Member of the Surbana Jurong Group

local people
global experience

Water Balance Report

Newry Pipeline Project

Reference No. P41876
Prepared for Southern Rural Water
20 September 2021

SMEC INTERNAL REF. 30042273

Document Control

Document:	Water Balance Report
File Location:	X:\Projects\300422\30042273 - MID2030 Phase 2\Project 1 - Newry\110 Detailed Design\115 Deliverables\115-2 Technical Notes
Project Name:	Newry Pipeline Project
Project Number:	30042273
Revision Number:	0

Revision History

REVISION NO.	DATE	PREPARED BY	REVIEWED BY	APPROVED FOR ISSUE BY
0	20/09/2021	Paul Byrnes, Michael Dudding, Mani Manivasakan	Mani Manivasakan Sander Van Hall	Sander Van Hall

Issue Register

DISTRIBUTION LIST	DATE ISSUED	NUMBER OF COPIES
Southern Rural Water	20 September 2021	Email
Click or tap here to enter text.		

SMEC Company Details

Approved by:	Sander van Hall		
Address:	Collins Square, Tower 4, Level 20, 727 Collins St, Melbourne, VIC, 3008		
Signature:			
Tel:	+61 3 9869 0885		Click or tap here to enter text.
Email:	Sander.vanHall@smec.com	Website:	www.smec.com

The information within this document is and shall remain the property of SMEC and Southern Rural Water.

Important Notice

This report is confidential and is provided solely for the purposes of SMEC and SRW. This report is provided pursuant to a Consultancy Agreement between SMEC Australia Pty Limited ("SMEC") and Southern Rural Water, under which SMEC undertook to perform a specific and limited task for Southern Rural Water. This report is strictly limited to the matters stated in it and subject to the various assumptions, qualifications and limitations in it and does not apply by implication to other matters. SMEC makes no representation that the scope, assumptions, qualifications and exclusions set out in this report will be suitable or sufficient for other purposes nor that the content of the report covers all matters which you may regard as material for your purposes.

This report must be read as a whole. The executive summary is not a substitute for this. Any subsequent report must be read in conjunction with this report.

The report supersedes all previous draft or interim reports, whether written or presented orally, before the date of this report. This report has not and will not be updated for events or transactions occurring after the date of the report or any other matters which might have a material effect on its contents, or which come to light after the date of the report. SMEC is not obliged to inform you of any such event, transaction or matter nor to update the report for anything that occurs, or of which SMEC becomes aware, after the date of this report.

Unless expressly agreed otherwise in writing, SMEC does not accept a duty of care or any other legal responsibility whatsoever in relation to this report, or any related enquiries, advice or other work, nor does SMEC make any representation in connection with this report, to any person other than Southern Rural Water. Any other person who receives a draft or a copy of this report (or any part of it) or discusses it (or any part of it) or any related matter with SMEC, does so on the basis that he or she acknowledges and accepts that he or she may not rely on this report nor on any related information or advice given by SMEC for any purpose whatsoever.

Table of Contents

EXECUTIVE SUMMARY....1

1 INTRODUCTION....5

2 BACKGROUND....6
- 2.1 Irrigation Area....6
- 2.2 Soil Types....6

3 WATER BALANCE - IRRIGATION SUPPLY....7
- 3.1 Rainfall and evaporation....7
- 3.2 Irrigation Water Supply....8
- 3.3 Channel outfalls....9
- 3.4 Pipeline impacts on the water balance....10

4 GROUNDWATER ASSESSMENT....11
- 4.1 Method....11
- 4.2 Groundwater Recharge....11
- 4.3 Groundwater Level Impact....12
- 4.4 Groundwater monitoring bores....13

5 NEWRY CREEK AND NATURAL DEPRESSIONS....16
- 5.1 Newry Creek inflows....16
- 5.2 Newry Creek diversion licences and use....17
- 5.3 Groundwater recharge into Newry Creek and depressions....17
- 5.4 Newry Creek Water Balance....17
- 5.5 Newry Creek Summary....17
  - 5.5.1 Channel Seepage and Leakage....17
  - 5.5.2 Channel Outfalls....18

6 CONCLUSIONS....19
- 6.1 Groundwater users....19
- 6.2 Newry Creek and Depression Users....19
- 6.3 Recommendations....19

7 REFERENCES....20

Appendices

APPENDIX A NEWRY WEATHER RECORDS

APPENDIX B GROUNDWATER BORE CHART ANALYSIS

List of Tables

Table 1: Annual Recharge Volume for the Combined Newry Irrigation Area 1
Table 2: Groundwater licence summary..... 1
Table 3: Summary of channel outfalls 3
Table 4: Newry Creek Water Balance 3
Table 5: Newry Creek Diversion Licences 3
Table 6: - Average water balance over period 2010/11 to 2019/20 8
Table 7: Recharge Rate to the Water Table Aquifers within the Wa De Lock GMA and areas with similar hydrogeology to the Wa De Lock GMA 12
Table 8: Annual Recharge Volume for the Combined Newry Irrigation Area 12
Table 9: Monitoring Bore – Observation of trends 15
Table 10: Summary of channel outfalls 16
Table 11: Newry Creek Diversion Licences 17
Table 12: Newry Creek Water Balance 17

List of Figures

Figure 1: Groundwater hydrographs for Newry and Tinamba bores..... 2
Figure 2: Newry Monthly Rainfall. Month 1 = January. 7
Figure 3: Newry monthly pan evaporation. Month 1 = January...... 7
Figure 4 - Newry River Study Area - Seasonal rainfall and evaporation 8
Figure 5 Newry Supply system Water balance..... 9
Figure 6 Newry river-channel outfalls 10
Figure 7: Groundwater Levels in the Newry and Tinamba Area.....13
Figure 8 Groundwater monitoring bores in the Newry River supply area.....14
Figure 9- Outfall 754D into Newry Creek.....16
Figure B-1 Bore 76860. The light blue vertical shading shows the irrigation season. The year marker is at the start of the year so 2016 is at the centre of the 2015/16 season. 23
Figure B-2 Bore 76892. The light blue vertical shading shows the irrigation season. The year marker is at the start of the year so 2016 is at the centre of the 2015/16 season. 24
Figure B-3 Bore 76888.....25
Figure B-4 Bore 130371 levels 26
Figure B-5 Bore 131257 27
Figure B-6 Bore 144943 28

Executive Summary

Southern Rural Water engaged SMEC to assess potential impacts from channel modernisation on groundwater and the surface water users at Newry. The potential impacts arise from:

- Reduction to groundwater recharge from irrigation channel seepage; and
- Removal of channel outfalls from the Newry River Channel system that discharge to the Newry Creek, other drains and natural depressions.

The investigation involved desktop reviews of relevant previous studies completed for surrounding areas, data analysis and consultation with SRW staff and other agencies. It does not include an ecological impact assessment.

Groundwater

Groundwater Recharge

Groundwater is typically recharged by infiltration from rainfall through the ground surface or by flow from adjacent aquifers and streams. Recharge to the shallow aquifer at Newry is predominantly from rainfall and irrigation of farmland (SKM, 1998, Reid 2004, GHD, 2010). Recent modelling in Gippsland (GHD, 2010 and DELWP, 2015) indicated that rainfall, irrigation, and potential channel seepage is between 93% and 99% of total groundwater recharge. The remaining recharge is from throughflow (from other aquifers) and rivers when in high flow.

Annual groundwater recharge estimates (refer Table 1) for the Newry Irrigation Area were prepared to understand the significance of channel seepage on groundwater recharge.

Table 1: Annual Recharge Volume for the Combined Newry Irrigation Area

SOURCE	AREA (HA)	ANNUAL RECHARGE RATE		ANNUAL RECHARGE VOLUME	
		Min	Max	ML/year - min	ML/year - max
Rainfall	2,670	50 mm/year	80 mm/year	1,335	2,136
Farmland Irrigation [1]	2,100	20% of annual irrigated volume[2]	30% of annual irrigated volume[2]	1,600	2,400
Channel Seepage	-	100% of seepage		400	400
Total				3,335 1.2 ML/ha	4,936 1.8 ML/ha

1. *Delivered by irrigation channels (i.e. excludes irrigation from groundwater)*
2. *Annual irrigated volume is approximately 8,000 ML/year*

The range of total groundwater recharge within the study area is between 3,335 ML/year and 4,936 ML/year and the recharge from channel seepage is between 8% and 13% of the total annual groundwater recharge.

Groundwater Licences

Table 2 shows that the total volume of groundwater licences is within the total range of recharge. No new licences can be issued in this groundwater management area (Wa De Lock 1) but can be accessed by trade with an existing entitlement. Typical usage is less than 30% of the licence volume. This indicates the aquifer is able to sustain pumping, retain water for storage and discharge excess water to streams and natural depressions.

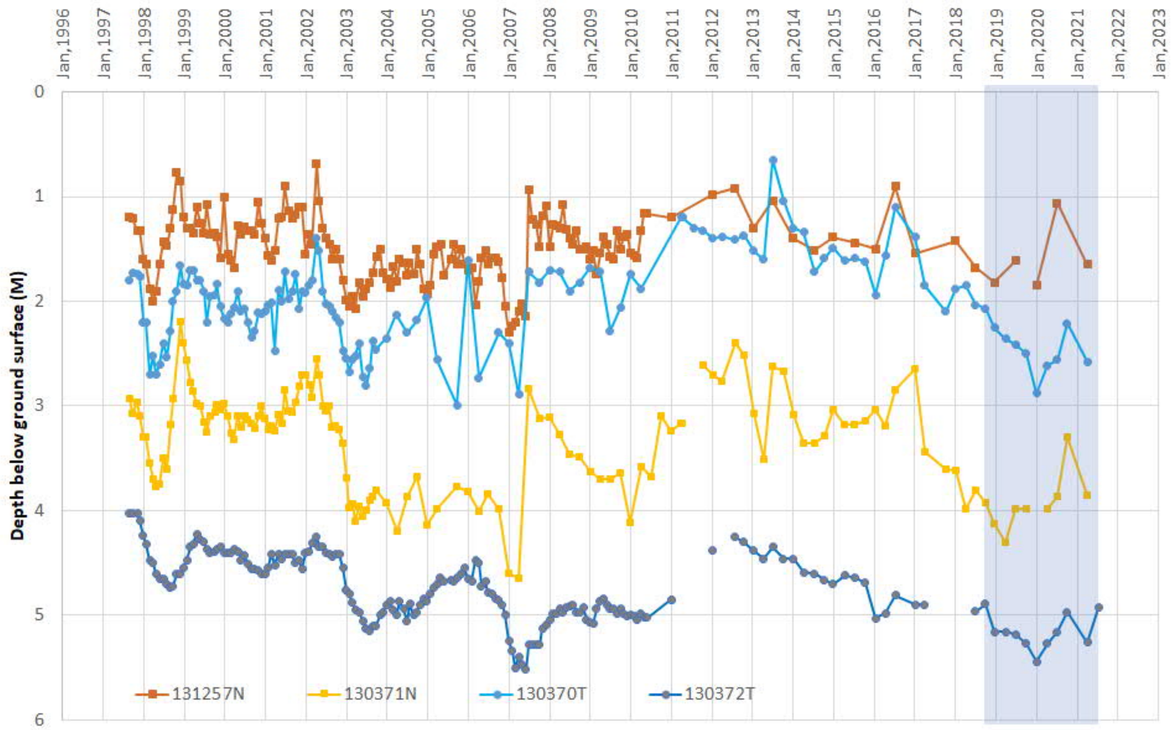
Table 2: Groundwater licence summary

	LICENCE VOLUME (ML)	AVERAGE USAGE (ML)
Licence volume	3,601	989

Groundwater Level Impact

The annual fluctuation in groundwater levels represents a change in the total volume of groundwater stored in the aquifer, with the level rising and falling in response to the annual fluctuation in recharge (from rainfall, irrigation seepage etc.) and discharge (to streams, natural depressions and groundwater pumping).

Figure 1: Groundwater hydrographs for Newry and Tinamba bores



Annual groundwater levels in the Newry area typically fluctuate up to 0.5 m between seasons (orange and brown lines on *Figure 1*). There are significant rainfall related changes or periods that contribute to the trends. For example the run of dry years from 2000 to 2010 combined with groundwater pumping significantly lowered the groundwater level. Given that channel seepage provides approximately 8% to 13% of recharge, its impact to annual groundwater levels is of similar proportion. As a result, a conservative estimate of seepage from irrigation channels contributes approximately 40 mm (8% of 0.5 m) to 65 mm (13% of 0.5 m) of the annual groundwater fluctuation.

The locations most likely to be affected by the decrease in channel seepage are near to irrigation channels (e.g. sites within 100 to 200 m of a channel). The chart in Figure 1 compares the Newry observation bores (orange and brown lines) with Tinamba observation bores (light blue and blue lines) on the opposite side of the Macalister River, including the period that the Tinamba pipeline has been in operation. Over the period of record, groundwater levels in Tinamba have followed a similar pattern to the Newry bores. This indicates that changes to groundwater levels observed in Tinamba are predominantly driven by rainfall and irrigation with the pipeline only likely to have a minor influence in localised areas. A similar pattern is expected following the Newry pipeline construction.

Newry Creek Flows

Newry Creek flows are largely from catchment rainfall runoff and channel outfalls during the irrigation season.

Natural Catchment

Newry Creek is a tributary of the Macalister River. It has a significant catchment to the north of the irrigation area. There is no inflow data because the catchment is ungauged but outflows to the Macalister River were gauged from 2000 until 2013.

Irrigation System

There are five channel outfalls to be decommissioned. One of these (754D) flows directly into the creek while the other four discharge directly to or via a drain into the Macalister River and to natural depressions. The data below shows a reduction to outfalls of almost 40% since 2016.

Table 3: Summary of channel outfalls

OUTFALL	PRE 2016 DISCHARGE (ML)	2016-2021 DISCHARGE (ML)	OUTFALL RECEPTOR
754D	440	270	Newry Creek
804	958	536	Natural depression
818D	244	186	Drain 6 (Macalister River)
831	140	21	Macalister River
Newry 4 ex	139	201	Natural depression
TOTAL	1,921	1,214	

The combined licence volume from Newry Creek and natural depressions is 1,083 ML. These sites are not metered because the Newry Creek has operated as an irrigation drain (i.e. usage from the stream has been encouraged to reduce nutrient outfalls to the Macalister River downstream).

There are several licences upstream of the existing outfalls, located in closed natural depressions. These licence sites do not rely on channel outfalls.

Newry Creek Water Balance

As there is no creek inflow data available, a comparative assessment was undertaken using the annual volume of water leaving the catchment, channel outfalls and diversion licences. This analysis is presented below:

Table 4: Newry Creek Water Balance

COMPONENT	NEWRY CREEK FLOWS (ML)	
	AVERAGE	MEDIAN
Leaving (Gauge @ Bellbird Corner)	4,296	2,536
Gains (Channel outfalls @ 754)	270	262
Outcome if no outfall	3,937	2,989

Table 5: Newry Creek Diversion Licences

	VOLUME (ML)
Total licences	1,083
Licences downstream of channel outfalls	654

Overall the coarse data analysis suggests the removal of channel outfalls will reduce annual flows by less than 10%. Actual flows along the stream course are more complex because it meanders through a system of pools that are not always connected, and along the way, there are gains (drainage lines, groundwater seepage) and losses (pumping, seepage, evapotranspiration). Except in two or three instances where licence sites are directly below outfalls the impact to licence holders from reduced outfalls is likely to be minor.

Conclusions and Recommendations

It is concluded that the modernisation of the Newry irrigation system by replacement of channels with a pipeline is likely to result in the following:

- Groundwater levels could decline by up to 65 mm mostly adjacent to irrigation channels. Based on Tinamba observation bores the impact well away from the channels should be negligible,
- Slightly lower groundwater levels should not affect bore yields noting that bore performance is also affected by low rainfall, bore condition and pump settings; and
- Removal of channel outfalls will have minimal impact to creek flows but may affect pumps immediately downstream.

Further investigations are recommended to:

- Observe groundwater levels post construction to identify any changes,
- Improve data base of licence sites and private bores; and
- Undertake a desktop assessment of potential environmental impacts.

1 Introduction

SRW engaged SMEC to undertake a high-level investigation to assess whether the proposed replacement of the existing channel network with a pipeline system at Newry might have impacts on two potential issues related to water availability:

- Likely impact on groundwater recharge and to licensed bore operators
- Impact of removal of Newry river-channel outfalls into Newry Creek.

SMEC's investigation involved desktop reviews of relevant previous/existing assessments as well as consultation with relevant SRW and external staff to complete the following tasks:

- Prepare a water balance,
- Summarise the likely affects based on information,
- Provide conclusions; and
- Recommend any additional investigations required to improve confidence.

This report summarises the investigations and analysis undertaken, and the preliminary conclusions reached based on these investigations.

2 Background

2.1 Irrigation Area

The Newry area is the first area in the Macalister Irrigation District (MID) supplied by the Main Northern Channel from the Lake Glenmaggie and consists of approximately 2300 ha of irrigated land that is currently serviced by the 36 km Newry Channel system.

Constructed in the 1920s, the channel system's design and construction standard is relatively poor, with many concrete structures beyond maintenance renewal. The poor design standards of the time and current condition combined with the lighter soil types means that the channels have relatively high seepage and leakage and are unsuited to modernisation using channel automation technology, which is used elsewhere in the MID.

The approved business case for modernising the area is to replace the channels with a gravity pipeline system.

2.2 Soil Types

In geological timescales, the floodplain is recent and has many abandoned river channels that are flanked by natural levees. These natural levees are the relatively high spots in the floodplain, and the SRW irrigation channels largely follow these natural levees.

The local soil system classifies the soil as the Newry type[1]. Box 1 contains its formal soil description.

Box 1 – Newry Soil

Apart from the abandoned [river] channels, the surface soils are deep very dark fine sandy clay loams to silty clay loams. The subsoils are similar in texture but tend to be browner and lighter in colour. On the levies of the abandoned [river] channels the overall soil profile textures are generally sandier (fine sandy loams). The Newry map unit is arbitrarily separated from the Thomson map unit because of the number of abandoned [river] channels and its overall apparent lighter soil texture. The soils are generally classified as Black Dermosols using the Australian Soil Classification.

Even though the soils in the area fit in the one category, there are significant variations across the irrigation area with soil permeability. Such variability is a common feature for most soil types.

The light soil type and floodplain's uneven landform means spray irrigation is far more suited and efficient than surface irrigation methods.

Traditionally, the area only had dairy or beef farms, which mainly used surface irrigation methods. Over the last ten years, significant vegetable production has replaced dairy areas, and it uses spray irrigation.

[1] http://vro.agriculture.vic.gov.au/dpi/vro/wgregn.nsf/pages/wg_soil_maffra_newry

3 Water Balance - Irrigation Supply

The water balance in Newry includes rainfall, irrigation supplies, losses (evaporation, seepage, leakage), metering errors (under recording) and diversions from groundwater, Macalister River, Newry Creek and the natural depressions.

The data detail and accuracy for each water element varies and these are presented in this report.

3.1 Rainfall and evaporation

The monthly rainfall and pan evaporation patterns were sourced from the Queensland Government database SILO[2] for Newry and are shown in Figure 2 and Figure 3 below. The rainfall is both more variable between years but has much less variability by month compared to evaporation. Average monthly rainfall is significant in each month during the irrigation season.

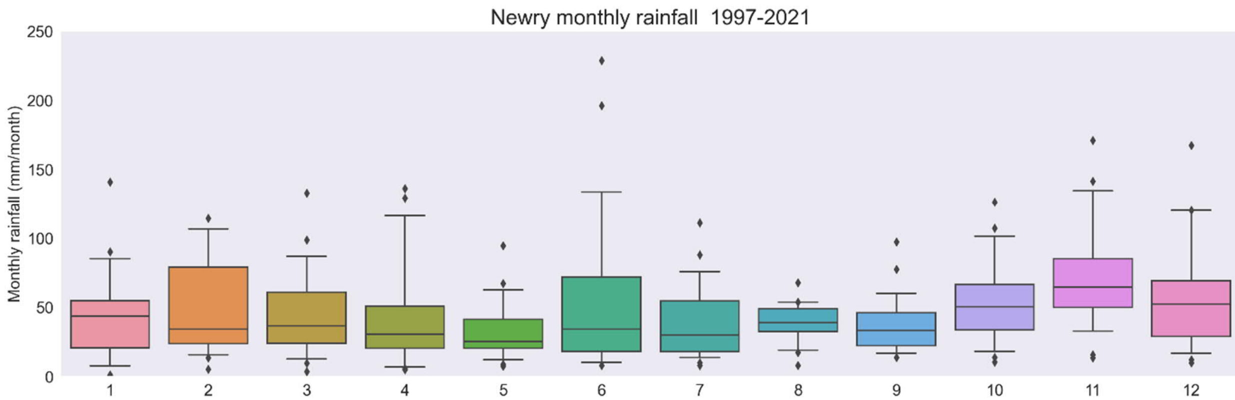


Figure 2: Newry Monthly Rainfall. Month 1 = January.

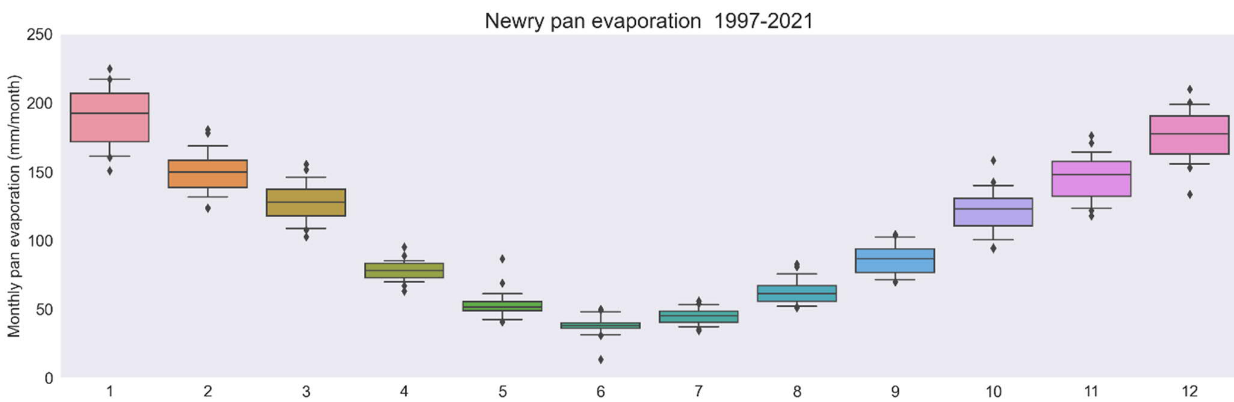


Figure 3: Newry monthly pan evaporation. Month 1 = January.

[2] *SILO Database - https://www.longpaddock.qld.gov.au/silo/*

Figure 4 shows the seasonal totals for rainfall and evaporation from 1990/91 to 2019/20. The graph includes the average [Evaporation minus Rainfall] values pre-1997 and post-1997/98.

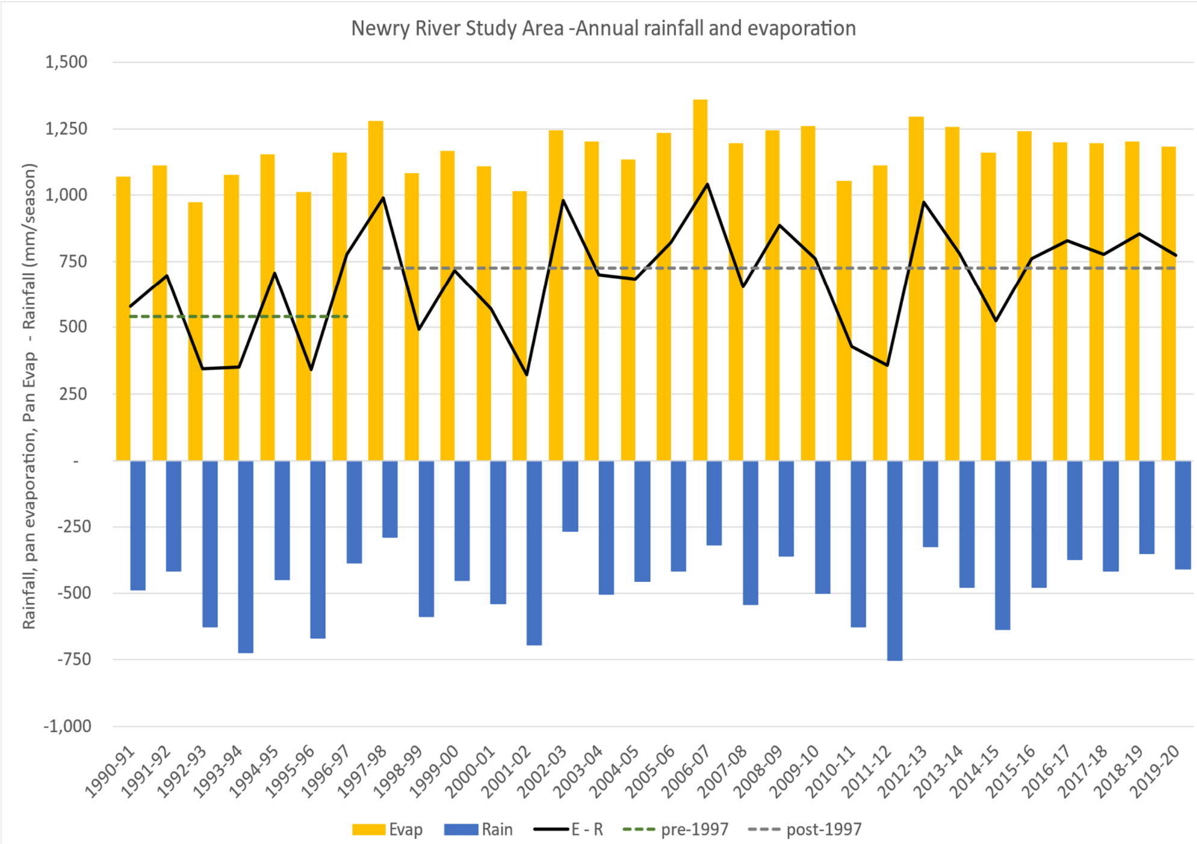


Figure 4 - Newry River Study Area - Seasonal rainfall and evaporation

Monthly rainfall and evaporation values from 1990/91 to 2019/20 are provided in Appendix A.

3.2 Irrigation Water Supply

Annual water balances were prepared for a ten-year period from 2010/11 to 2019/20 to understand the magnitude of losses and trends.

Table 6 shows the annual average water balances for the ten-year period from 2010/11 to 2019/20.

Table 6: - Average water balance over period 2010/11 to 2019/20

ELEMENT	DATA SOURCE	INFLOWS	OUTFLOWS	NOTE
Inflows	Measurement (FlumeGate)	11,407		1
Deliveries	Measurement (Dethridge outlets)		7,071	2
Deliveries (under recorded)	Estimate		608	3
Outfalls	Measurement (FlumeGate)		1,332	4
Evaporation	Channel data and climate		88	5
Seepage	Channel data and SKM 2012		400	

ELEMENT	DATA SOURCE	INFLOWS	OUTFLOWS	NOTE
Other losses			1,908	6
Total		11,407	11,407	

Notes:
1 – Newry Offtake FlumeGate (718) measurement
2 – Deliveries recorded by mix of Large and Small Dethridge Outlets
3 – The under-recording is 8.6% of deliveries, which is the value specified by the Victorian Water Savings Protocol (VWSP)
4 – Combined value measured from 4 FlumeGates
5 – Evaporation estimate combines rainfall, evaporation, evaporation adjustment factor and channel surface area.
6 - Other losses – this includes leakage, inflow measurement errors and unauthorised water usage.

The other losses in the water balance fluctuate seasonally as it is the balancing term and includes the combined uncertainty from the other elements. From a modelling perspective, the seepage and leakage would be stable, as all the factors that impact it are stable, such as channel operating levels, soil types, season length, channel dimensions and water quality.

Figure 5 shows the water balance elements from 2010/11 to 2019/20.

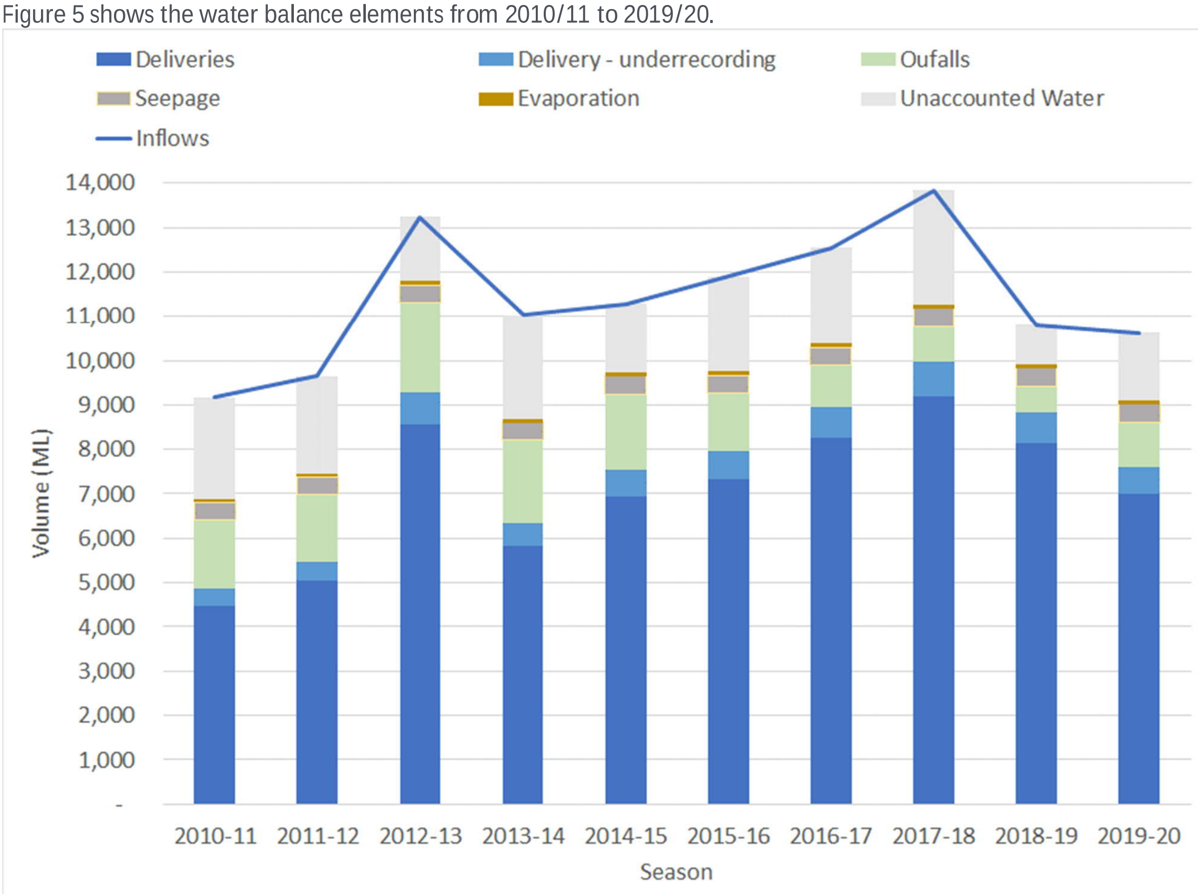


Figure 5 Newry Supply system Water balance

3.3 Channel outfalls

There are five channel outfalls in the Newry river-channel system:

- Outfalls 818D and 831 discharge into the Macalister River and so have no impact inside the study area,
- Outfall 754D outfalls into Newry Creek,
- Outfall 804 outfalls in a natural depression; and
- Newry 4 ex. which discharges to the Newry 4 drain.

A sixth outfall 858D also discharges to the Newry Creek from the Main northern system. This outfall will remain in place. Section 5.1discusses outfall 754D.

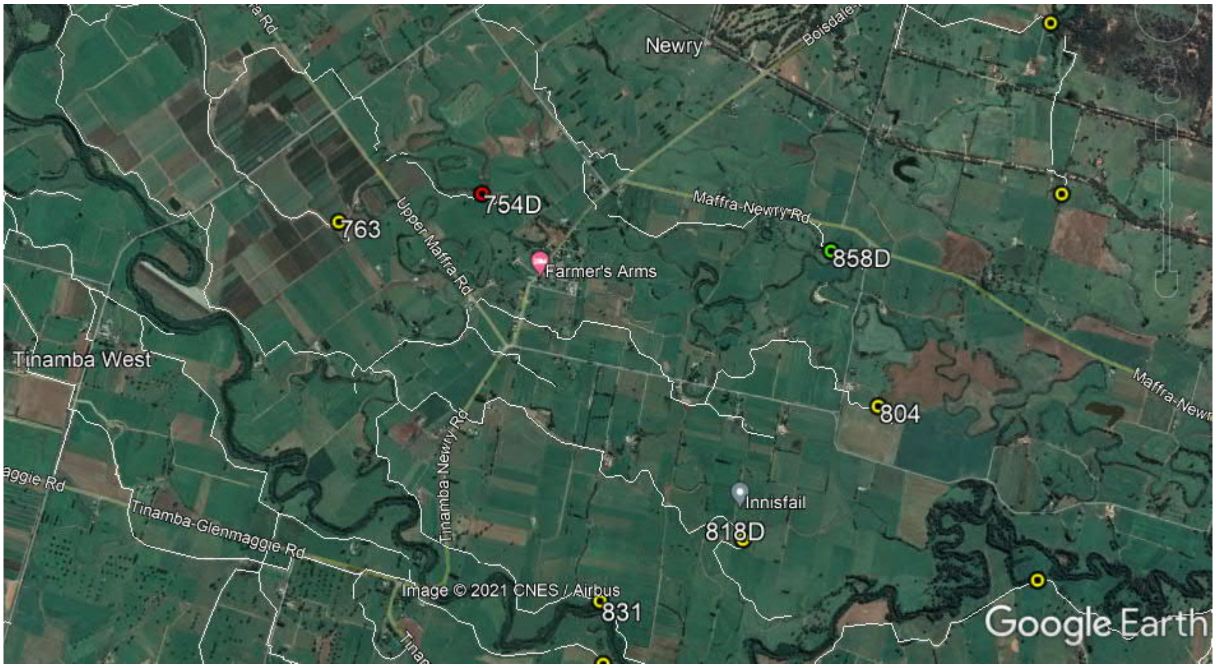


Figure 6 Newry river-channel outfalls

3.4 Pipeline impacts on the water balance

Once the new pipeline replaces the channel, the changes to the water balance will be:

- No outfalls from Newry river-channel,
- Elimination of seepage losses,
- Minimal leakage losses; and
- Improved flow measurement.

The impact of these water balance changes depends on where the water losses are currently discharged to. The following sections cover these impacts.

4 Groundwater Assessment

The seepage of water from the existing irrigation supply channels is a form of groundwater recharge that contributes to observed groundwater levels. Piped replacement of these channels is expected to reduce groundwater recharge, which may lead to a decrease in groundwater levels.

The following is an assessment of the potential decline in groundwater levels that may occur due to the proposed Newry Pipelining project that would replace all existing open channels with pipeline.

4.1 Method

The degree to which channel seepage may affect groundwater levels can be evaluated by comparing the amount of recharge from the channel relative to the total recharge from all sources such as rainfall, irrigation and throughflow.

4.2 Groundwater Recharge

Recharge to the shallow aquifer is predominantly from diffuse sources such as rainfall and irrigation accessions (SKM, 1998, Reid 2004, GHD, 2010). The water balance from recent numerical groundwater modelling of the Gippsland groundwater systems indicates recharge through the ground surface such as rainfall, irrigation, and channel seepage is between 93% and 99% of total groundwater recharge, with the remainder coming from throughflow (from other aquifers) and rivers when in high flow (GHD, 2010 and DELWP, 2015)). A summary of the groundwater recharge rates from various authors ranges between approximately 30 mm/year and 80 mm/year (Table 1).

The recharge rates identified in SKM (1998) and Reid (2004) are very preliminary in nature, and are not considered reliable (Reid, 2004). Recharge estimates from calibrated numerical models are more robust because they simulate both recharge and discharge and are calibrated against observed groundwater levels. Two relatively recent and highly detailed models that model a large proportion of the coastal margin (which includes the Quaternary and Upper Tertiary aquifers in the Newry area and adjacent areas) indicate recharge is in the order of 50 and 80 mm/year (DEWLP, 2015, and GHD, 2010, Table 1 and Table 2).

Because the area representing the coastal margin within these model domains is mostly un-irrigated the recharge rates used in these models are largely representative of recharge from rainfall only. Given that the majority of the Newry Irrigation Area is irrigated, accessions from irrigation and channel seepage will need to be added to the recharge rate. Note: Irrigation accessions from groundwater pumping are likely to be significantly less than the volume of groundwater pumped (due to evaporation and crop evapotranspiration), so are not added to the estimate of recharge.

Approximately 8,000 ML/year is irrigated from surface water sources of which only a portion would be expected to recharge groundwater. For this assessment we have assumed recharge from accessions varies between 20% and 30% of the total annual irrigation volume with the remainder being taken up by the irrigated crops and direct evaporation (Table 2).

The amount of channel seepage that reaches groundwater will be less than the total seepage due to some seepage discharging to the surface along the edges of channel embankments plus interception of seepage by vegetation adjacent to the channel. The percentage of seepage that reaches groundwater will vary significantly from site to site depending on local factors such as channel construction, height above surrounding ground levels, and vegetation type and density adjacent to the channel. Due to the high degree of uncertainty in estimating the percentage of seepage reaching groundwater, a conservative approach is taken by assuming all seepage from irrigation channels reaches groundwater. The actual seepage from the irrigation channels has been estimated based on previous work undertaken by SRW (SKM, 2012) to be approximately 400 ML/year.

The resultant range of total recharge in the study area is between 3,335 ML/year and 4,936 ML/year (Table 2).

Recharge from channel seepage represents between 8% and 13% of the total annual groundwater recharge.

Table 7: Recharge Rate to the Water Table Aquifers within the Wa De Lock GMA and areas with similar hydrogeology to the Wa De Lock GMA

SOURCE	MM/YEAR	METHOD
SKM (1998)[1]	45 to 60	Estimated
	30 to 40	Groundwater hydrograph fluctuation
Reid (2004)[1]	45 to 60	Estimated, adjusted aquifer area
	60 to 80	Groundwater hydrograph, increased Sy, adjusted aquifer area
DELWP (2015)	84[2]	Gippsland Regional Groundwater Numerical Model
GHD (2010)	25 to 100[3, 4]	East Gippsland Regional Groundwater Numerical Model

Note:

1. *Zones 1 and 2 Wa De Lock GMA*
2. *Average for the period 1971 to 1989*
3. *For the Mitchell River area in similar geology to the Wa De Lock GMA*
4. *Average of 48 mm/year for the East Gippsland Regional Groundwater Numerical Model*
5. *Assumes 14,170 ha combined area of the Newry Irrigation Area and Newry Catchment*

Table 8: Annual Recharge Volume for the Combined Newry Irrigation Area

SOURCE	AREA (HA)	ANNUAL RECHARGE RATE		ANNUAL RECHARGE VOLUME	
		Min	Max	ML/year - min	ML/year - max
Rainfall	2,670	50 mm/year	80 mm/year	1,335	2,136
Irrigation Accession[1]	2,100	20% of annual irrigated volume[2]	30% of annual irrigated volume[2]	1,600	2,400
Channel Seepage	-	100% of seepage		400	400
Total				3,335 1.2 ML/ha	4,936 1.8 ML/ha

Note:

1. *From irrigation channels (i.e. excludes irrigation from groundwater)*
2. *Annual irrigated volume is approximately 8,000 ML/year*

4.3 Groundwater Level Impact

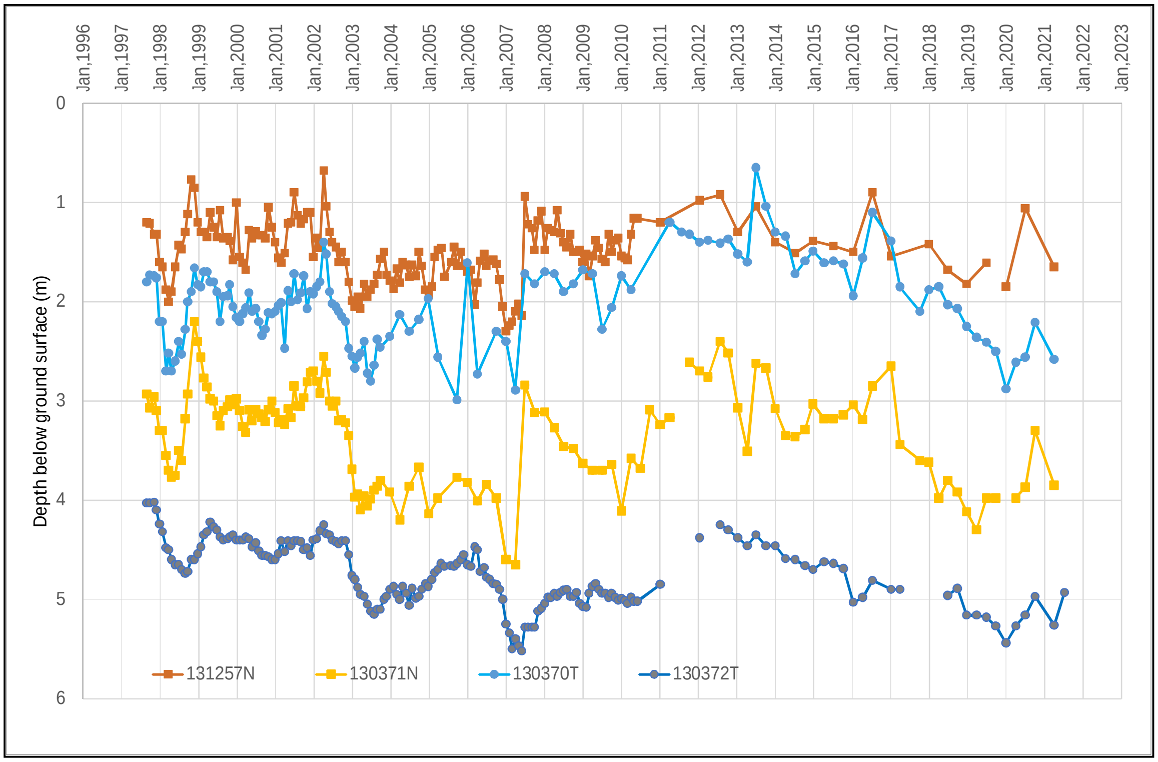
The annual fluctuation in groundwater levels represents a change in the total volume of groundwater stored in the aquifer, with the level rising and falling in response to the annual fluctuation in recharge and discharge (predominantly baseflow). Given that recharge from seepage is estimated to be between 8% and 13% of recharge, this also represents the average total percentage contribution of seepage to annual groundwater level rise.

Annual groundwater levels in the Newry area typically fluctuate by less than 0.5 m (Figure 1). As a result, we would expect seepage from irrigation channels to contribute approximately 40 mm (8% of 0.5 m) to 65 mm (13% of 0.5 m) of the annual groundwater fluctuation. This is likely to be an over-estimate because it has been assumed that all seepage from the channels reaches groundwater (ie losses due to leakage to the surface, or interception by evapotranspiration have not been excluded).

The chart in *Figure 7* compares the Newry observation bores (130371 and 131257) with Tinamba observation bores (130370 and 130372) on the opposite side of the Macalister River including the period since the Tinamba pipeline construction commenced in 2018/19. Over the period of record groundwater levels in Tinamba have followed a similar pattern to the Newry bores. This indicates that changes to groundwater levels observed in Tinamba are predominantly driven by rainfall and irrigation with the pipeline only likely to have a minor influence in localised areas. A similar pattern is expected following the Newry pipeline construction.

The change in groundwater level would be expected to occur over a one to five-year period representing the period it is likely for groundwater discharge (to nearby surface water features) to respond to the reduced groundwater recharge.

Figure 7: Groundwater Levels in the Newry and Tinamba Area



4.4 Groundwater monitoring bores

The monitoring bores in the area and the pattern in the bore levels provide significant insight into the relative recharge contributions from various sources. The bore reading periods vary, and so does the reading frequency.

Readings were monthly prior to 2010 and quarterly after 2010. Statistically, it is possible to break down the bore level profiles into:

- Seasonality - which is the repeating pattern each season
- Trend - which is the pattern between seasons

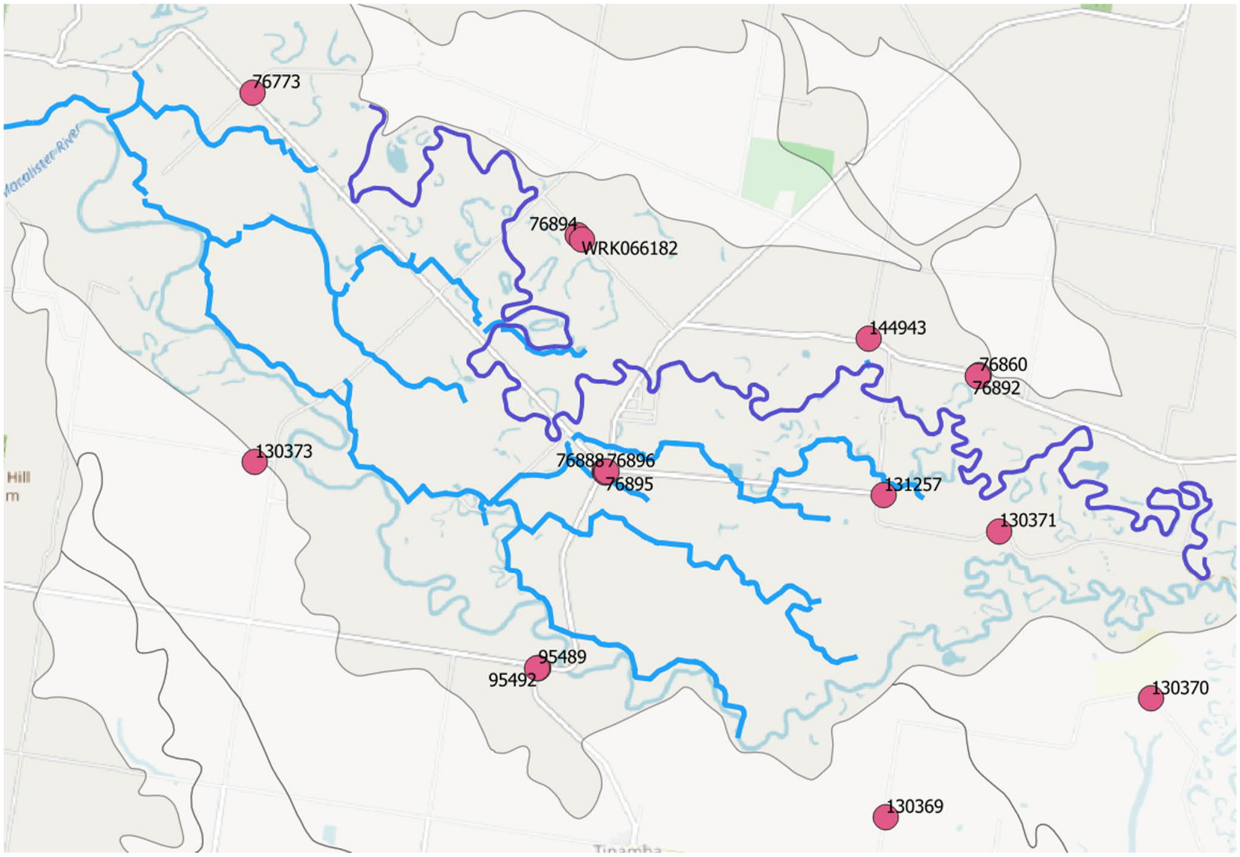


Figure 8 Groundwater monitoring bores in the Newry River supply area

Water level data from a total of six bores was analysed and the observations and conclusions are summarised in Appendix B.

The main observations are:

<u>Observations</u>

- Bores north of Newry Creek have declined slightly in the last 20 years whereas bores to the south and closer to the Macalister River recover after dry seasons,
- There are declines in dry years – which could be due to low recharge and or increased groundwater pumping.
- Groundwater level rebounds following high rainfall; and
- Groundwater level data shows no evidence of significant recharge from SRW channels (this aligns very well with the ground water balance presented in Section 4.3).

Table 9: Monitoring Bore – Observation of trends

BORE NO	BORE DEPTH (M)	OBSERVATIONS	CONCLUSION
76860	20	• Water levels fluctuate in the in the top 2 metres. • The longer-term trend is an underlying decline in levels. • Declines in dry years (e.g., 2006/07) indicating pumping drawdown. • Recharge from high rainfall (196 mm in June 2007).	• No seasonality patterns. • Level data shows no evidence of significant recharge from SRW channel.
76892	5.75	• Water levels fluctuate in the in the top 2 metres. • The longer-term trend is an underlying decline in levels. • Some seasonality prior to 1997, with levels increasing in the irrigation season. • Declines in dry years (e.g., 2002/03, 2006/07), indicating pumping drawdown. • Recharge from high rainfall (e.g., 136 mm April 2002, 196 mm in June 2007.	• Overall, more trend than seasonality patterns. • Level data shows no evidence of significant recharge from SRW channel.
76888	20	• Water levels fluctuate mainly between 3 and 6 metres below the top of the bore. • The longer-term trend is an underlying decline in levels. • Some seasonality prior to 1997 with levels increasing during the irrigation season. • Declines in dry years (e.g., 1997/98, 2002/03, 2006/07) indicating pumping drawdown. • Recharge from high rainfall (e.g., 136 mm April 2002, 196 mm in June 2007).	• Overall, more trend than seasonality patterns. • Level data shows no evidence of significant recharge from SRW channel.
130371	10	• Water levels fluctuate between 2 and 5 metres. • The long-term trend is stable. • Little evidence of seasonal patterns. • Declines in dry years (e.g., 2002/03, 2006/07) indicating pumping drawdown. • Recharge from high rainfall (e.g., 134 mm in Nov 1998, 196 mm in June 2007.	• Overall, much more trend than seasonality. • Level data shows no evidence of significant recharge from SRW channel.
131257	11	• Water levels fluctuate in the range between 0.5 and 2.5 metres below the bore top. • The longer-term trend is stable. • Little evidence of seasonal patterns. • Declines in dry years (e.g., 1997/98, 2002/03, 2006/07), indicating pumping drawdown. • Recharge from high rainfall (e.g., 134 mm in Nov 1998, 196 mm in June 2007.	• Overall, much more trend than seasonality. • Level data shows no evidence of significant recharge from SRW channel.
144943	11	• Water levels fluctuate between 1.5and 5.0 metres. • The longer-term trend is small decline in bore levels. • Little evidence of seasonal patterns. • Sharp declines in some years indicating nearby pumping. • Recharge from high rainfall (e.g., 134 mm in Nov 1998, 196 mm in June 2007).	• Overall, much more trend than seasonality. • Level data shows no evidence of significant recharge from SRW channel.

5 Newry Creek and natural depressions

5.1 Newry Creek inflows

Natural Catchment

Newry Creek has a significant catchment to the north of the Newry Creek irrigation area. The catchment is ungauged so there is no data on the inflows from the catchment north of the irrigation area. The section of Newry Creek located in the floodplain, follow the old river channels of the Macalister River.

Irrigation System

There are five channel outfalls to be decommissioned. One of these (754D) flows directly into the creek while the other four discharge directly to or via a drain into the Macalister River and to natural depressions. The data below shows a reduction to flows to outfalls of almost 40% since 2016.

Table 10: Summary of channel outfalls

OUTFALL	PRE 2016 DISCHARGE (ML)	2016-2021 DISCHARGE (ML)	OUTFALL RECEPTOR
754D	440	270	Newry Creek
804	958	536	Natural depression
818D	244	186	Drain 6 (Macalister River)
831	140	21	Macalister River
Newry 4 ex	139	201	Drain / natural depression
TOTAL	1,921	1,214	

The average outfall volume for recent seasons (2016/17 to 2019/20) is about 270 ML/season.

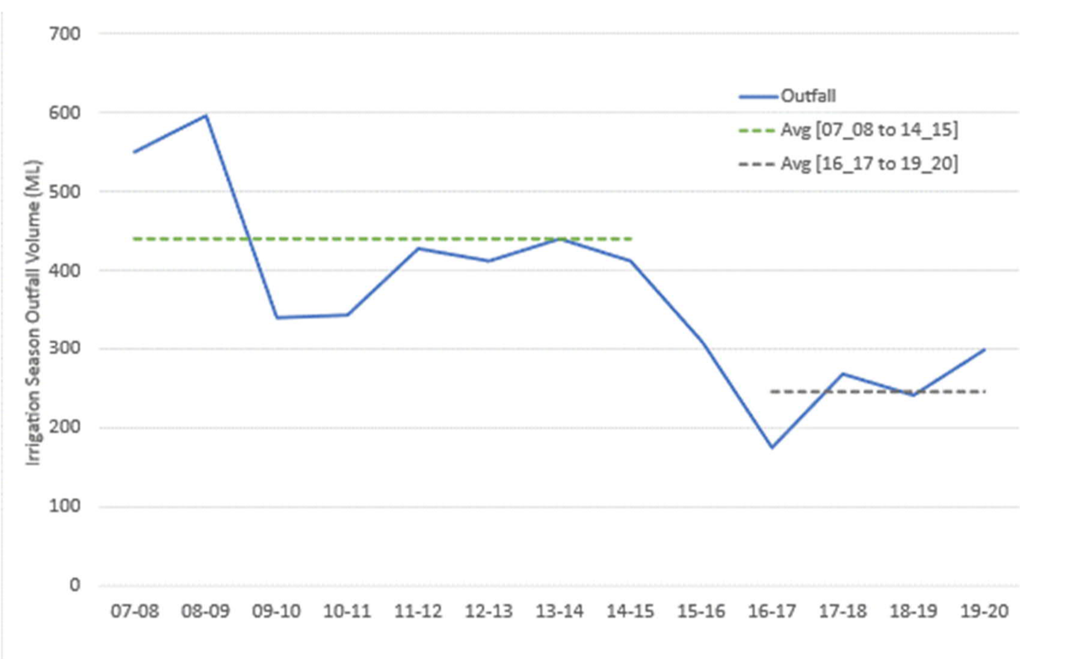


Figure 9- Outfall 754D into Newry Creek

5.2 Newry Creek diversion licences and use

The combined licence volume from Newry Creek and natural depressions is 1,083 ML. These sites are not metered because the Newry Creek has operated as an irrigation drain (i.e. extraction from these sources has been encouraged to reduce flows (and thus nutrient outfalls) from the catchment to the Macalister River downstream).

Table 11: Newry Creek Diversion Licences

	VOLUME (ML)
Total licences	1,083
Licences downstream of channel outfalls	654

There are several licences upstream of the existing outfalls, located in closed natural depressions. These licence sites do not rely on channel outfalls.

5.3 Groundwater recharge into Newry Creek and depressions

Groundwater recharge to the Newry Creek and natural depressions can occur from the water table is it is above the surface water level. The review of the bore levels concluded there is minor aquifer recharge from channel leakage to the surface water features. Any impact would be localised to points where the surface water level is lower than the surrounding water table.

It was notable that the bores located north of Newry Creek and distant (>1.3 km) from the river-channel system have declined slightly in the past 20 years, indicative of lower than average rainfall. Bores south of the Newry Creek have generally recovered with rainfall which possibly indicates the influence of the Macalister River on base groundwater levels.

5.4 Newry Creek Water Balance

As there is no creek inflow data available, a comparative assessment was undertaken using the annual volume of water leaving the catchment, channel outfalls and diversion licences.

This analysis is presented in *Table 4*.

Table 12: Newry Creek Water Balance

COMPONENT	NEWRY CREEK FLOWS (ML)	
	AVERAGE	MEDIAN
Leaving (Gauge @ Bellbird Corner)	4,296	2,536
Gains (Channel outfalls @ 754)	270	262
Outcome if no outfall	3,937	2,989

5.5 Newry Creek Summary

Replacing the channels with pipelines will eliminate outfalls and seepage losses and reduce leakage losses.

5.5.1 Channel Seepage and Leakage

Seepage and leakage losses along the section of the Newry river -channel adjacent to the Macalister River (~10 km length) will mostly discharge to the river. For sections of channel located away from the Macalister River seepage and leakage could:

- Evaporate from the soil,
- Flow into Newry Creek or into natural depressions directly; and
- Flow into Newry Creek or natural depressions indirectly by raising the water table and increasing the water tables discharge.

Leakage from the river-channel to Newry Creek or to natural depressions is detectable. If it is significant it is stopped or reduced by SRW's maintenance interventions.

5.5.2 Channel Outfalls

The elimination of outfalls will reduce inflows into Newry Creek by 270 ML/year. This represents 5 to 10% of the coarse analysis of annual flows.

Actual flows along the stream course are more complex because it meanders through a system of pools that are not always connected, and along the way, there are gains (drainage lines, groundwater seepage) and losses (pumping, seepage, evapotranspiration). Except in two or three instances where licence sites are directly below outfalls the impact to licence holders from reduced outfalls is likely to be minor.

6 Conclusions

Once the new pipeline replaces the channel, the changes to the water balance will be:

- No outfalls,
- Elimination of channel seepage and leakage losses; and
- Improved flow measurement and water accounting.

6.1 Groundwater users

Replacing the channels with pipes will eliminate seepage and leakage but based on the available data, it is likely to have minimal impact on groundwater recharge and groundwater levels.

The review of the groundwater balance and monitoring bore data showed:

- groundwater recharge is approximately between 3,335 and 4,936 ML which includes a 10% contribution from SRW channel losses,
- Rainfall is the dominant groundwater recharge source,
- There is little to no seasonal patterns that would indicate significant groundwater recharge from channel seepage and leakage,
- Groundwater levels could decline by up to 65 mm mostly adjacent to irrigation channels. Based on Tinamba observation bores the impact well away (>100m) from the channels is likely to be minor,
- Slightly lower groundwater levels should not affect bore yields noting that bore performance is also affected by low rainfall, bore condition and pump settings,
- Removal of channel seepage and leakage is unlikely to impact the current groundwater usage (900-1,000 ML): and
- Consistent with lower rainfall, there is a slight declining trend in some observation bores since 1997/98.

6.2 Newry Creek and Depression Users

The following conclusions are made:

- The removal of outfalls will reduce inflows into Newry Creek by 270 ML/year, which will have minimal impact to creek flows but may affect pumps immediately downstream,
- A further 944 ML of outfalls will be removed which was opportunistically available to users from natural depressions and drains; and
- There is no data to indicate significant channel seepage and leakage losses into the Newry Creek and the natural depressions or subsequent impact to water access once the channels are replaced.

Assessment of environmental impacts resulting from the replacement of the open channel with the pipeline were outside of the scope of this project. SRW is required to obtain planning, cultural heritage and environmental approvals to construct the pipeline.

6.3 Recommendations

Further investigations are recommended to:

- Observe groundwater levels post construction to identify any changes; and
- Improve data base of licence sites and private bores.

Noting that this study did not review environmental impacts from the new pipeline, SRW and its partner agencies should:

- Undertake a desktop assessment of potential environmental impacts from the reductions to outfalls, seepage and leakage to the Newry Creek.

7 References

DELWP (2015): Gippsland Regional Groundwater Numerical Model. Technical Report, June 2015

GHD (2010): Report for 'ecoMarkets' Groundwater Models. Report on Transient Groundwater Flow Modelling: East Gippsland CMA

Reid (2004): PAV Groundwater Audit

SKM (1998): Permissible Annual Volume Project. The Wa De Lock GMA. January 1998

SKM (2012): Application of the Department of Sustainability and Environment's water savings protocol to the Macalister Irrigation District

Appendix A Newry Weather Records

Newry monthly rainfall

Newry Monthly Rainfall

month	1	2	3	4	5	6	7	8	9	10	11	12	Total
year													
1990	0.3	46.6	56.1	198.9	31.2	18.1	27.9	56.9	84.8	95.8	32.7	33.6	683
1991	122.8	11.2	12.7	27.9	10.2	110.6	54.5	53.6	60	37.5	17.5	57.5	576
1992	47.2	46.6	33	36.6	28.1	85.1	13.7	31.2	101.4	52.2	97.1	147.5	720
1993	47.1	56.3	43.6	20.4	31.1	33.9	61.1	12.7	205.4	74.6	57.9	47.1	691
1994	31.1	198.3	43.6	27.8	25.3	42.5	8.8	10.2	42.8	56.4	81	42.3	610
1995	71.2	23.7	21.5	43.2	57.7	36.7	30	20.8	60	154.1	134.4	63.2	717
1996	62.6	61.6	29.9	54.6	28.1	31.3	54.5	41.6	45.4	28.2	91.6	26.1	556
1997	50.8	15.6	43.7	4.8	37.8	71.8	15.2	19	48.1	22.8	46.1	42.3	418
1998	31	37.9	14.7	11	15.7	127.7	13.8	41.5	33.2	65.2	134.4	75.6	602
1999	90.1	34	65.4	20.4	28.1	10.2	18.3	38.9	23.2	52.3	13.5	89.1	484
2000	43.6	26.9	36.5	33.5	94.6	14.6	20	33.7	97.2	60.6	81	16.8	559
2001	54.6	18.1	36.4	116.3	25.4	36.6	75.8	53.7	33.1	74.6	97.2	120.3	742
2002	40.3	79.2	40	136.3	20.2	33.9	9.9	7.9	19.7	40.9	53.7	26.1	508
2003	7.5	26.9	29.8	39.8	11.9	36.7	39.8	47.4	35.4	101.5	49.9	69.3	496
2004	43.6	30.3	3.4	98.3	25.4	34	34.7	36.2	45.4	34.2	71.2	63.2	520
2005	54.6	85.5	29.8	25.3	8.7	22	71.9	36.2	30.9	34.2	81.1	52.2	532
2006	43.6	15.6	16.9	46.9	57.8	13.1	54.5	53.6	35.4	10.3	15.5	12	375
2007	12.3	61.7	60.8	30.6	25.4	196.2	61.2	26.7	18.2	31.1	170.9	52.2	747
2008	85.2	106.7	9.4	14.3	28.2	10.2	27.8	28.9	16.6	13.8	115	57.5	514
2009	1	30.4	36.4	50.7	7.3	19.9	20	38.8	60	48.3	71.2	22.8	407
2010	22.9	114.3	43.6	30.5	49.2	33.9	7.8	53.6	19.8	69.7	97.2	69.2	612
2011	40.3	85.5	98.8	50.6	41.4	18.1	54.5	53.6	56.9	107.3	141.4	57.5	806
2012	20.5	106.7	132.9	14.3	62.4	133.8	20.1	38.8	42.7	41	53.8	29.7	697
2013	1	37.9	33	25.2	20.2	228.7	25.7	38.8	40.2	52.2	71.3	42.3	617
2014	31	13.3	75.7	87.2	25.3	56	16.8	44.5	48.1	60.7	57.8	167.3	684
2015	54.7	37.9	12.7	129.4	22.6	56.1	32.4	67.7	13.8	34.2	53.7	37.8	553
2016	141	5	75.7	22.7	28.1	85.1	111	17.3	77.3	60.7	57.9	26.1	708
2017	14.1	23.7	51.8	27.8	13.8	7.8	15.3	44.4	26.9	69.8	32.7	120.3	448
2018	54.7	23.7	14.8	5.8	25.3	22	37.3	24.7	30.9	28.2	76.1	47.1	391
2019	20.5	34	39.9	6.9	41.4	39.5	32.3	33.7	33.2	18	39.1	9.9	348
2020	80.4	79.1	24	67.4	22.7	14.6	88	53.6	16.6	126.2	49.8	57.5	680
2021	80.5	20.9	86.7	20.5	67.1	101.6							377

Newry monthly evaporation

Newry pan-evaporation

													Total
1990	179	109	116	65	54	36	44	53	75	106	132	159	1,127
1991	156	146	124	77	41	39	40	74	77	124	161	147	1,206
1992	169	136	112	73	41	37	56	61	64	95	103	126	1,072
1993	159	135	102	81	49	44	39	68	72	111	134	167	1,159
1994	183	106	92	77	68	34	50	68	79	122	136	192	1,206
1995	157	152	129	77	42	36	39	74	74	98	116	135	1,130
1996	149	128	119	73	47	34	38	61	89	127	145	146	1,157
1997	200	158	111	81	44	37	43	68	71	127	161	190	1,290
1998	203	166	155	83	55	41	40	51	86	126	123	166	1,296
1999	151	137	117	72	55	33	45	55	93	111	158	167	1,193
2000	162	178	118	73	52	36	41	52	84	94	122	189	1,200
2001	172	151	128	77	41	40	35	68	74	100	118	134	1,136
2002	161	123	126	67	47	50	47	60	102	130	163	183	1,259
2003	217	143	127	71	49	48	50	65	104	95	149	180	1,297
2004	176	161	139	85	51	49	48	65	72	120	143	156	1,265
2005	175	132	121	95	57	37	43	67	70	122	149	197	1,265
2006	193	155	146	89	49	32	42	61	98	158	171	195	1,389
2007	211	181	137	78	69	37	46	76	87	140	132	171	1,364
2008	198	135	138	74	48	44	39	58	104	138	147	156	1,277
2009	225	157	129	81	50	31	54	83	94	110	176	192	1,383
2010	210	144	123	78	51	38	37	61	81	120	132	153	1,229
2011	164	124	109	70	41	39	45	56	89	107	133	163	1,138
2012	193	133	102	75	61	33	39	66	96	124	143	199	1,265
2013	217	165	152	83	52	39	50	81	91	139	130	176	1,373
2014	214	169	134	63	61	36	52	54	91	123	164	158	1,320
2015	164	139	135	75	57	40	48	55	83	134	150	210	1,289
2016	161	158	118	84	87	44	56	56	71	143	148	177	1,302
2017	201	145	135	83	42	31	42	68	92	120	149	162	1,270
2018	190	150	139	76	50	38	53	61	86	116	129	181	1,268
2019	207	157	131	84	52	40	48	66	77	125	157	200	1,345
2020	175	139	118	72	54	37	35	52	76	101	154	178	1,189
2021	186	141	108	78	52	14							

Appendix B Groundwater Bore Chart Analysis

Figure B-1 shows bore 76860 located to the north-east of the supply area, north of Newry Creek.

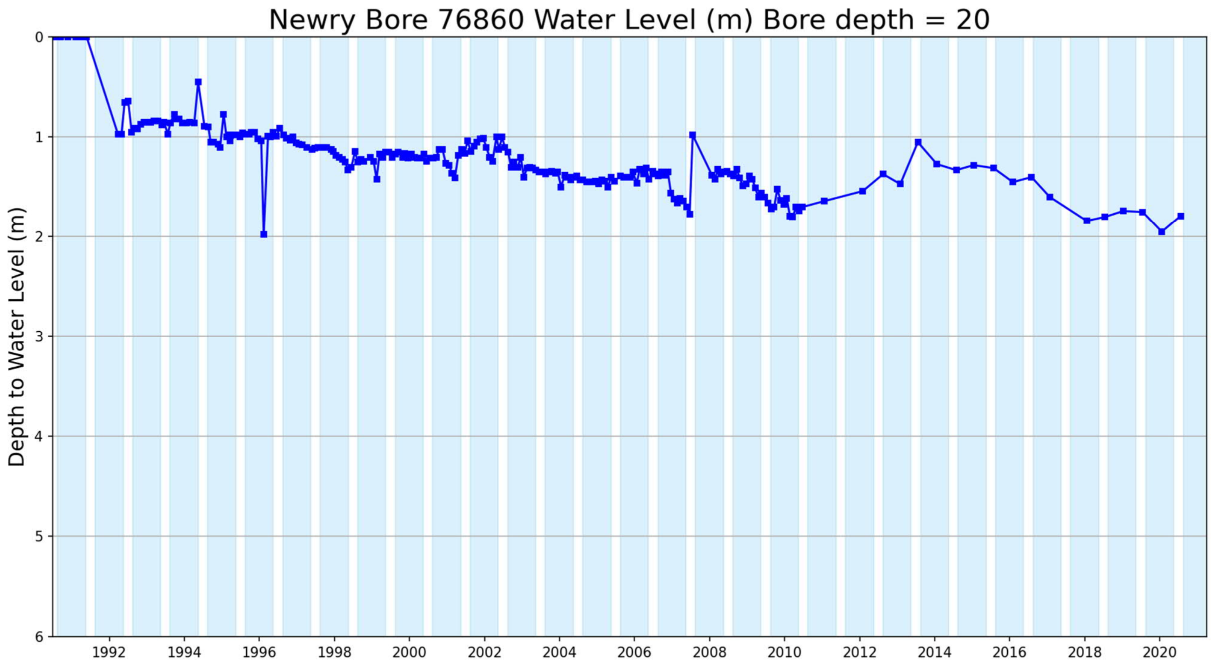


Figure B-1 Bore 76860. The light blue vertical shading shows the irrigation season. The year marker is at the start of the year so 2016 is at the centre of the 2015/16 season.

The figure shows the levels fluctuate in the in the top 2 metres. The longer-term trend is an underlying decline in levels.

The profile shows:

- Declines in dry years (e.g., 2006/07) indicating pumping drawdown
- Recharge from high rainfall (196 mm in June 2007)
- No seasonality pattern

The level history shows no evidence of channel recharge.

Figure B-2 shows bore 76892 located to the north-east of the supply area, north of Newry Creek.

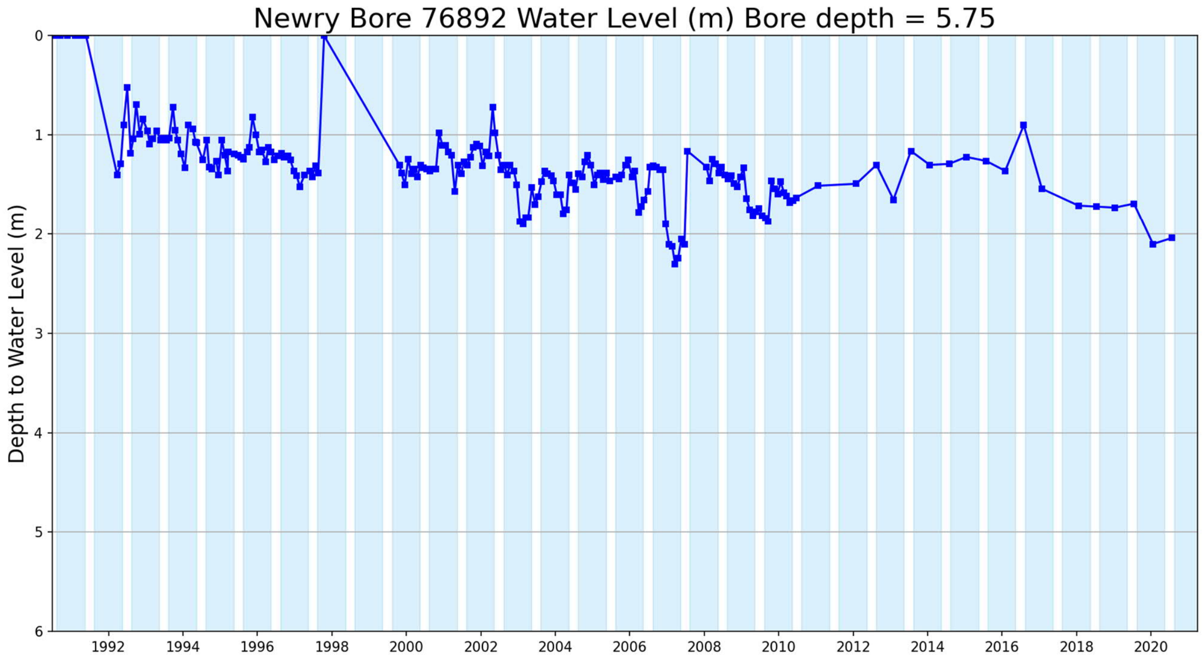


Figure B-2 Bore 76892. The light blue vertical shading shows the irrigation season. The year marker is at the start of the year so 2016 is at the centre of the 2015/16 season.

The figure shows the levels fluctuate in the in the top 2 metres. The longer-term trend is an underlying decline in levels.

The profile shows:

- Some seasonality prior to 1997, with levels increasing in the irrigation season,
- Declines in dry years (e.g., 2002/03, 2006/07), indicating pumping drawdown,
- Recharge from high rainfall (e.g., 136 mm April 2002, 196 mm in June 2007; and
- Overall, more trend than seasonality patterns.

The level history shows no evidence of channel recharge.

Figure B-3 shows bore 76888 located near the Newry township.

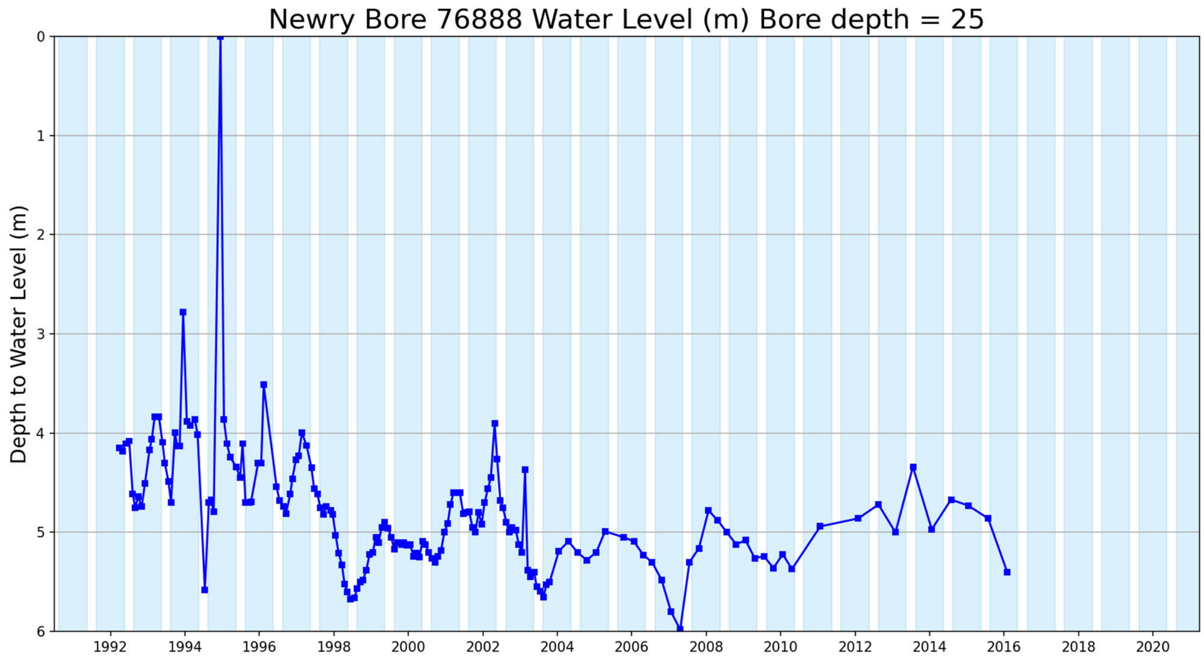


Figure B-3 Bore 76888

The figure shows the levels fluctuate mainly between 3 and 6 metres below the top of the bore. The longer-term trend is an underlying decline in levels.

The profile shows:

- Some seasonality prior to 1997 with levels increasing during the irrigation season,
- Declines in dry years (e.g., 1997/98, 2002/03, 2006/07) indicating pumping drawdown,
- Recharge from high rainfall (e.g., 136 mm April 2002, 196 mm in June 2007); and
- Overall, more trend than seasonality patterns.

The level history shows no evidence of channel recharge.

Figure B-4 shows the water levels for bore 130371, located to the eastern end of the supply area.

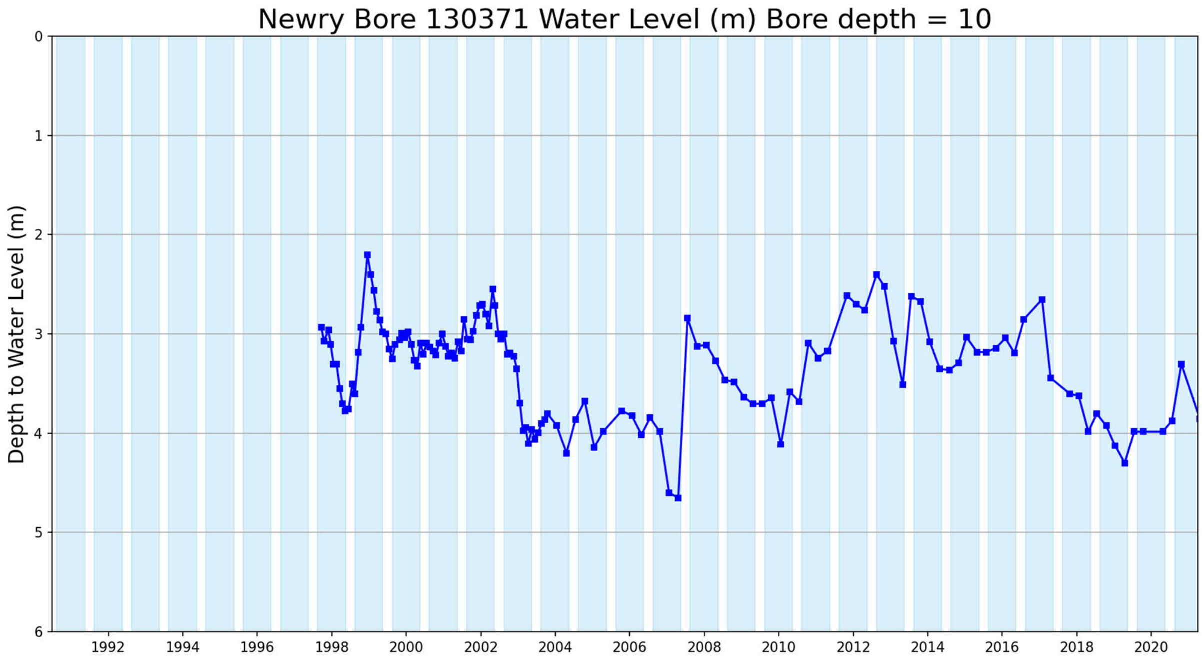


Figure B-4 Bore 130371 levels

The figure shows the levels fluctuate in the range between 2 and 5 metres below the bore top.

The long-term trend is stable. The profile shows:

- Little evidence of seasonal patterns,
- Declines in dry years (e.g., 2002/03, 2006/07) indicating pumping drawdown,
- Recharge from high rainfall (e.g., 134 mm in Nov 1998, 196 mm in June 2007; and
- Overall, much more trend than seasonality.

The level history shows no evidence of channel recharge.

Figure B-5 shows the water levels for bore 131257, located to the eastern end of the supply area, south of Newry Creek and is about 100m from a channel

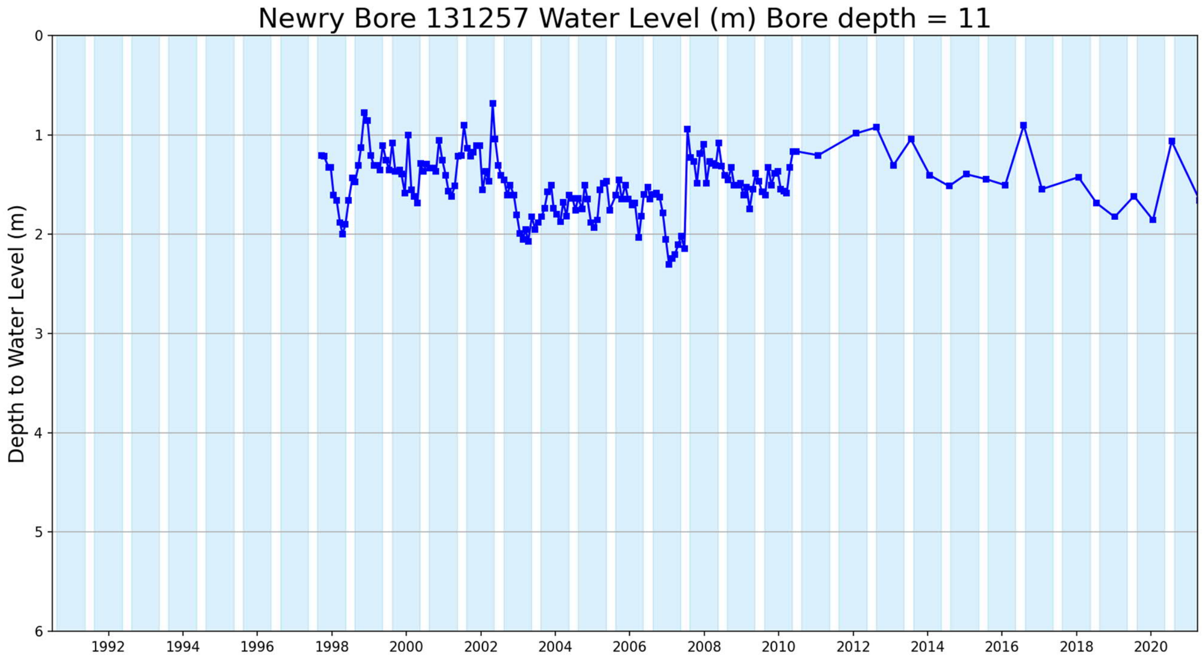


Figure B-5 Bore 131257

The figure shows the levels fluctuate in the range between 0.5and 2.5 metres below the bore top.

The longer-term trend is stable. The profile shows:

- Little evidence of seasonal patterns,
- Declines in dry years (e.g., 1997/98, 2002/03, 2006/07), indicating pumping drawdown,
- Recharge from high rainfall (e.g., 134 mm in Nov 1998, 196 mm in June 2007; and
- Overall, much more trend than seasonality.

The level history shows no evidence of channel recharge.

Figure B-6 shows the water levels for bore 144943, located centrally and north of Newry Creek.

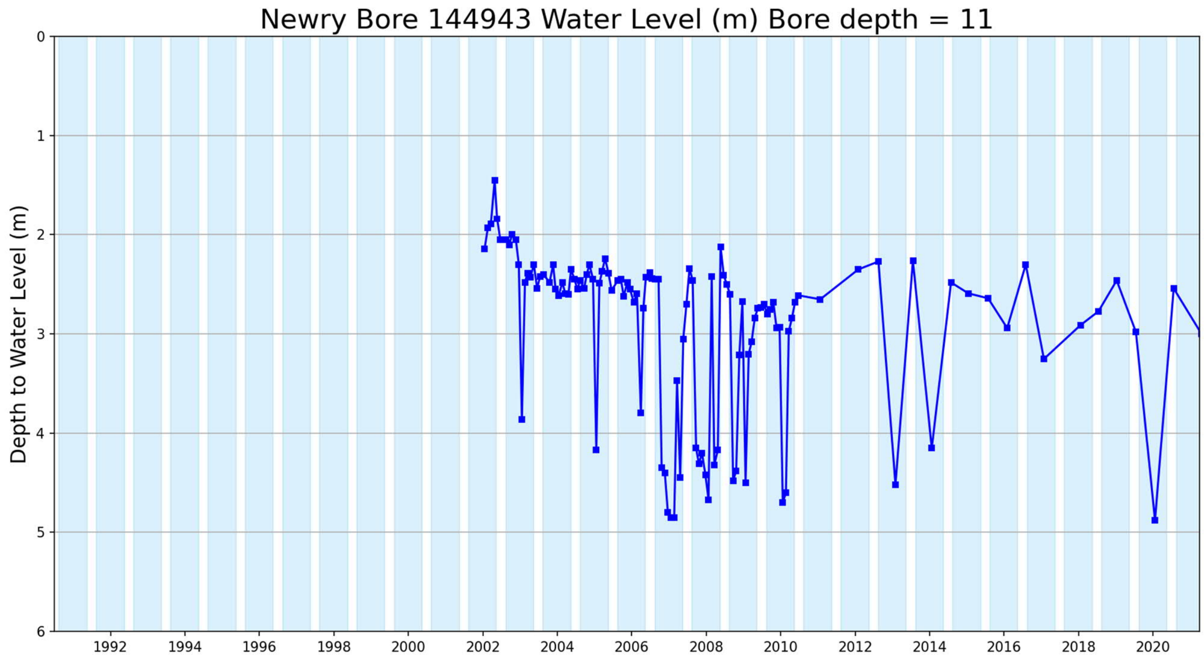


Figure B-6 Bore 144943

The figure shows the levels fluctuate in the range between 1.5and 5.0 metres below the bore top.

The longer-term trend is small decline in bore levels. The profile shows:

- Little evidence of seasonal patterns
- Sharp declines in some years indicating nearby pumping
- Recharge from high rainfall (e.g., 134 mm in Nov 1998, 196 mm in June 2007)
- Overall, much more trend than seasonality

The level history shows no evidence of channel recharge.

local people
global experience

SMEC is recognised for providing technical excellence and consultancy expertise in urban, infrastructure and management advisory. From concept to completion, our core service offering covers the life-cycle of a project and maximises value to our clients and communities. We align global expertise with local knowledge and state-of-the-art processes and systems to deliver innovative solutions to a range of industry sectors.

www.smec.com