Attachment 1078

EARTHTECH
HYDROGEOLOGY • GEOTECHNICAL ENGINEERING • ENGINEERING GEOLOGY

PIK/L3165-1/cam

19 November 2013

Auckland Council
Private Bag 92300
Auckland 1142

Attention: Mr Greg Murphy
Team Leader – Water Allocation

Dear Sir

RE: FRANKLIN KAAWA AQUIFER GROUNDWATER AVAILABILITY REVIEW

1. Background

Current Kaawa aquifer groundwater availabilities in Schedule 2 of the Auckland Council Regional Plan: Air, Land and Water (ACRP:ALW) are specified for six management areas in the Franklin area. The listed availabilities are based on AC Technical Publication TP133. The availabilities and current groundwater allocations are presented on Table 1.1.

Table 1.1: Existing Kaawa Aquifer Availability and Allocation

Management Area	Availability[1] (m^3/yr)	Current Allocation[2] (m^3/yr)	Water Allocated (%)
Pukekohe West Kaawa	1,780,000	579,270	33%
Waiuku Kaawa	2,450,000	1,169,470	48%
Waiau Pa Kaawa	1,560,000	1,503,645	96%
Karaka Kaawa	617,000	433,200	70%
Pukekohe Kaawa	1,860,000	1,689,900	91%
Bombay – Drury Kaawa	718,000	257,310	36%
Totals	**8,985,000**	**5,632,795**	**63%**

Notes:
1 From Schedule 2 ACRP:ALW
2 From AC database November 2013

Table 1.1 shows that the Waiau Pa Kaawa (96%) and Pukekohe Kaawa (91%) Management Areas are nearly fully allocated. Globally, 63% of available groundwater within the Kaawa aquifer system has been allocated to existing users.

The main objective of this review is to re-evaluate the extent of the Kaawa Management Areas using the principal groundwater flowpaths, same recharge methodology and overall aquifer availability as defined by TP133. The existing Kaawa Management Areas have also been reassessed in terms of suitability for future use in groundwater allocation.

The availability calculation methodology outlined in TP133 has been adopted. Hence the 9Mm^3/yr total availability (Table 1.1) has been reassigned to revised management areas according to flowpath geometry.

In addition to the above, groundwater level monitoring from the Kaawa aquifer has been checked for evidence of over-abstraction.

This review work was commissioned by the Water Allocation team as part of their replacement process for expired consents for the Franklin Kaawa aquifer. The review has also been used to revise the Kaawa Management Areas in a submission by Auckland Council (AC) to the recently notified Proposed Auckland Unitary Plan (PAUP).

2. Availability Calculation Method

The existing Kaawa groundwater availabilities are calculated in Section 7.3 of TP133 using an aquifer recharge model. The recharge model uses a combination of:

i. Analytical well equations to assess vertical recharge via volcanic conduits.
ii. Flownets to assess combined recharge from closely spaced volcanic conduits, groundwater discharge zones (to Waiuku River and Drury Creek) and flow between individual management areas.

The following availability calculations have been completed for this review:

i. Initial checking of TP133 availability calculations using detailed spreadsheet information provided by AC.
ii. Re-apportioning groundwater availability according to the revised management areas.

Both sets of calculations are presented on Tables A1 and A2 attached to Appendix A.

3. Revised Management Areas

The Kaawa aquifer groundwater flowpaths are shown on Figure 3.6 of TP133. This figure is attached in Appendix B. Three of the six existing management areas (Karaka, Waiau Pa-Glenbrook and Waiuku) are located in down gradient zones of particular flowpaths. Setting availabilities in these down gradient areas without considering flow over the total flowpath length can result in unnecessary restrictions to local availability. Hence a reduction in management areas from six to four is recommended so that each new management area extends over a particular groundwater flowpath.

The revised Kaawa Management Areas are shown on Figure 3.1. The revised areas together with respective recharge sources and groundwater flowpaths are summarised on Table 3.1.

Table 3.1: Revised Kaawa Management Areas

Management Area	Recharge Sources	Groundwater Flowpath
Waiuku Kaawa (new)	Pukekohe Hill Bald Hill South Cone Bald Hill North Cone Masters Road Cone Somerville Road Cone	Overall westerly flowpath from Pukekohe Hill discharging to Waiuku River and Awhitu.
Glenbrook Kaawa (new)	Pukekohe Hill Patumahoe Road Cone Day Road Cone	Overall northwesterly flowpath from Pukekohe Hill discharging to Waiuku River.
Pukekohe Kaawa (new)	Pukekohe Hill	Northerly flowpath from Pukekohe Hill discharging to Drury Creek. Some cross boundary discharge to Bombay-Drury Kaawa.
Bombay – Drury Kaawa (existing)	Rutherford Road Cone	Northerly flowpath from Rutherford Road Cone discharging to Drury Creek area.

4. Revised Groundwater Availability

The revised groundwater availabilities from Table A1 and A2 are summarised on Table 4.1.

Table 4.1: Revised Kaawa Aquifer Availabilities

Management Area	Availability (m^3/yr)
Waiuku Kaawa (new)	2,957,000
Glenbrook Kaawa (new)	2,863,000
Pukekohe Kaawa (new)	2,481,000
Bombay – Drury Kaawa (existing)	718,000
Totals	**9,019,000**

The 34,000m^3/yr difference in the total availabilities between Tables 1.1 and 4.1 is due to the methodology used in the reassessment of the Waiuku and Glenbrook aquifer areas. The difference represents 0.4% of the total and is considered to be within the accuracy of the availability calculation method.

5. Kaawa Aquifer Groundwater Level Monitoring

Auckland Council operates the following Kaawa monitoring bores:

i. Glenbrook Hall No. 7417001
ii. Waiau Pa No. 7418003
iii. Mauku No. 7428047
iv. Divers Road No. 7427003
v. Batty Road No. 7418013
vi. Ostrich Farm Road No. 7418012
vii. Tuhimata Road No. 7419003
viii. Maraeorahia No. 7427005

The majority of the above bores have a long-term monitoring record extending from 1985. Groundwater level plots from five selected monitoring bores area attached in Appendix C.

From the Auckland Council and Appendix C monitoring plots, the following groundwater level trends can be observed for the last ten years of record.

All of the above Kaawa monitoring bores show an overall trend of falling summer low levels from 2001 to 2008/09 followed by rising summer lows from 2008/09 to 2012. These trends are considered to be due to background seasonal rainfall variability based on a detailed analysis of groundwater level plots from the North Waikato Regional Landfill for bores remote from any takes or landfill construction areas (Earthtech, 2013).

All of the bores show a relatively low 2013 summer level associated with the very dry 2012/13 summer conditions.

For the last ten years of record, none of the Kaawa monitoring bores show long-term declining trends indicative of groundwater over-abstraction. This shows that even though the aquifer is highly allocated in the existing Waiau Pa and Pukekohe Management Areas, the existing takes are sourced from recharge and not from aquifer storage.

6. Review Comments

6.1 Management Area Boundaries

The boundaries between the management areas generally represent either groundwater divides or flow lines within the extensive Kaawa aquifer system. These boundaries are not fixed and can migrate in response to significant changes in groundwater flow such as from large groundwater takes.

It is therefore recommended that for all future large takes ($Q \geq 500m^3/d$) in close proximity of management zone boundaries a capture zone assessment be carried out. A "capture zone" refers to the recharge region that contributes to groundwater extracted by a take. A capture zone analysis would allow the assessment of the take in terms of groundwater availability from respective management zone areas.

The capture zone assessment would be carried out as part of a take application.

6.2 Local Groundwater Availability

For large groundwater takes ($Q \geq 500m^3/d$), the availability assessment should also include a check of local availability with respect to recharge sources from the volcanic cones (which act as point source conduits) identified in TP133.

6.3 Kaawa Aquifer North of Management Areas

TP133 (Cross Sections 5-5′ and 6-6′, presented on TP133 Figure 2.5) shows the Kaawa aquifer extending to the north of the management zones in the Kingseat area. Associated groundwater availability has not been assessed by TP133 due to the limited northern extent of the Kaawa flownet (see Figure 3.6 – Appendix B). The Table 4.1 calculated availabilities exclude the Kaawa aquifer in the Kingseat area.

For future Kingseat Kaawa takes, groundwater availability needs to be assessed. On the basis of the Figure 3.6 flownet presented in TP133, associated recharge in this area is expected to be primarily from vertical leakage through the overlying Puketoka Formation.

6.4 Regional Boundary

Figure 3.1 shows that the Regional Council boundary extends over the groundwater flowpath associated with the Waiuku Kaawa Management Area. Therefore existing and future groundwater allocations from both Regional Council areas need to be accounted for in the 2,957,000m^3/yr total Waiuku Kaawa availability.

The Kaawa aquifer availabilities associated with Auckland Council areas to the south of the Figure 3.1 management area boundaries relate to separate groundwater flow systems to those assessed for the new management areas presented on Table 3.1. Groundwater availabilities associated with takes in these areas will require specific assessment.

Yours faithfully

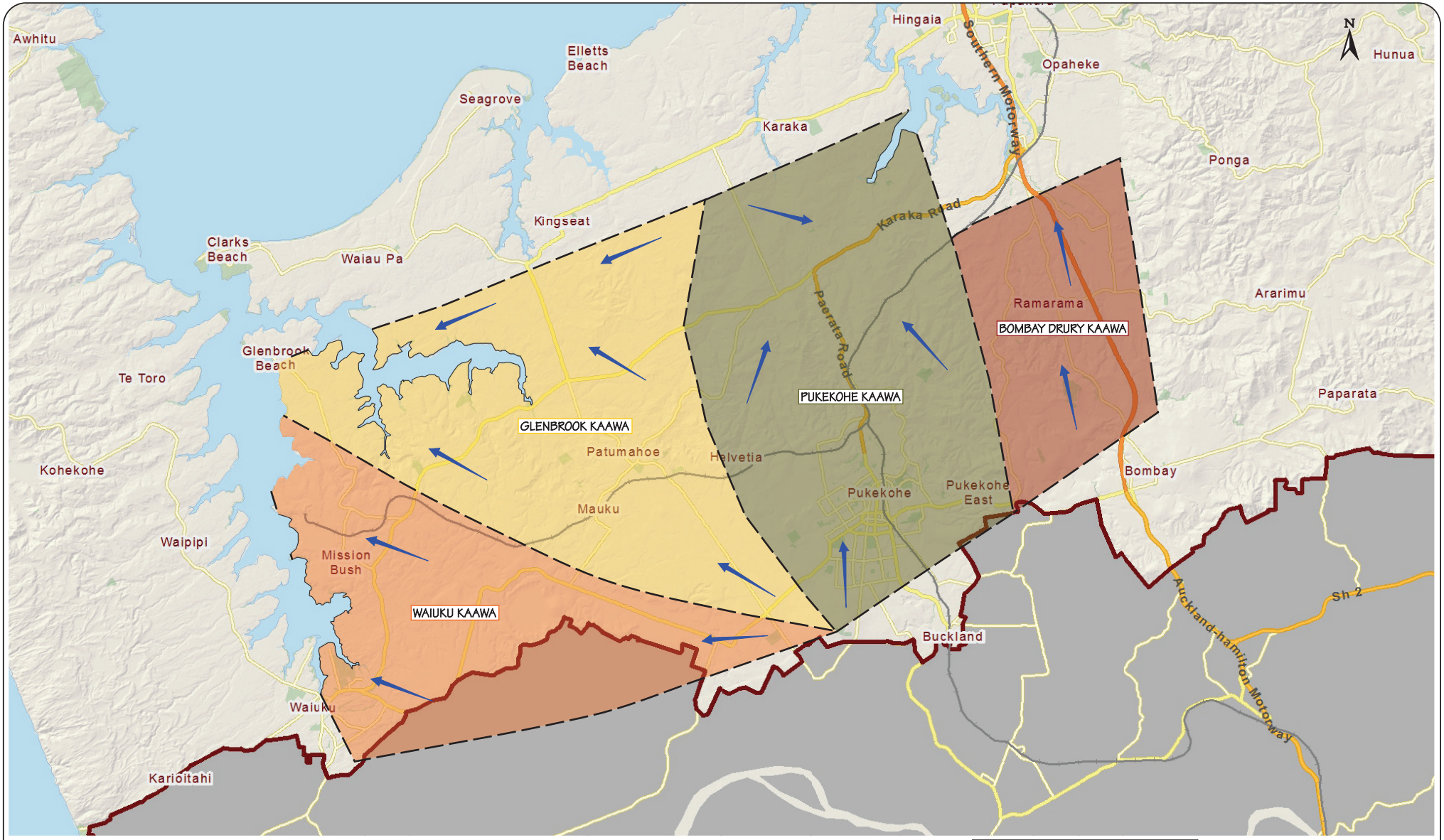
P I KELSEY
Senior Hydrogeologist
EARTHTECH CONSULTING LTD

Encl. Appendix A – Groundwater Availability Calculations
Appendix B – Kaawa Aquifer Flownet
Figure 3.1 – Proposed Revised Kaawa Aquifer Management Areas

References

ARC (2002) South Auckland Groundwater, Kaawa Aquifer Recharge Study and Management of the Volcanic and Kaawa Aquifers. Auckland Regional Council, Technical Publication 133, November 2002.

Earthtech (2013) Groundwater Monitoring Report. Landfill Construction Effects on Groundwater Divides for Stages 1 to 3A. North Waikato Regional Landfill. Report prepared for EnviroWaste. Ref R3147-1 dated 29 April 2013.



Map from Auckland Council GIS Viewer - downloaded 18 November 2013

LEGEND

Groundwater Flow Directions (from TP133 Figure 3.6 Flownet)

Regional Council Boundary

0m 1000 2000 3000 4000 5000m

Scale 1:100,000

EARTHTECH

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FRANKLIN KAAWA AQUIFER GROUNDWATER AVAILABILITY

Auckland Regional Council

Proposed Revised Kaawa Aquifer Management Areas

DRAWING NO.: FIG. 3.1

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TRACED:	C.M	DATE:	19/11/13	1:100000	REF: 3165

APPENDIX A

Groundwater Availability Calculations

Table A1: Kaawa West Aquifer Allocation Review
Table A2: Kaawa East Aquifer Allocation Review

Table A1 : Kaawa West Aquifer Availability Review

A) TP133 Water Balance

Management Areas	*Flow Net Zone*	*Volcanic Conduit*	Inflows	Outflows	Notes
Pukekohe West					
Pukekohe Hill (2)	2		2,185,742		
Patumahoe Rd		4	1,571,794		
Bald Hill (2)		7	736,779		
Bald Hill (1)		8	851,389		
Waiuku MA				1,614,119	
Waiau Pa MA				1,959,721	
Inflow-Outflow for Balance				**1,771,864**	
Totals			***5,345,704***	***5,345,704***	
Volcanic Conduit Inflow			**5,345,704**		
TP133 Availability	Table 7.11			**1,780,036**	**at 33.3% inflow**
Waiuku					
Pukekohe West MA	3		1,614,119		
Masters Rd		6	1,309,829		
Somerville Rd		9	1,146,100		
Awhitu Penninsula-Waiuku R	4			1,336,222	
Waiau Pa Glenbrook MA				284,533	
Inflow-Outflow for Balance				**2,449,293**	
Totals			***4,070,048***	***4,070,048***	
Volcanic Conduit Inflow			**2,455,929**		
TP133 Availability	Table 7.12			**2,451,109**	**at 60.2% inflow** > than 50% ref in text
Waiau Pa - Glenbrook					
Pukekohe West MA	7		870,631		
Pukekohe West MA	8		1,089,090		
Waiuku MA	12		284,533		
Day Rd		5	916,880		
Waiuku River	10			1,562,044	
Inflow-Outflow for Balance				**1,599,090**	
Totals			***3,161,134***	***3,161,134***	
Volcanic Conduit Inflow			**916,880**		
Availability	Table 7.13			**1,560,043**	**at 50% inflow**

Availability Summary		*Recharge (Inflow)*	*Inflow-OutFlow*	*TP133*
In terms of Management Areas				
Pukekohe West		**5,345,704**	1,771,864	1,780,036
Waiuku		**4,070,048**	2,449,293	2,451,109
Waiau Pa - Glenbrook		**3,161,134**	1,599,090	1,560,043
	Totals	**12,576,886**	**5,820,247**	**5,791,188**
	% inflow	**100%**	46%	46%

Note : Availability at 46% recharge not correct due to double counting of flow between Management Areas

In terms of Volcanic Conduit Inflows		Recharge	**Inflow-OutFlow**	***TP133***
Pukekohe West		**5,345,704**	1,771,864	1,780,036
Waiuku		**2,455,929**	2,449,293	2,451,109
Waiau Pa - Glenbrook		**916,880**	1,599,090	1,560,043
	Totals	**8,718,513**	**5,820,247**	**5,791,188**
	% inflow	**100%**	**67%**	**66%**

Note : Availability assessed at 67% of total aquifer recharge through volcanic conduits.

B) Earthtech Revised Water Balance

New Management Areas	*Flow Net Zone*	*Volcanic Conduit*	Inflows	Outflows	Notes
Glenbrook Kaawa					
Pukekohe Hill (2) 60%	2		1,311,445		
Patumahoe Rd		4	1,571,794		
Day Rd		5	916,880		
Waiuku River 60%	10			937,226	
Inflow-Outflow for Balance				**2,862,893**	
Totals			***3,800,119***	***3,800,119***	
Propose Availability				**2,862,893**	**75%** **of inflow**
Waiuku Kaawa					
Pukekohe Hill (2) 40%	2		874,297		
Bald Hill (2)		7	736,779		
Bald Hill (1)		8	851,389		
Masters Rd		6	1,309,829		
Somerville Rd		9	1,146,100		
Waiuku River 40%				624,818	
Awhitu Penninsula-Waiuku R	4			1,336,222	
Inflow-Outflow for Balance				**2,957,354**	
Totals			***4,918,394***	***4,918,394***	
Propose Availability				**2,957,354**	**60%** **of inflow**

Availability Summary		**Recharge**	**Inflow-Outflow**
Glenbrook		3,800,119	2,862,893
Waiuku		4,918,394	2,957,354
	Totals	**8,718,513**	**5,820,247**
	% inflow	**100%**	**67%**

Table A2 : Kaawa East Aquifer Availability Review

A) TP133 Water Balance

Management Areas	*Flow Net Zone*	*Volcanic Conduit*	Inflows	Outflows		Notes
Pukekohe						
Pukekohe Hill (1)	1		3,728,474			
Karaka MA	5			1,243,872		
Bombay MA	13			616,213		
Inflow-Outflow for Balance				**1,868,389**		
Totals			**3,728,474**	**3,728,474**		
Volcanic Conduit Inflow			**3,728,474**			
TP133 Availability	Table 7.8			***1,860,085***	**at 50% inflow**	
Karaka						
Pukekohe MA	5		1,243,872			
Drury Creek	6			621,077		corrected value Fn6
Inflow-Outflow for Balance				**622,795**		
Totals			**1,243,872**	**1,243,872**		
Volcanic Conduit Inflow			**0**			
TP133 Availability	Table 7.9			**621,078**	**at 50% inflow**	
Bombay-Drury						
Rutherford Rd		11	851,389			
Bombay MA	13		616,213			
Drury Downgradient				728,030		
Inflow-Outflow for Balance				**739,572**		
Totals			**1,467,602**	**1,467,602**		
Volcanic Conduit Inflow			**851,389**			
TP133 Availability	Table 7.10			**717,851**	**at 50% inflow**	

Availability Summary		*Recharge (Inflow)*	*Inflow-Outflow*	*TP133*
In terms of Management Areas				
Pukekohe		**3,728,474**	*1,868,389*	*1,860,085*
Karaka		**1,243,872**	622,795	621,078
Bombay-Drury		**1,467,602**	739,572	717,851
	Totals	**6,439,948**	**3,230,756**	**3,199,014**
	% inflow	100%	50%	50%

Note : Availability at 50% recharge not correct due to double counting of flow between Management Areas

In terms of Volcanic Conduit Inflows		Recharge	*Inflow-Outflow*	TP133
Pukekohe		**3,728,474**	*1,868,389*	1,860,085
Karaka		**0**	622,795	621,078
Bombay-Drury		**851,389**	739,572	717,851
	Totals	**4,579,863**	**3,230,756**	**3,199,014**
	%inflow	100%	71%	70%

Note : Availability assessed at 70% of total aquifer recharge through volcanic conduits.

B) Earthtech Revised Water Balance

New Management Areas	*Flow Net Zone*	*Volcanic Conduit*	Inflows	Outflows		Notes
Pukekohe Kaawa						
Pukekohe Hill	1		3,728,474			
Bombay	13			616,213		
Drury Creek	6			621,077		corrected value Fn6
Inflow-Outflow for Balance				**2,491,184**		
Totals			**3,728,474**	**3,728,474**		
Volcanic Conduit Inflow			**3,728,474**			
Propose Availability				**2,491,184**	**67%**	**of inflow**
For TP133 Availability Pukekohe plus Karaka				**2,481,163**	**67%**	**of inflow**
Bombay-Drury Kaawa						
Rutherford Rd		11	851,389			
Bombay MA	13		616,213			
Drury Downgradient				728,030		
Inflow-Outflow for Balance				**739,572**		
Totals			**1,467,602**	**1,467,602**		
Volcanic Conduit Inflow			**851,389**			
Propose Availability				**739,572**	**87%**	**of inflow**
For TP133 Availability				**717,851**	84%	**of inflow**

Availability Summary		Recharge	Inflow-OutFlow	TP133
Pukekohe - Karaka		3,728,474	2,491,184	2,481,163
Bombay - Drury		851,389	739,572	717,851
	Totals	**4,579,863**	**3,230,756**	**3,199,014**
	% inflow	**100%**	**71%**	70%

APPENDIX B

Kaawa Aquifer Flownet

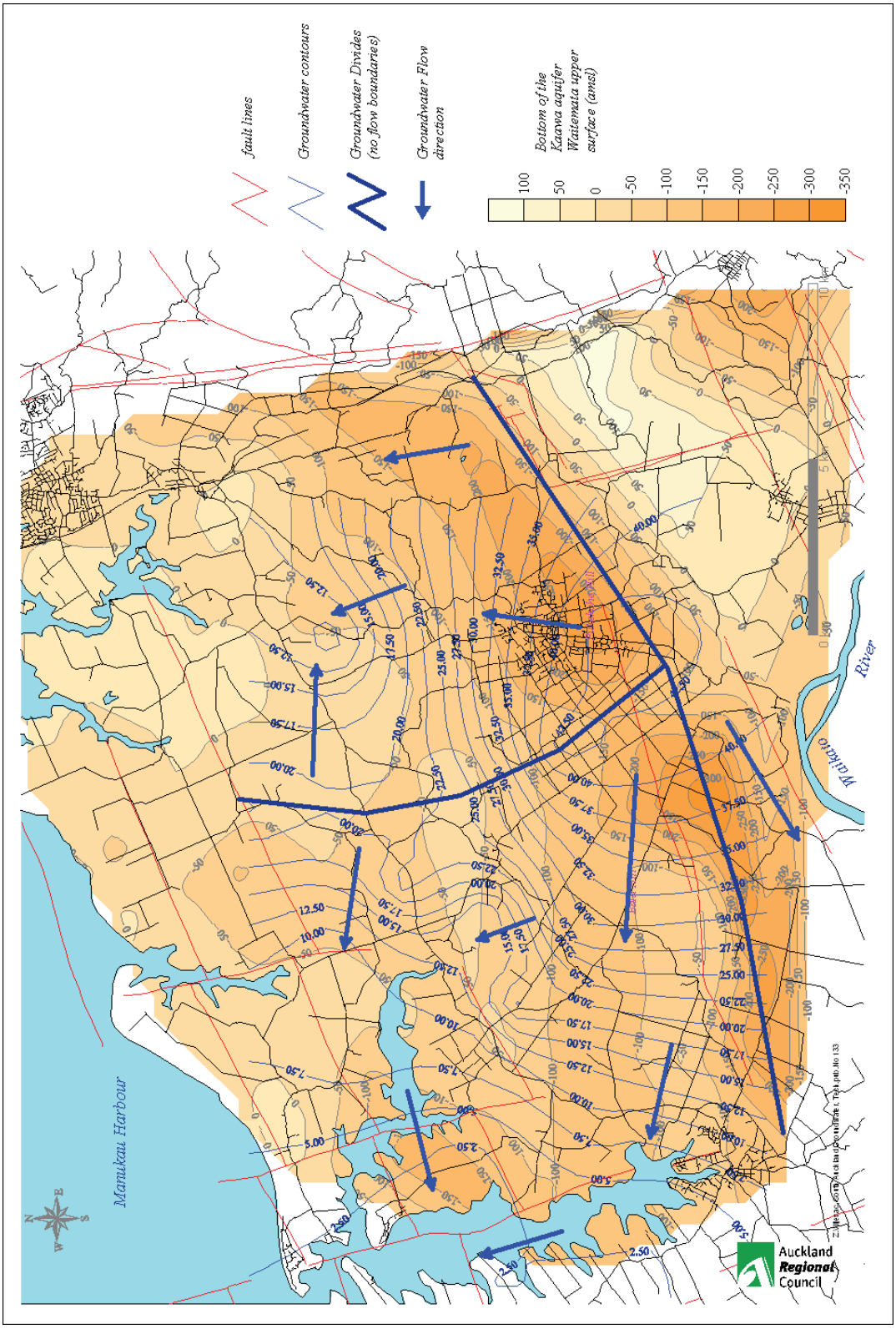
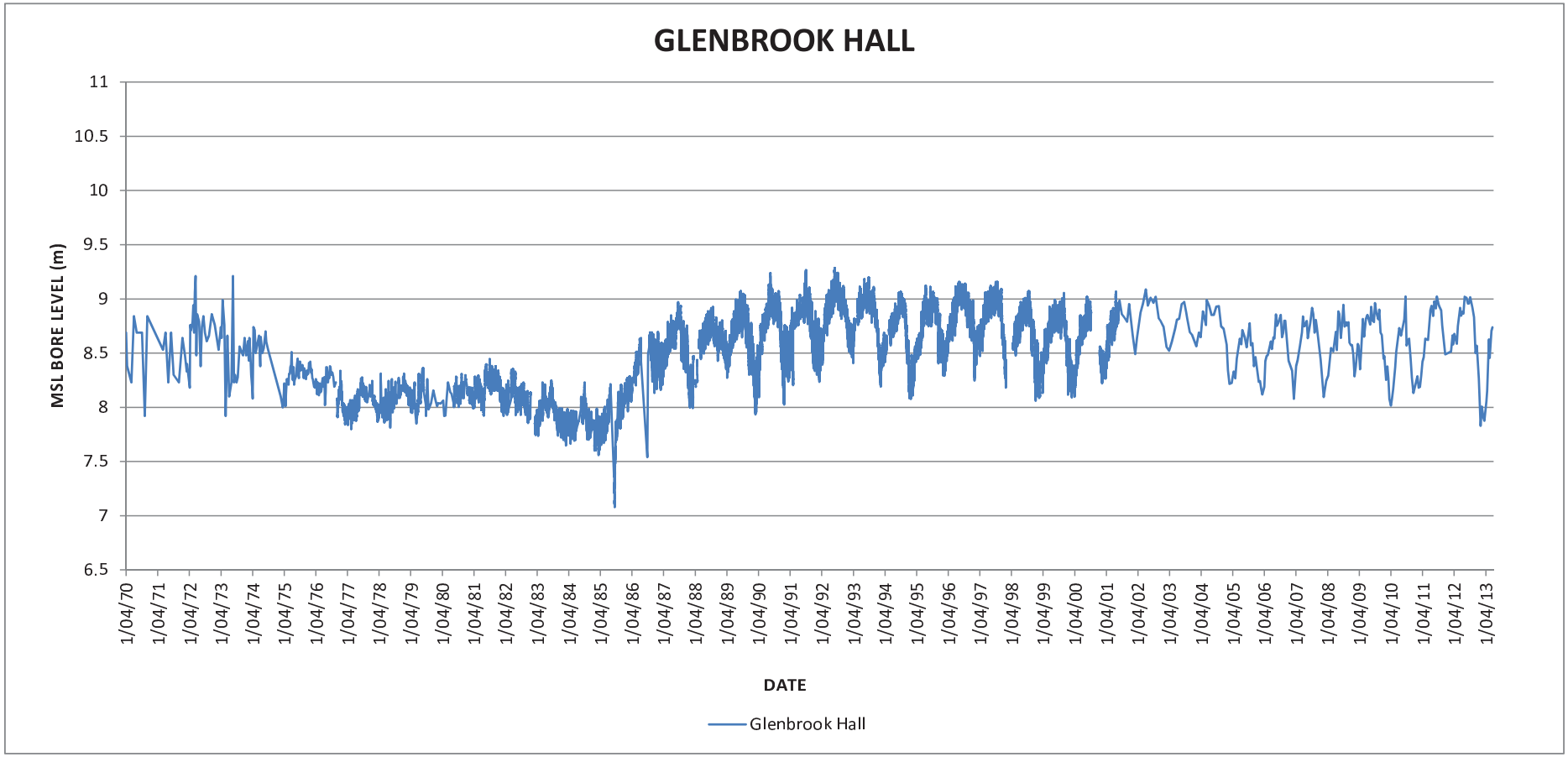


Figure 3.6 Kaawa aquifer groundwater levels

APPENDIX C

Kaawa Groundwater Level Monitoring Plots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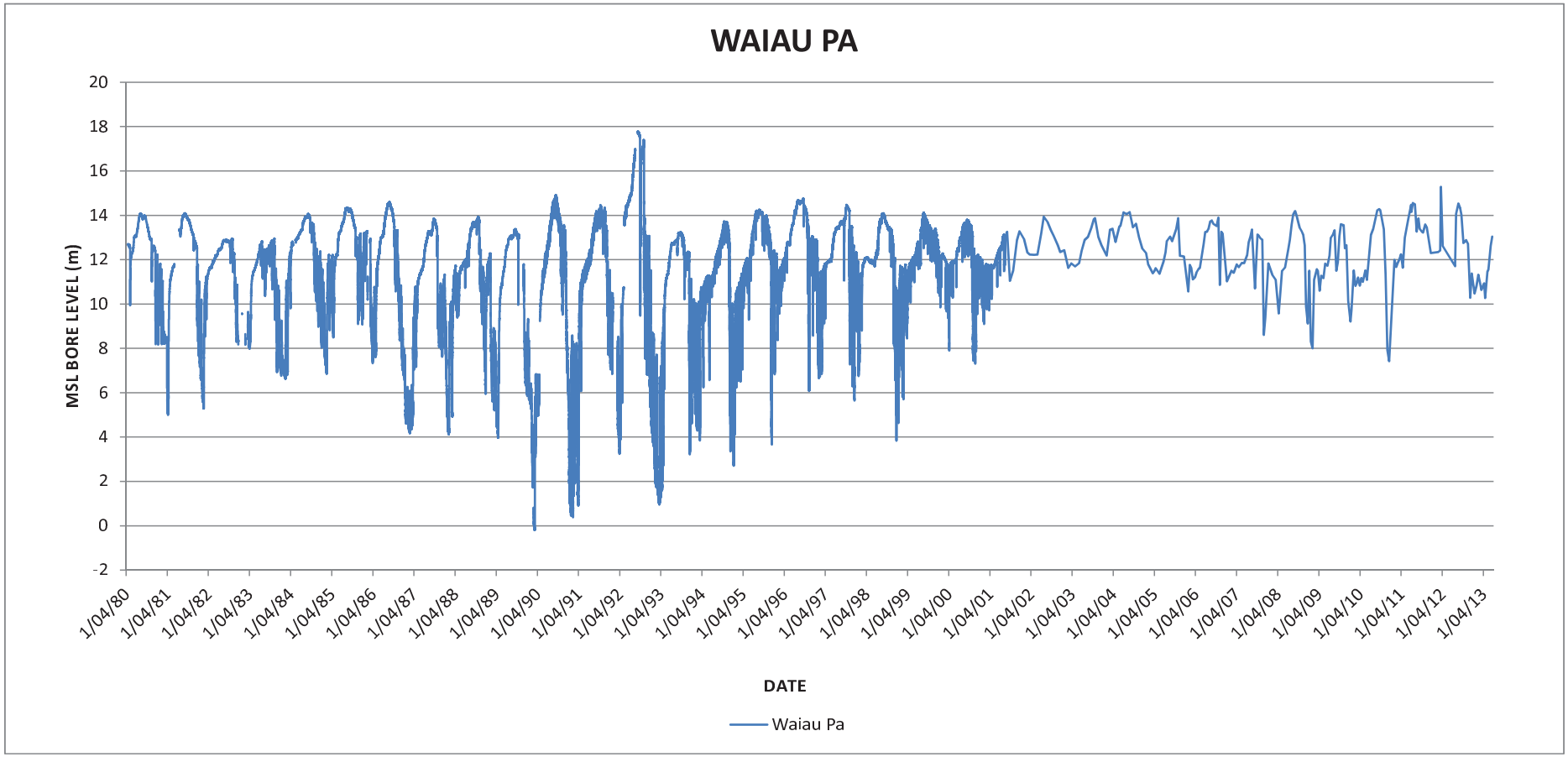
Glenbrook Hall


WAIAU PA
MSL BORE LEVEL (m)
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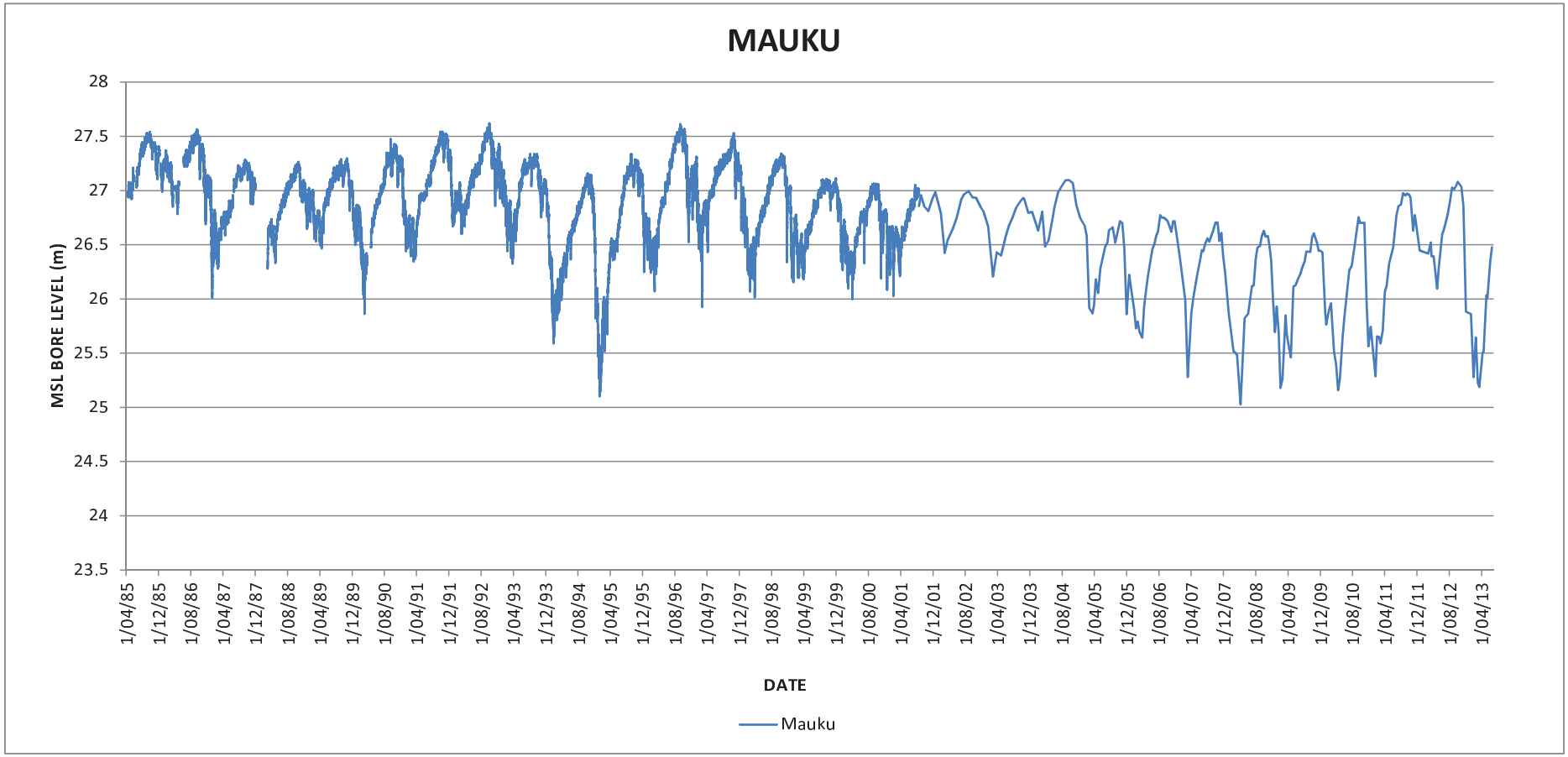
Waiau Pa


MAUKU
MSL BORE LEVEL (m)
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1/08/86
1/04/87
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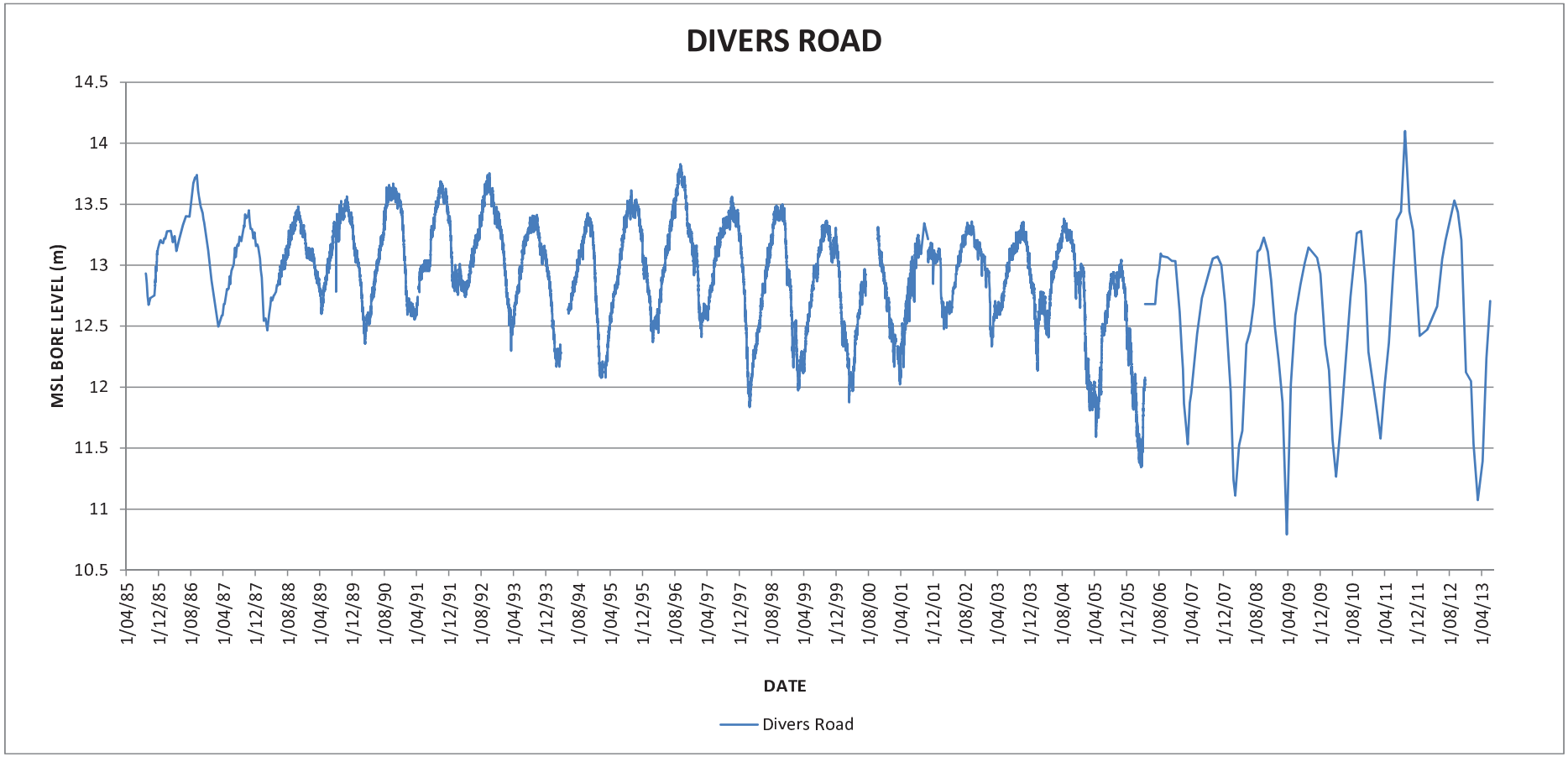
Mauku


DIVERS ROAD
MSL BORE LEVEL (m)
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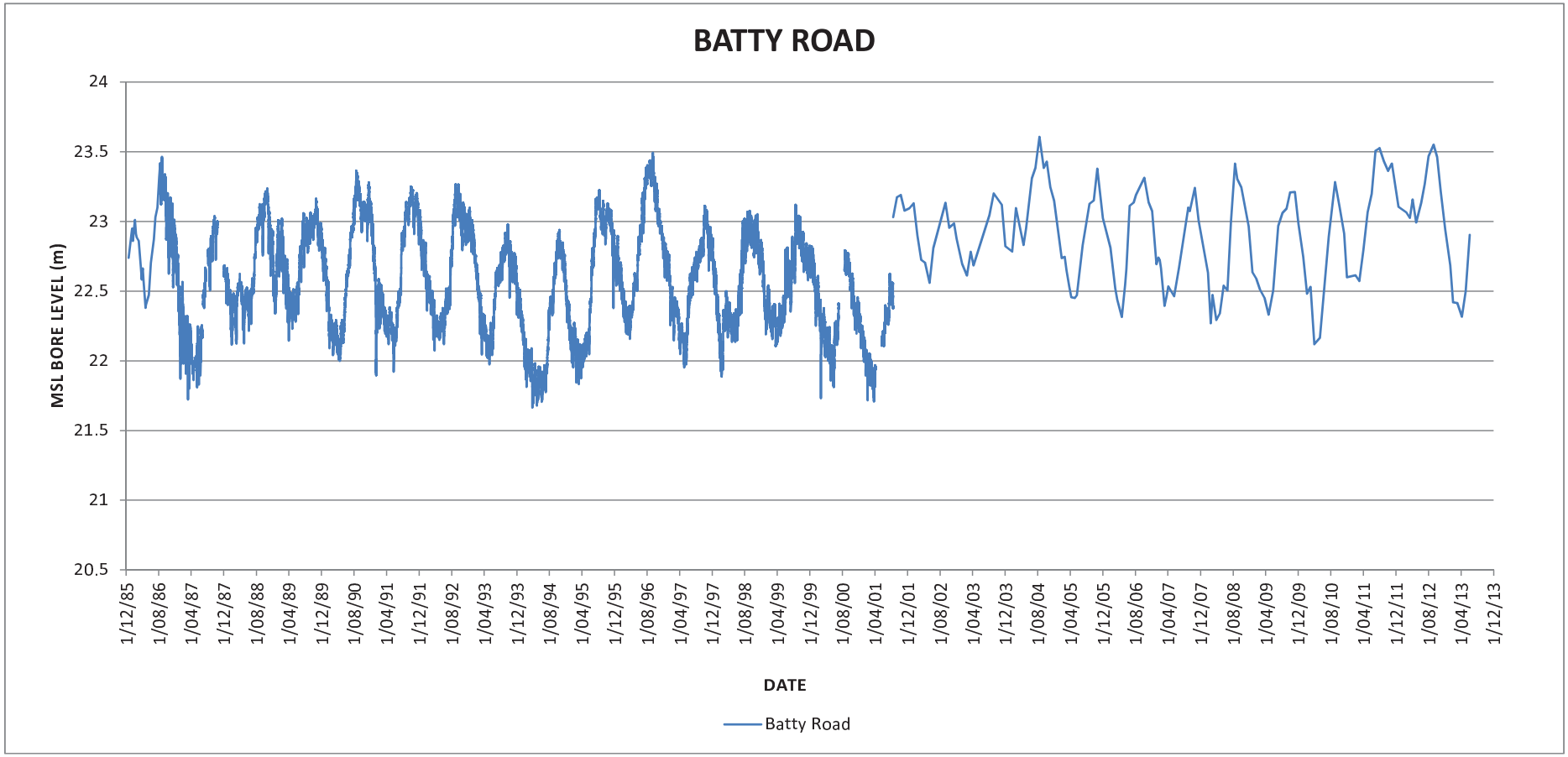
DATE
Divers Road


BATTY ROAD
MSL BORE LEVEL (m)
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23
22.5
22
21.5
21
20.5
1/12/85
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