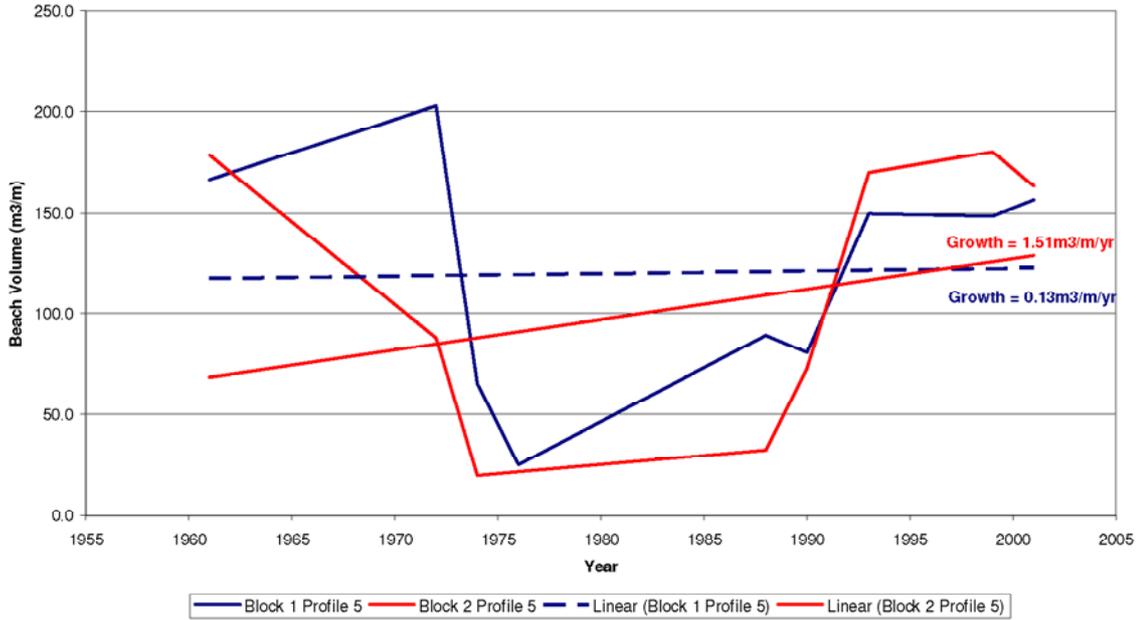
**PROFILE S:**

- 1961
- 1972
- 1974
- 1976
- 1988
- 1990
- 1993
- 1999

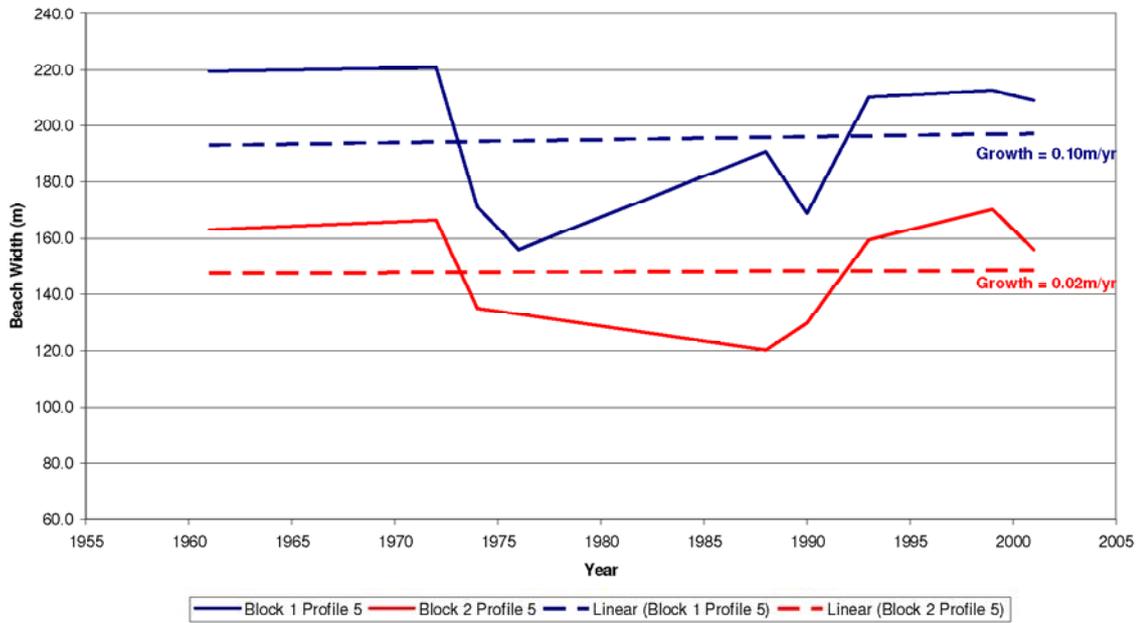


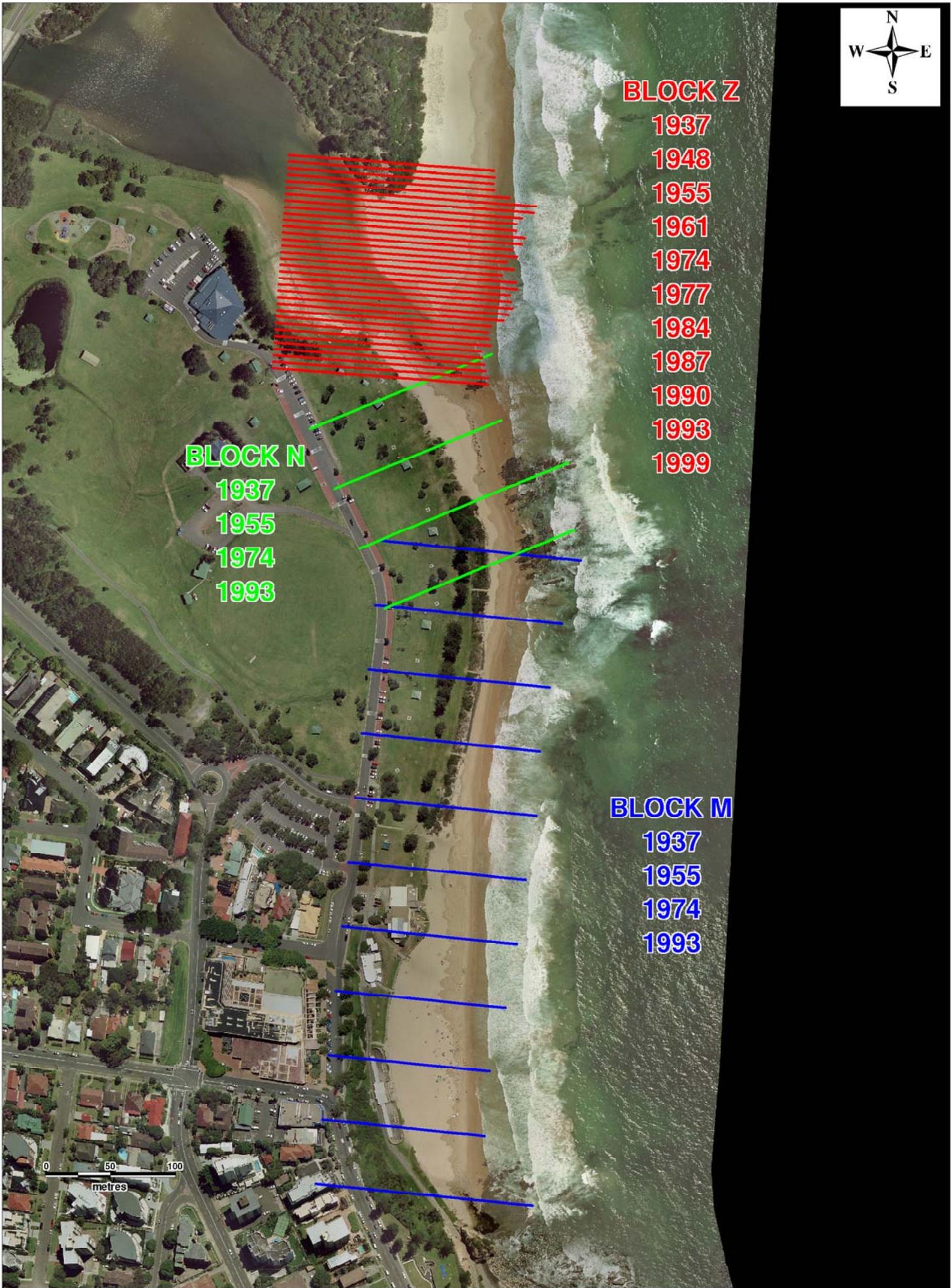


Corrimal - Beach Volume History



Corrimal - Beach Width History





**BLOCK Z**

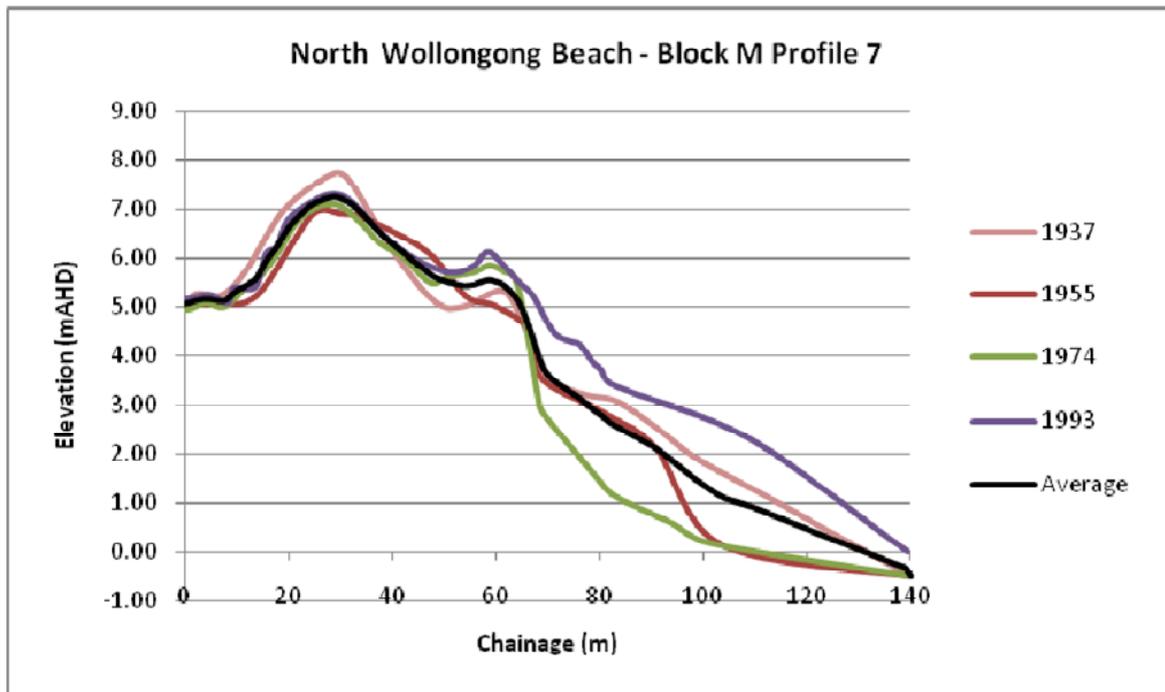
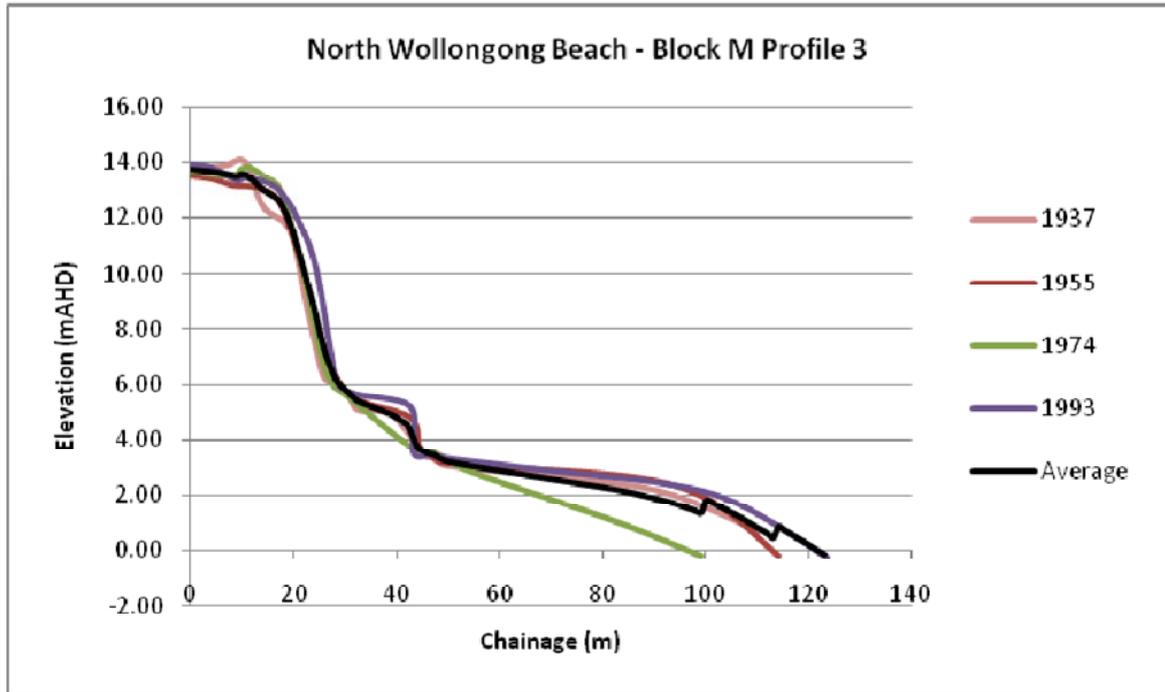
- 1937
- 1948
- 1955
- 1961
- 1974
- 1977
- 1984
- 1987
- 1990
- 1993
- 1999

**BLOCK N**

- 1937
- 1955
- 1974
- 1993

**BLOCK M**

- 1937
- 1955
- 1974
- 1993



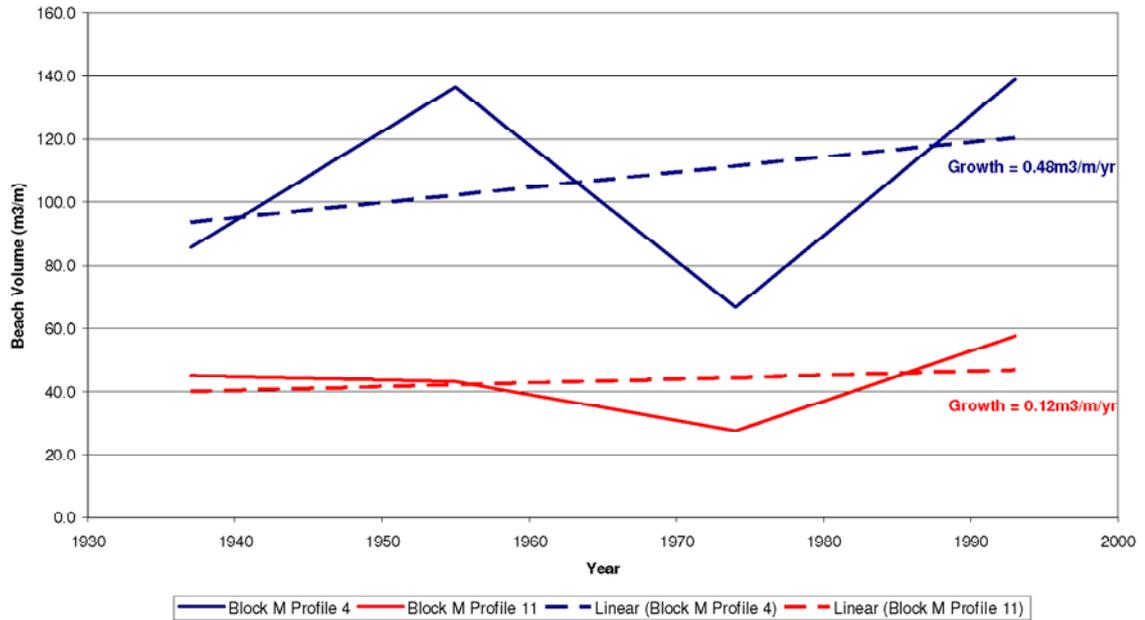


0 50 100  
metres

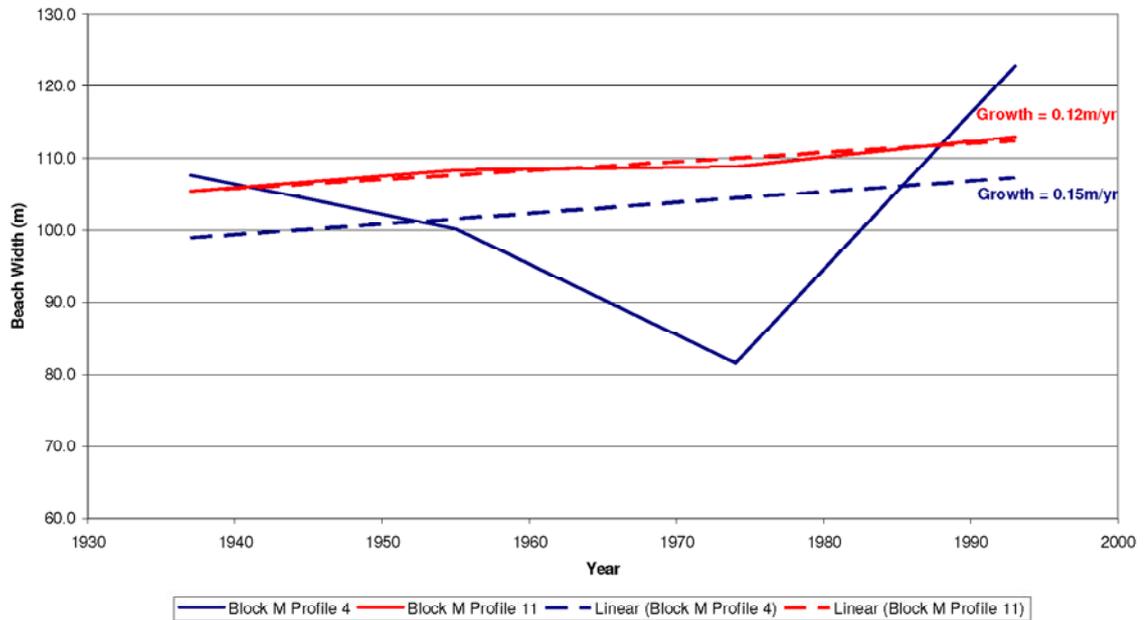


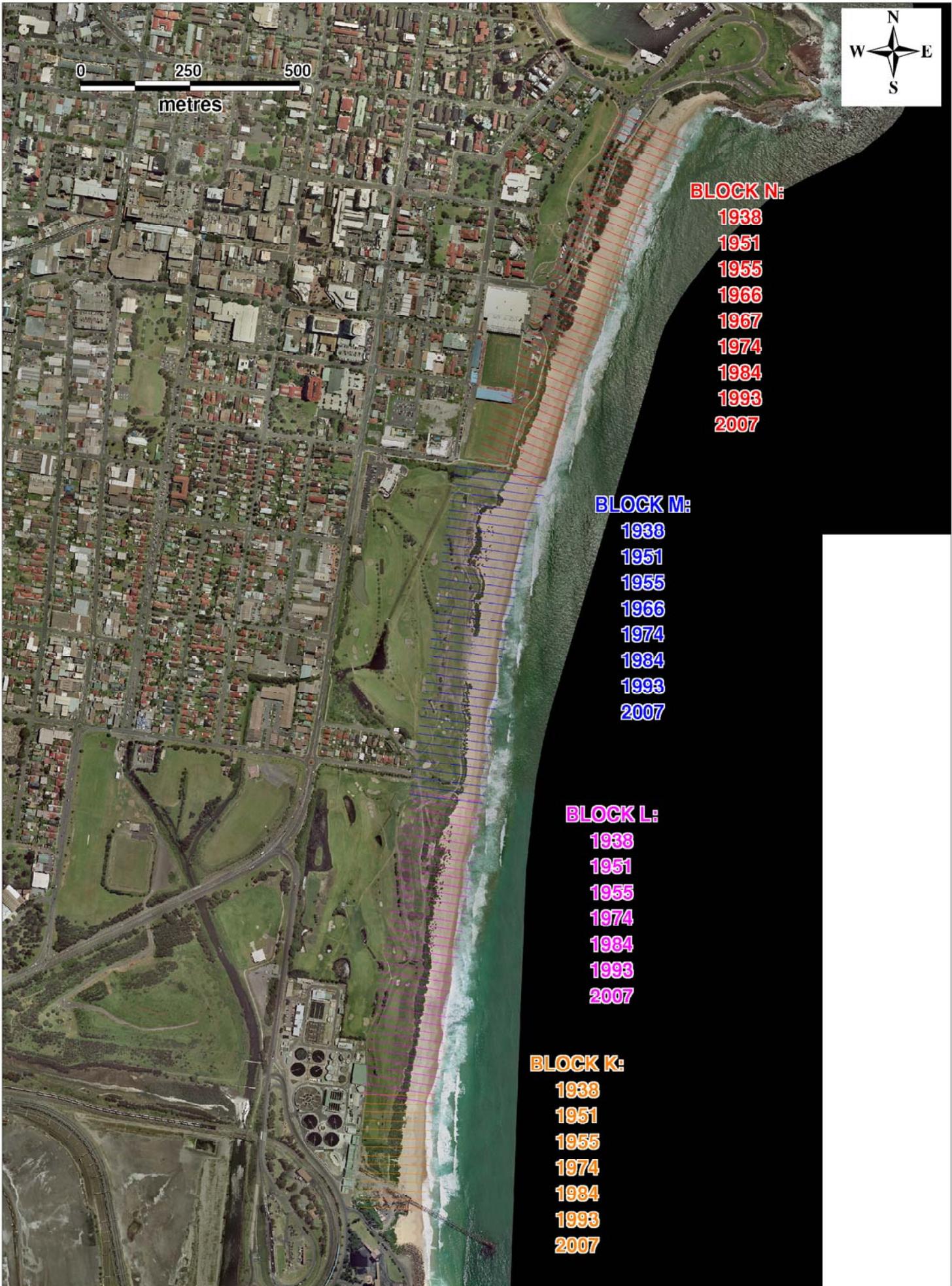
- 1993
- 1974
- 1955
- 1937

North Wollongong Beach - Beach Volume Trend



North Wollongong Beach - Beach Width Trend



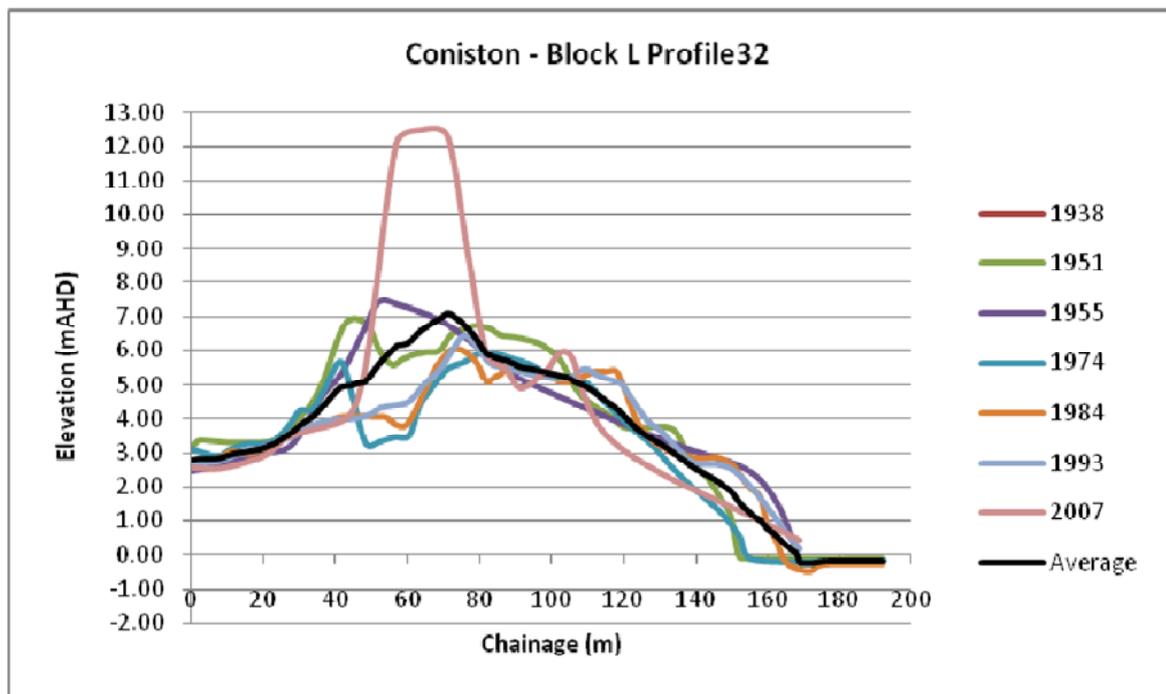
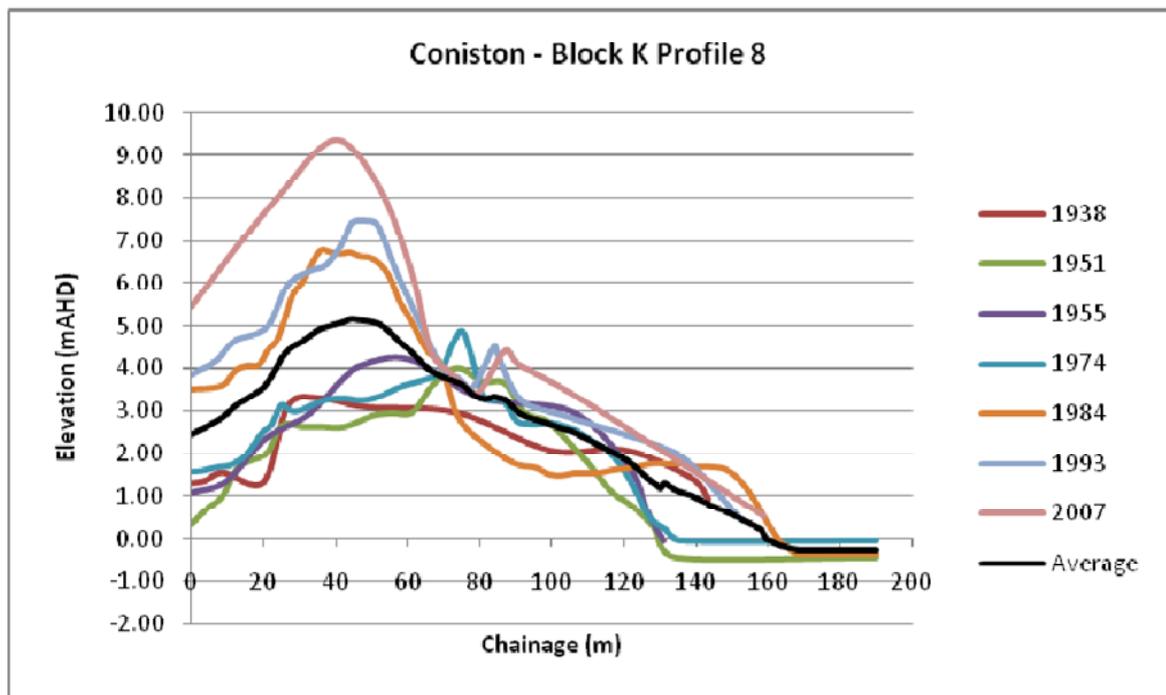


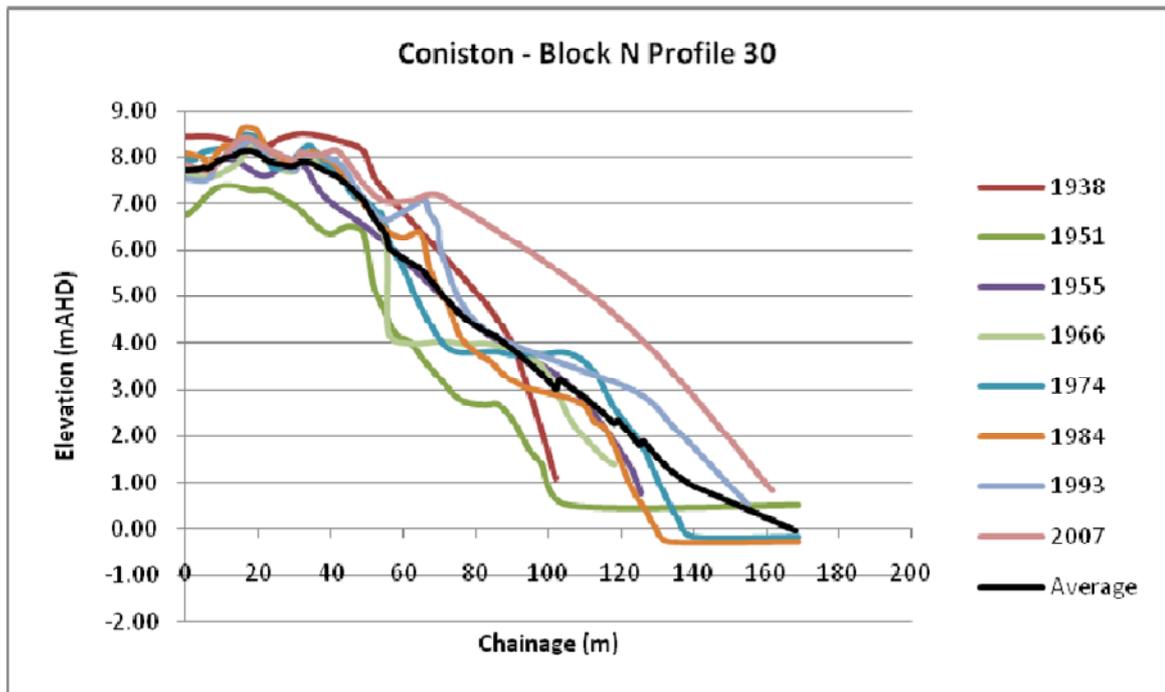
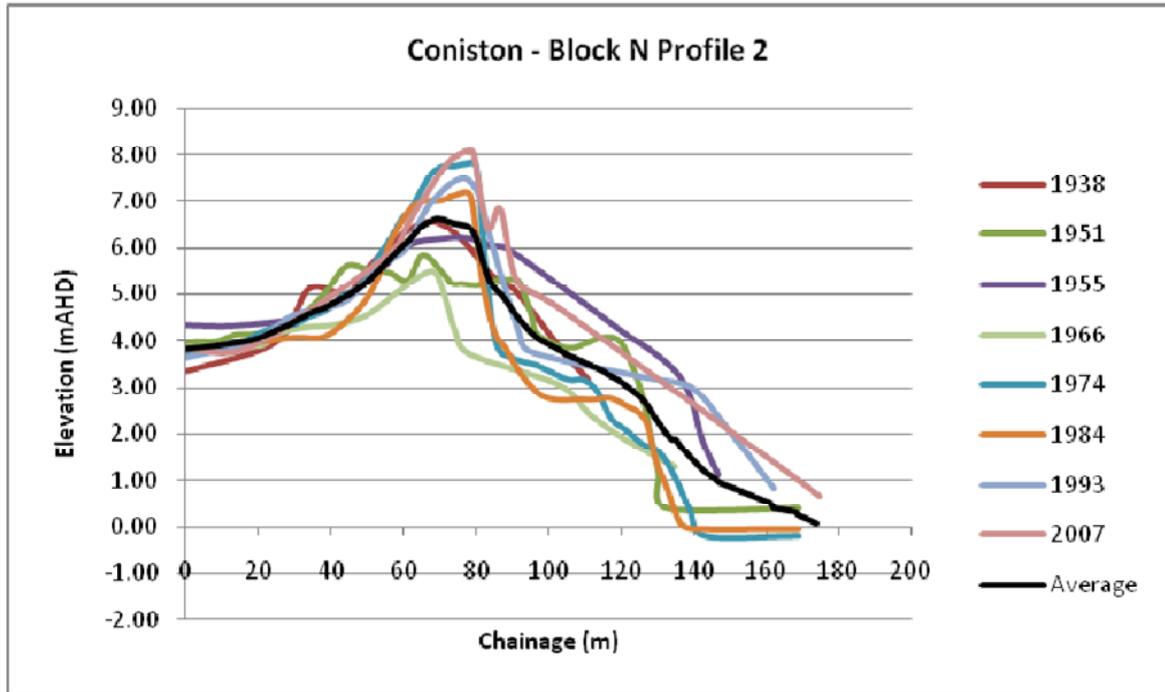
**BLOCK N:**  
 1938  
 1951  
 1955  
 1966  
 1967  
 1974  
 1984  
 1993  
 2007

**BLOCK M:**  
 1938  
 1951  
 1955  
 1966  
 1974  
 1984  
 1993  
 2007

**BLOCK L:**  
 1938  
 1951  
 1955  
 1974  
 1984  
 1993  
 2007

**BLOCK K:**  
 1938  
 1951  
 1955  
 1974  
 1984  
 1993  
 2007

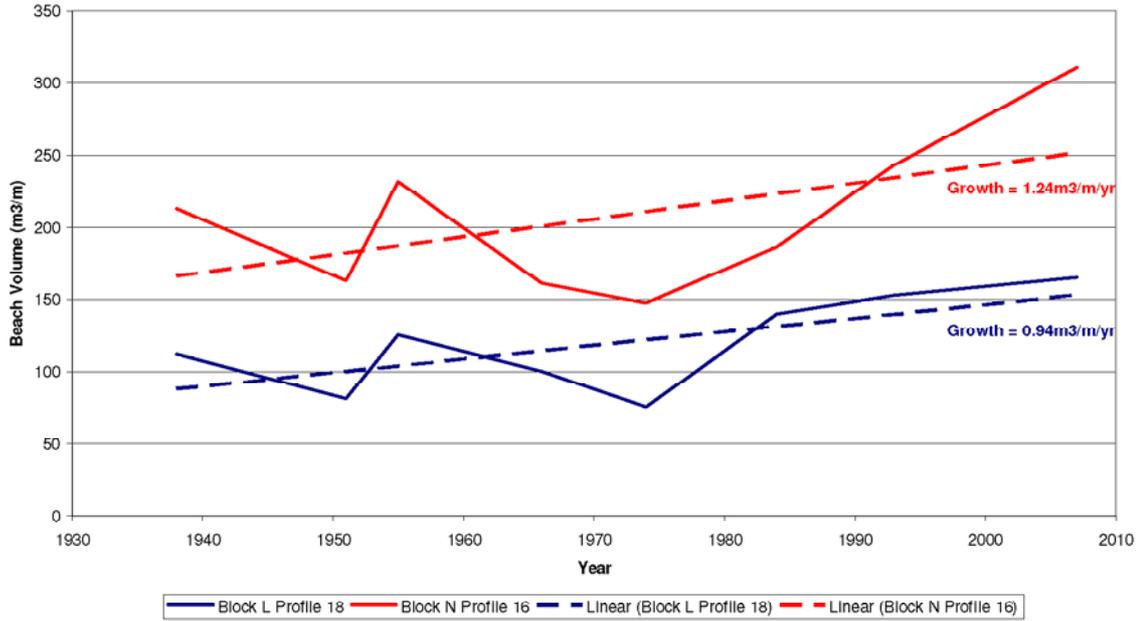




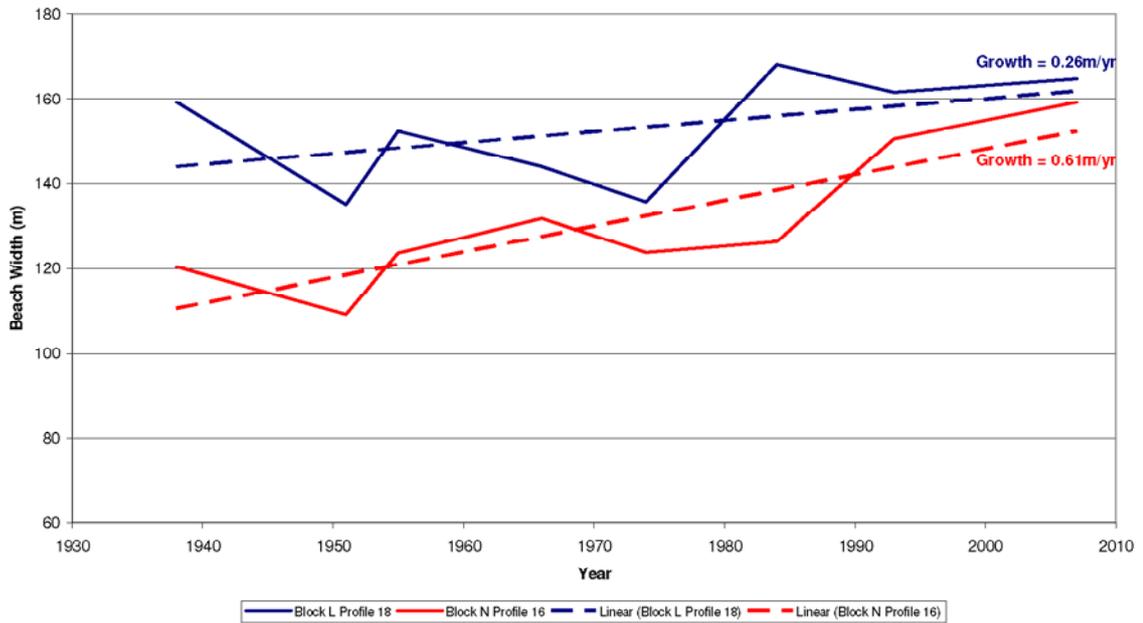




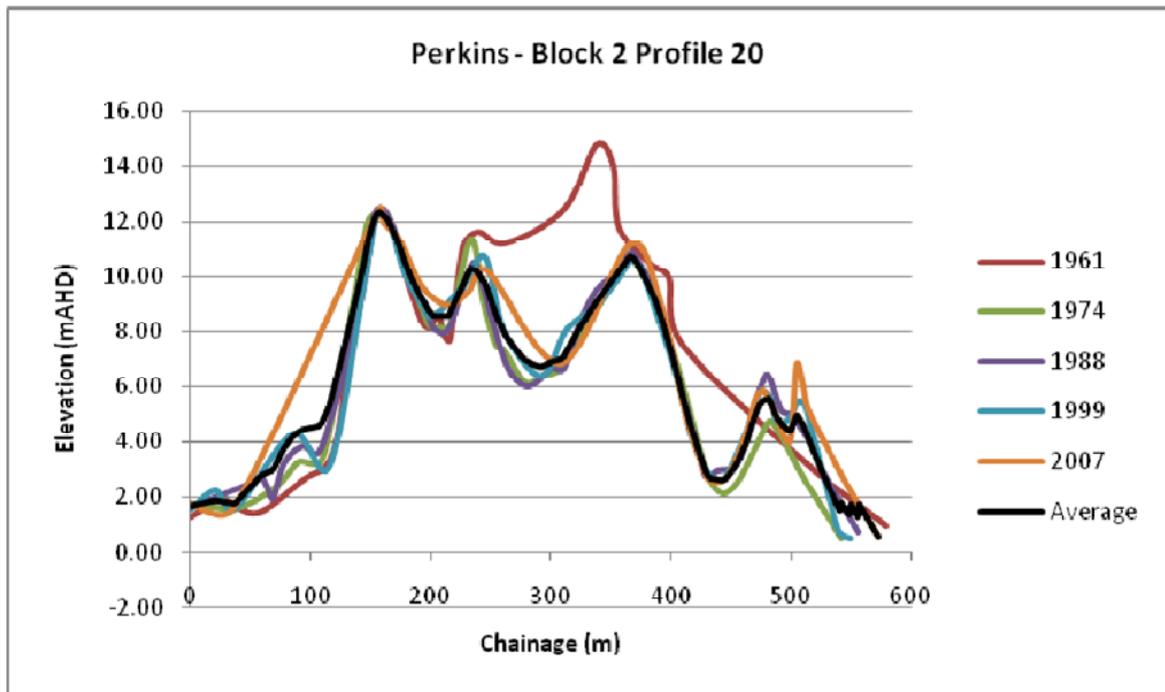
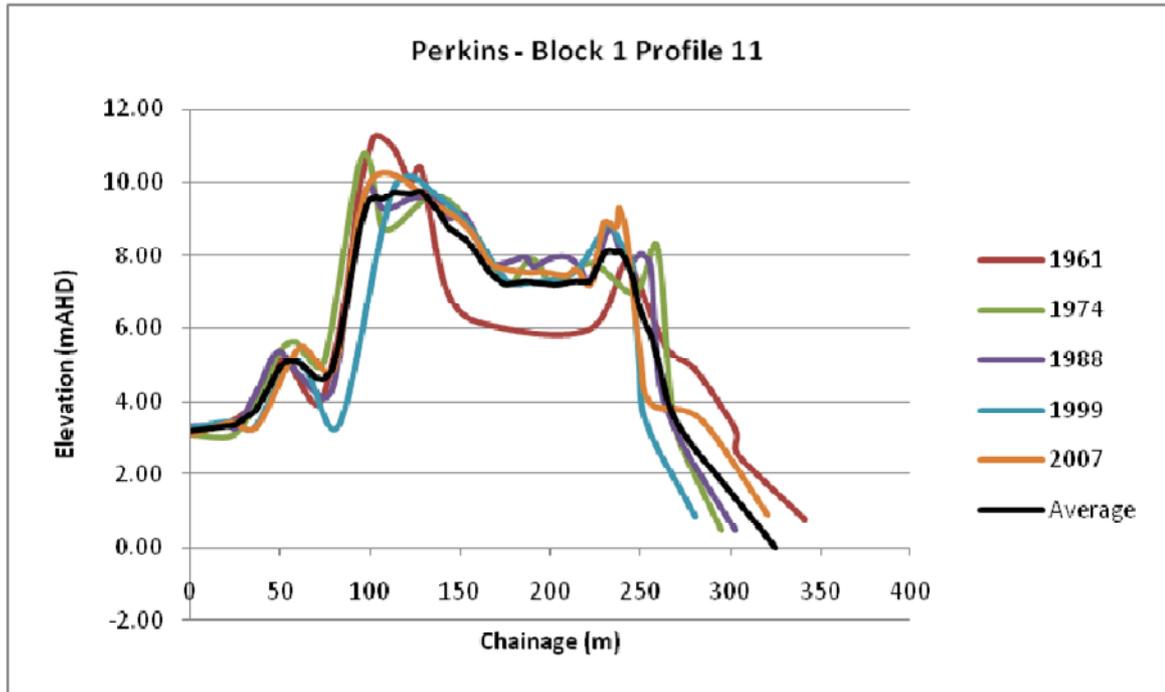
Coniston - Beach Volume History

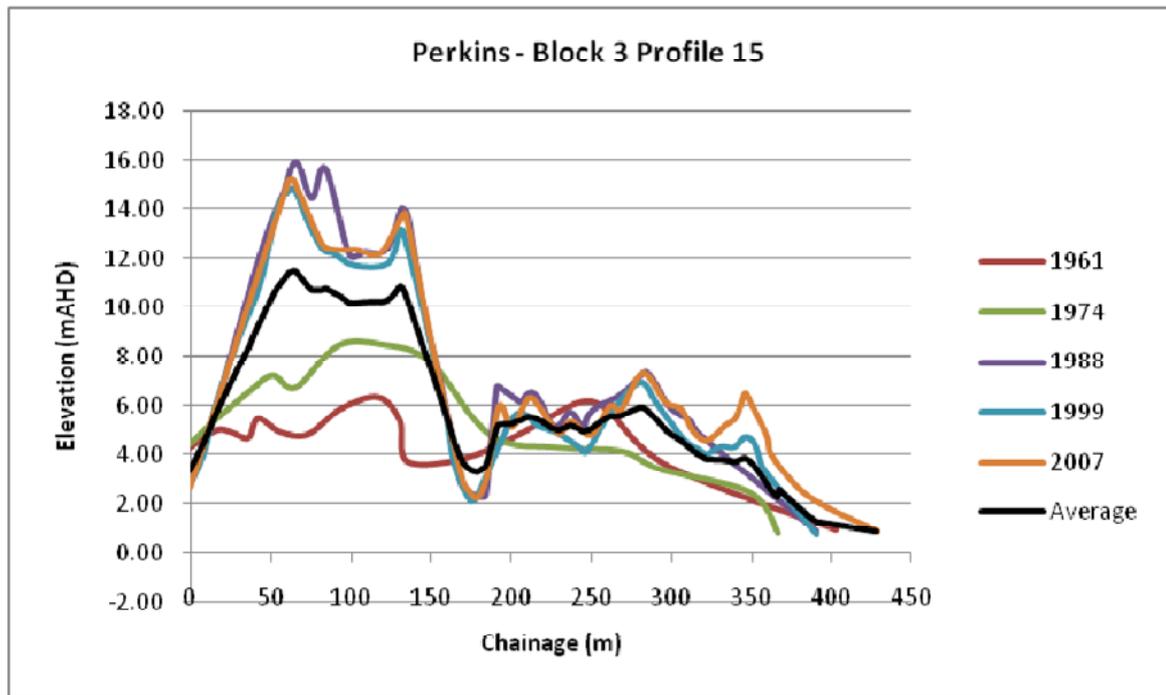


Coniston - Beach Width History











0 250 500  
metres

Kemblawarra

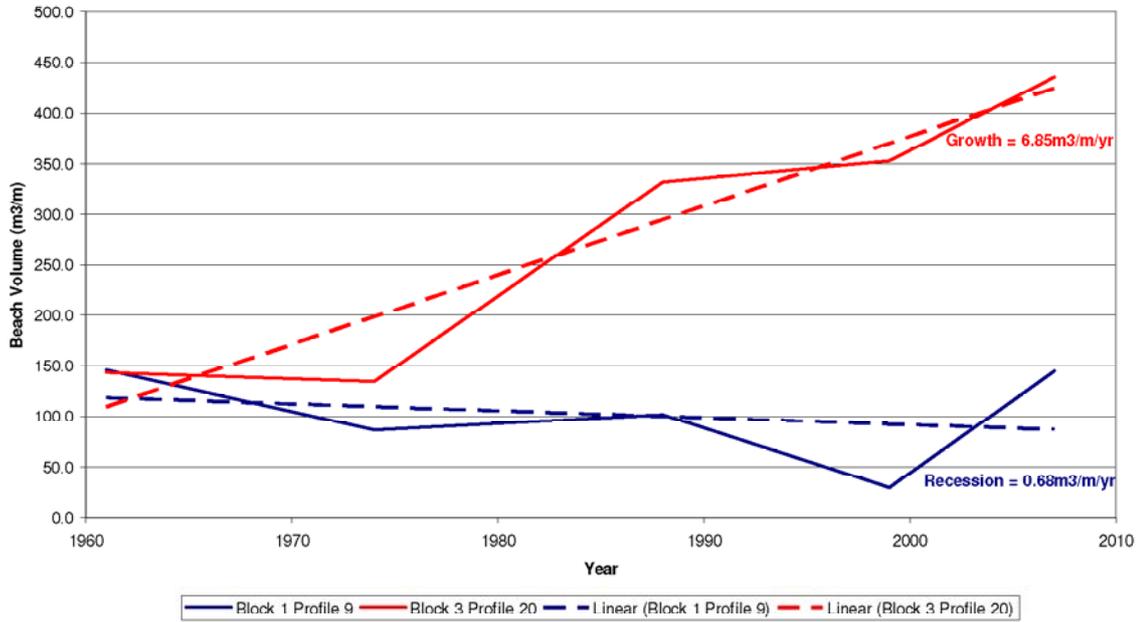


- 2007
- 1999
- 1988
- 1974
- 1961

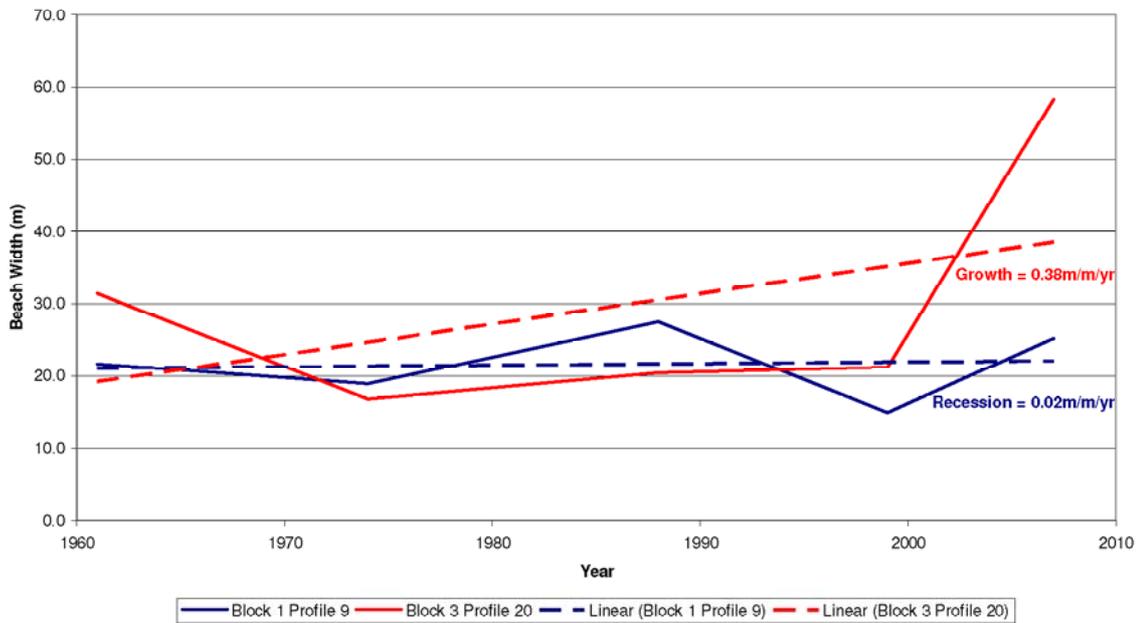


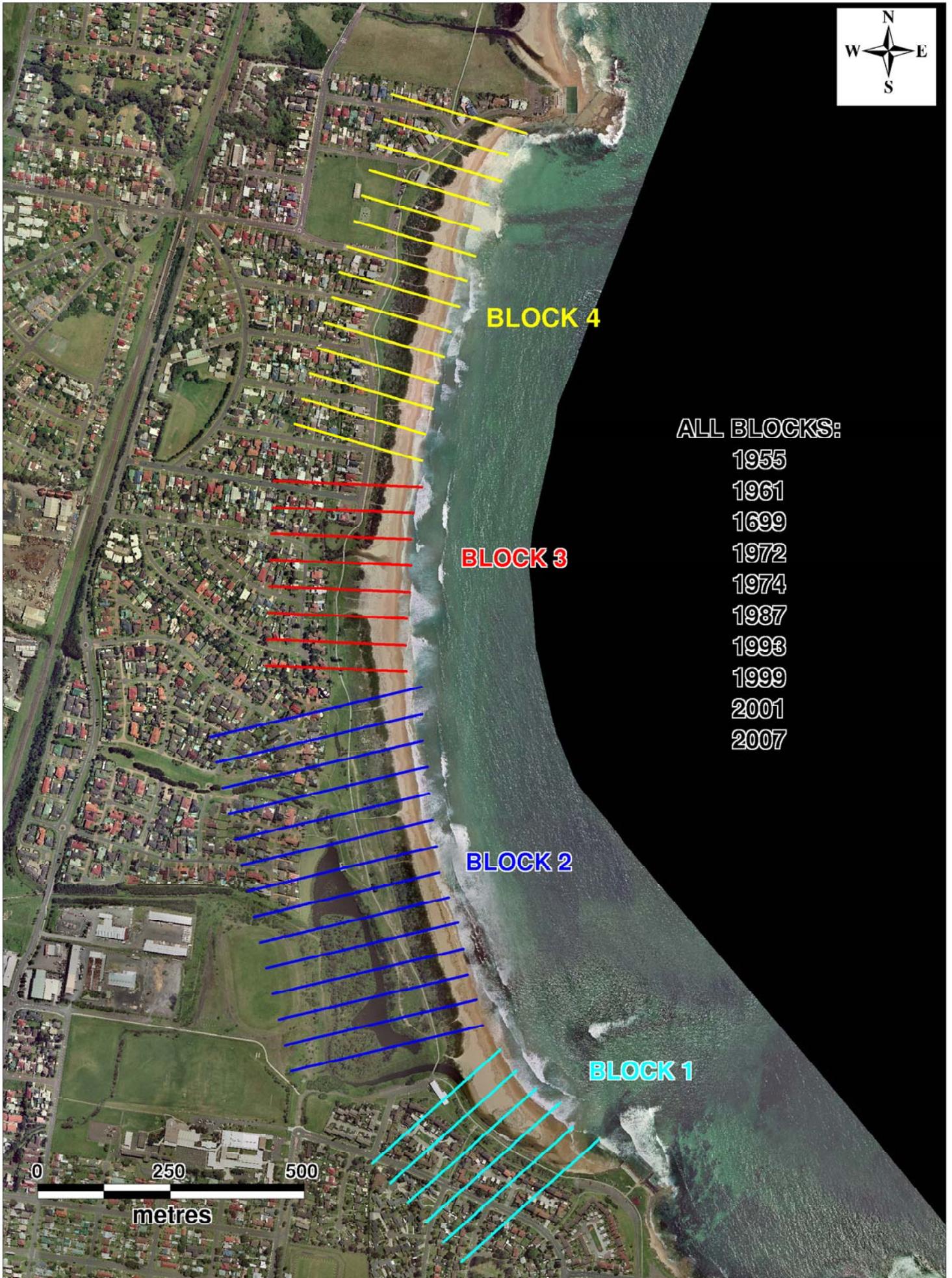


Perkins Beach - Beach Volume History



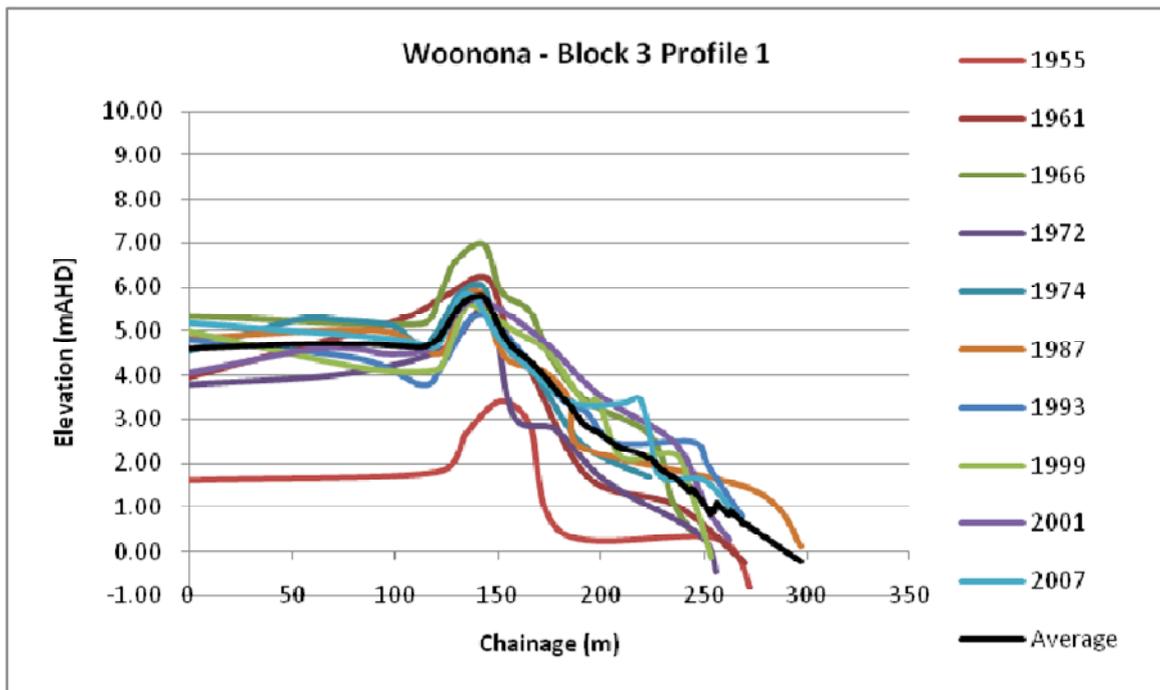
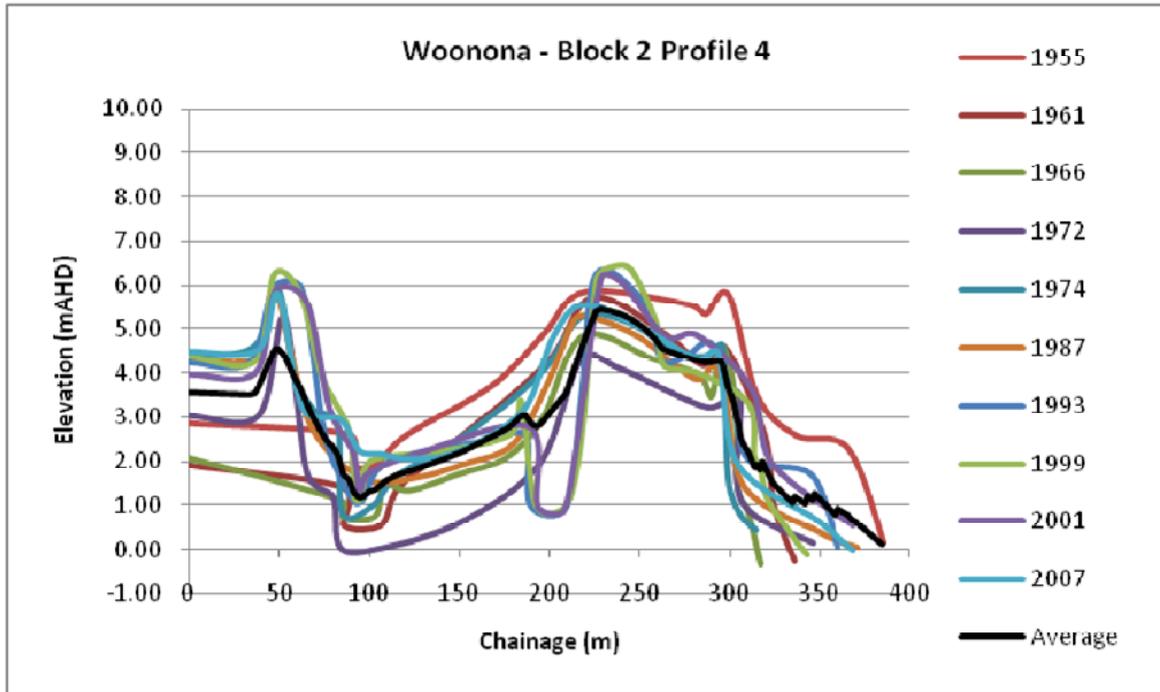
Perkins Beach - Beach Width History

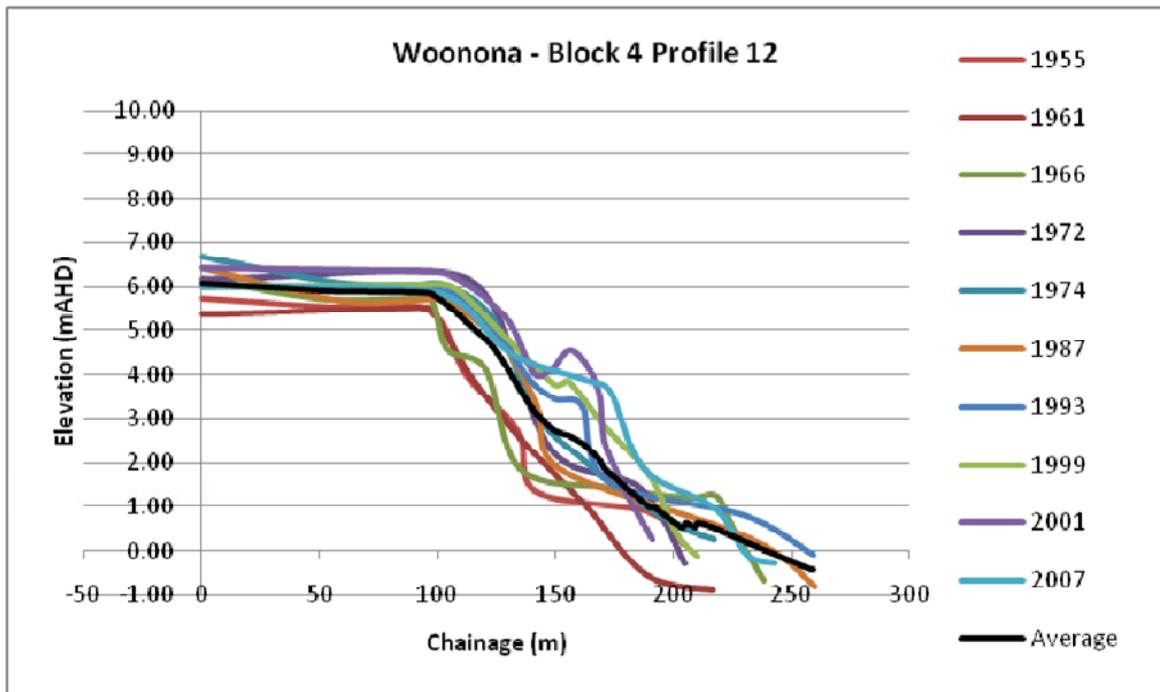
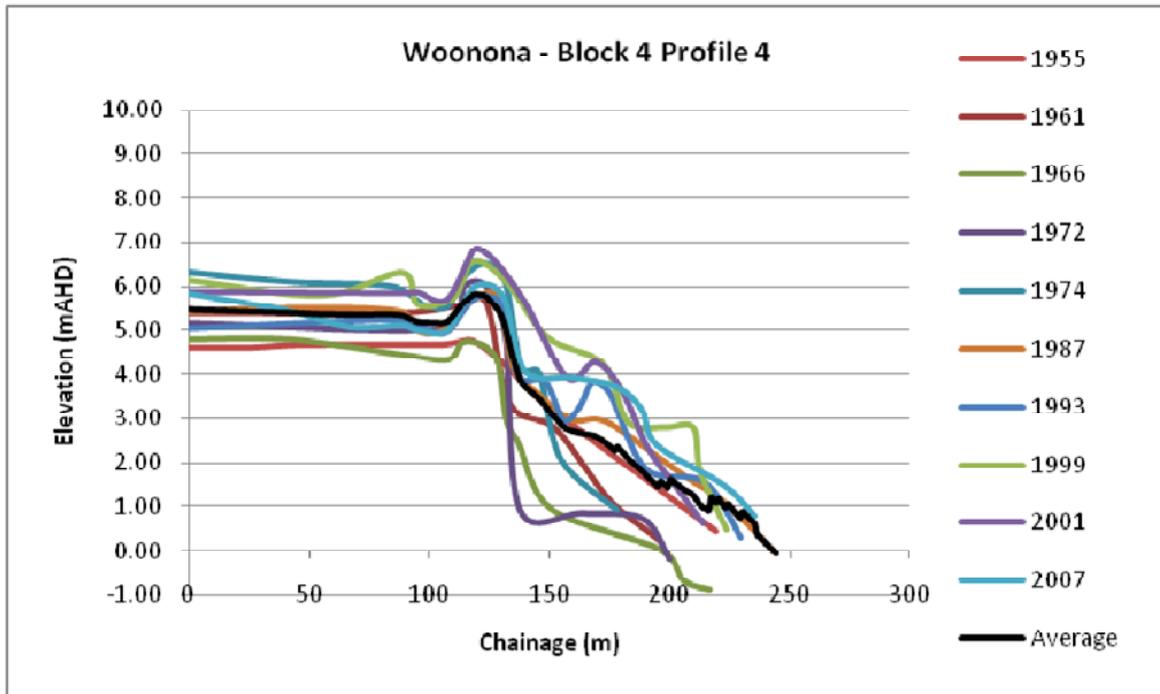


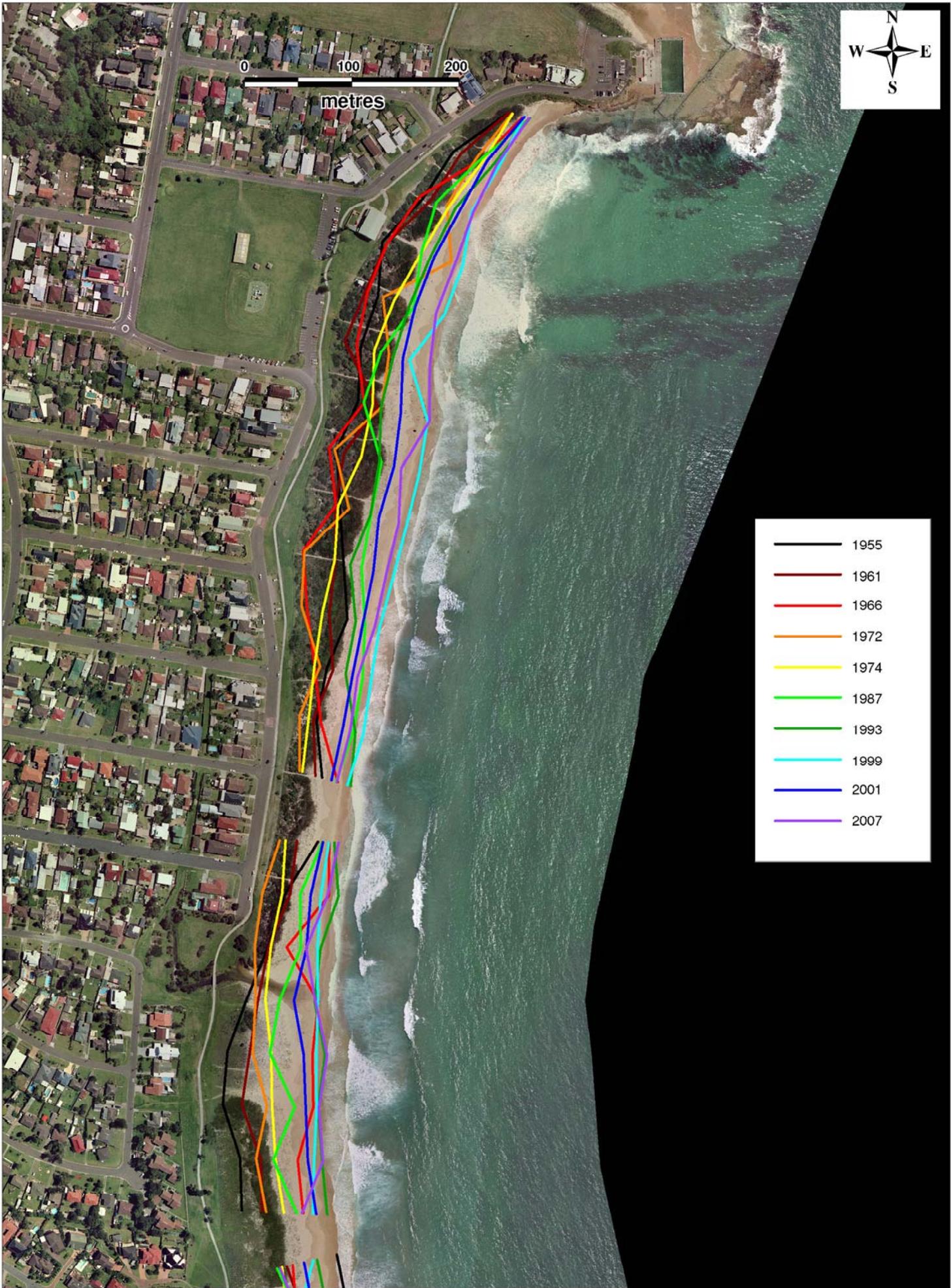


**ALL BLOCKS:**

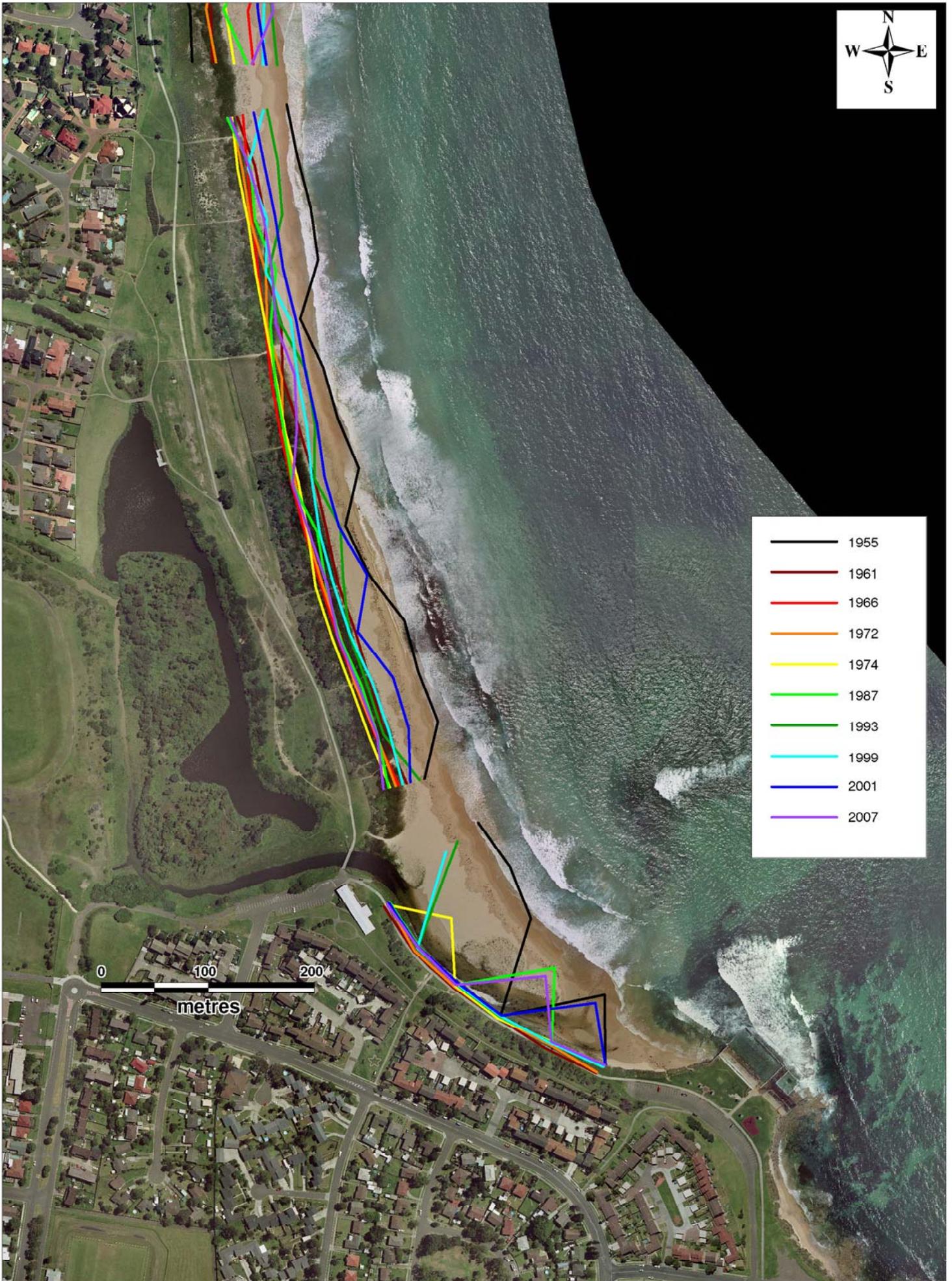
- 1955
- 1961
- 1699
- 1972
- 1974
- 1987
- 1993
- 1999
- 2001
- 2007





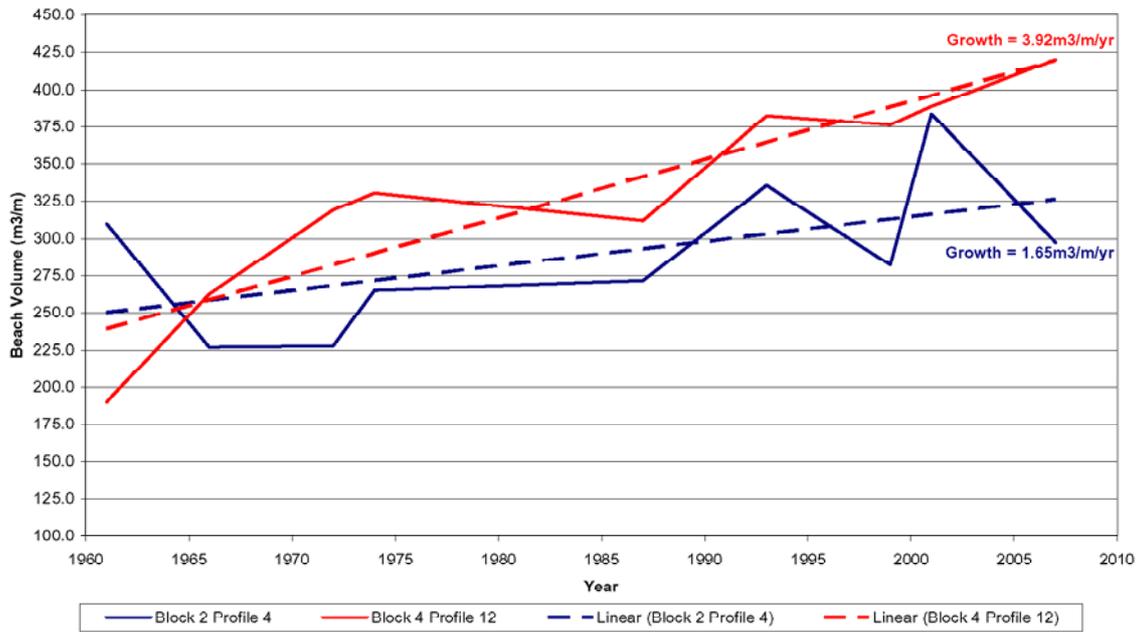


- 1955
- 1961
- 1966
- 1972
- 1974
- 1987
- 1993
- 1999
- 2001
- 2007

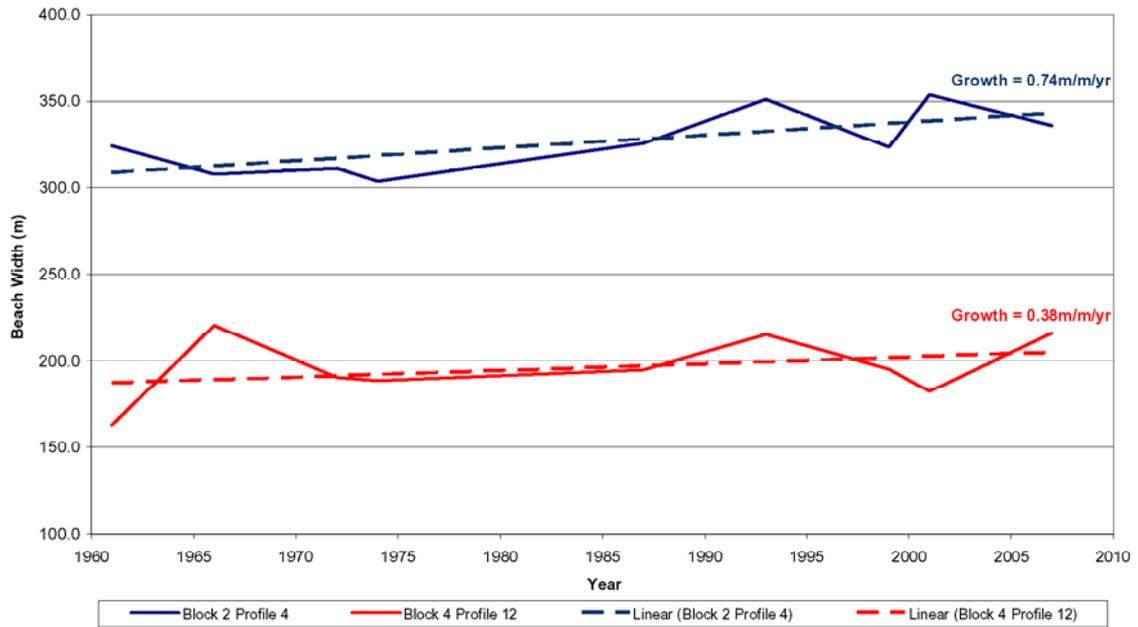


- 1955
- 1961
- 1966
- 1972
- 1974
- 1987
- 1993
- 1999
- 2001
- 2007

Woonona - Beach Volume History

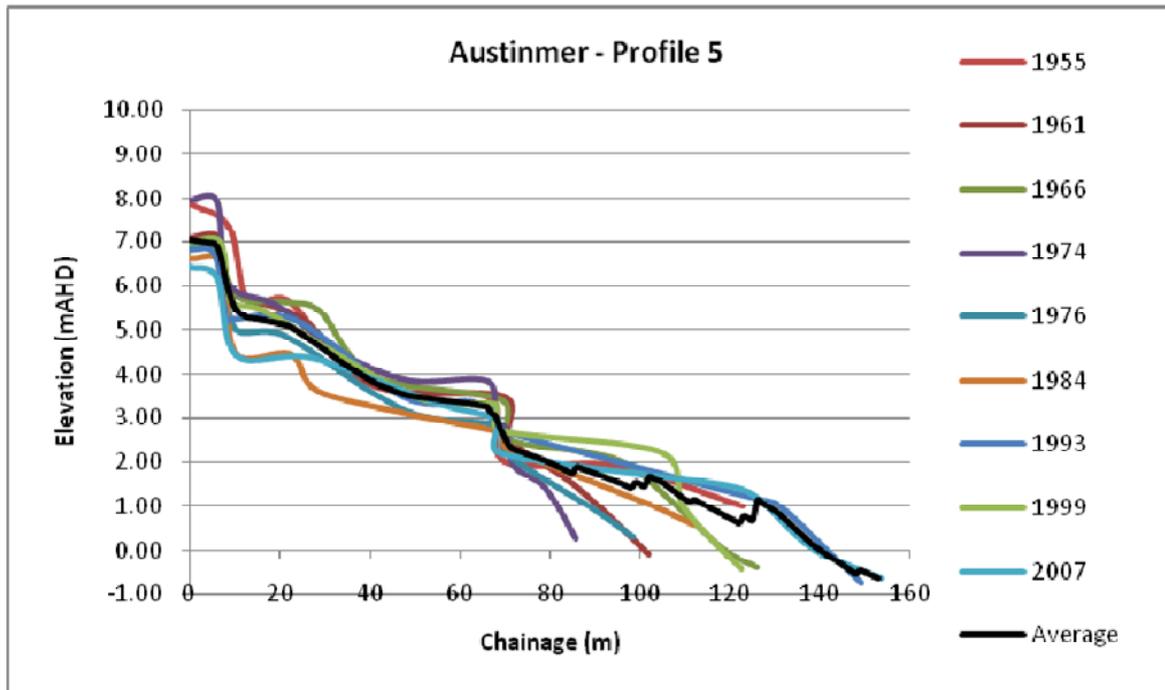
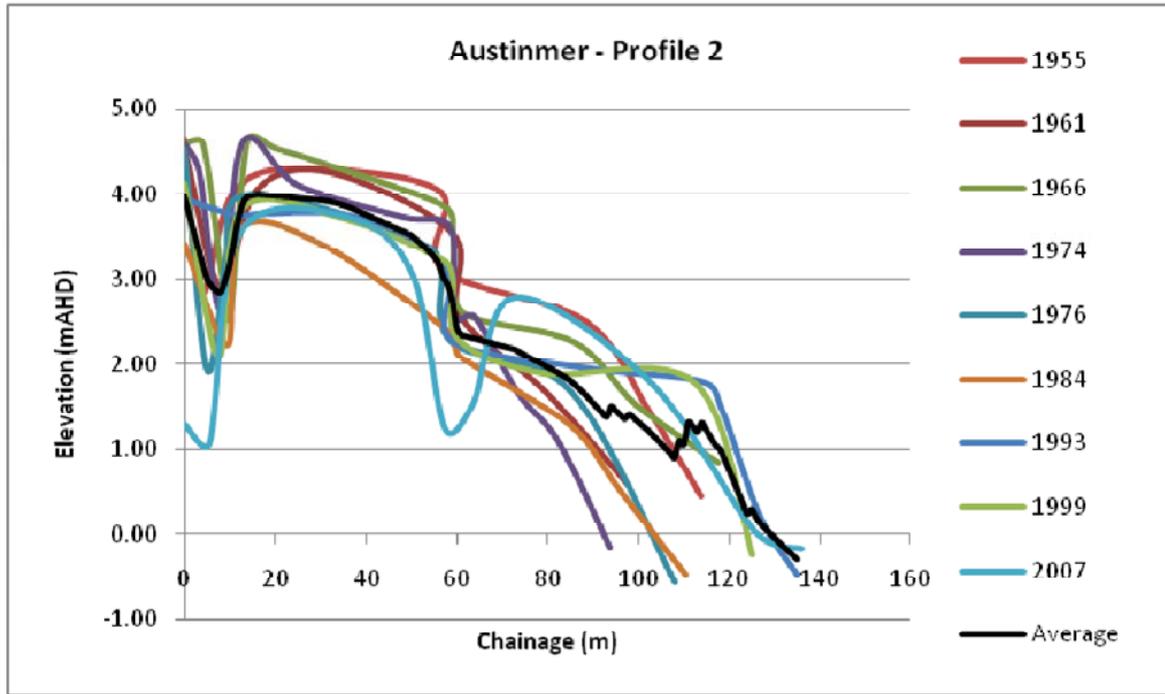


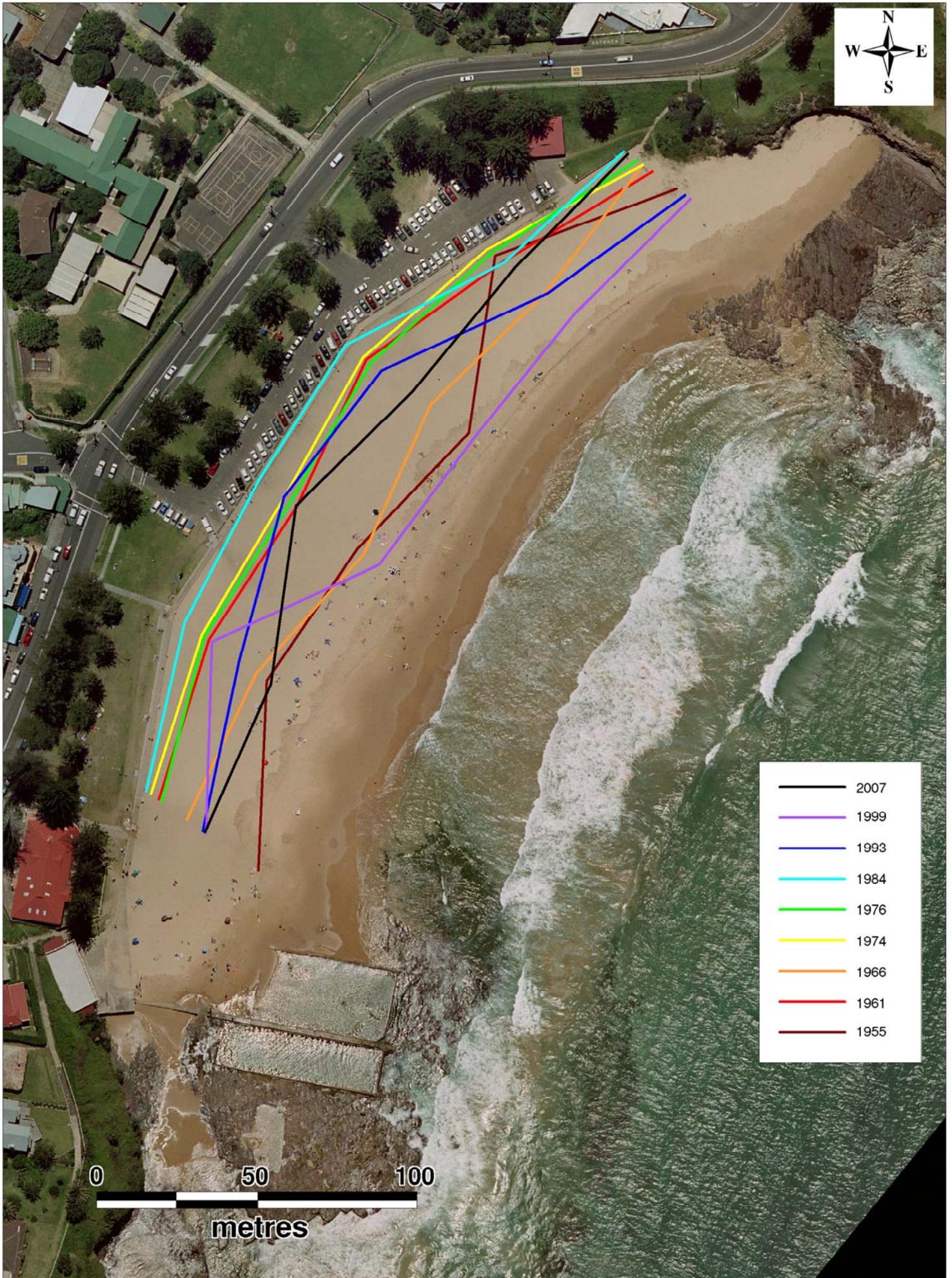
Woonona - Beach Width History



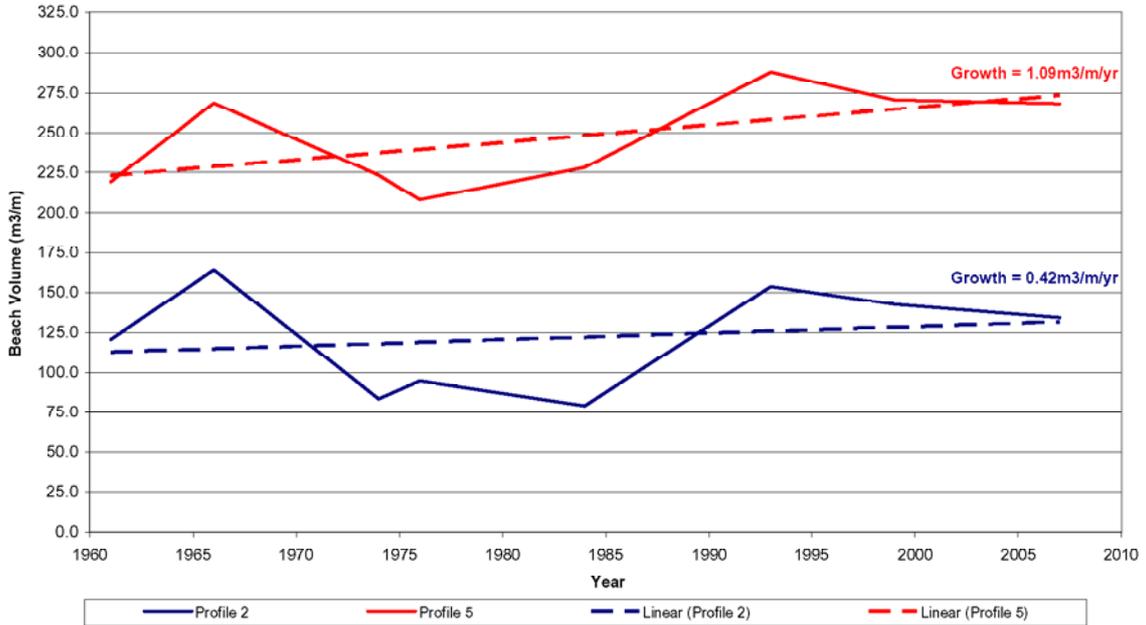


**BLOCK N:**  
1955  
1961  
1966  
1974  
1976  
1984  
1993  
1999  
2007

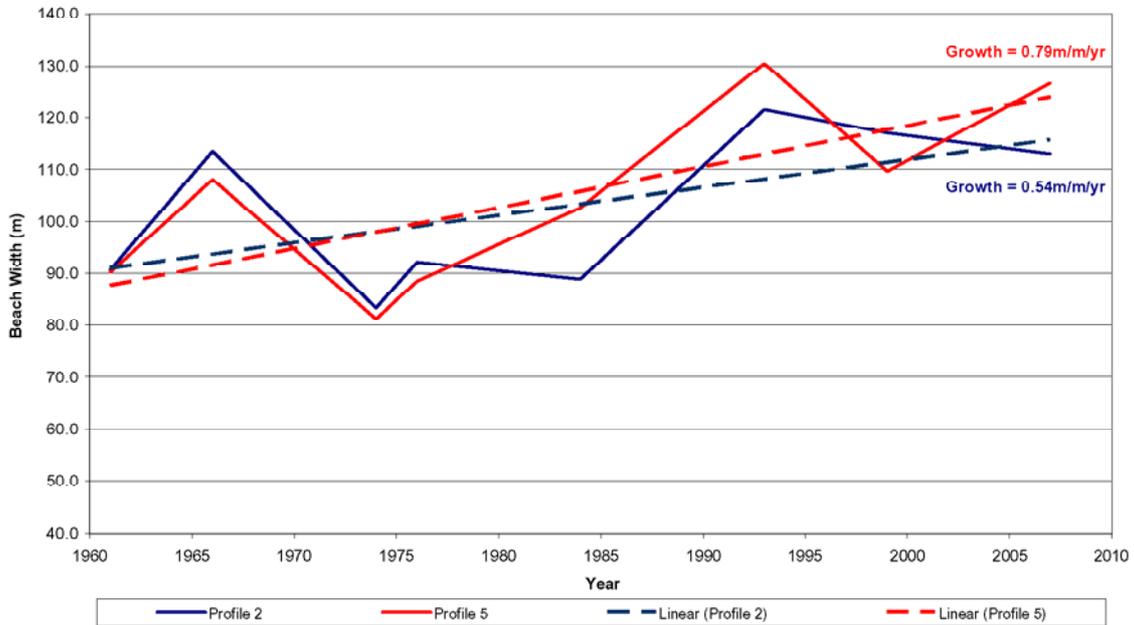




Austinmer - Beach Volume History



Austinmer - Beach Width History



**Appendix C**

# **Nearshore Wave Conditions**

Table C.1: Wave Height (Hs) at 6m Depth for Beach Profiles

Beach	Location	Wave Height (Hs)				
		100	50	25	10	5
Stanwell Park	North	4.19	4.15	4.09	4.01	3.94
Stanwell Park	Central	4.11	4.07	4.01	3.94	3.88
Stanwell Park	South	4.14	4.09	4.04	3.97	3.91
Coalcliff	-	4.17	4.11	4.03	3.93	3.84
Scarborough/Wombarra	North	3.95	3.92	3.88	3.83	3.78
Scarborough/Wombarra	Central	3.96	3.93	3.88	3.84	3.79
Scarborough/Wombarra	South	3.95	3.92	3.88	3.83	3.79
Coledale	6	3.80	3.77	3.74	3.69	3.65
Coledale	3	3.85	3.83	3.78	3.73	3.69
Sharkies	-	3.89	3.85	3.79	3.72	3.66
Austinmer North	North	4.78	4.72	4.63	4.53	4.43
Austinmer	Central	4.38	4.35	4.30	4.24	4.18
Austinmer	South	3.69	3.66	3.62	3.57	3.53
Thirroul	26	3.61	3.61	3.52	3.39	3.32
Thirroul	19	4.08	4.02	3.95	3.87	3.80
Thirroul	13	4.03	3.99	3.93	3.86	3.80
Thirroul	5	4.14	4.10	4.04	3.96	3.89
McCauley's	1	4.20	4.17	4.13	4.07	4.02
McCauley's	2	3.88	3.85	3.81	3.76	3.72
Sandon Point	3 - 4	3.42	3.36	3.62	3.26	3.37
Sandon Point	2 - 12	3.77	3.69	3.61	3.50	3.42
Sandon Point	2 - 5	4.23	4.19	4.13	4.05	3.98
Bulli	1 - 12	4.33	4.27	4.20	4.11	4.03
Bulli	1 - 3	4.89	4.82	4.72	4.60	4.51
Woonona/Bellambi	North	4.22	4.23	4.22	4.21	4.17
Woonona/Bellambi	Central	4.51	4.45	4.37	4.27	4.18
Woonona/Bellambi	South 1	3.78	3.73	3.66	3.57	3.50
Woonona/Bellambi	South 2	3.96	3.92	3.86	3.78	3.71
Bellambi Harbour	-	3.27	3.20	3.09	2.95	2.81
Bellambi Point	1	4.33	4.27	4.18	4.07	3.98

Beach	Location	Wave Height (Hs)				
		100	50	25	10	5
Bellambi Point	2	3.76	3.73	3.68	3.63	3.60
Corrimal	North	4.10	4.06	4.00	3.91	3.83
Corrimal	2 - 7	4.16	4.11	4.03	3.94	3.86
Corrimal	1-10	4.34	4.28	4.21	4.11	4.03
Towradgi Point	North	4.22	4.15	4.08	3.98	3.90
Towradgi/Fairy Meadow	North	4.54	4.47	4.39	4.28	4.18
Towradgi/Fairy Meadow	Central 1	4.27	4.21	4.14	4.06	3.98
Towradgi/Fairy Meadow	Central 2	4.73	4.66	4.61	4.49	4.39
Towradgi/Fairy Meadow	Central 3	4.66	4.60	4.53	4.43	4.33
Towradgi/Fairy Meadow	South	4.25	4.20	4.13	4.05	3.98
Fairy Meadow (Fairy Ck)	North	3.99	3.93	3.86	3.78	3.70
North Wollongong	M - 7	3.51	3.47	3.41	3.35	3.29
North Wollongong	M - 3	3.98	3.93	3.86	3.79	3.72
Wollongong City/Coniston	N - 30	4.66	4.60	4.51	4.41	4.32
Wollongong City/Coniston	N - 2	4.89	4.82	4.73	4.62	4.52
Wollongong City/Coniston	L - 32	4.64	4.57	4.48	4.37	4.26
Wollongong City/Coniston	K - 8	4.63	4.55	4.44	4.31	4.18
Perkins	3 - 15	4.67	4.61	4.52	4.42	4.33
Perkins	2 - 20	4.47	4.41	4.34	4.24	4.16
Perkins	3 - 15	4.57	4.51	4.43	4.33	4.25

Table C.2: Wave Height (Hs) for Cliff Locations

Profile Name	Wave Height (Hs) - m				
	100	50	25	10	5
Cliff 1	4.26	4.22	4.15	4.08	4.01
Cliff 4	4.45	4.40	4.33	4.23	4.14
Cliff 6	4.42	4.37	4.30	4.21	4.13
Cliff 9	4.27	4.22	4.15	4.07	4.00
Cliff 17	4.00	3.96	3.91	3.84	3.78
Cliff 21	4.09	4.04	3.97	3.89	3.83
Cliff 24	4.20	4.14	4.06	3.97	3.88
Cliff 29	4.35	4.29	4.20	4.09	4.00
Cliff 30	3.94	3.91	3.86	3.80	3.74
Cliff 36	3.85	3.82	3.78	3.73	3.69
Cliff 40	4.51	4.45	4.37	4.28	4.23
Cliff 43	4.71	4.64	4.55	4.45	4.37
Cliff 45	4.25	4.20	4.13	4.04	3.98
Cliff 47	2.93	2.91	2.89	2.86	2.84
Cliff 48	4.45	4.38	4.29	4.17	4.05
Cliff 50	3.55	3.51	3.46	3.39	3.32
Cliff 51	4.58	4.52	4.44	4.35	4.27
Cliff 54	4.69	4.63	4.53	4.47	4.41
Cliff 57	4.78	4.73	4.65	4.54	4.45
Cliff 59	5.23	5.13	5.00	4.85	4.73
Cliff 60	3.90	3.85	3.78	3.70	3.63
Cliff 66	4.39	4.33	4.24	4.15	4.07

**Appendix D**

**Design Water and  
Run-up Levels**

Table D.1: Design Still Water Levels (including Wave Setup) for the Wollongong Coastline under Existing and Climate Change Conditions

Beach	Location	Design Still Water Level (mAHD)														
		100			50			25			10			5		
		2010	2050	2100	2010	2050	2100	2010	2050	2100	2010	2050	2100	2010	2050	2100
Stanwell Park	North	3.3	3.64	4.14	3.19	3.53	4.03	3.06	3.4	3.9	2.94	3.28	3.78	2.81	3.15	3.65
Stanwell Park	Central	3.13	3.47	3.97	3.07	3.41	3.91	2.99	3.33	3.83	2.91	3.25	3.75	2.78	3.12	3.62
Stanwell Park	South	3.17	3.51	4.01	3.1	3.44	3.94	2.98	3.32	3.82	2.81	3.15	3.65	2.69	3.03	3.53
Coalcliff	-	3.3	3.64	4.14	3.15	3.49	3.99	2.97	3.31	3.81	2.89	3.23	3.73	2.75	3.09	3.59
Scarborough/Wombarra	North	3.03	3.37	3.87	2.93	3.27	3.77	2.83	3.17	3.67	2.69	3.03	3.53	2.58	2.92	3.42
Scarborough/Wombarra	Central	2.97	3.31	3.81	2.84	3.18	3.68	2.68	3.02	3.52	2.56	2.9	3.4	2.46	2.8	3.3
Scarborough/Wombarra	South	3.07	3.41	3.91	2.95	3.29	3.79	2.91	3.25	3.75	2.75	3.09	3.59	2.57	2.91	3.41
Coledale	6	2.95	3.29	3.79	2.84	3.18	3.68	2.73	3.07	3.57	2.57	2.91	3.41	2.43	2.77	3.27
Coledale	3	2.99	3.33	3.83	2.91	3.25	3.75	2.82	3.16	3.66	2.72	3.06	3.56	2.62	2.96	3.46
Sharkies	-	3.14	3.48	3.98	3.09	3.43	3.93	2.99	3.33	3.83	2.89	3.23	3.73	2.78	3.12	3.62
Austinmer North	North	3.17	3.51	4.01	3.05	3.39	3.89	2.99	3.33	3.83	2.85	3.19	3.69	2.74	3.08	3.58
Austinmer	Central	2.63	2.97	3.47	2.5	2.84	3.34	2.38	2.72	3.22	2.24	2.58	3.08	2.11	2.45	2.95
Austinmer	South	3.01	3.35	3.85	2.88	3.22	3.72	2.77	3.11	3.61	2.56	2.9	3.4	2.46	2.8	3.3
Thirroul	26	2.98	3.32	3.82	2.91	3.25	3.75	2.79	3.13	3.63	2.7	3.04	3.54	2.64	2.98	3.48
Thirroul	19	2.91	3.25	3.75	2.8	3.14	3.64	2.74	3.08	3.58	2.37	2.71	3.21	2.34	2.68	3.18
Thirroul	5	2.98	3.32	3.82	3.02	3.36	3.86	2.91	3.25	3.75	2.77	3.11	3.61	2.76	3.1	3.6
McCauley's	1	3.05	3.39	3.89	3	3.34	3.84	2.94	3.28	3.78	2.86	3.2	3.7	2.79	3.13	3.63
Sandon Point	3-4	2.87	3.21	3.71	2.7	3.04	3.54	2.44	2.78	3.28	2.2	2.54	3.04	1.98	2.32	2.82
Sandon Point	2-12	3.03	3.37	3.87	2.92	3.26	3.76	2.81	3.15	3.65	2.56	2.9	3.4	2.43	2.77	3.27
Sandon Point	2-5	3.2	3.54	4.04	3	3.34	3.84	2.87	3.21	3.71	2.73	3.07	3.57	2.34	2.68	3.18
Bulli	1-12	3.43	3.77	4.27	3.24	3.58	4.08	3.07	3.41	3.91	2.86	3.2	3.7	2.67	3.01	3.51
Bulli	1-3	3.57	3.91	4.41	3.49	3.83	4.33	3.35	3.69	4.19	3.08	3.42	3.92	3.04	3.38	3.88
Woonona/Bellambi	North	3.1	3.44	3.94	3.0	3.34	3.84	2.88	3.22	3.72	2.79	3.13	3.63	2.58	2.92	3.42
Woonona/Bellambi	Central	3.5	3.84	4.34	3.39	3.73	4.23	3.26	3.6	4.1	3.07	3.41	3.91	2.92	3.26	3.76

Beach	Location	Design Still Water Level (mAHD)														
		100			50			25			10			5		
		2010	2050	2100	2010	2050	2100	2010	2050	2100	2010	2050	2100	2010	2050	2100
Woonona/Bellambi	South 2	3.23	3.57	4.07	3.12	3.46	3.96	3.0	3.34	3.84	2.86	3.2	3.7	2.73	3.07	3.57
Bellambi Harbour	-	3.13	3.47	3.97	3.01	3.35	3.85	2.9	3.24	3.74	2.75	3.09	3.59	2.63	2.97	3.47
Bellambi Point	1	2.98	3.32	3.82	2.88	3.22	3.72	2.81	3.15	3.65	2.72	3.06	3.56	2.61	2.95	3.45
Bellambi Point	2	3.4	3.74	4.24	3.27	3.61	4.11	3.16	3.5	4.0	2.99	3.33	3.83	2.86	3.2	3.7
Corrimal	North	3.02	3.36	3.86	2.92	3.26	3.76	2.81	3.15	3.65	2.67	3.01	3.51	2.56	2.9	3.4
Corrimal	2-7	3.31	3.65	4.15	3.2	3.54	4.04	3.08	3.42	3.92	2.93	3.27	3.77	2.8	3.14	3.64
Corrimal	1-10	3.32	3.66	4.16	3.23	3.57	4.07	3.1	3.44	3.94	2.99	3.33	3.83	2.91	3.25	3.75
Towradgi Point	North	3.11	3.45	3.95	2.99	3.33	3.83	2.98	3.32	3.82	2.82	3.16	3.66	2.6	2.94	3.44
Towradgi/Fairy Meadow	North	3.79	4.13	4.63	3.68	4.02	4.52	3.54	3.88	4.38	3.41	3.75	4.25	3.28	3.62	4.12
Towradgi/Fairy Meadow	Central 1	3.26	3.6	4.1	3.17	3.51	4.01	3.05	3.39	3.89	2.95	3.29	3.79	2.89	3.23	3.73
Towradgi/Fairy Meadow	Central 2	3.66	4.0	4.5	3.56	3.9	4.4	3.41	3.75	4.25	3.33	3.67	4.17	3.2	3.54	4.04
Towradgi/Fairy Meadow	Central 3	3.04	3.38	3.88	2.93	3.27	3.77	2.95	3.29	3.79	2.7	3.04	3.54	2.54	2.88	3.38
Towradgi/Fairy Meadow	South	3.28	3.62	4.12	3.19	3.53	4.03	3.04	3.38	3.88	2.86	3.2	3.7	2.67	3.01	3.51
Fairy Meadow (Fairy Ck)	North	3.33	3.67	4.17	3.14	3.48	3.98	3.09	3.43	3.93	2.93	3.27	3.77	2.62	2.96	3.46
North Wollongong	M-7	3.02	3.36	3.86	2.86	3.2	3.7	2.87	3.21	3.71	2.68	3.02	3.52	2.58	2.92	3.42
North Wollongong	M-3	3.03	3.37	3.87	2.93	3.27	3.77	2.82	3.16	3.66	2.7	3.04	3.54	2.58	2.92	3.42
Wollongong City/Coniston	N-30	3.33	3.67	4.17	3.21	3.55	4.05	3.11	3.45	3.95	2.96	3.3	3.8	2.83	3.17	3.67
Wollongong City/Coniston	N-2	3.35	3.69	4.19	3.33	3.67	4.17	3.17	3.51	4.01	3.01	3.35	3.85	2.86	3.2	3.7
Wollongong City/Coniston	L-32	3.58	3.92	4.42	3.47	3.81	4.31	3.3	3.64	4.14	3.12	3.46	3.96	3.07	3.41	3.91
Perkins	3-15	2.97	3.31	3.81	2.81	3.15	3.65	2.8	3.14	3.64	2.6	2.94	3.44	2.47	2.81	3.31
Perkins	2-20	3.07	3.41	3.91	3.0	3.34	3.84	2.88	3.22	3.72	2.79	3.13	3.63	2.66	3.0	3.5
Perkins	3-15	3.29	3.63	4.13	3.1	3.44	3.94	2.98	3.32	3.82	2.76	3.1	3.6	2.63	2.97	3.47

Table D.2: 2% Wave Run-up Levels for the Wollongong Coastline under Existing and Climate Change Conditions

Cliff Number	Cliff Slope	Base Case 2% Run-up Height (mAHD)									
		5yrARI		10yrARI		25yrARI		50yrARI		100yrARI	
		2010	2100	2010	2100	2010	2100	2010	2100	2010	2100
Cliff 1	0.5	6.1	8.2	6.3	8.4	6.5	8.7	6.8	9.0	6.9	9.1
Cliff 2	0.4	5.7	7.8	5.9	8.0	6.2	8.3	6.4	8.5	6.6	8.8
Cliff 3	0.4	5.4	7.4	5.6	7.5	5.8	7.7	6.0	8.0	6.1	8.2
Cliff 4	0.5	5.9	8.1	6.1	8.2	6.2	8.3	6.3	8.5	6.5	8.7
Cliff 5	0.6	6.8	9.0	7.1	9.3	7.4	9.7	7.9	10.2	8.2	10.5
Cliff 6	0.5	5.6	7.7	5.9	7.9	6.3	8.3	6.6	8.6	6.8	8.9
Cliff 7	0.7	7.7	10.2	7.8	10.3	7.9	10.4	8.1	10.6	8.2	10.8
Cliff 8	0.6	6.7	9.2	7.0	9.4	7.3	9.7	7.7	10.1	7.9	10.3
Cliff 9	0.4	5.5	7.3	5.7	7.5	6.0	7.8	6.2	8.1	6.4	8.3
Cliff 10	0.6	7.2	9.4	7.4	9.7	7.8	10.0	8.0	10.3	8.3	10.6
Cliff 11	0.7	7.6	10	7.8	10.3	8.1	10.6	8.3	10.8	8.4	10.9
Cliff 12	0.6	7.8	10.1	8.1	10.4	8.3	10.7	8.6	11.0	8.9	11.2
Cliff 13	0.4	5.2	7.2	5.4	7.4	5.6	7.6	5.7	7.8	5.9	7.9
Cliff 14	0.4	5.8	7.5	6.0	7.8	6.3	8.1	6.5	8.3	6.7	8.5
Cliff 15	0.5	6.1	8.6	6.3	8.7	6.4	8.9	6.8	9.0	6.7	9.4
Cliff 16	0.5	6.4	8.5	6.6	8.8	6.8	9.0	7.0	9.3	7.2	9.5
Cliff 17	0.2	4.4	5.9	4.6	6.1	4.8	6.4	5.0	6.6	5.2	6.8
Cliff 18	0.5	6.8	8.9	7.1	9.2	7.4	9.5	7.7	9.8	7.9	10.0
Cliff 19	0.7	7.4	10	7.6	10.1	7.8	10.3	8.1	10.6	8.3	10.9
Cliff 20	0.5	7.5	9.6	7.8	9.9	8.3	10.3	8.6	10.7	8.9	11.0
Cliff 21	0.4	7.0	9.0	7.3	9.3	7.5	9.6	7.8	9.8	8.1	10.0
Cliff 22	0.7	7.2	9.6	7.6	9.9	7.6	10.1	7.9	10.3	8.0	10.5

**Appendix E**

**Shoreline Recession and  
Storm Demand Results**

Beach	Profile	Closure Depth (mAHD)	2050 Shoreline Recession (m)	2100 Shoreline Recession (m)	Storm Demand SBeach (m <sup>3</sup> /m)	Factored Storm Demand (m <sup>3</sup> /m)
Stanwell Park	North	-12.0	16.7	38.1	35.2	41.3
Stanwell Park	Central	-12.0	16.7	38.1	56.1	65.9
Stanwell Park	South	-12.0	16.7	38.1	45.4	53.3
Coalcliff	-	-11.3	7.6	17.2	32.3	37.9
Scarborough / Wombarra	North	-11.0	10.4	23.7	34.0	39.9
Scarborough / Wombarra	Central	-11.4	10.4	23.7	37.8	44.4
Scarborough / Wombarra	South	-12.0	9.4	21.3	41.3	48.5
Coledale	6	-10.5	8.7	19.7	43.4	51.0
Coledale	3	-10.3	8.7	19.7	46.0	54.0
Sharkies	-	-11.0	7.2	16.4	57.4	67.4
Austinmer North	North	-8.8	8.0	18.2	196.8	231.1
Austinmer	Central	-11.4	21.6	49.2	32.0	37.6
Austinmer	South	-11.5	8.4	18.6	28.9	33.9
Thirroul	26	-6.5	8.1	18.5	94.4	110.9
Thirroul	19	-7.5	8.5	19.6	157.0	184.4
Thirroul	13	-10.2	8.1	18.9	171.1	200.9
Thirroul	5	-10.6	7.9	18.1	142.9	167.8
McCauley's	1	-9.0	-	-	67.9	79.7
McCauley's	2	-10.7	18.9	43.1	101.3	119.0
Sandon Point	3-4	-4.7	7.9	17.1	67.0	78.7
Sandon Point	2-12	-4.9	11.6	23.7	64.5	75.8
Sandon Point	2-5	-8.0	12.2	24.1	102.5	120.4
Bulli	1-12	-10.6	8.1	17.2	212.9	250.0
Bulli	1-3	-7.1	7.0	15.9	171.5	201.4
Woonona/ Bellambi	North	-12.0	17.6	36.2	68.9	82.7
Woonona/ Bellambi	Central	-12.0	18.9	42.9	125.5	147.4
Woonona/ Bellambi	South 1	-12.0	19.0	43.1	55.9	65.7
Woonona/ Bellambi	South 2	-12.0	18.7	42.8	60.6	71.2
Bellambi Harbour	-	-10.7	13.2	30.1	82.7	97.1
Bellambi Point	1	-10.9	16.3	37.1	25.5	29.9

Beach	Profile	Closure Depth (mAHD)	2050 Shoreline Recession (m)	2100 Shoreline Recession (m)	Storm Demand SBeach (m <sup>3</sup> /m)	Factored Storm Demand (m <sup>3</sup> /m)
Bellambi Point	2	-10.9	16.9	38.0	24.6	28.9
Corrimal	North	-12.0	12.7	24.4	51.6	60.6
Corrimal	2-7	-12.0	12.1	27.5	71.9	84.5
Corrimal	1-10	-12.0	12.1	27.5	41.7	49.0
Towradgi Point	North	-5.9	12.3	25.2	93.3	109.6
Towradgi / Fairy Meadow	North	-12.0	11.3	25.7	137.8	161.9
Towradgi / Fairy Meadow	Central 1	-12.0	12.2	25.9	187.1	219.8
Towradgi / Fairy Meadow	Central 2	-12.0	13.2	30.0	197.1	231.5
Towradgi / Fairy Meadow	Central 3	-12.0	12.6	24.8	145.0	170.3
Towradgi / Fairy Meadow	South	-10.8	11.3	22.4	95.8	112.5
Fairy Meadow (Fairy Ck Entrance)	North	-6.1	12.1	23.1	79.5	93.3
North Wollongong	M-7	-8.5	9.7	19.8	123.1	144.6
North Wollongong	M-3	-8.1	9.7	19.8	90.2	106.0
Wollongong City / Coniston	N-30	-12.0	10.4	23.1	158.7	186.4
Wollongong City / Coniston	N-2	-12.0	10.8	24.3	93.4	109.7
Wollongong City / Coniston	L-32	-12.0	10.7	24.4	132.8	156.0
Wollongong City / Coniston	K-8	-12.0	6.7	15.1	113.0	132.7
Perkins	3-15	-12.0	14.1	32.1	80.8	94.9
Perkins	2-20	-12.0	12.1	27.4	91.1	106.9
Perkins	3-15	-12.0	9.1	20.6	140.9	165.5