Appendix C

Wyong Water Supply – Distribution System Review 2007

WYONG WATER SUPPLY: DISTRIBUTION SYSTEM REVIEW

Prepared for:

NSW - WS Document No: DC07129
November 2007

Foreword

This report has been prepared for Wyong Shire Council by the Water Services unit of NSW Water Solutions Group, NSW Department of Commerce. Commerce acknowledges the input and assistance provided by Enn Karm and Daryl Mann of Wyong Shire Council.

This report presents a hydraulic review of development plans for Wyong Shire Council over the next 50 years.

The core Department of Commerce project team members involved in the preparation of this document were:

- Vu Dao
- Allan Young

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List of Abbreviations

AAD	- Average Annual Demand
ADD	- Average Daily Demand
CWT	- Clear Water Tank
GWCWA	- Gosford Wyong Councils Water Authority
HLPS	- High Lift Pumping Station
HWC	- Hunter Water Corporation
JWSS	- Joint Water Supply Scheme
LGA	- Local Government Area
ML	- Mega Litres
ML/d	- Mega Litres per day
MV	- Motorised Valve
m, mm	- metre, millimetre
PDD	- Peak Day Demand
PRV	- Pressure Reducing Valve
PS	- Pumping Station
WAE	- Works As Executed
WS	- Water Supply
WSC	- Wyong Shire Council
WTP	- Water Treatment Plant

1 INTRODUCTION

1.1 WYONG DISTRIBUTION SYSTEM

The Wyong Distribution System comprises of a network of water supply infrastructure owned and operated by Wyong Shire Council (WSC), situated on the Central Coast of New South Wales. This Local Government Area (LGA) is expecting significant population growth over the next few decades, along with a corresponding projected doubling of the current unrestricted Peak Day Demand (PDD) of approximately 70 ML/d, by 2051. Increased demand of this scale has necessitated an evaluation of the capacity of existing infrastructure to be performed, along with the development of a viable plan for future augmentation in line with these forecasts.

1.2 EXISTING WATER SUPPLY INFRASTRUCTURE

At present, water supply in the Central Coast incorporates functions of the following constituent entities:

- Wyong Distribution System;
- Gosford Distribution System, owned and operated by Gosford City Council; and
- Joint headworks owned and controlled by Gosford City and Wyong Shire Councils. This is known as the Joint Water Supply Scheme (JWSS) and is responsible for the delivery of potable water to the independent distribution systems through the provision of source water and subsequent treatment and transfer processes.

Each council is responsible for the management of its own distribution system, while the Gosford Wyong Councils Water Authority (GWCWA) controls the JWSS. Consequently, this report is primarily concerned with the Wyong Distribution System, whilst recognising the presence of links between the Wyong, Gosford and Hunter Water Corporation (HWC) systems. These links facilitate water transfers to the adjacent LGAs of Gosford and Lake Macquarie, which is served by the HWC, to suit operational requirements in various situations.

In accordance with the brief, this report will focus upon infrastructure located within Wyong Shire downstream of the Mardi Water Treatment Plan (WTP) Clear Water Tank. This asset base consists of 20 reservoirs, 17 pump stations, pipelines (including approximately 205 km of mains, ranging between 250 mm and 1050 mm in diameter) along with corresponding valving. Furthermore, it is specified that existing pipelines of a diameter greater than or equal to 250 mm are to be considered, with a 200 mm threshold for proposed future works. WSC maintains an asset register linked to its GIS, with an installed capability for controlling and monitoring operations and recording data such as reservoir levels, pumping station operations and flow meter readings at 15 minute intervals.

Transfers from the JWSS to the Wyong Distribution System are typically delivered through the WTP Clear Water Tank at Mardi. Links to the Gosford Distribution System consist of a coastal connection delivering up to 20 ML/d each way through a 10 km long, 450 mm diameter transfer main and pump station. Alternatively, 80 ML/d may be transferred from Gosford to Wyong via a 17 km long, 750-1050 mm transfer main by utilising the booster pump station at Ourimbah, with a reciprocal exchange possible upon the completion of the Mardi High Lift Pump Station (HLPS). The existing link with the HWC system at Mannering Park/Vales Point provides an additional 7 ML/d supply when required.

1.3 CURRENT DEVELOPMENT PLANS

Some parts of the LGA are experiencing urban infill, along with a degree of redevelopment, and it is envisaged that elevated levels of higher density development may take place in the vicinity of The Entrance. There are also plans for green-field development to occur around Warnervale, in the northern part of WSC. Conscious of this probable, extensive future development within the shire, augmentation of the water distribution system was already investigated between 1985 and 1990, although many of the proposed upgrades were never implemented. In the past, WSC has been able to mitigate supply requirements through a variety of demand management activities and this is one factor which led to some of these works not being realised. It is, however, now deemed vital that a review of, and the preparation of a future development plan for, the Wyong Distribution System is undertaken.

A number of projects are already being developed for the JWSS headworks and Wyong Distribution System in order to increase supply capacity. These include:

- Expansion of Mardi Dam outlet works (raising capacity from 100 ML/d to 160 ML/d in order to utilise Mardi WTP to full potential);
- Completion of Mardi HLPS (160 ML/d upgradeable to 240 ML/d);
- Northern Connection Main (750 mm, connecting from Mardi HLPS to Warnervale); and
- Construction of a 30 ML/d link to HWC, along with a reservoir.

It is envisaged that the realisation of Mardi HLPS, the Northern Connection Main and the additional link to the HWC will enable bulk water transfer to take place between Mardi WTP and the HWC. Furthermore, the completion of a pipeline to Wyong will allow transfers from the HWC to the northern part of WSC.

1.4 OBJECTIVES

Three basic objectives are outlined by the brief as being essential components to be addressed within this report;

- Establishment of development and demand forecasts, to be approved by WSC, at intervals of 5 years based on current, planned and potential zonings and in consideration of population forecasts, along with the evaluation of ADD, PDD and AAD figures in line with these findings;
- Creation of a calibrated, upgradeable hydraulic model using Infoworks WS software reflecting the layout of the Wyong Distribution System, both for use in devising a future capital works program based on forecasted demands and by WSC itself, with appropriate training; and
- Determining the operational scenarios and capital works schemes, including transfers, that may be implemented to enable the Wyong Distribution System to achieve its required capacity by 2051. This includes identifying and evaluating options, and presenting a plan estimating the costs and delivery timeframe of proposed works.

1.5 EXISTING SYSTEM

The current Wyong water supply network is primarily fed under gravity from the Mardi WTP CWT. From the Mardi CWT the treated water is fed into two systems: a northern system and the southern system, which are separated geographically by Wyong Creek.

The northern system is fed from the CWT under gravity which is then boosted north by No.4 Pumping Station. This pumping station supplies water primarily to the Kanwal and Wyong Reservoirs. Supply to the Kanwal reservoirs are regulated by the Kanwal Motorised Valve (MV). The Doyalson and Halekulani reservoirs are in turn serviced from the head of the Kanwal reservoirs. The remaining reservoirs, Kanangra and Treelands, are supplied by local booster pumping stations, No. 10 and No.13 PS respectively.

The southern system is fed under gravity from the CWT and boosted by No.2 pumping station towards the Entrance and Southern Lakes. Wyrrabalong is the major reservoir in the southern system supported by the smaller local reservoirs such as The Entrance, Bateau Bay and Tuggerah 1 reservoirs, most of which are supplied by local booster pumping stations.

Under the current operating regimes Tuggerah 2 is only used to supplement water levels in the Kanwal reservoirs if they drop below critical levels. This is accomplished by opening a valve allowing the head of Tuggerah 2 reservoir to drive additional flow to Kanwal reservoirs in lieu of the lower Mardi CWT head.

The nodal diagram of the current Wyong water supply network and the layout of the network on a GIS layer including locations of pumping stations, reservoirs and pipelines are shown in Figure 1-1 and Figure 1-2 respectively.

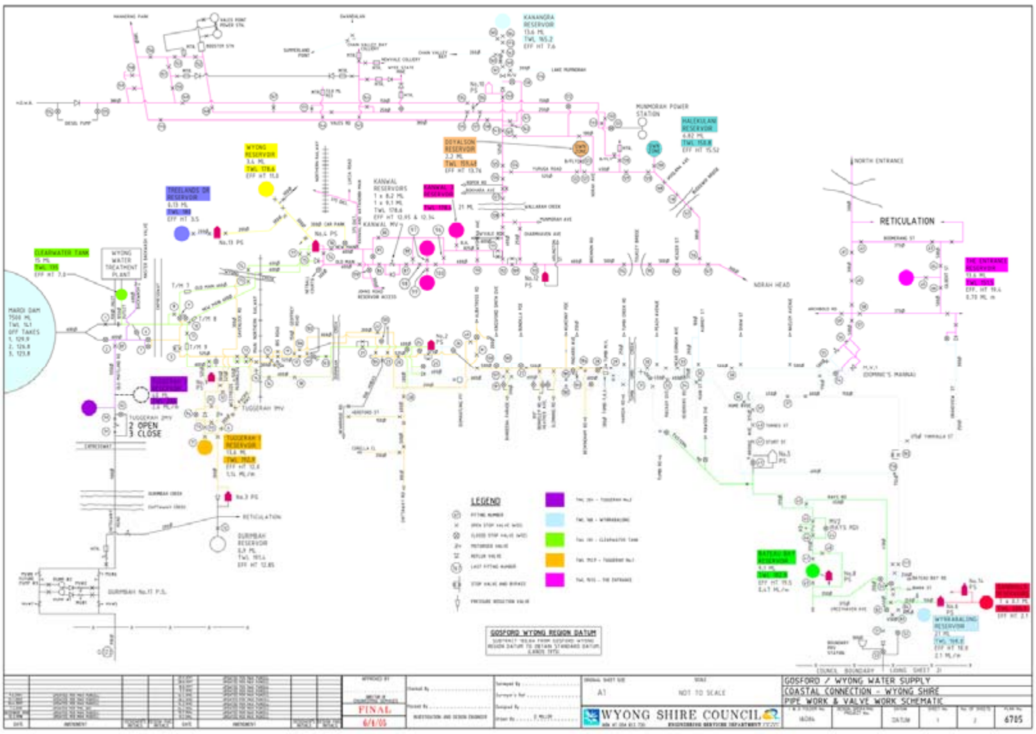


Figure 1-1: WSC Network Nodal Diagram of Wyong Network

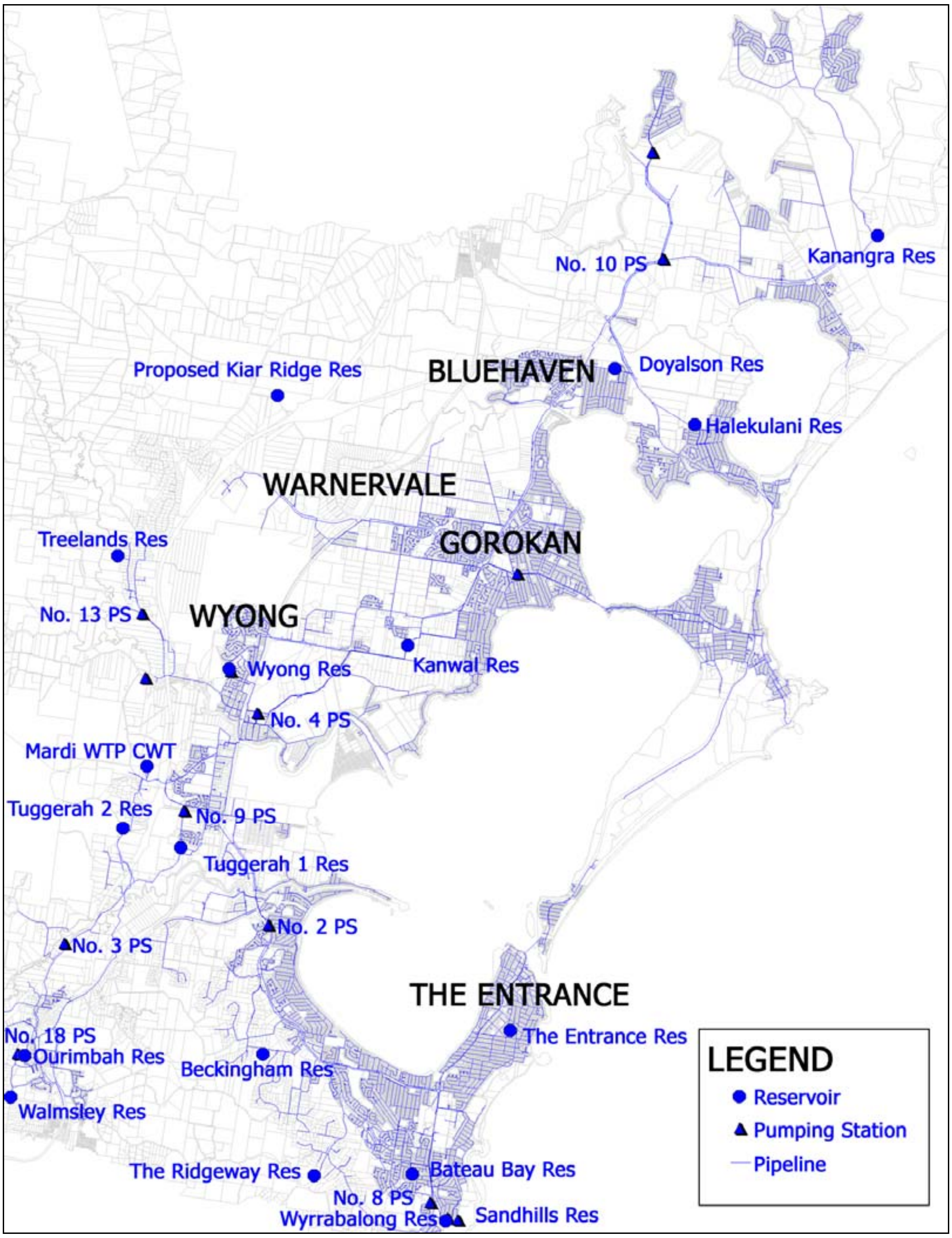


Figure 1-2: Layout of Existing Wyong Water Supply Network

2 HYDRAULIC MODELLING

2.1 HYDRAULIC MODEL DEVELOPMENT

The following processes were carried out in order to develop a functional hydraulic model of the Wyong Distribution System:

- Network model development. Creating the pipes, reservoirs and other infrastructure pertaining to the system in order to accurately reflect the assets present within the existing Wyong network;
- System Operation development. Generating the rules and operating regimes governing the system. This had to be reflected in the “controls” assigned to reservoirs, pumping stations etc;
- Importing system demands. Analysing consumption patterns, zoning and development plans in order to estimate current and future levels of demand;
- Model Calibration. To demonstrate the accuracy of the model. Calibrated to existing peak day demand; and
- Hydraulic runs for the 5 year demand increments up to 2051 to determine necessary system augmentations at each increment.

2.1.1 Network Development

A model of the Wyong Distribution System was developed using InfoWorks WS (Water Supply) software package by Wallingford Software. The basis of this model was formed directly from Council GIS data and network nodal diagrams, along with extensive consultation with Council personnel. These discussions were consolidated in a subsequent phase through the review of assumptions and other possible sources of error with WSC, along with thorough examination of available Work as Executed (WAE) drawings in order to more accurately represent the actual system layout. To some extent, inaccuracies within the Council GIS data initially compromised progress and resulted in considerable difficulty arising in the formation phase.

The hydraulic components of the Wyong Distribution System were modelled with the aid of the Infoworks WS software. This application effectively allowed the GIS data used in establishing the physical location of the network to be directly imported into the model, thereby avoiding the possibility of further undermining the fidelity of these values. When a suitable network layout was achieved, node heights were adjusted and details of pipes and other infrastructure were checked to ensure that the data had been converted correctly in the importation process. Finally, demand data for the various zones, as described below, was incorporated into the ultimate InfoWorks WS model in order to facilitate the performing of hydraulic simulations.

2.1.2 Methodology of Importing GIS Data

During the importation of the GIS data into the model it was evident that there were errors in the original GIS data that were impacting on producing a hydraulic model that would accurately reflect the reality of the water supply network. These errors include incorrect pipe sizes read from the Works as Executed drawings (WAE), typos resulting in incorrect pipe sizes, pipelines not being fully connected or drawn “close enough” to the visual eye but not close enough for Infoworks WS to interpret a connection of the pipelines, missing data etc. To overcome these issues a comprehensive review of the GIS data was undertaken to identify these errors. This was achieved by re-examining original WAE drawings, examining the model against known performance, discussions with WSC operating staff etc. When errors were identified a data entry "flag" was added in the Infoworks WS model. These flags identified areas where data was missing and **added**, where data was missing and needed to be **inferred** from surrounding data, or where data was **modified** from what was imported from the GIS due to incorrect data (listed within the data entry flags as AD, IN, or MO respectively). Examples of uses of these data entry flags are provided below:

- Where pipeline diameter sizes were missing but could be inferred from surrounding pipework (ie a blank section of pipe located in between two sections of DN100 pipe is likely to be a DN100 pipe) and assessed as such within the Inference tool within Infoworks WS a data flag of IN was added to the pipeline.

- If a section of pipeline could not be inferred (eg a blank pipe surrounded by a DN100 pipe and a section of DN200 pipe) the data was added based upon a best guess (erring on the side of conservatism) or additional information the data flag of AD was added to the data field. Another example is if a section of pipeline did not exist in the model and had to be added independent of GIS data.

- Under the situation where a pipeline size was shown found to be incorrect or if a pipeline needed to be broken into two separate pieces and thereby altering the asset numbering, the data flag of MO would be used.

An image illustrating the use of data entry flags is shown below in

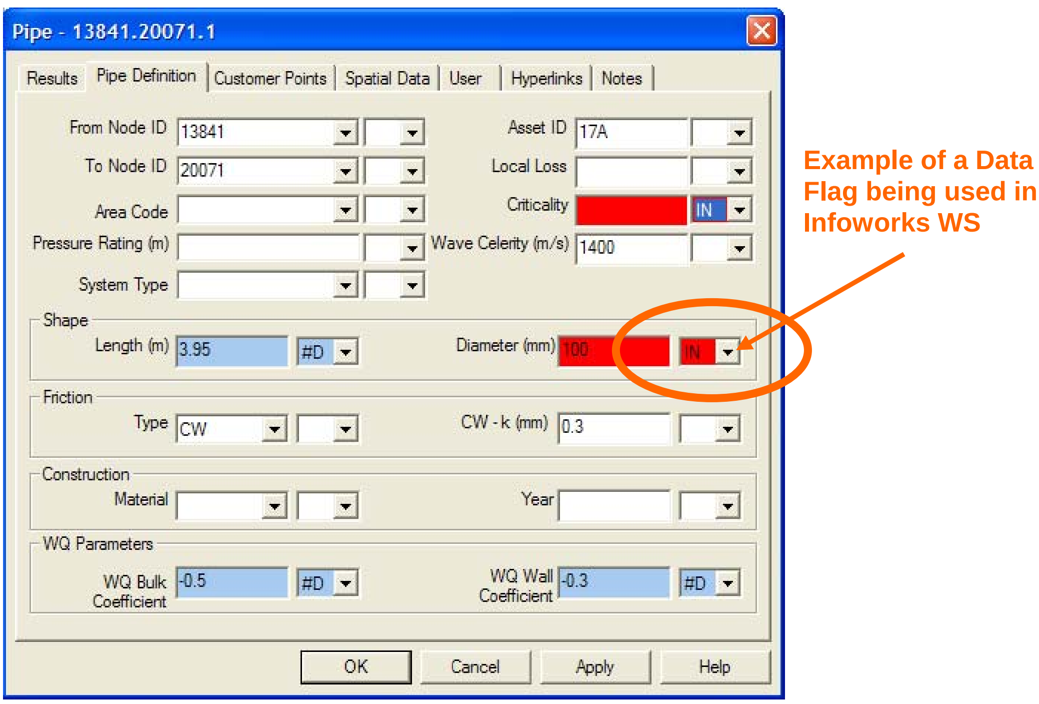


Figure 2-1: Infoworks WS Data Entry Flags

2.1.3 System Operation

Consultation was undertaken with WSC in order to attain a level of understanding of the Wyong Distribution System conducive to the creation of a model which reflected the system and its operations as accurately as possible. To this end, operating rules were established through discussions with council, as well as from previous hydraulic studies completed by the Department. The items determined in conjunction with WSC protocol include control philosophies for pumping stations, stop/start levels, reservoir float valve open/close levels and open close values for key motorised valves.

2.1.4 Importing of Demand Data

Projected future levels of demand within the Wyong Distribution System have been analysed previously by the Department of Commerce and presented in the Document *"Long Term Demand Projections"*. This study considered factors such as current and projected demand and zoning data along with addressing several population growth and development scenarios which would have an impact on future water usage levels. In particular, the Whelan Report was commissioned to prepare population, tenement, commercial area and industrial area projections from the present through to 2051 for potential development precincts as indicated by WSC. This study also included locations of future subdivisions, timing for demands and specific consumption data for individual meters over 5 year increments throughout the duration of the period in question.

User categories were stipulated in accordance with the Local Environment Plan, with ADD values estimated by utilising the total recorded demand data collected by meters over a five and a half year period commencing in 2001. PDD figures were calculated for each combination of Small Area and Local Environment zoning, and for all users. These PDD figures are contingent upon factors related to the size, arrangement, location and occupancy of tenement, as well as location parameters such as soil moisture storage, average rainfall, and surface evaporation rates. ADD and PDD values were subsequently used as a basis for analysing future demands, in conjunction with the findings of the Whelan Report which identified projected dwelling numbers and population according to estimates of available land supply and urban releases until 2051.

In turn, the allocation of pre-defined demand allowances across these projected figures enabled comparisons with demand projections in the GWCWA March 2002 review to be made. Additional projections have also been derived as part of an Investigation Report completed in 2003 and the Whelan Report. These cases, illustrating scenarios featuring variations in parameters such as water efficiency and population, were also addressed as part of the comprehensive treatment of this matter within the aforementioned Department of Commerce document. WSC have reviewed and accepted the suggested demand values which underpin the water supply network model.

A methodology outlining how the demands produced from the demand model were imported into the Infoworks hydraulic models is provided in **Appendix B**

2.1.5 Model Calibration

Part of the validation process integral to the development of a viable, accurate model was the requirement for a calibration run to be performed. This step represents an opportunity to assess the capacity of the model to replicate observed events, whilst simultaneously offering the possibility of refining the parameters in use within it. Assessment of the successfulness of the calibrated model was based on known low pressure areas, reservoir zonings, as well as recorded pumping station and reservoir performance over the course of the nominated PDD. A live run of the calibrated model was presented to council and signed off to enable work on future runs to commence.

Descriptions of some of the characteristics that the model was calibrated against are summarised below:

Low Pressure Zones

WSC identified the regions of Central East Gorokan and Bluehaven as low pressure problem areas. Both these zones draw water from Kanwal reservoirs and due to their high ground levels suffer low residual pressures when Kanwal reservoirs drop.

The calibrated model duplicated these findings and is represented in the minimum residual pressures as simulated in the calibrated model shown below in Figure 2-2

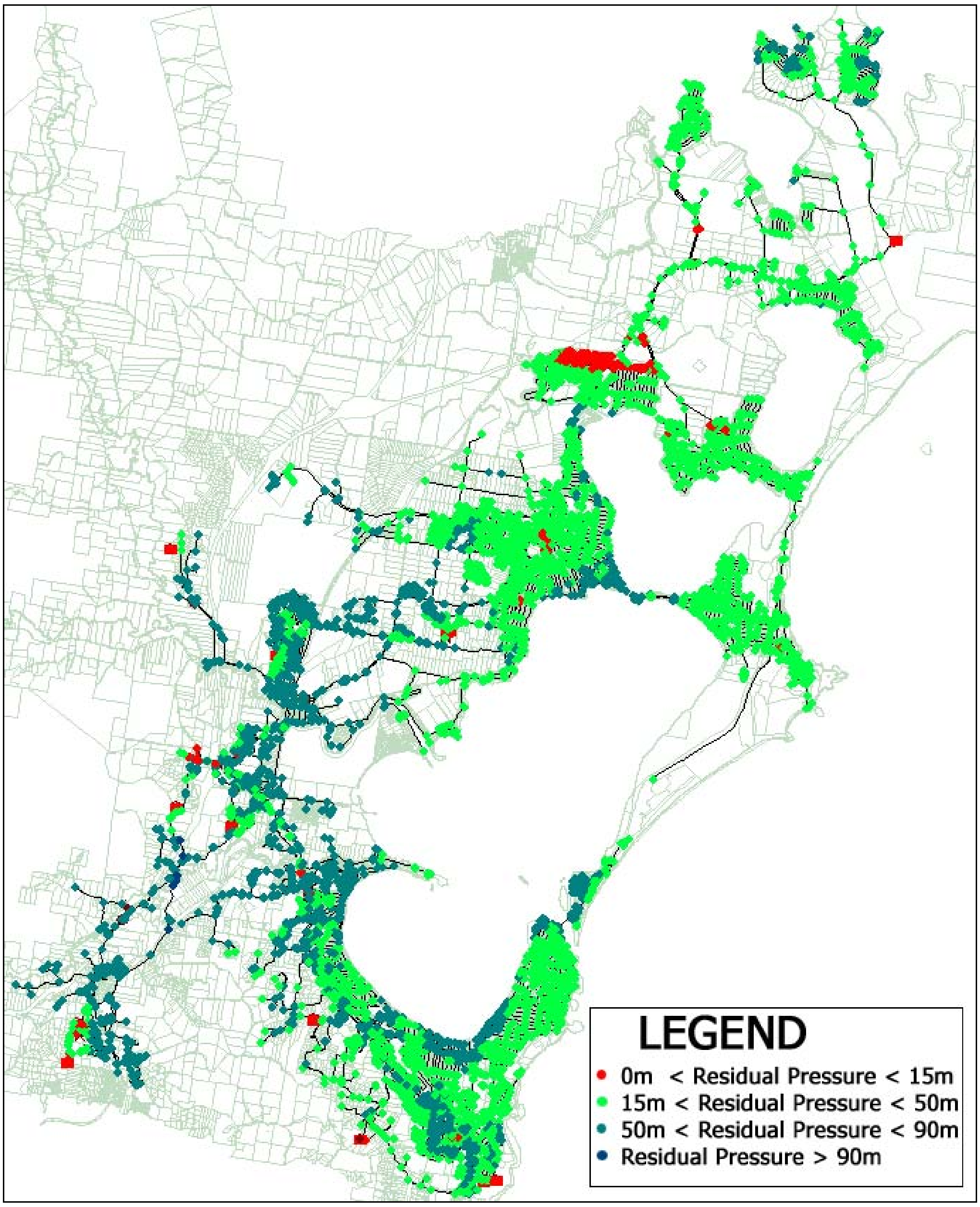


Figure 2-2: Node Minimum Residual Pressures during Calibration Run

2.2 FUTURE MODEL SIMULATIONS

2.2.1 General

The future hydraulic simulations were assessed under the demand scenarios derived in the "Long Term Demand Projections Report" prepared by Commerce. The hydraulic modelling philosophy and methodology to derive the future distribution systems are summarised below.

2.2.2 Methodology

In order to optimise the staging of works it was decided to model the system for 2051 then model backwards towards the current system arrangement. The purpose of this methodology was to ensure that the staged works were orientated and timed in accordance with progressively increasing demands, introductions of new development areas and were all focused towards a final optimised distribution system in 2051. Each staging of the network had to ensure that the following primary requirements were met:

- Minimum nodal pressure of 15m at the nodes
- Sufficient reservoir refilling over the peak day demand (PDD)
- Maintain integrity of the system operating philosophy
- Provide a supply source to match each of the new subdivisions introduced into the system.

In addition to these basic hydraulic requirements staging of the works was assessed with respect to the following key criteria:

- Examine how long could the northern system be supplied from Tuggerah 2/Mardi HLPS without the need of Kiar Ridge Reservoir;
- Analyse the need to upgrade Tuggerah 2 reservoir;
- Assess the stress on Kanwal reservoirs under the increased demands predominately in the northern precinct of the Wyong System.

2.2.3 Proposed System Operating Philosophy

The introduction of the Mardi HLPS into the system requires that the system now be exposed to the head of Tuggerah 2 reservoir or the head of the Mardi HLPS on a permanent basis as opposed to only when required for emergency top ups of Kanwal Reservoirs. Therefore the future model runs have been assessed with No.4 PS and No.2 PS deactivated and valving modified so that the all water delivered from the CWT is exposed to the head of Tuggerah 2 reservoir or the head of the Mardi HLPS pumps.

2.2.4 Expansion of the Northern Water Supply System

The majority of the future capital works relate to proposed infill and future expansion of development areas within the Warnervale region and northern regions of the shire. This is a reflection of the demands produced in the previous *"Long Term Demand Projections".* To cater for this expansion new distribution and reticulation works have been proposed to supply these development areas and staged. The location and alignments of these new works in the northern development areas have been based on a proposed water supply reticulation plan for the northern precincts of the shire provided by WSC. It should be noted that this plan has been used as a guide only and modified to suit the results of the hydraulic analysis. A copy of the reticulation development plan mentioned is provided below in Figure 2-3

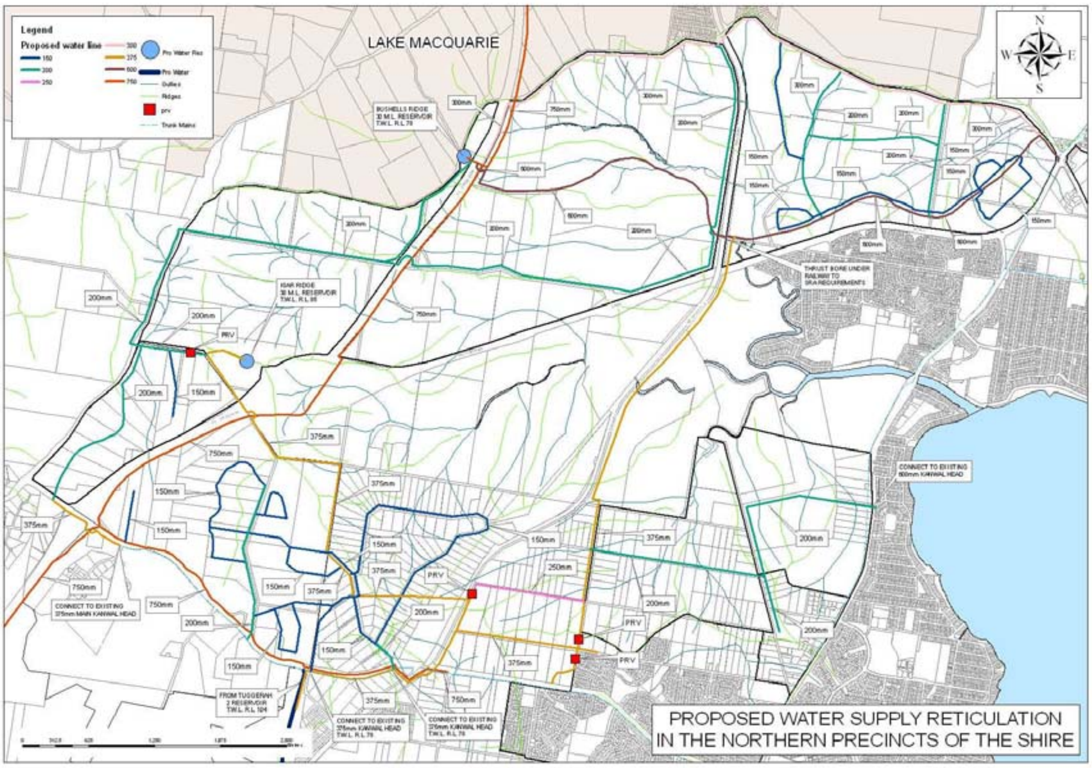


Figure 2-3: Proposed Reticulation Plan of Northern Precincts by WSC

Future small diameter reticulation pipelines(less than 200mm), for the most part, have not been modelled except where shown on the aforementioned reticulation plan. This is due to the uncertainty on the arrangement of the future subdivisions and road alignments. Without these details it is impossible to accurately assess the amount, size and layout the of reticulation network required for each subdivision.

2.2.5 Results Files

The results of the hydraulic simulations including overviews of reservoir zonings, minimum residual pressures and hydraulic grade lines for the various options are provided in **Appendix A.**

3 DISTRIBUTION SYSTEM DEVELOPMENT PLAN

3.1 STAGING OF WORKS

Based on the results of the future 5 year increment simulations within Infoworks WS a distribution system development plan was created with the aim of optimising the staging of the delivery of capital works required. A summary of the development plan is outlined in Figure 3-1 and Table 3-1 below.

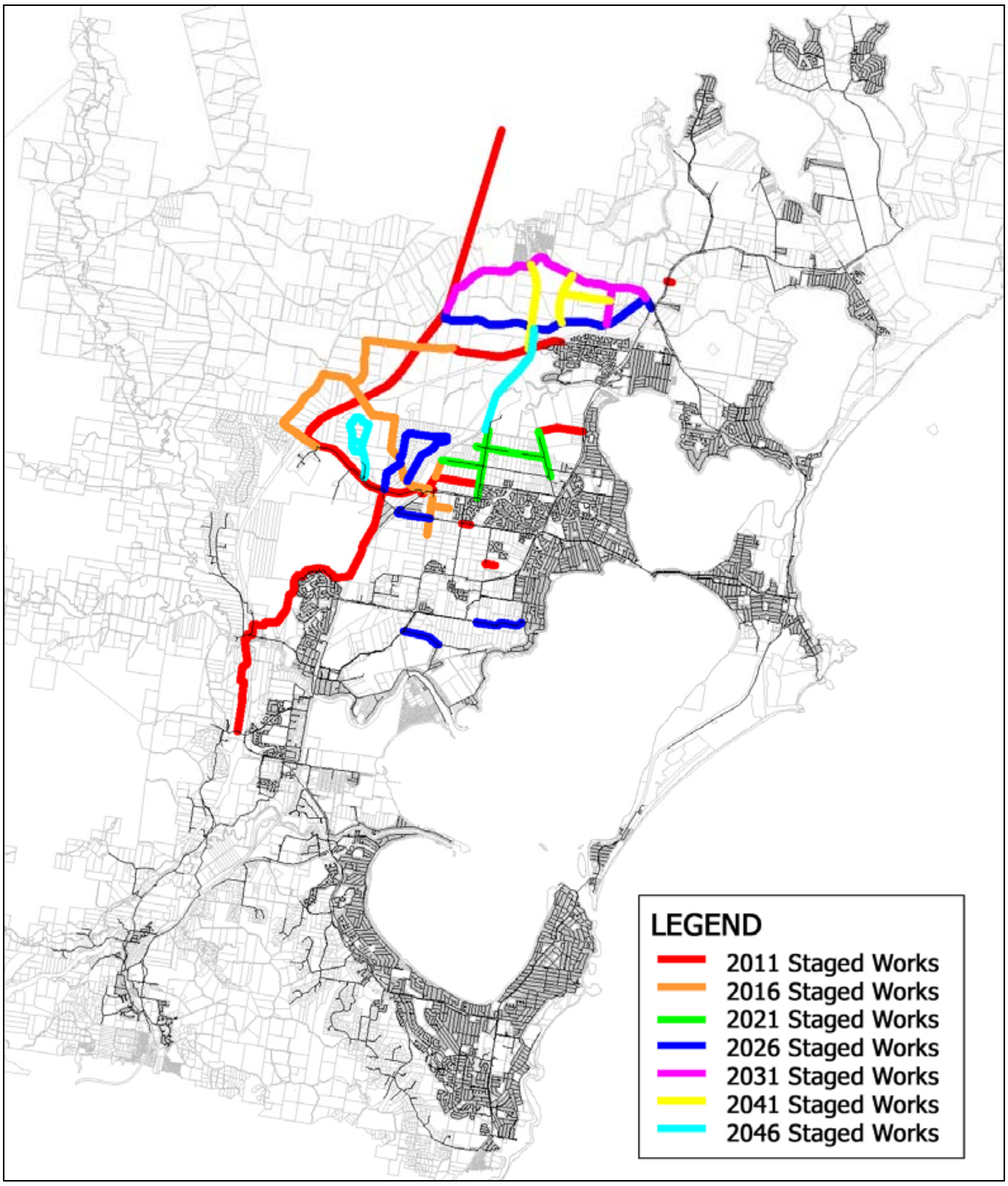


Figure 3-1: Overview of Distribution System Development Plan

Table 3-1: Summary of Staged Capital Works

Component	DEVELOPMENT PLAN STAGE Quantities (m)									Total
	2011	2016	2021	2026	2031	2036	2041	2046	2051	
DN100 Pipe	239			1011						1250
DN150 Pipe		465		3160				600		4225
DN200 Pipe	4313	4844	3105	3451	988		4940	1467		23108
DN250 Pipe			1077							1077
DN300 Pipe					300					300
DN375 Pipe	1964	1388	1907					3112		8371
DN450 Pipe		4434								4434
DN600 Pipe				6236						6236
Kiar Ridge Reservoir		15ML								

Details of the 5 yearly increment development plan stages are expanded in the following sections with descriptions of works required and the reason for their proposed timing of their implementation.

3.1.1 2011

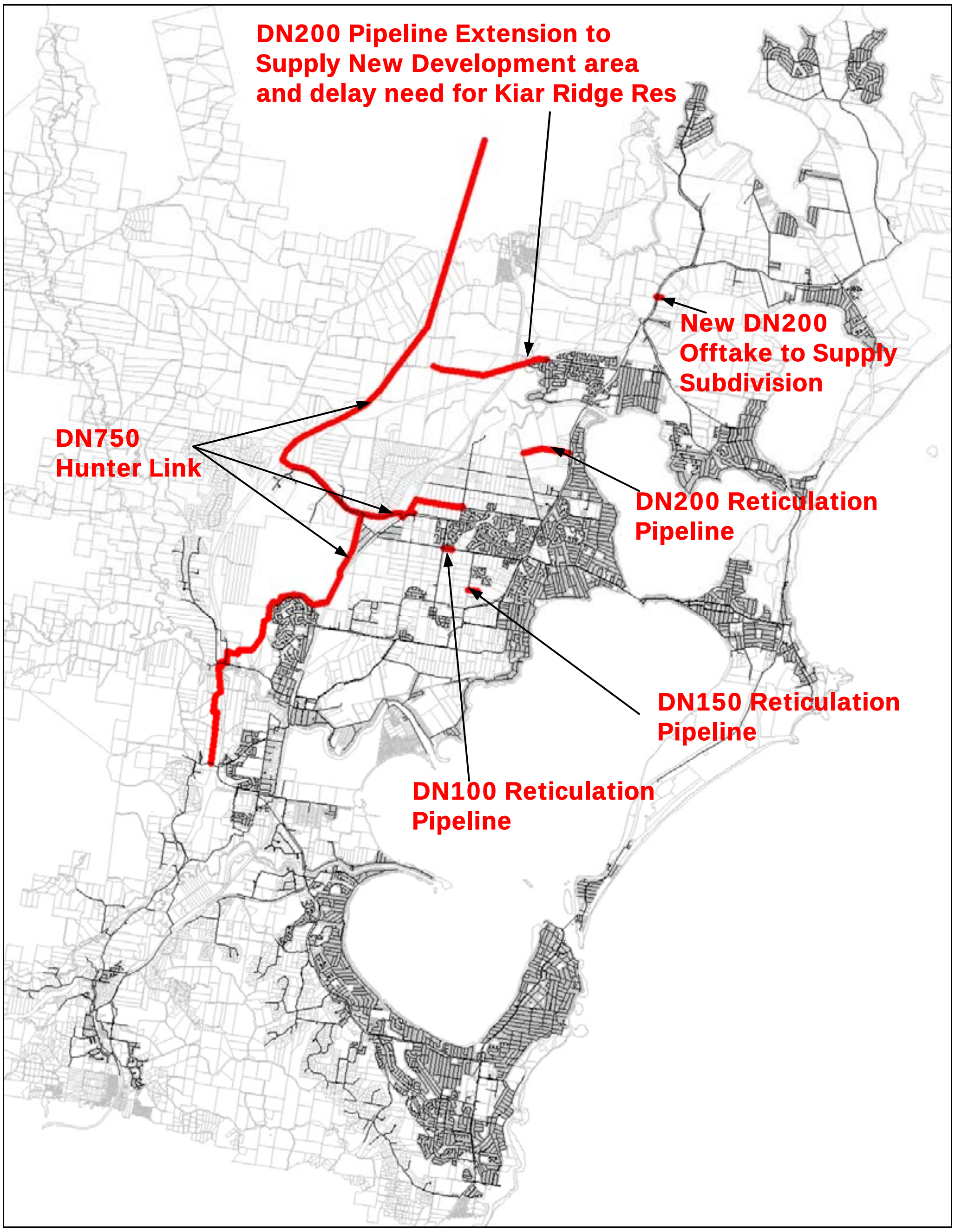


Figure 3-2: Staged Capital Works for 2011

As assessed under the projected peak day demand the results of the hydraulic simulations indicated that with the introduction of the Mardi HLPS, the DN750 Hunter link and connection with the Mardi transfer pipelines and several other minor augmentations, the requirement for Kiar Ridge reservoir could be postponed until 2016. These works would ensure that Kanwal reservoirs could maintain sufficient head at known low pressure areas and delay the need for Kiar Ridge reservoir.

The Hunter link has been included in this staging of the works as it is required to be operating prior to 2011 to delay the need for Kiar Ridge reservoirs til 2016. Without this link supply to the north to supplement and relieve system stresses on Kanwal reservoirs would not be possible.

3.1.2 2016

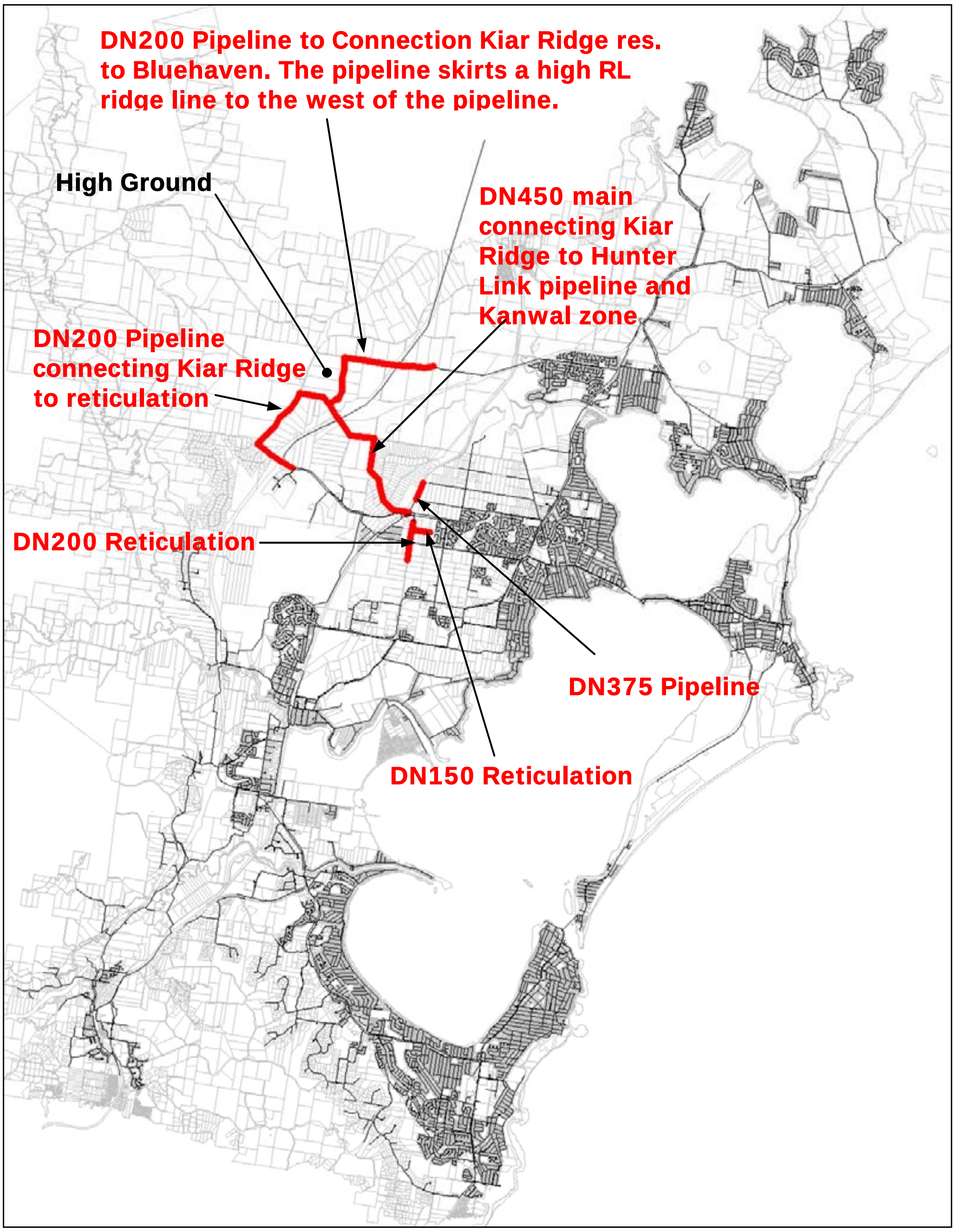


Figure 3-3: Staged Capital Works for 2016

With the increased 2016 PDD the network was found to be no longer able to supply known critical low pressure areas from Kanwal reservoir and as such required the implementation of the Kiar Ridge reservoir to supplement supply to these areas. The suburb of Bluehaven especially was found to be continually suffering low pressures as its location and elevation were found to make it sensitive to changes in levels at Kanwal reservoirs. This situation would only become more of an issue as system demands increase and would stress Kanwal's ability to supply these demands further. It is therefore recommended that the suburb of Bluehaven be linked to the Kiar Ridge reservoir which would remedy the low pressure issues at Bluehaven and in turn reduce the demand on Kanwal reservoirs.

With the introduction of the Kiar ridge reservoirs to service the additional demands and new development areas in the northern system, the majority of the pipeline capital works nominated in this stage are required to provide distribution and reticulation supply connections to and from Kiar Ridge reservoir. The alignment of one of these supply connections (the DN200 pipeline running north then east and connects up with Bluehaven) was forced to skirt a high level ridgeline that runs north of Kiar Ridge and as such could not follow the alignment proposed in the WSC Proposed WS Reticulation in the Northern Precincts Plan.

3.1.3 2021

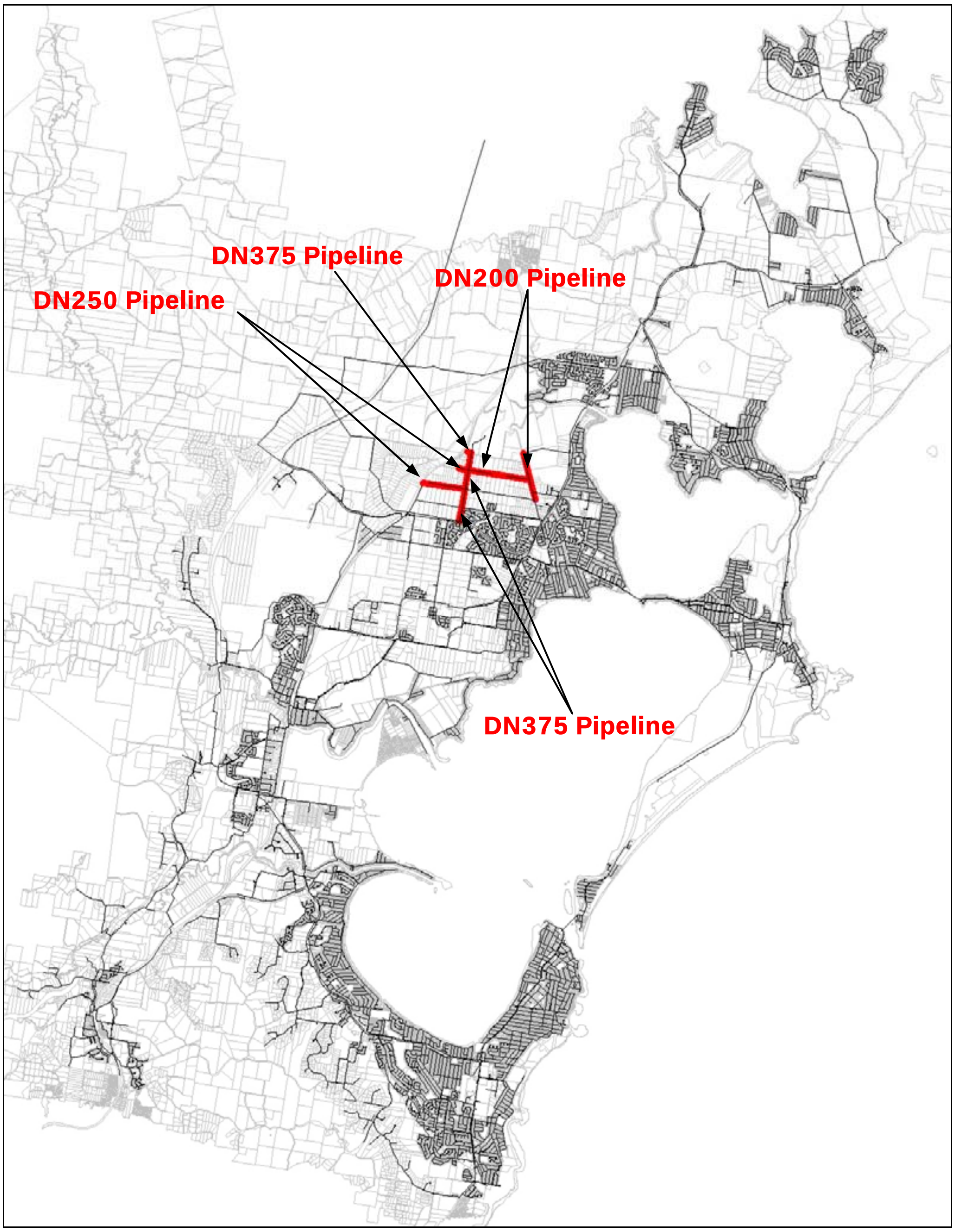


Figure 3-4: Staged Capital Works for 2021

With Kiar ridge now supplementing supply in the north, capital works staged for 2021 were nominated to provide additional reticulation capacity in West Gorokan. These works were directly related to increased consumers and demands from new development areas and infilling of West Gorokan staged for 2021.

3.1.4 2026

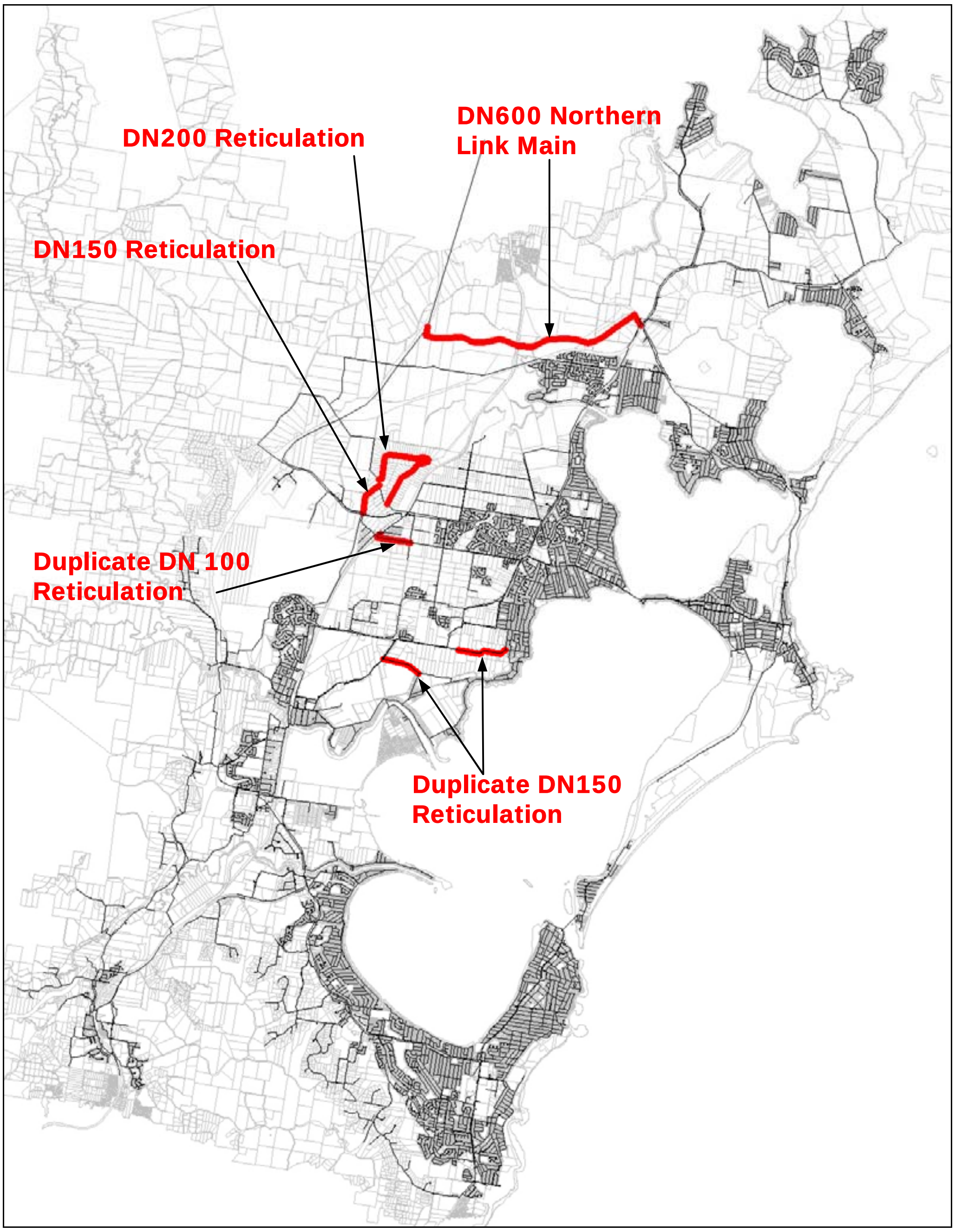


Figure 3-5: Staged Capital Works for 2026

Under this peak day demand capital works were limited to a new DN600mm main linking the Hunter link near Bushells Ridge to north of Bluehaven and local reticulation upgrades around Warnervale. The DN600 main provides sufficient capacity to supply demands in the north of the shire while also allowing for future expansion in this area. In addition it also provides a larger link to provide greater capacity and flow to the north-eastern areas of the shire including Mannering Park, Vales Point and Gwandalan.

3.1.5 2031

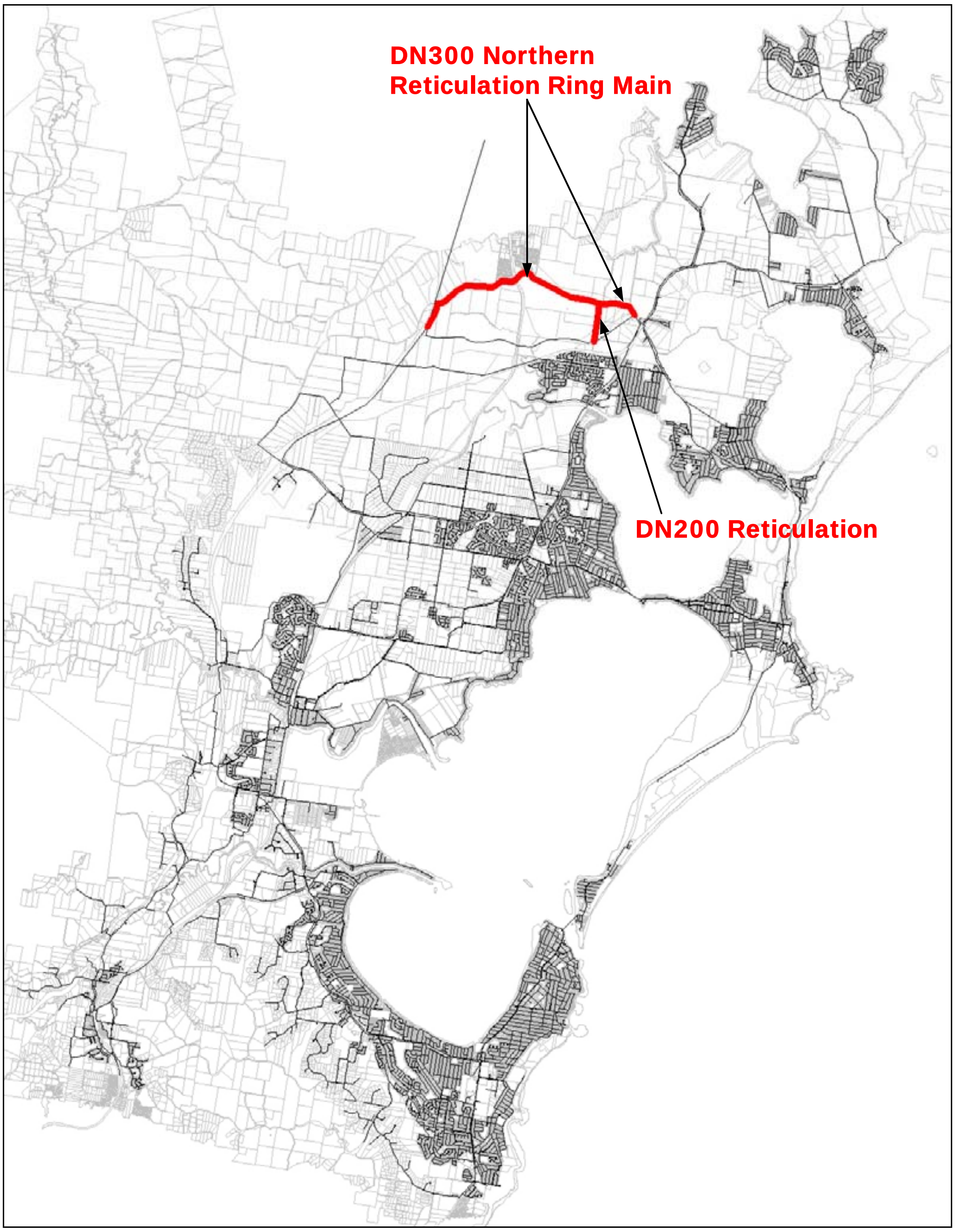


Figure 3-6: Staged Capital Works for 2031

Under this phase a DN300 ring main north of the DN600 northern link has been implemented to provide a reticulation source to development areas in the north of the shire.

3.1.6 2036

No new capital works were required for this development stage.

3.1.7 2041

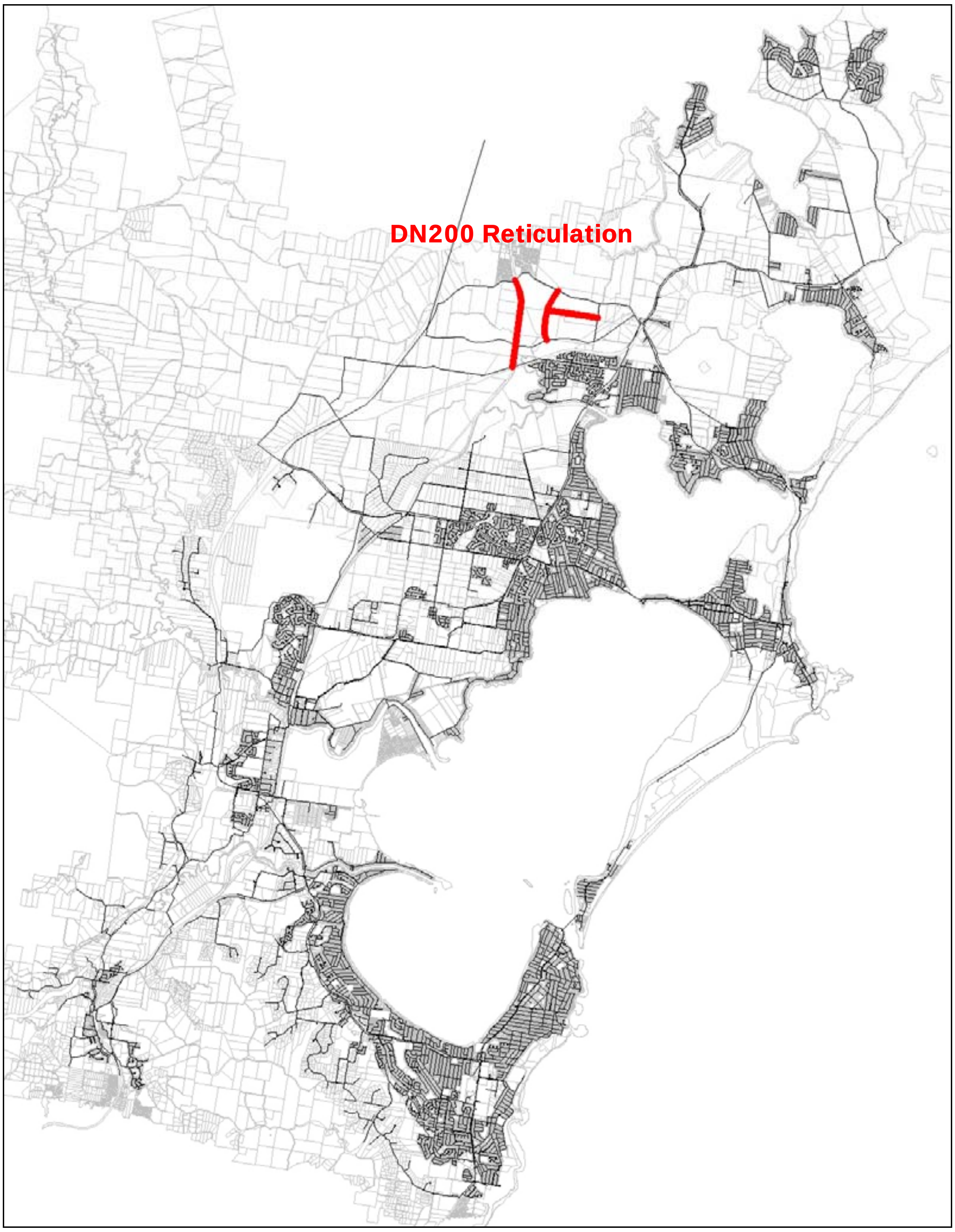


Figure 3-7: Staged Capital Works for 2041

Additional reticulation lines were added under this staging of the works in the northern areas to supply infilling of development areas in the northern most precincts of the shire.

3.1.8 2046

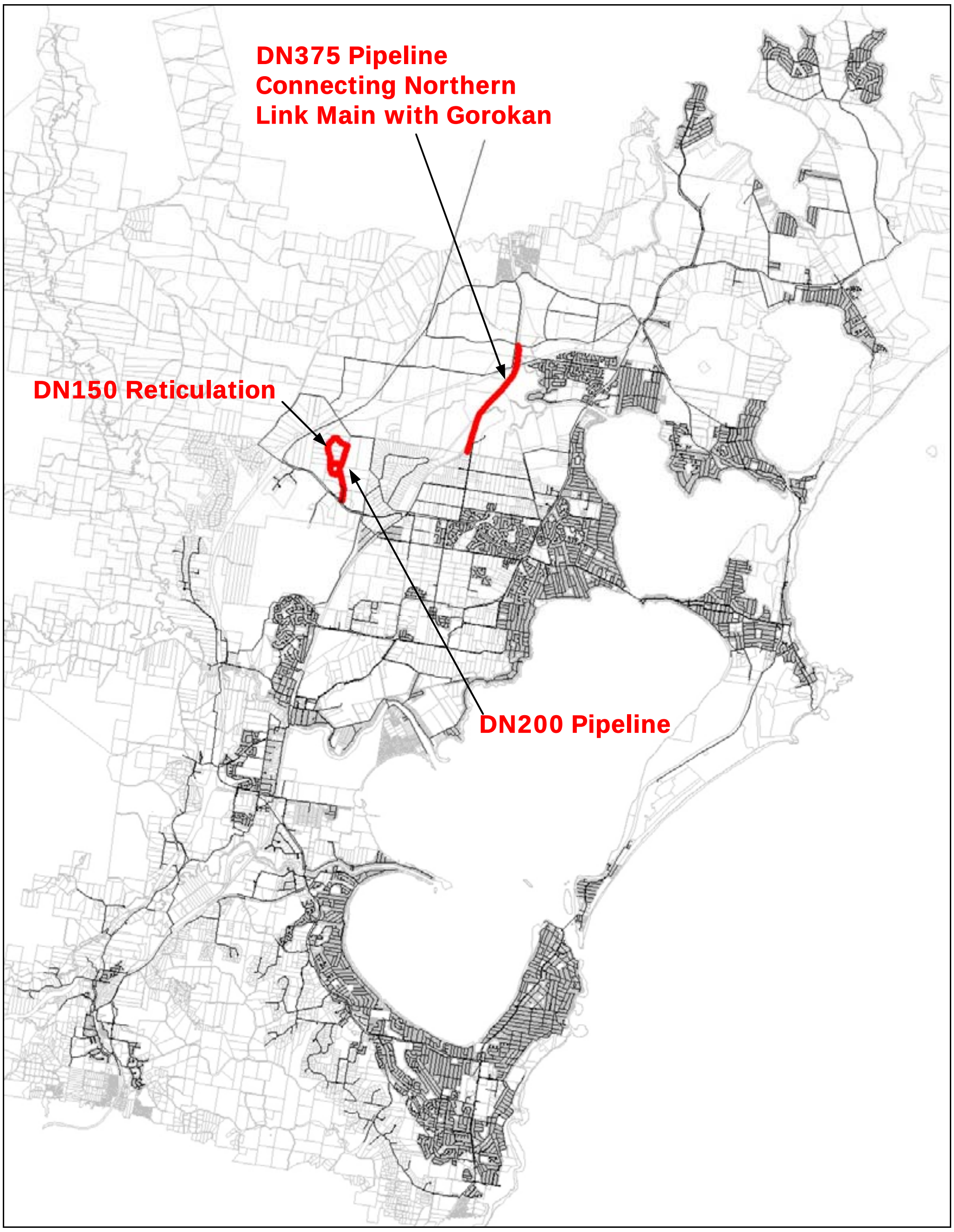


Figure 3-8: Staged Capital Works for 2046

3.1.9 2051

No new capital works were required for this development stage.

3.2 Discussion of Key Works

3.2.1 Kiar Ridge Reservoir

Kiar Ridge has been selected as the preferred site for the northern precincts new reservoir as opposed to Bushells Ridge as there is insufficient head at Bushells ridge to supply high development areas in Warnervale. In addition the extra head and closer proximity of Kiar Ridge to the Warnervale area allows it to more effectively supplement Kanwal reservoirs. This is of critical importance when assessed with the stresses and demands on Kanwal under the new PDD events.

Under the Peak Day Demand Kanwal is required to supply all of the northern regions with only 40ML of total capacity. This is insufficient with areas such as Bluehaven and central East Gorokan sensitive to level changes in Kanwal reservoirs. To reduce the impact of low levels in Kanwal it is recommended that Kiar Ridge be connected to the reservoir zone of Kanwal and allow the head of both reservoirs to supply the northern precinct.

A 15ML reservoir was found to be sufficient to provide the additional supply required for the northern precincts. Kiar Ridge at 15ML capacity would, when combined with the existing reservoirs, just exceed the 2051 PDD supply requirements for the Wyong system. In addition during 2051 PDD it was found that the reservoir did not empty and would refill during the course of the Peak Day.

3.2.2 Tuggerah 3 Reservoir

Under the demand scenarios modelled there is no need to implement Tuggerah 3 reservoir prior to 2051. The addition of Kiar Ridge reservoir in the northern system brings reservoir supply capacity in the north to approximately 70ML while the southern system can rely on approximately on 55ML of storage capacity. Tuggerah 2 adds an additional 40ML of capacity to the system. The total storage capacity of the system exceeds the 2051 PDD.

Under the peak day demand hydraulic simulation for 2051 the Mardi HLPS is capable of ensuring that Tuggerah 2 refills during the day and does not turn off and on frequently during the course of the PDD.

3.2.3 Pressure Relief Valves in Northern Precinct Development Areas

The northern precincts reticulation development plan previously recommended several PRVs throughout the northern system to reduce the maximum residual pressures from Kiar Ridge reservoir on low lying reticulation zones. This, however, would impact on the ability of Kiar Ridge to supplement supply to areas such as East Gorokan and North East towards Gwandalan when Kanwal is no longer able to provide sufficient head to supply these areas. It is therefore recommended that the use of PRVs in this area be avoided.

3.2.4 Transfer In/Out of the Wyong Network

Transfers out of the Wyong system were examined under non-PDD events. For the purposes of the study 50% of the PDD was nominated as the cut-off point for system transfers to the Hunter and Gosford. Under this condition the Hunter link, the Tuggerah 2 to Gosford Link and the Coastal link have the hydraulic capacity to deliver the nominated flow rates of 30ML/d, 80ML/d and 8ML/d respectively.

Details of the hydraulic grade lines for these scenarios can be found in **Appendix B**.

4 COSTINGS

The costs involved in implementing the proposed works identified in the Distribution System Development Plan were estimated based on known supply rates and recent tender prices. This was achieved by first calculating the cost of the pipelines for each of the staged options before assessing these costings in a Net Present Value (NPV) analysis. The results of these costings are tabulated below.

Table 4-1: Pipeline Cost Estimates Based on Pipeline Lengths for Each Stage

STAGE	PIPELINE SIZE	QUANTITY (m)	RATE /m	COST
2011	375	1964	$516	$1,012,617
	200	4313	$244	$1,054,091
	100	239	$131	$31,407
				$2,098,114
2016	450	4434	$648	$2,871,494
	375	1388	$516	$715,638
	200	4844	$244	$1,183,866
	150	465	$194	$90,295
				$4,861,293
2021	375	1907	$516	$983,228
	250	1077	$305	$328,797
	200	3105	$244	$758,857
				$2,070,883
2026	600	6236	$997	$6,218,954
	200	3451	$244	$843,419
	150	3160	$194	$613,620
	100	1011	$131	$132,853
				$7,808,846
2031	300	6304	$368	$2,320,818
	200	988	$244	$241,466
				$2,562,283
2041	200	4940	$244	$1,207,329
				$1,207,329
2046	200	1467	$244	$358,533
	150	600	$194	$116,510
	375	3112	$516	$1,604,513
				$2,079,556

Table 4-2: NPV Analysis of Distribution System Development Plan

Staged Works

Item	Description	Quantity	Unit	Rate	AMT	Present Worth		
					$k	4%	7%	10%
1.0	**Capital Cost**							
1.1	**Pipeline**							
1.1.1	Stage 2011 Pipeline Works		Allow		$2,098,114	$1,793,477	$1,600,641	$1,433,040
1.1.2	Stage 2016 Pipeline Works		Allow		$4,861,293	$3,415,480	$2,644,221	$2,061,663
1.1.3	Stage 2021 Pipeline Works		Allow		$2,070,883	$1,195,883	$803,124	$545,328
1.1.4	Stage 2026 Pipeline Works		Allow		$7,808,846	$3,706,410	$2,159,211	$1,276,809
1.1.5	Stage 2031 Pipeline Works		Allow		$2,562,283	$999,602	$505,145	$260,137
1.1.6	Stage 2041 Pipeline Works		Allow		$1,207,329	$318,194	$120,998	$47,258
1.1.7	Stage 2046 Pipeline Works		Allow		$2,079,556	$450,475	$148,595	$50,542
1.2	**Reservoirs**							
1.2.1	Kiar Ridge Reservoir	1	Allow		$7,200,000	$5,058,624	$3,916,323	$3,053,503
1.3	**Prime Cost**				$29,888,304	$16,938,145	$11,898,258	$8,728,280
1.4	**General contingencies**	(prime cost)		25%	$7,472,076	$4,234,536	$2,974,565	$2,182,070
1.5	**Contractors on-costs**	(prime cost)		10%	$2,988,830	$1,516,987	$1,189,826	$872,828
1.6	**Direct Cost**				$40,349,210	$22,689,668	$16,062,649	$11,783,179
1.7	**Pre-construction activities**	(direct cost)		10%	$4,034,921	$2,286,650	$1,606,265	$1,178,318
1.8	**Supervision**	(direct cost)		5%	$2,017,461	$1,143,325	$803,132	$589,159
1.9	**Total Capital Cost**				$46,401,592	$26,119,642	$18,472,046	$13,550,655
2.0	**Operation and Maintenance Costs**							
2.1	**Maintenance Costs**							
2.1.1	Civil (0.5% of capital costs)	Item	Allow		$2,606,939	$2,385,837	$1,242,935	$710,273
	Total O & M				$2,606,939	$2,385,837	$1,242,935	$710,273
	Total NPV				$49,008,531	$28,505,479	$19,714,982	$14,260,929

Year (2007–2021)

Item	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1.0															
1.1															
1.1.1	$0	$0	$0	$0	$2,098,114	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,861,293	$0	$0	$0	$0	$0
1.1.3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,070,883
1.1.4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.2															
1.2.1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$7,200,000	$0	$0	$0	$0	$0
1.3	$0	$0	$0	$0	$2,098,114	$0	$0	$0	$0	$12,061,293	$0	$0	$0	$0	$2,070,883
1.4	$0	$0	$0	$0	$524,529	$0	$0	$0	$0	$3,015,323	$0	$0	$0	$0	$517,721
1.5	$0	$0	$0	$0	$209,811	$0	$0	$0	$0	$1,206,129	$0	$0	$0	$0	$207,088
1.6	$0	$0	$0	$0	$2,832,454	$0	$0	$0	$0	$16,282,746	$0	$0	$0	$0	$2,795,692
1.7	$0	$0	$0	$0	$283,245	$0	$0	$0	$0	$1,628,275	$0	$0	$0	$0	$279,569
1.8	$0	$0	$0	$0	$141,623	$0	$0	$0	$0	$814,137	$0	$0	$0	$0	$139,785
1.9	$0	$0	$0	$0	$3,257,322	$0	$0	$0	$0	$18,725,157	$0	$0	$0	$0	$3,215,046
2.0															
2.1															
2.1.1	$0	$0	$0	$0	$16,287	$16,287	$16,287	$16,287	$16,287	$109,912	$109,912	$109,912	$109,912	$109,912	$125,988
Total O & M															
Total NPV															

Year (2022–2036)

Item	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
1.0															
1.1															
1.1.1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.4	$0	$0	$0	$0	$7,808,846	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,562,283	$0	$0	$0	$0	$0
1.1.6	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.2															
1.2.1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.3	$0	$0	$0	$0	$7,808,846	$0	$0	$0	$0	$2,562,283	$0	$0	$0	$0	$0
1.4	$0	$0	$0	$0	$1,952,212	$0	$0	$0	$0	$640,571	$0	$0	$0	$0	$0
1.5	$0	$0	$0	$0	$780,885	$0	$0	$0	$0	$256,228	$0	$0	$0	$0	$0
1.6	$0	$0	$0	$0	$10,541,943	$0	$0	$0	$0	$3,459,082	$0	$0	$0	$0	$0
1.7	$0	$0	$0	$0	$1,054,194	$0	$0	$0	$0	$345,908	$0	$0	$0	$0	$0
1.8	$0	$0	$0	$0	$527,097	$0	$0	$0	$0	$172,954	$0	$0	$0	$0	$0
1.9	$0	$0	$0	$0	$12,123,234	$0	$0	$0	$0	$3,977,945	$0	$0	$0	$0	$0
2.0															
2.1															
2.1.1	$125,988	$125,988	$125,988	$125,988	$186,604	$186,604	$186,604	$186,604	$186,604	$206,494	$206,494	$206,494	$206,494	$206,494	$206,494
Total O & M															
Total NPV															

Year (2037–2051)

Item	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
1.0															
1.1															
1.1.1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.2	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.4	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.5	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.6	$0	$0	$0	$0	$1,207,329	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.1.7	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,079,556	$0	$0	$0	$0	$0
1.2															
1.2.1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1.3	$0	$0	$0	$0	$1,207,329	$0	$0	$0	$0	$2,079,556	$0	$0	$0	$0	$0
1.4	$0	$0	$0	$0	$301,832	$0	$0	$0	$0	$519,889	$0	$0	$0	$0	$0
1.5	$0	$0	$0	$0	$120,733	$0	$0	$0	$0	$207,956	$0	$0	$0	$0	$0
1.6	$0	$0	$0	$0	$1,629,894	$0	$0	$0	$0	$2,807,400	$0	$0	$0	$0	$0
1.7	$0	$0	$0	$0	$162,989	$0	$0	$0	$0	$280,740	$0	$0	$0	$0	$0
1.8	$0	$0	$0	$0	$81,495	$0	$0	$0	$0	$140,370	$0	$0	$0	$0	$0
1.9	$0	$0	$0	$0	$1,874,378	$0	$0	$0	$0	$3,228,510	$0	$0	$0	$0	$0
2.0															
2.1															
2.1.1	$206,494	$206,494	$206,494	$206,494	$215,865	$215,865	$215,865	$215,865	$215,865	$232,008	$232,008	$232,008	$232,008	$232,008	$232,008
Total O & M															
Total NPV															

APPENDIX A –SIMULATION RESULTS & HGLS

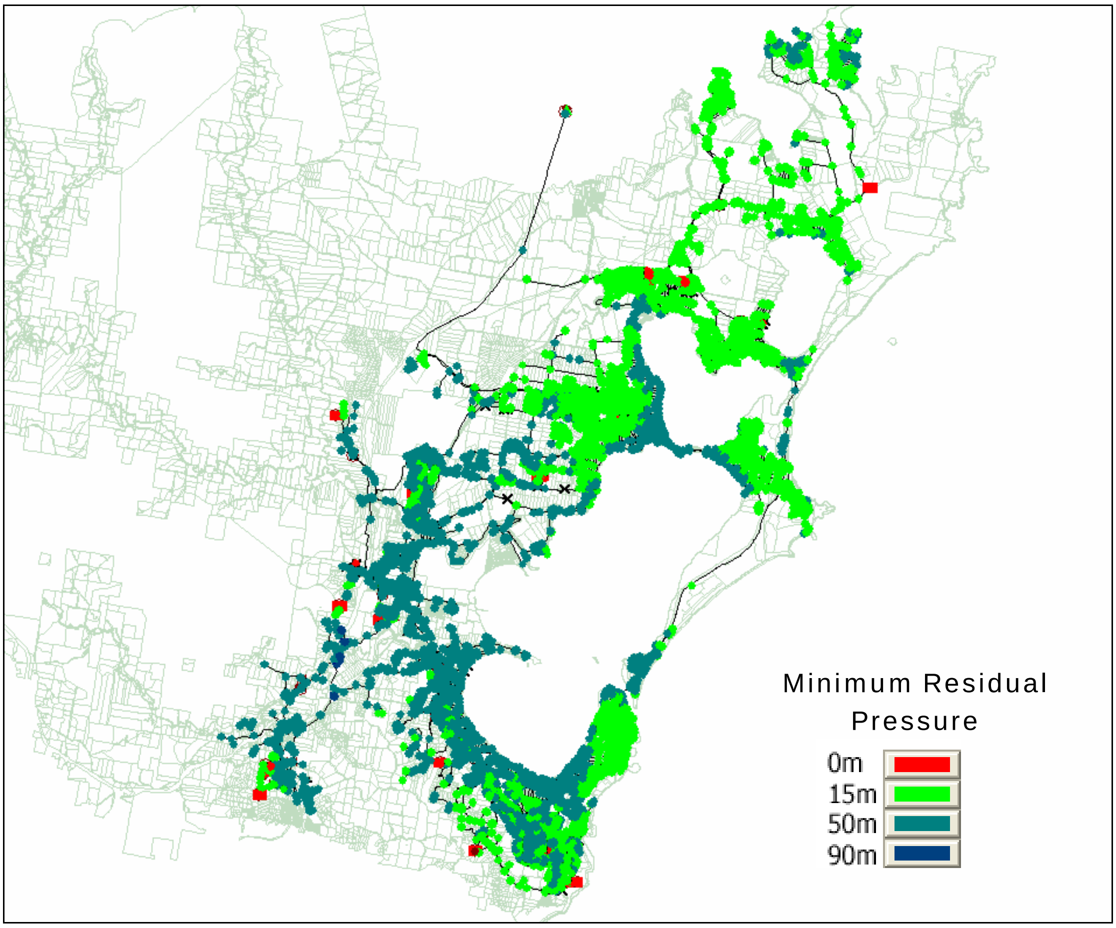
SIMULATION RESULTS AND HGLS

Result files generated for each of the future runs are provided below.

2011 SIMULATION RESULTS

The following are a compilation of charts, figures and schematics as produced from the simulation results files for the 2011 staged hydraulic model.

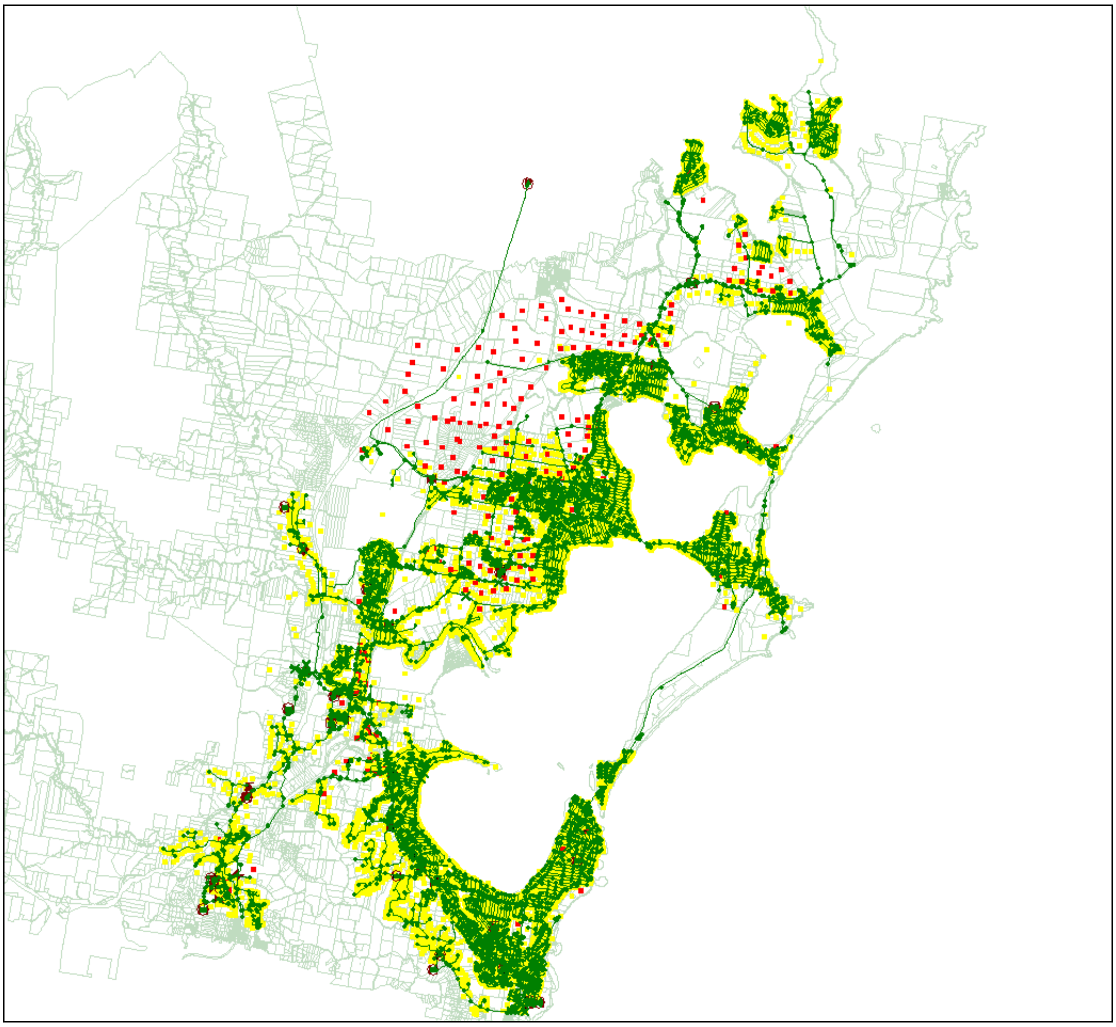
Minimum Residual Pressures



The above figure illustrates the minimum residual pressures experienced at each node during the course of the 24hr PDD simulation.

Red nodes represent locations where residual pressures of less than 15m are experienced. Light green for those above 15m and less than 50m. Dark green for those above 50m and less than 90m. Dark blue for those above 90m.

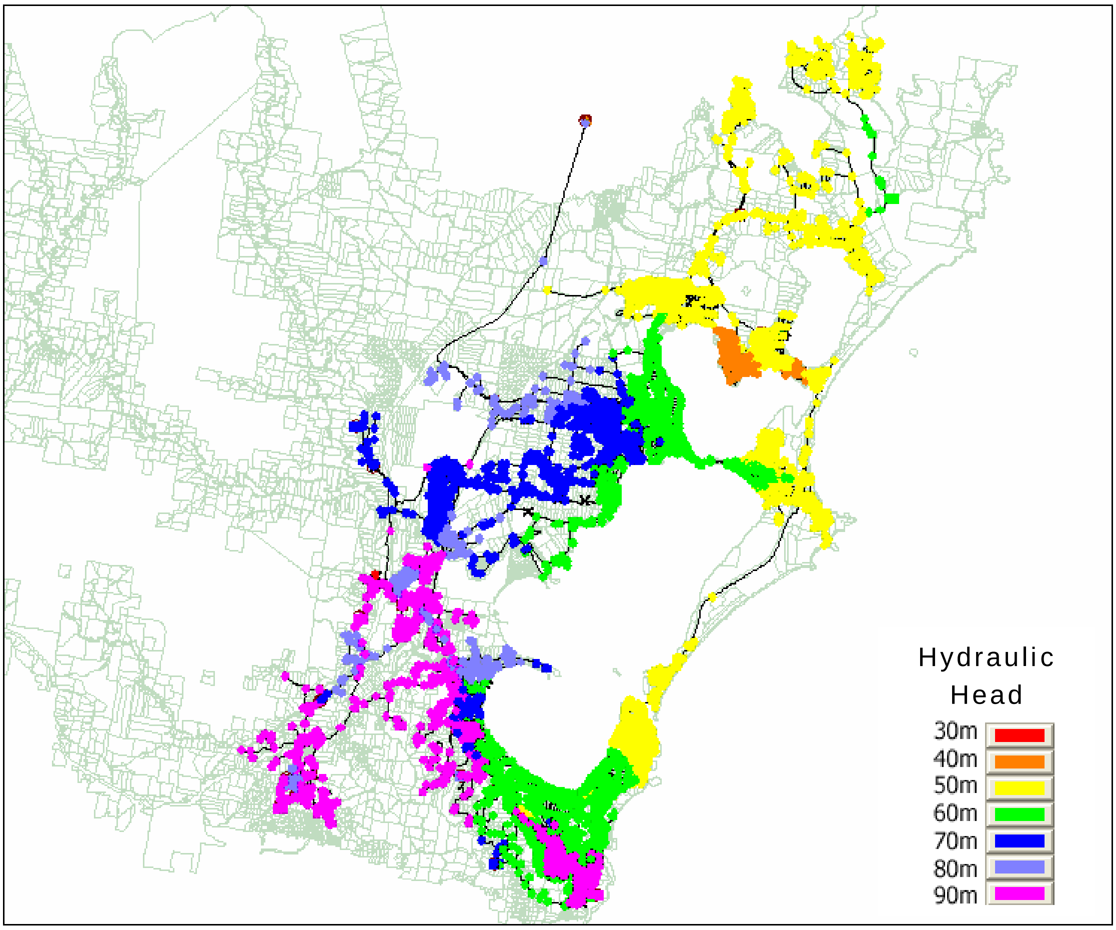
Customer Points



This figure identifies locations of development areas examined as part of the Long Term Demand Projection study and those that have been allocated a demand due to the current level of staging. Those that do not have demands allocated are shown in red. Those customers points that do have an allocated demand (pre-existing or current staged development zones) are shown in yellow.

With the progression of the staged works a number of the previously red nodes will turn yellow indicating infilling of that particular subdivision/development area during that particular staging of the works. It should be noted that the capital works programs is essentially driven by the timing of the expansion of these zones, nominated in the previous demand study.

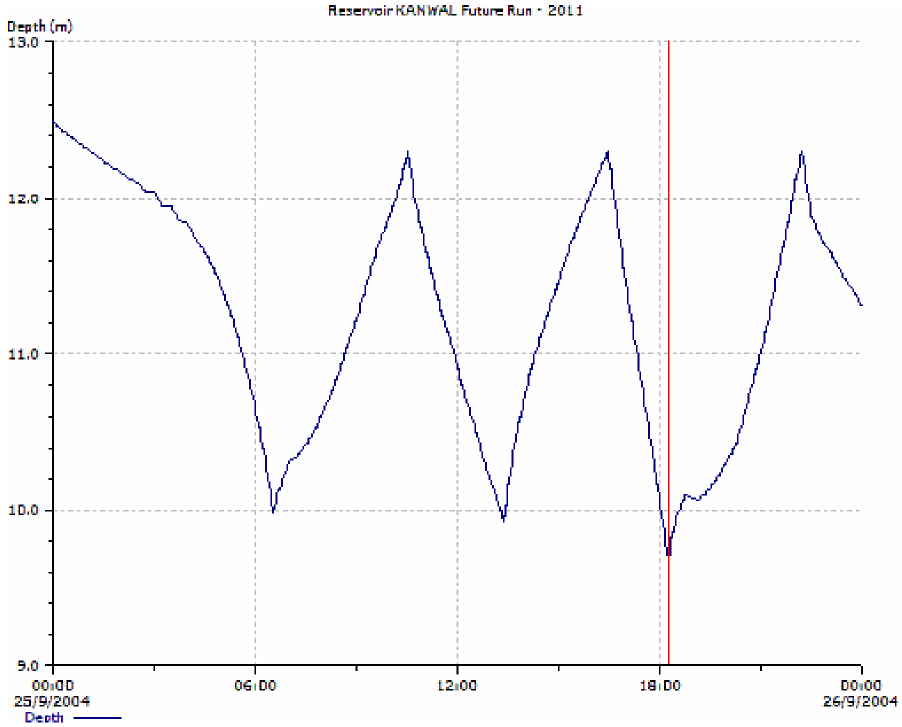
Simulated Head Conditions

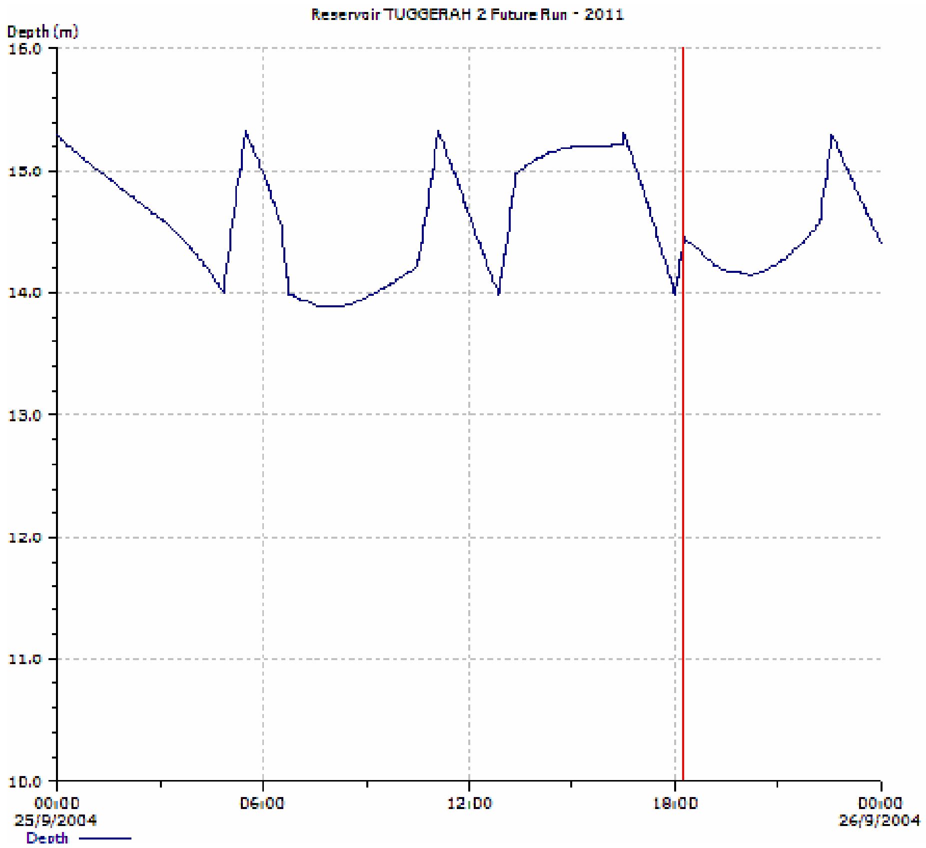


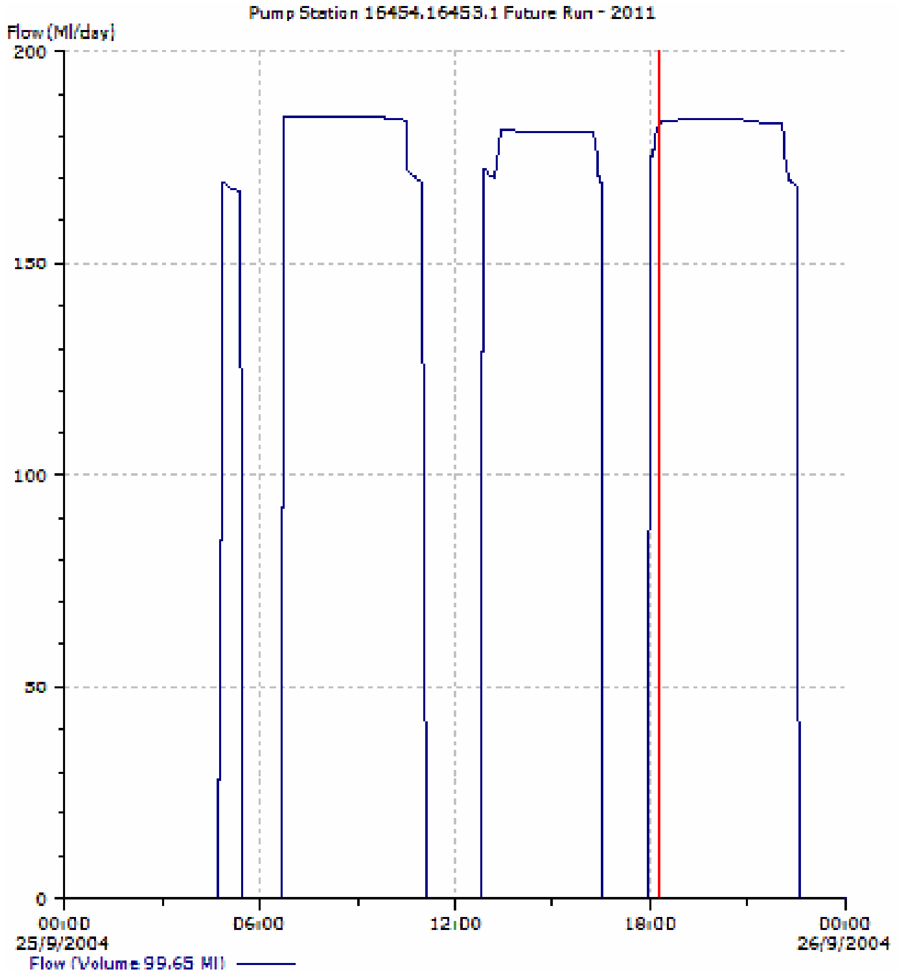
The above figure is a graphical representation of the head conditions experienced at one given time. For the purposes of this study the time step chosen to illustrate system head conditions corresponds to the time step when the Kanwal reservoirs are at their lowest levels. This criterion was chosen as Kanwal reservoirs play a significant role in the delivery of water to the northern system, which is where the majority of future expansion is predicted to occur.

Reservoir Levels & MHLPS Performance

The following figures illustrate the performance of the MHLPS and a series of key reservoirs during the course of the simulation PDD. The figures are identified at the top of the charts except for the Mardi HLPS which has been given the following Infoworks WS computer generated identifier - 16454.16453.1

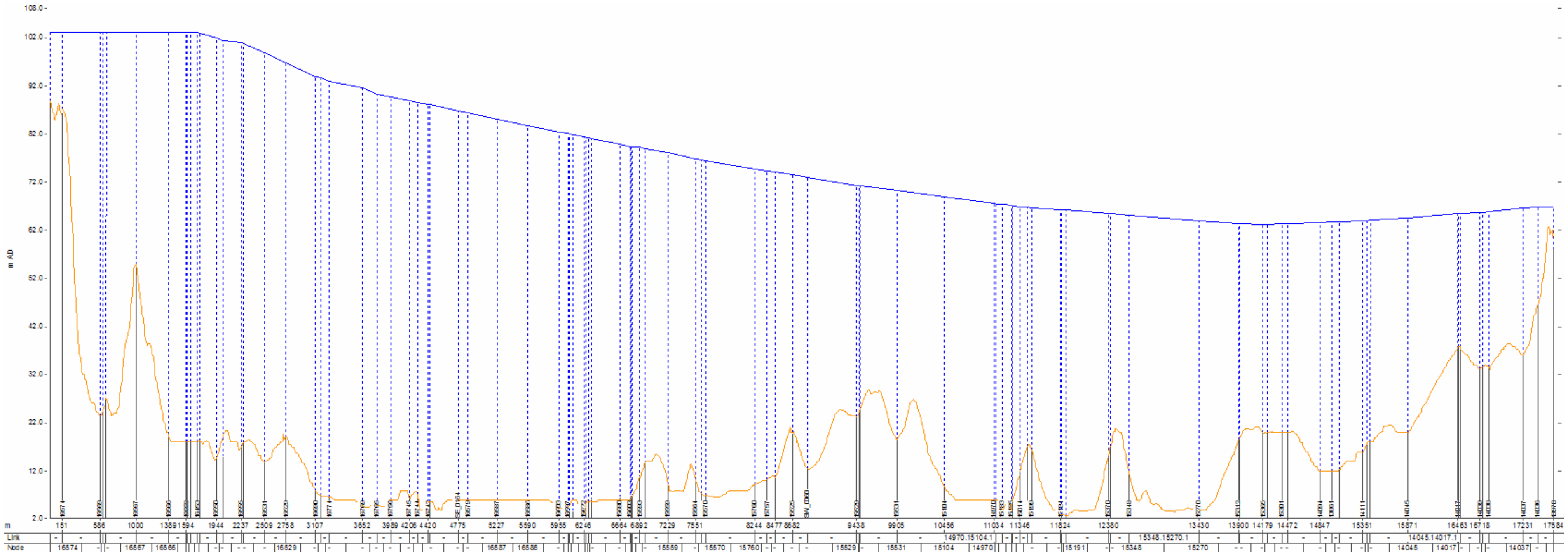



Reservoir TUGGERAH 2 Future Run - 2011
Depth (m)
16.0
15.0
14.0
13.0
12.0
11.0
10.0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Depth

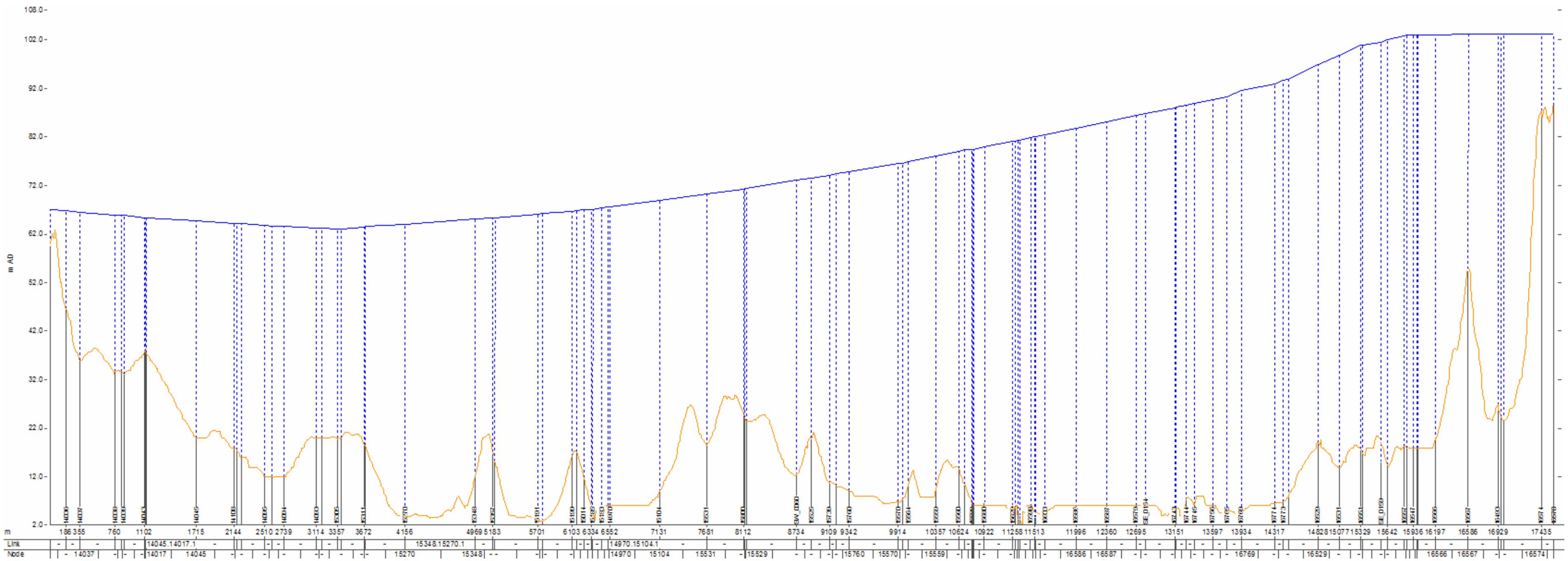

Pump Station 16454.16453.1 Future Run - 2011
Flow (Ml/day)
200
150
100
50
0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Flow (Volume 99.65 Ml)

System Hydraulic Grade Lines (HGLs)

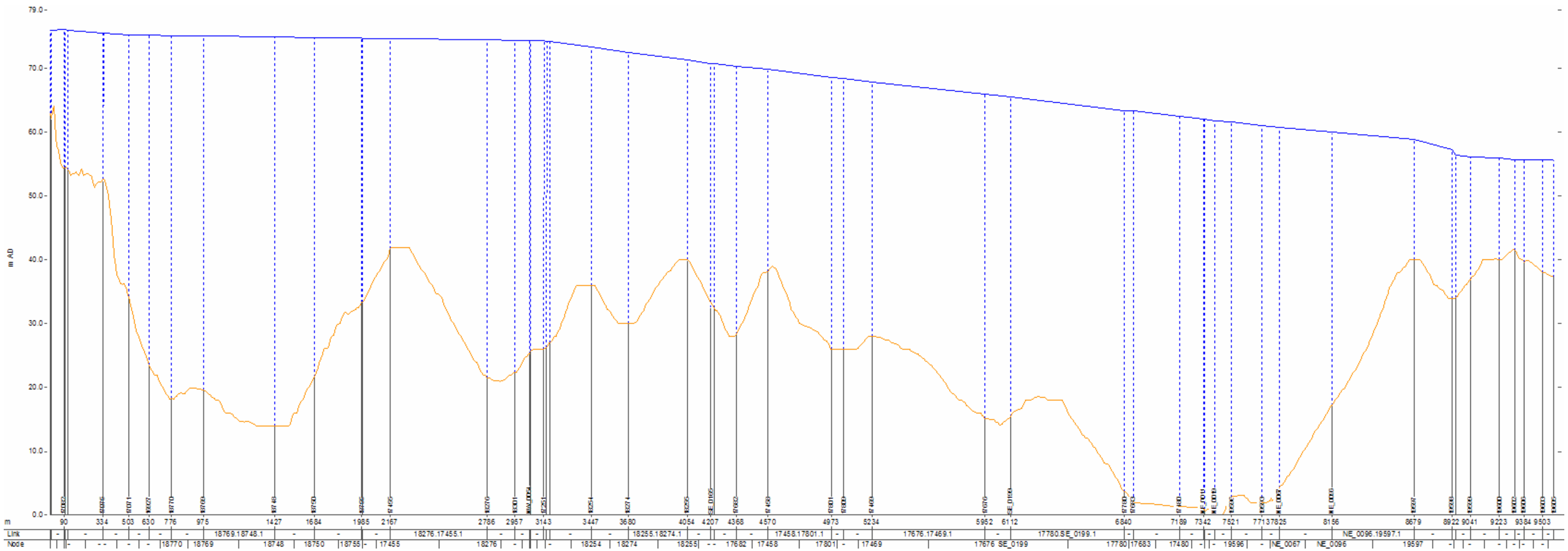
As with the previous simulation result charts and figures the HGLs have all been generated at the time step corresponding to the lowest water levels in Kanwal reservoir during the course of that particular hydraulic simulation.



Tuggerah 2 Reservoir to Kanwal Reservoir



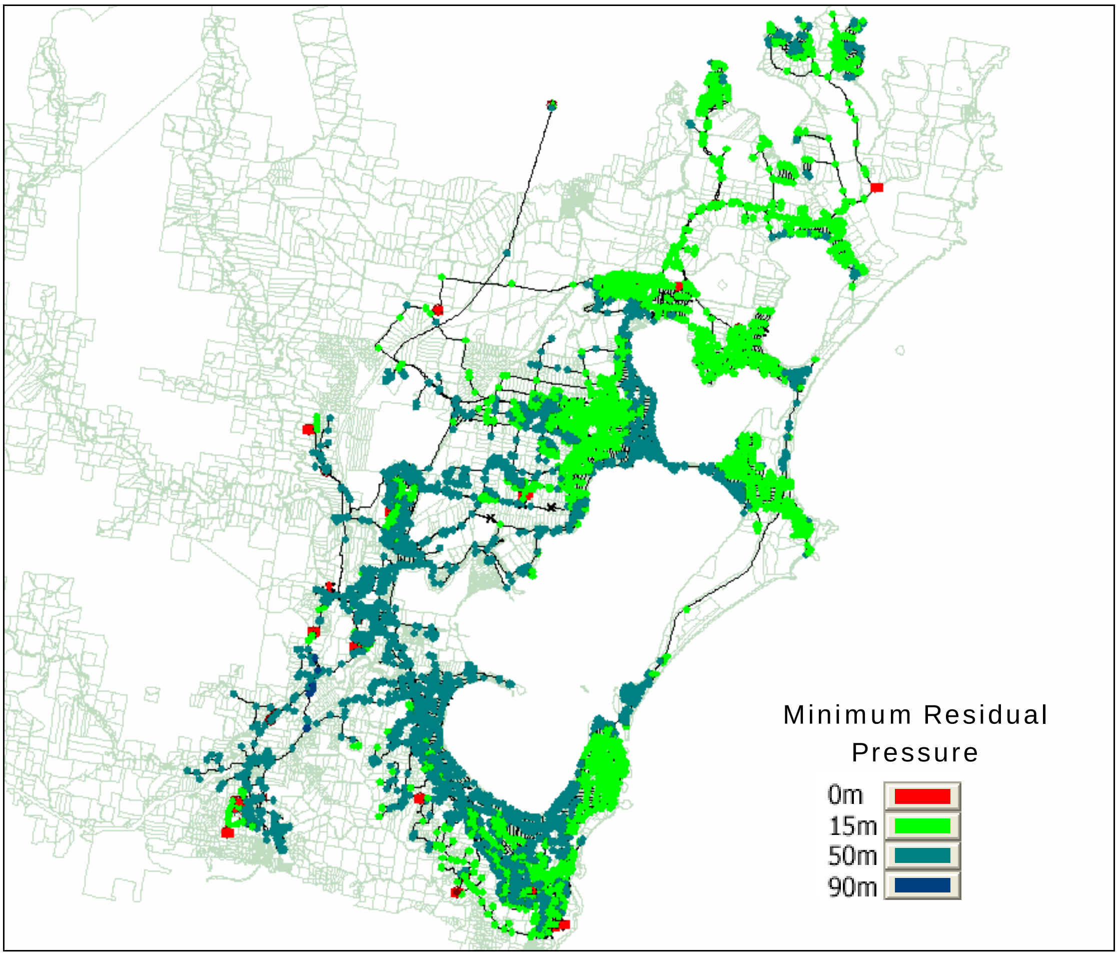
Wyrrabalong Reservoir to Tuggerah 2 Reservoir



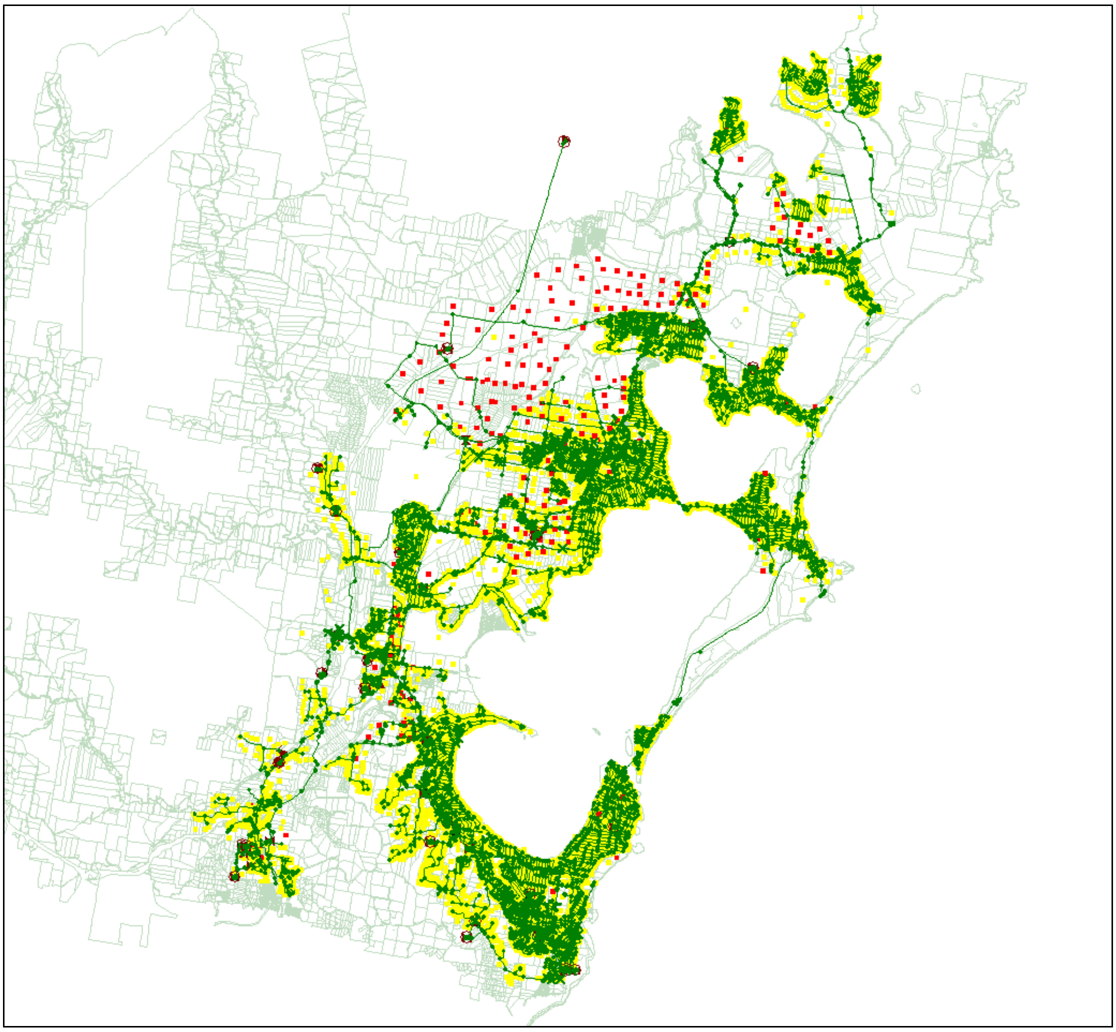
Kanwal Reservoirs to the Bluehaven area.

2016 Simulation Results

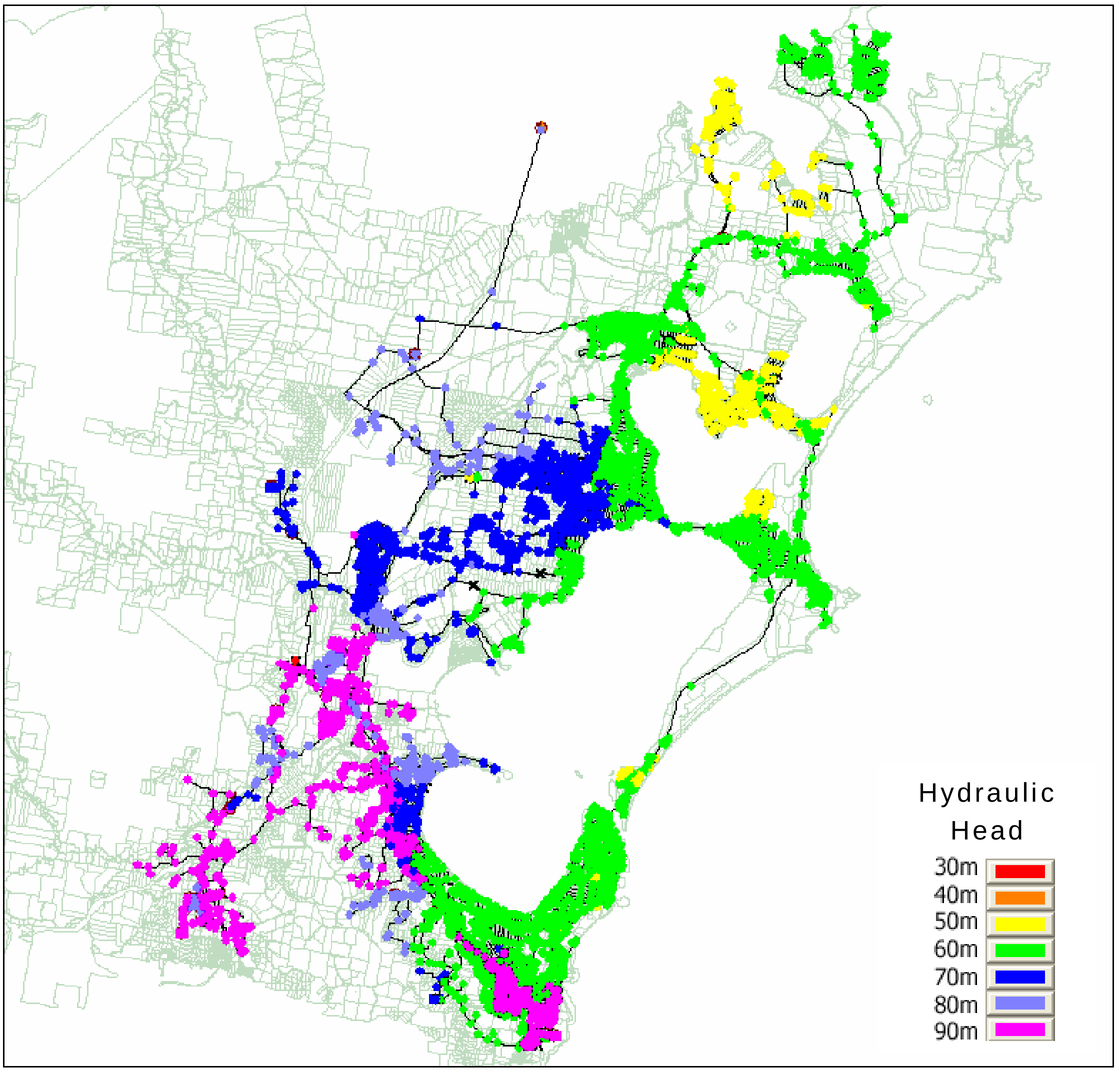
Minimum Residual Pressures



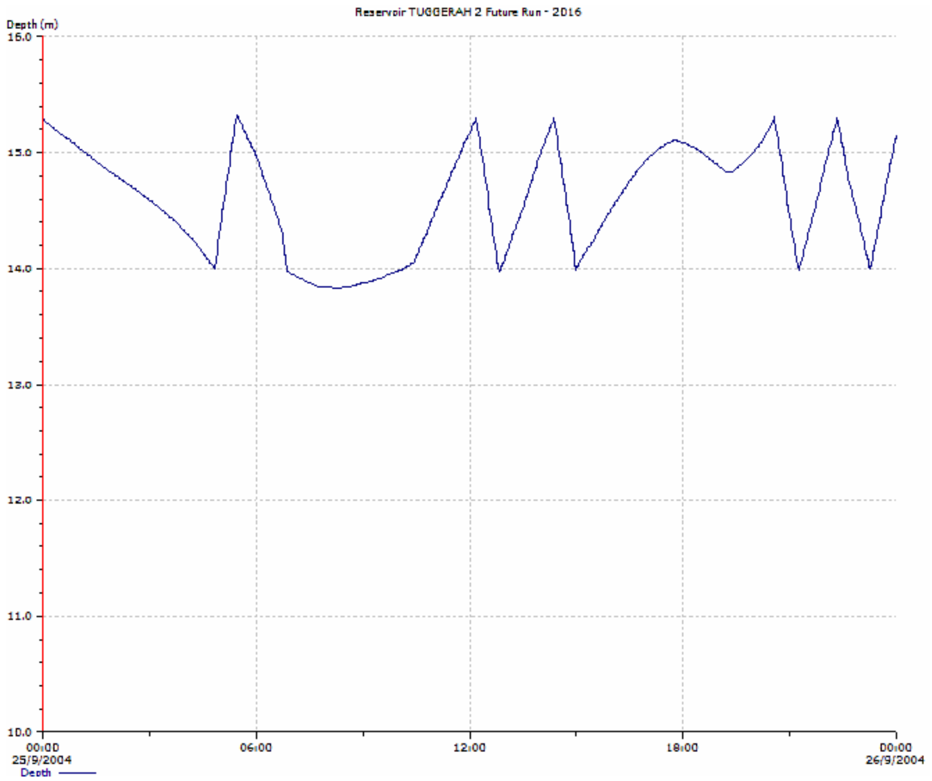
Customer Points

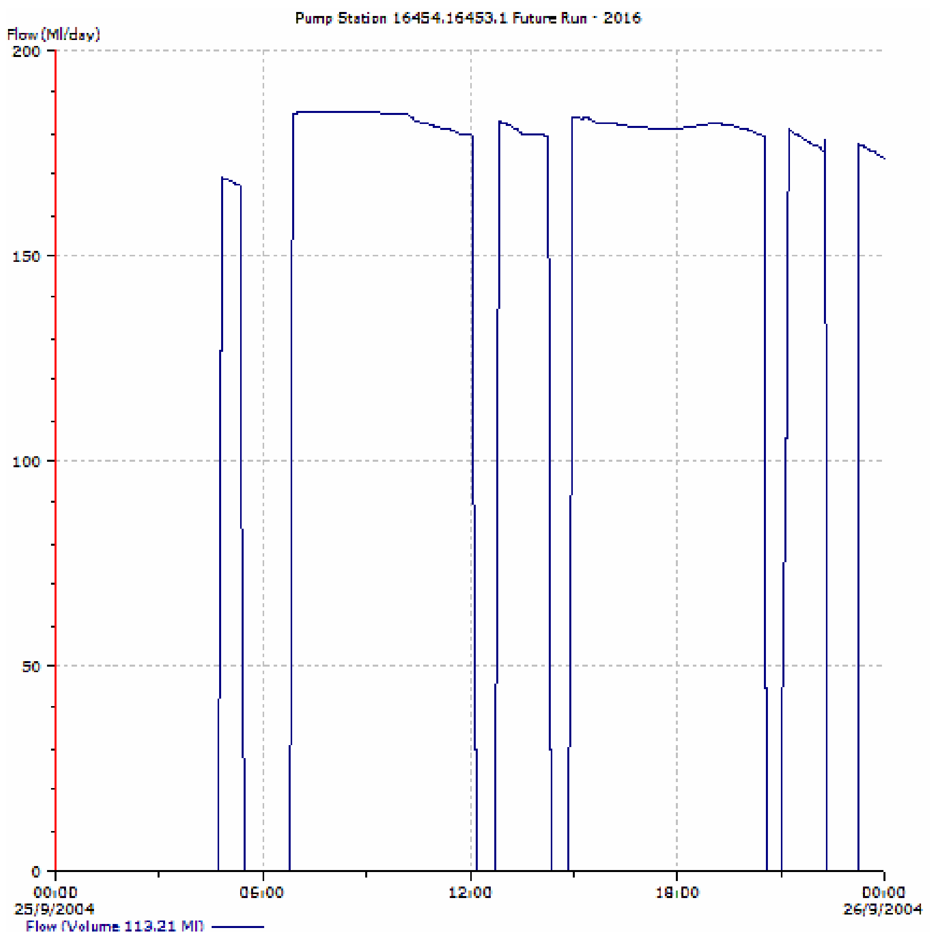


Simulated Head Conditions

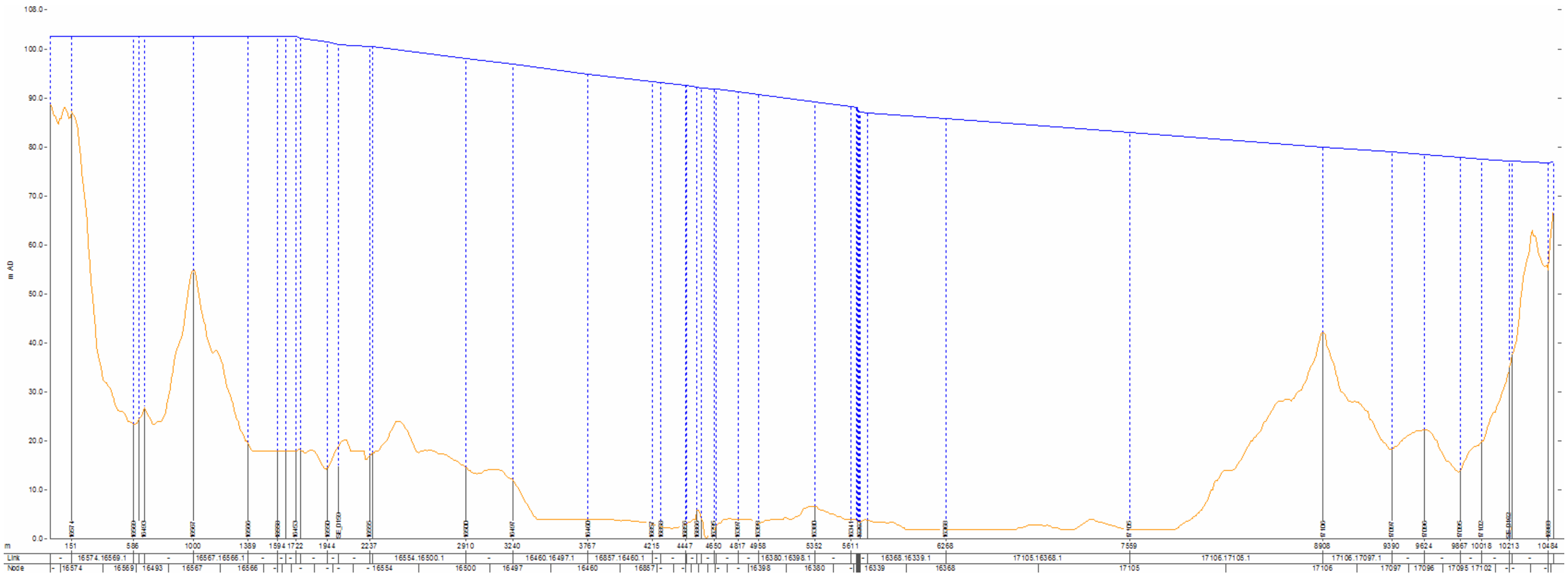


Reservoir Levels & MHLPS Performance

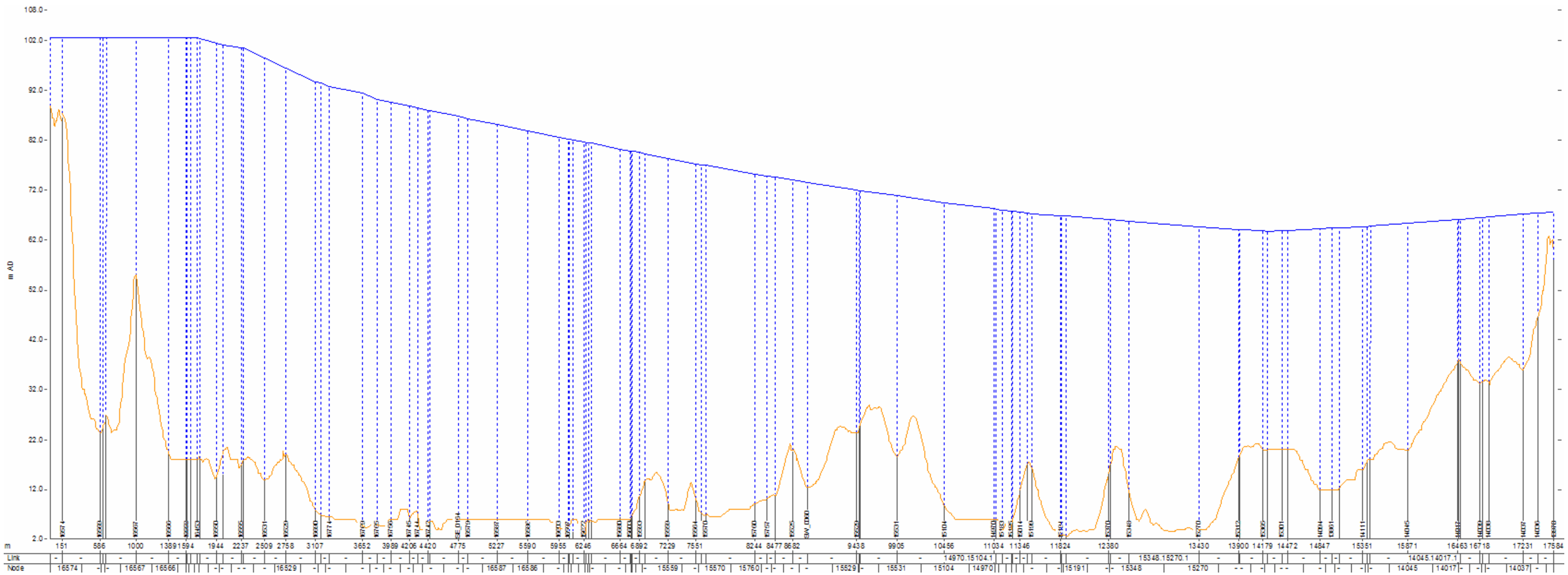




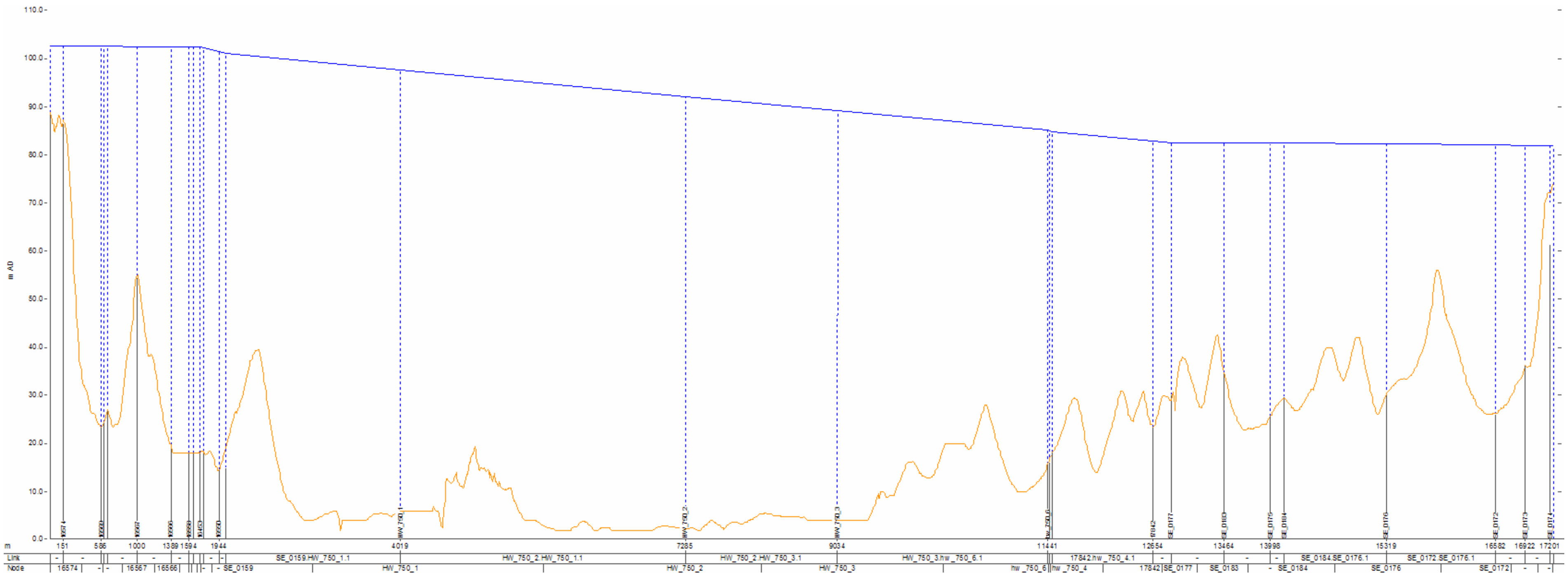
System Hydraulic Grade Lines (HGLs)



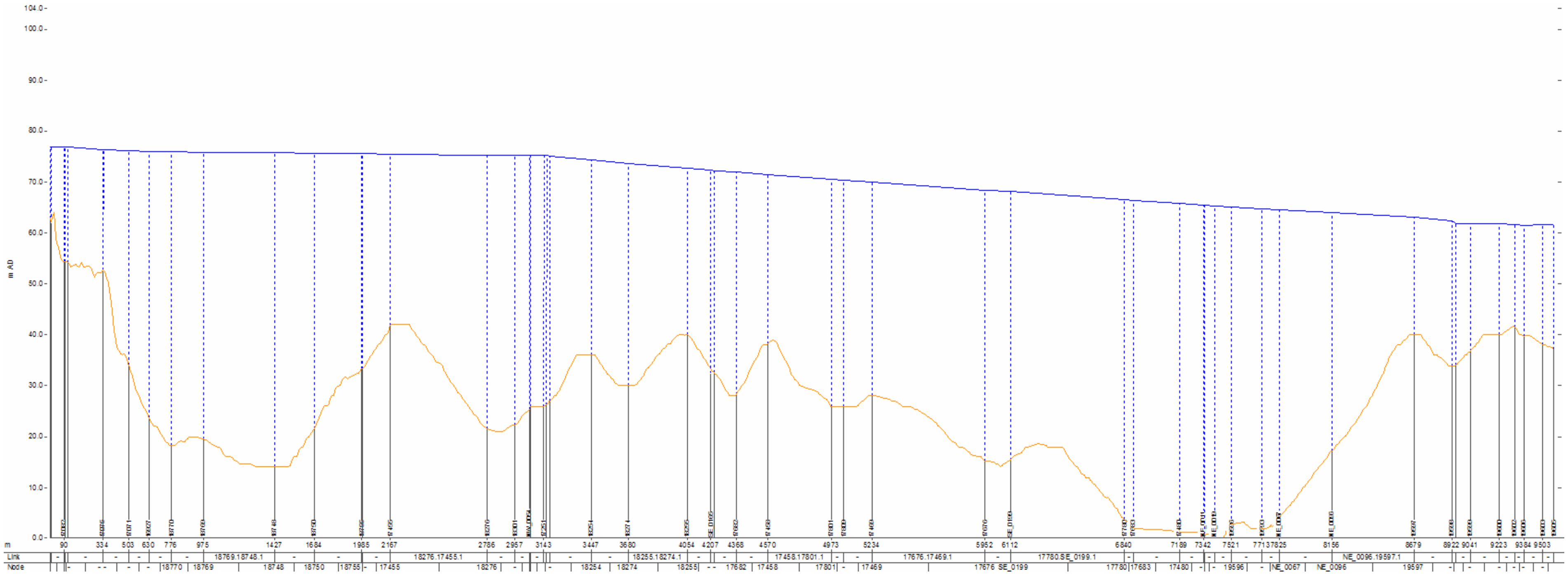
Tuggerah 2 Reservoir to Kanwal Reservoirs



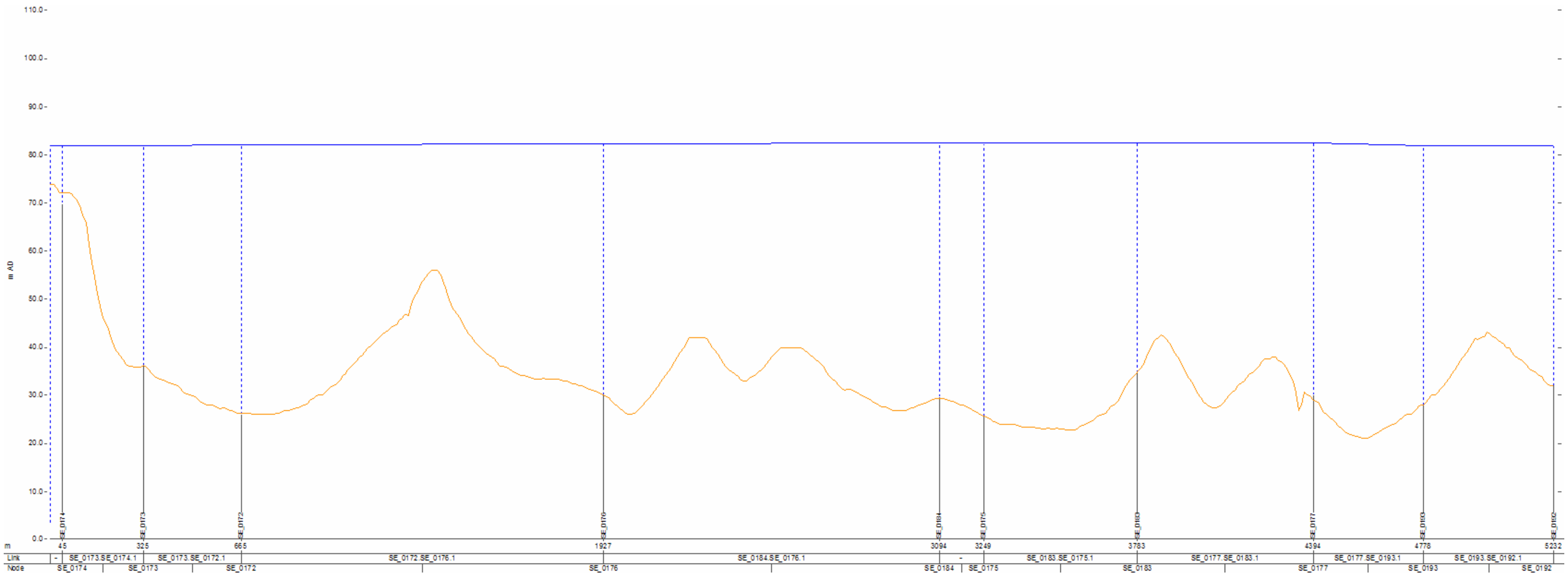
Tuggerah 2 Reservoir to Wyrrabalong Reservoir



Tuggerah 2 Reservoir to Kiar Ridge Reservoir



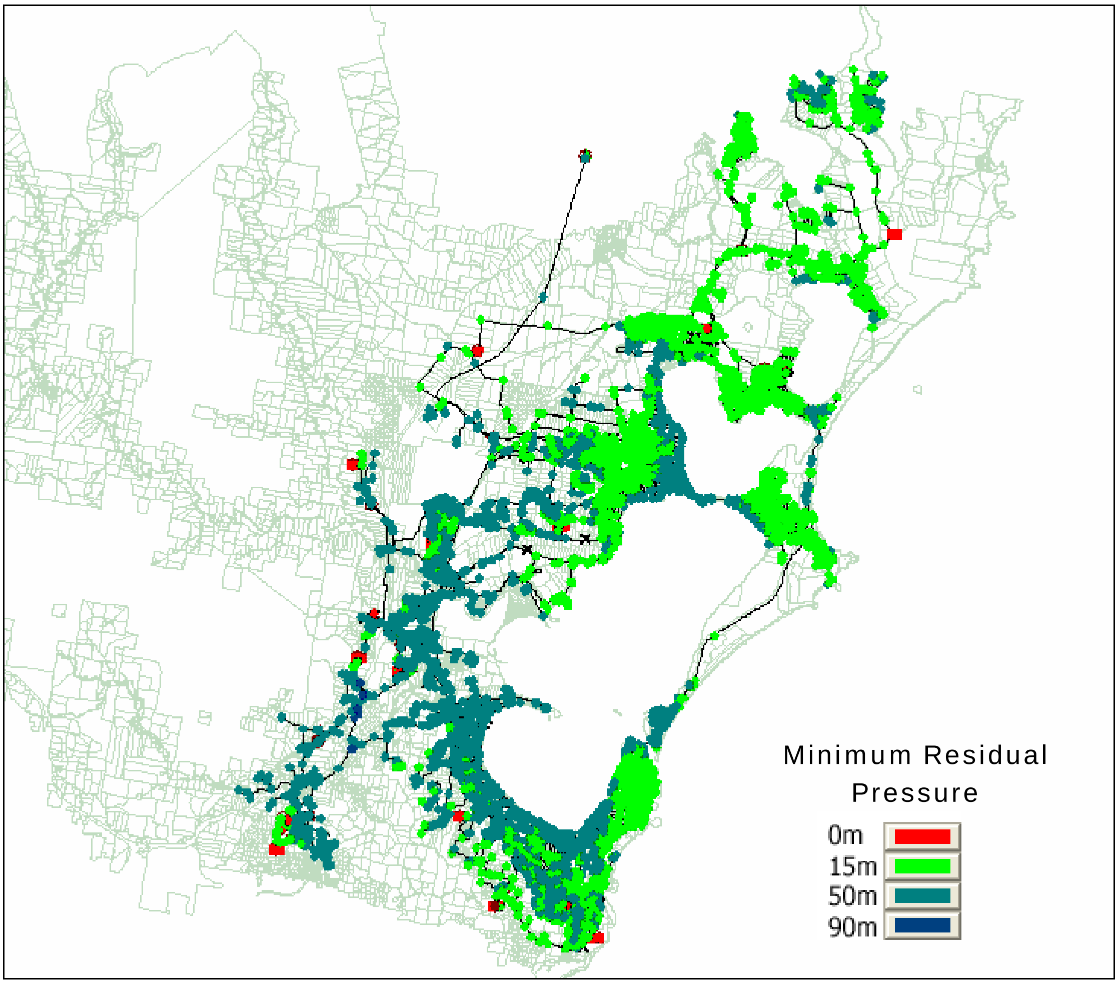
Kanwal Reservoirs to Bluehaven Area



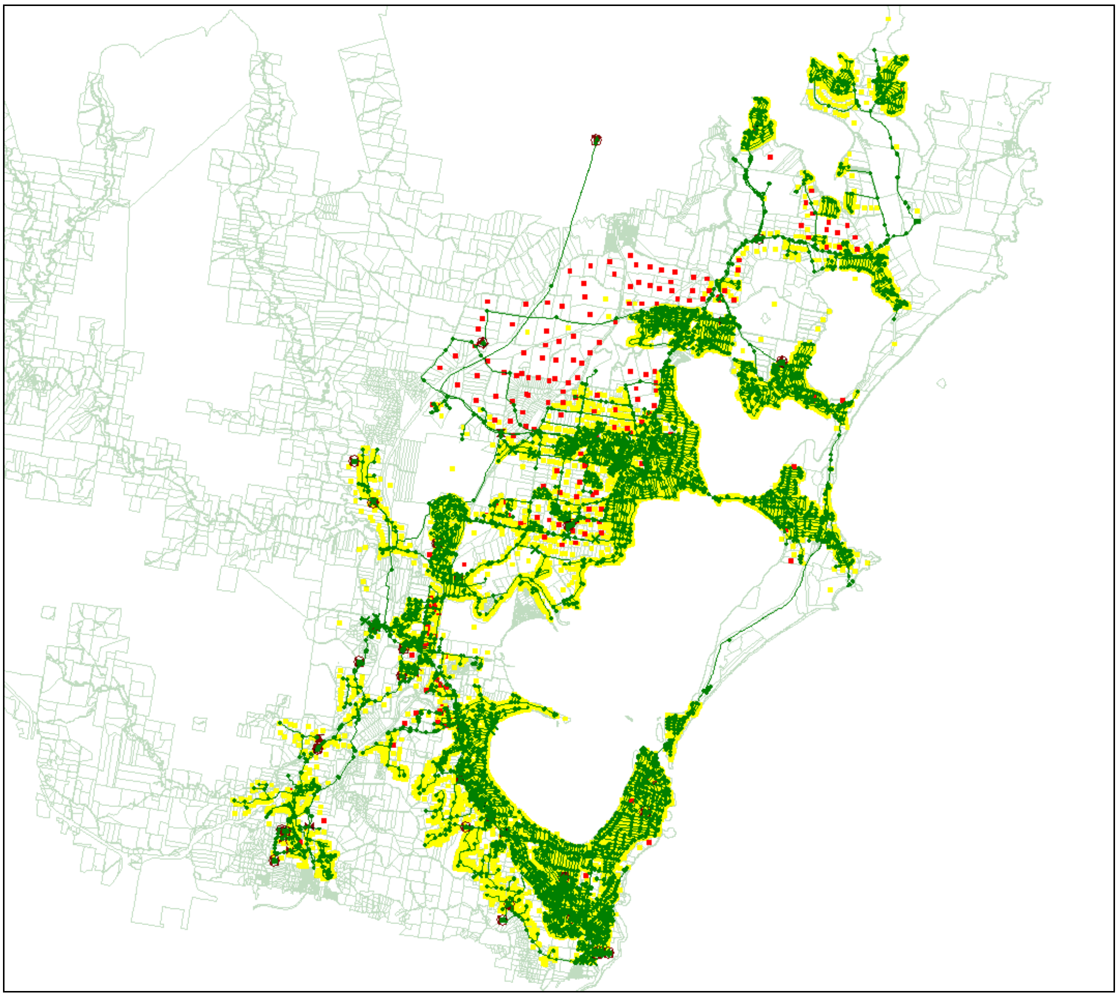
Kiar Ridge Reservoir to Warnervale High Level Zone

2021 Simulation Results

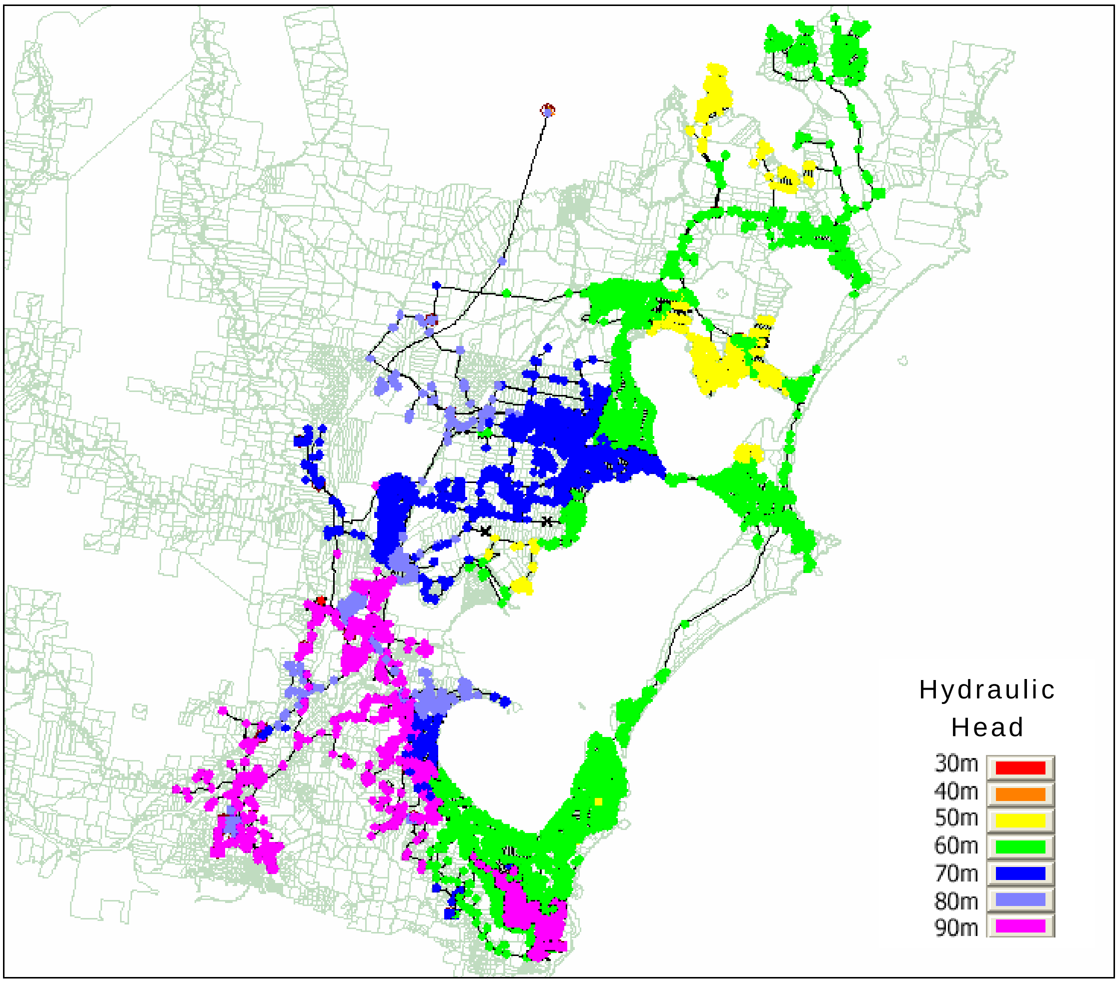
Minimum Residual Pressures



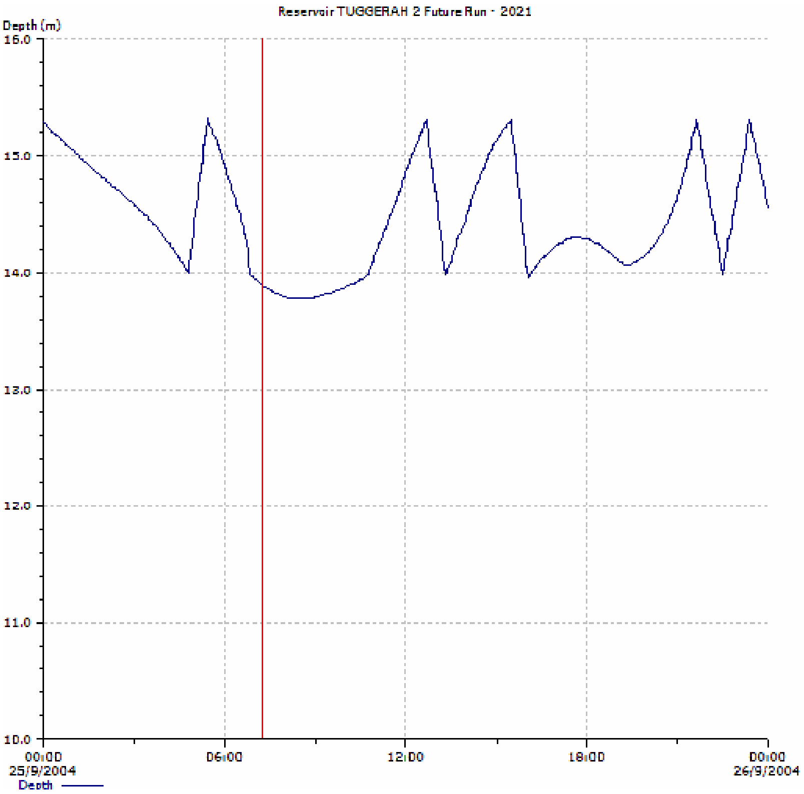
Customer Points

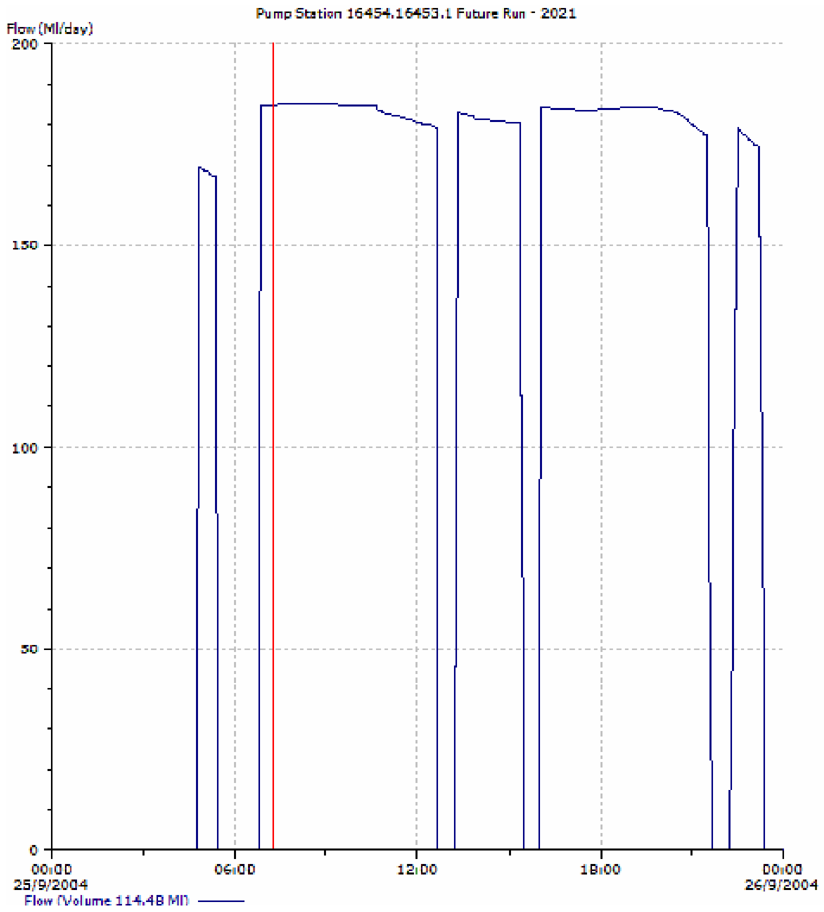


Simulated Head Conditions

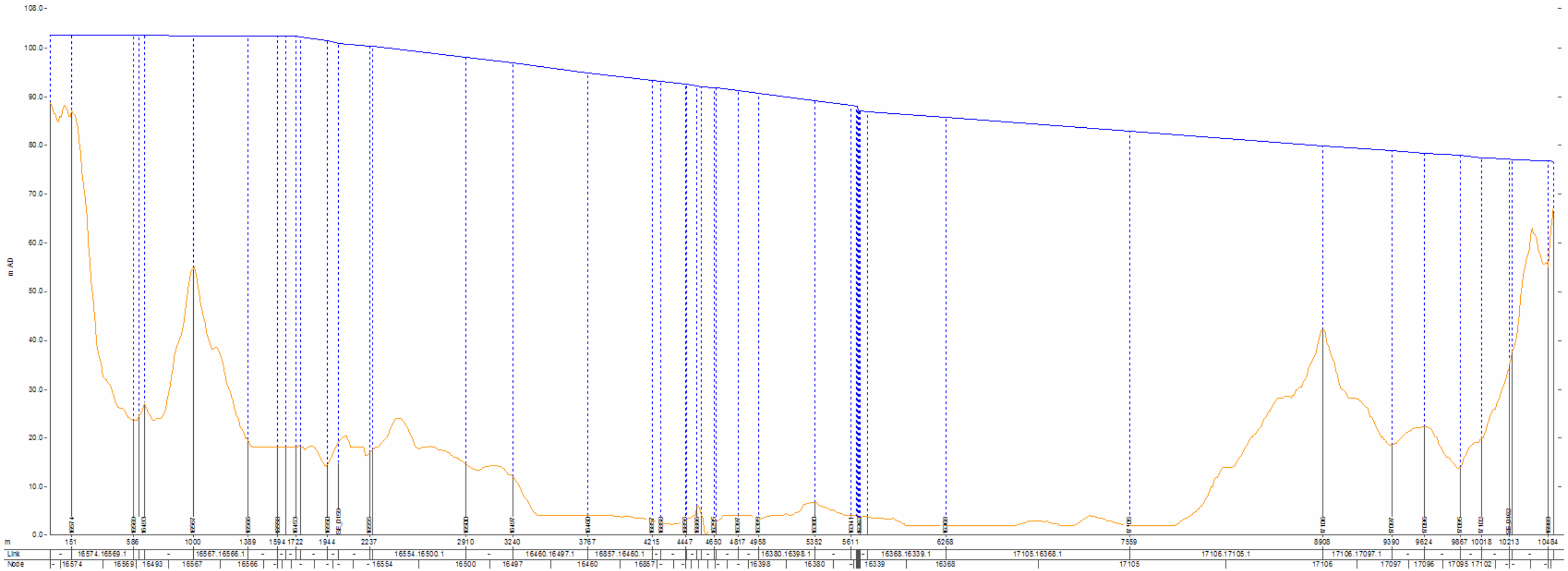


Reservoir Levels & MHLPS Performance

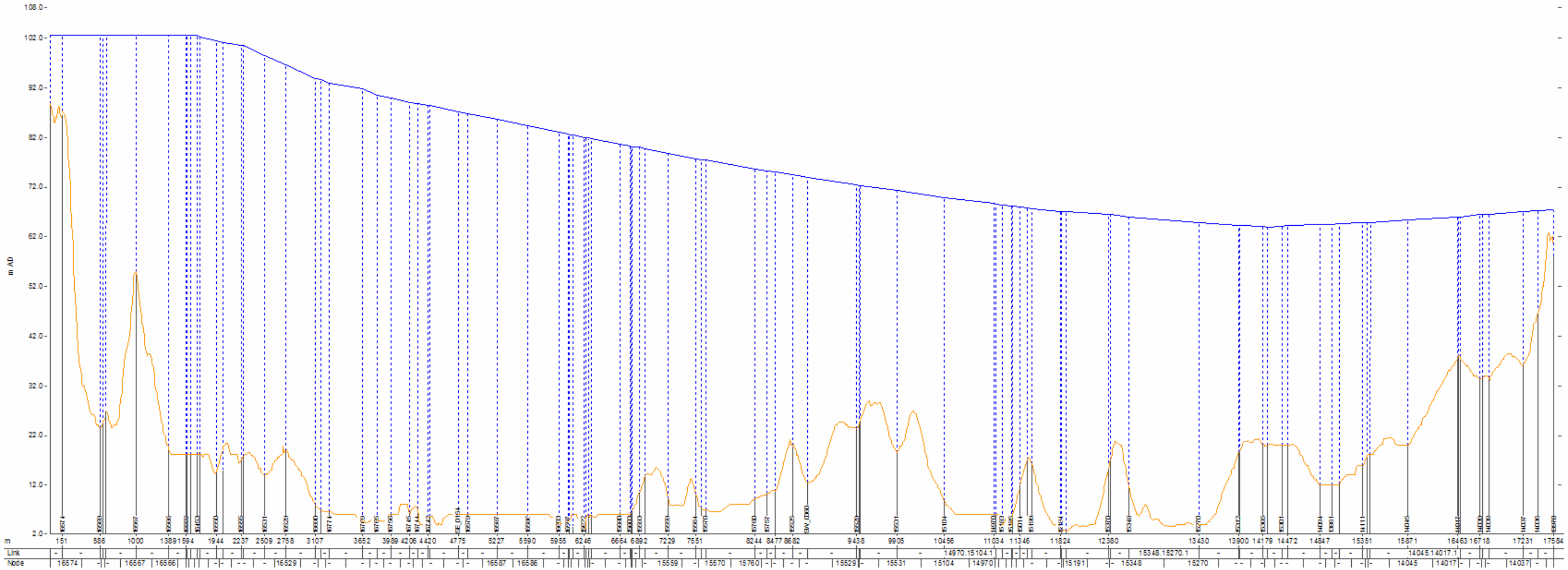



Pump Station 16454.16453.1 Future Run - 2021
Flow (Ml/day)
200
150
100
50
0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Flow (Volume 114.48 Ml)

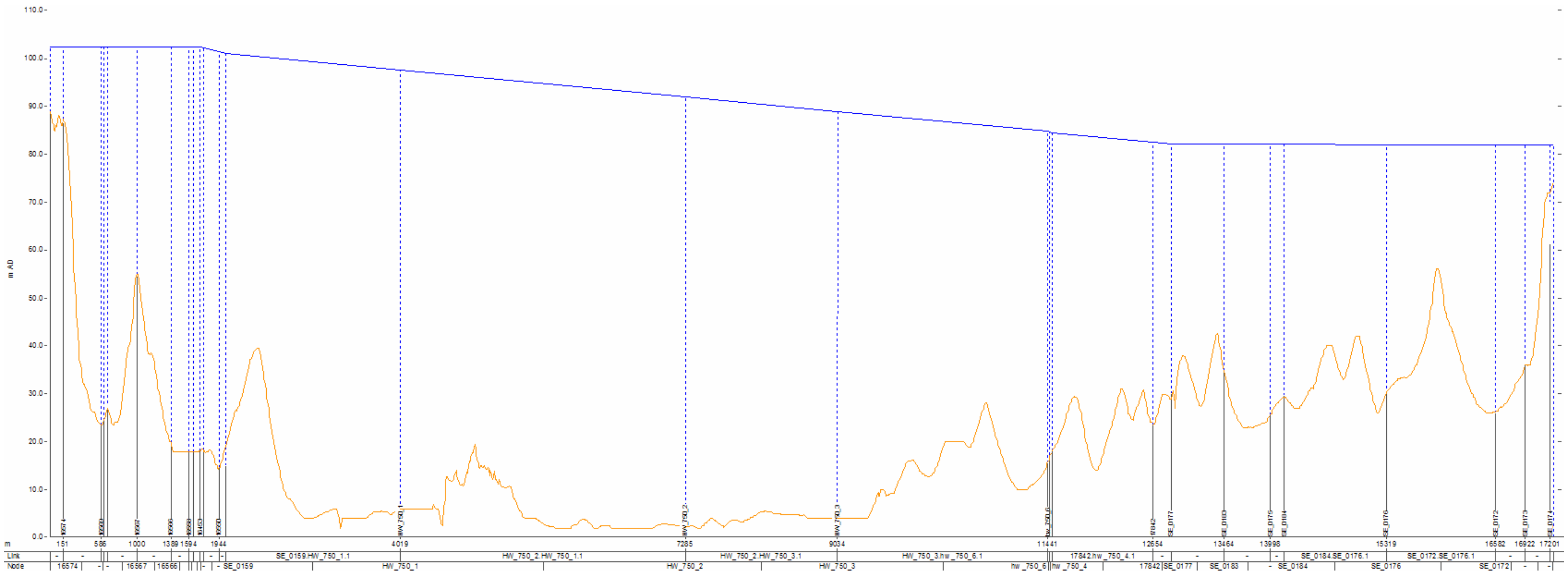
System Hydraulic Grade Lines (HGLs)



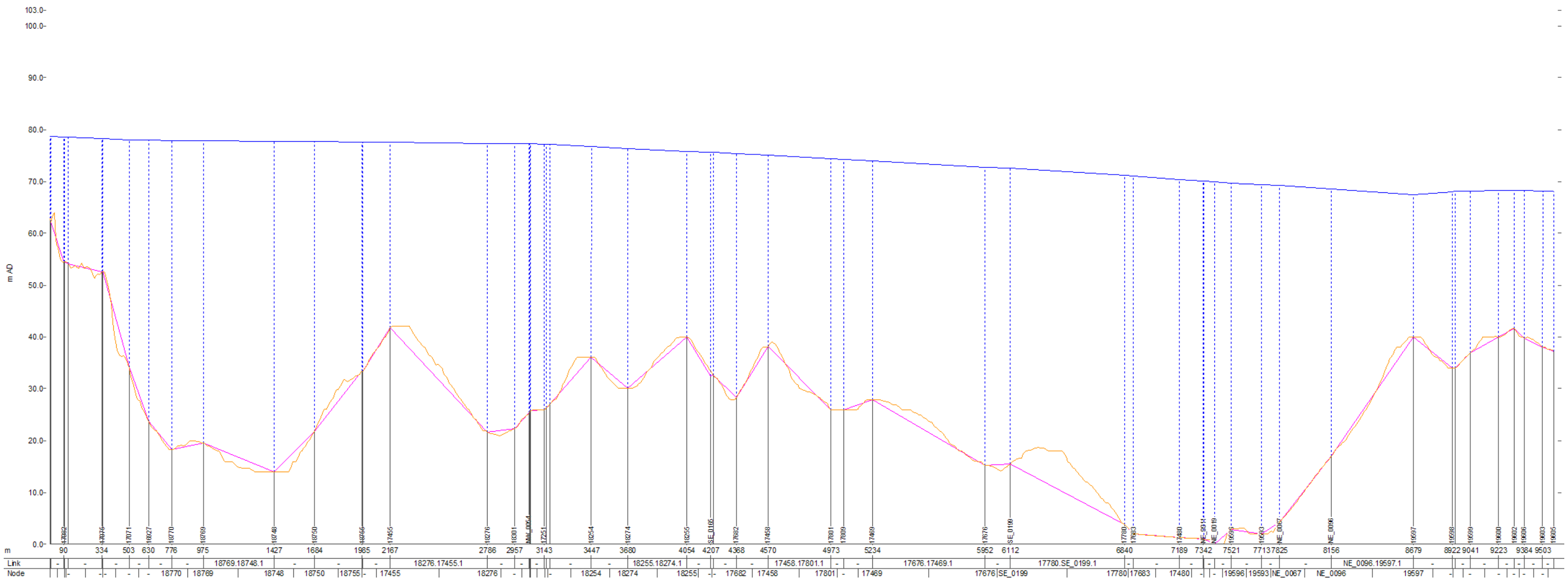
Tuggerah 2 Reservoir to Kanwal Reservoirs



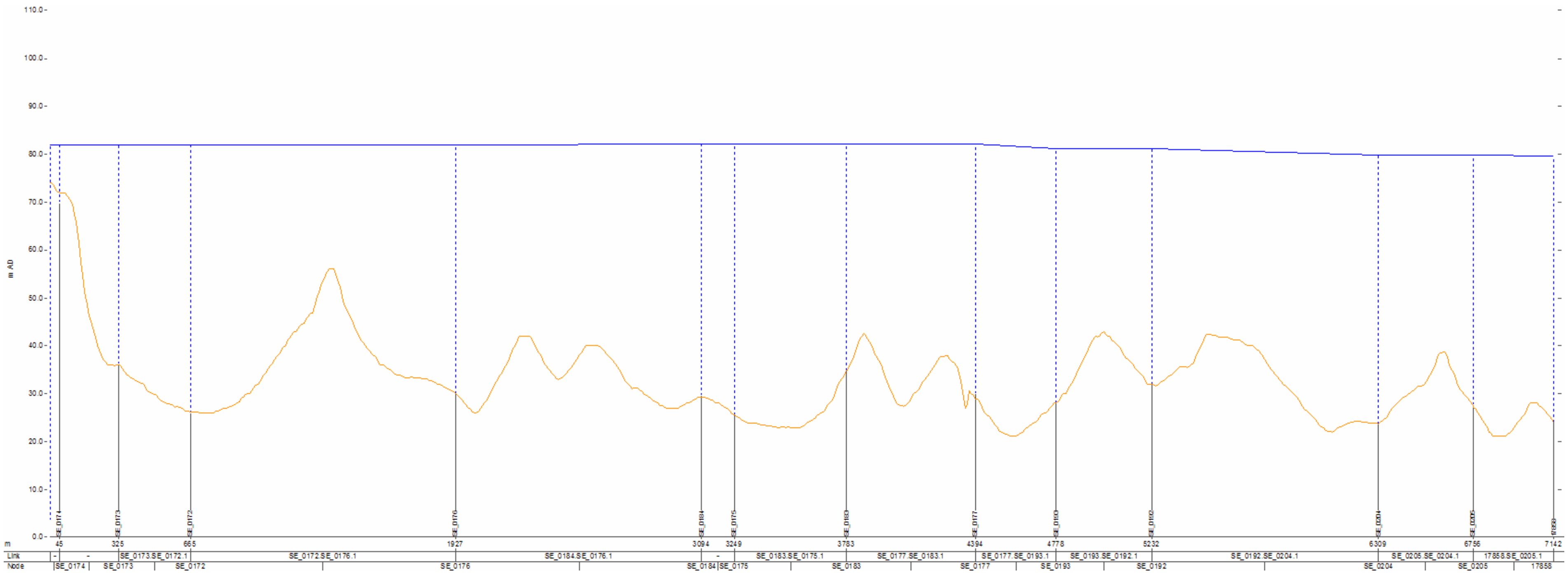
Tuggerah 2 Reservoir to Wyrrabalong Reservoir



Tuggerah 2 Reservoir to Kiar Ridge Reservoir



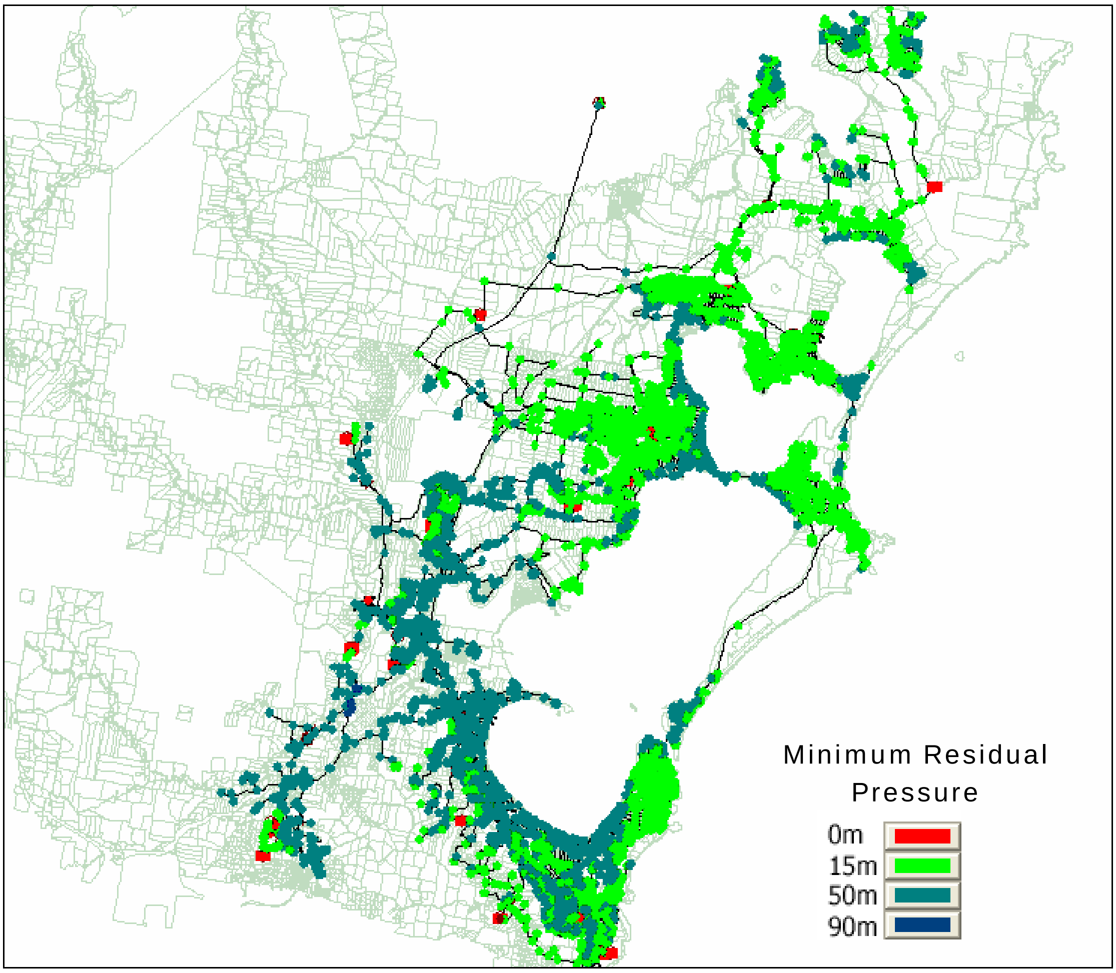
Kanwal Reservoirs to Bluehaven Area



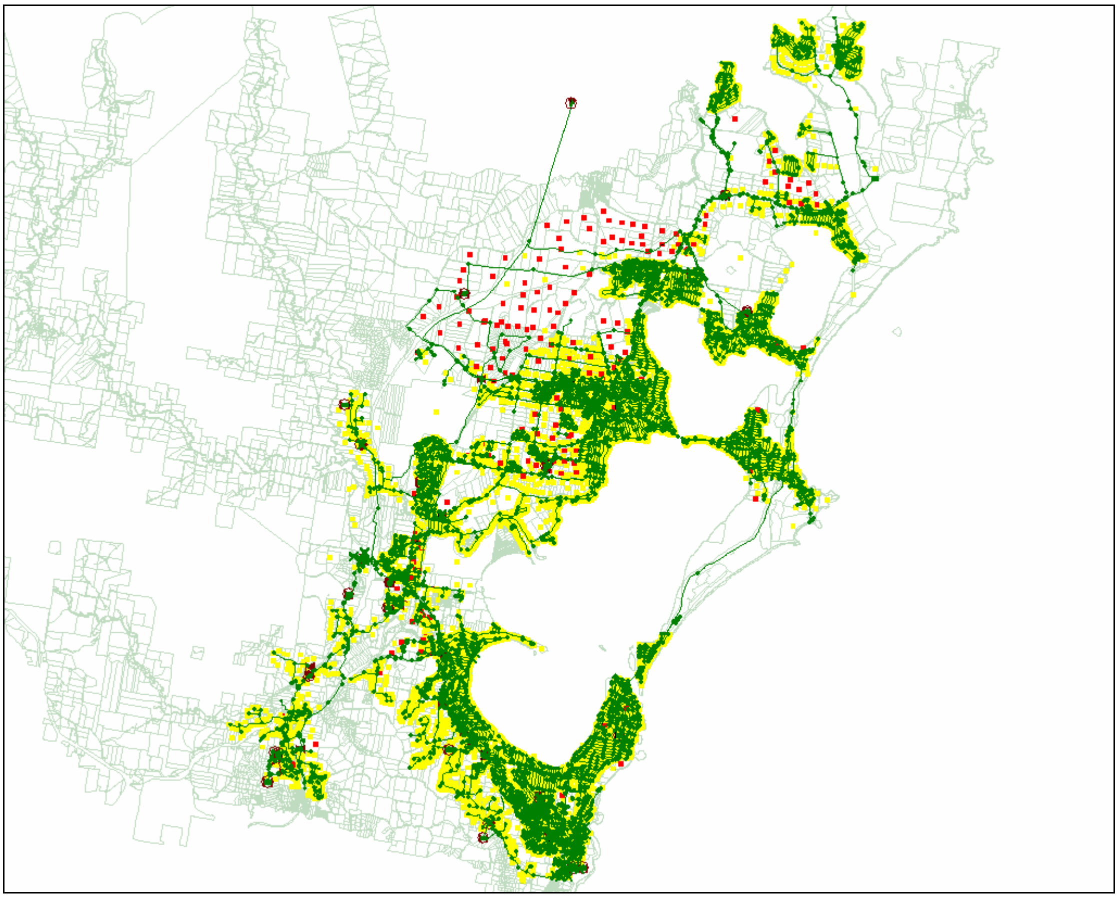
Kiar Ridge Reservoir to Warnervale High Level Zone

2026 Simulation Results

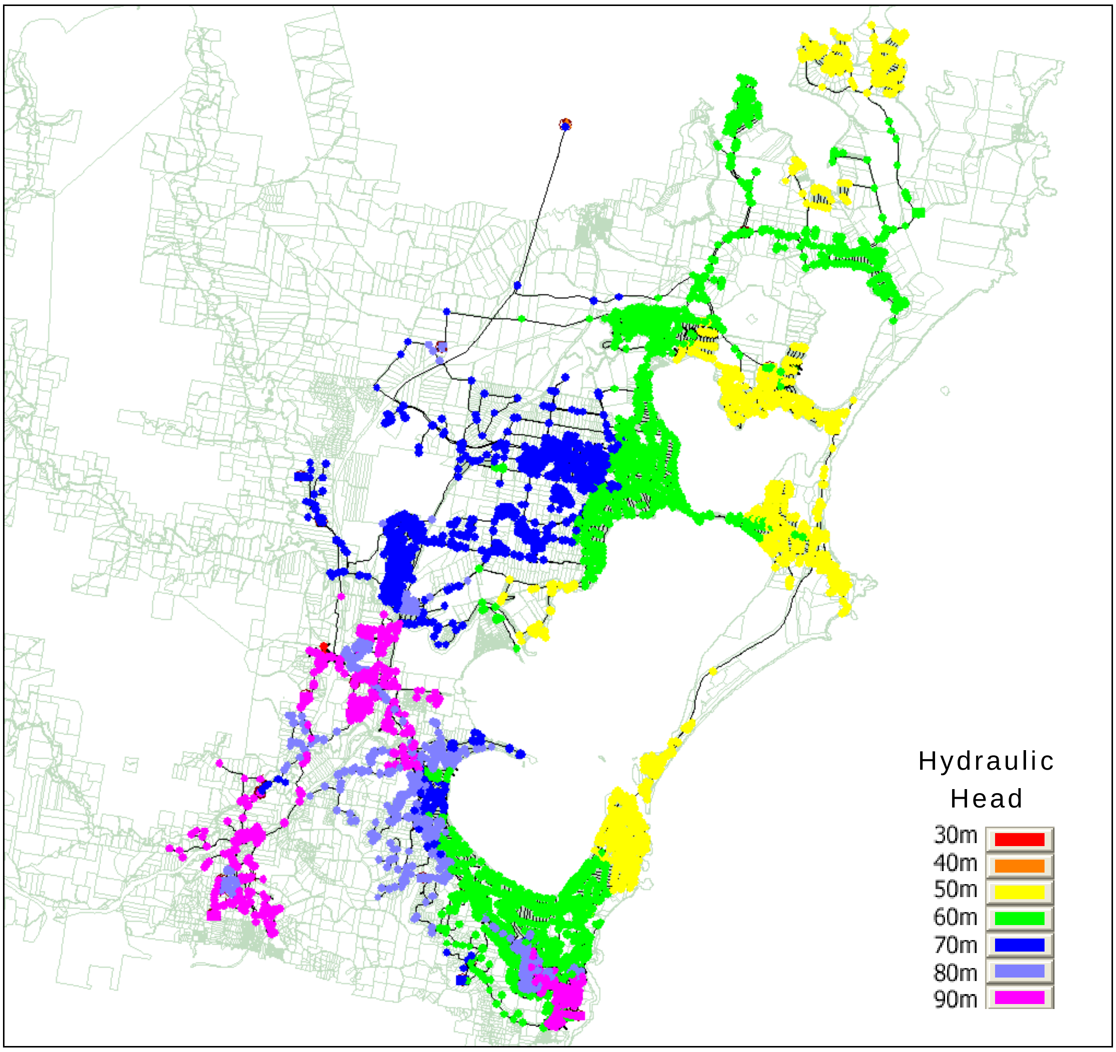
Minimum Residual Pressures



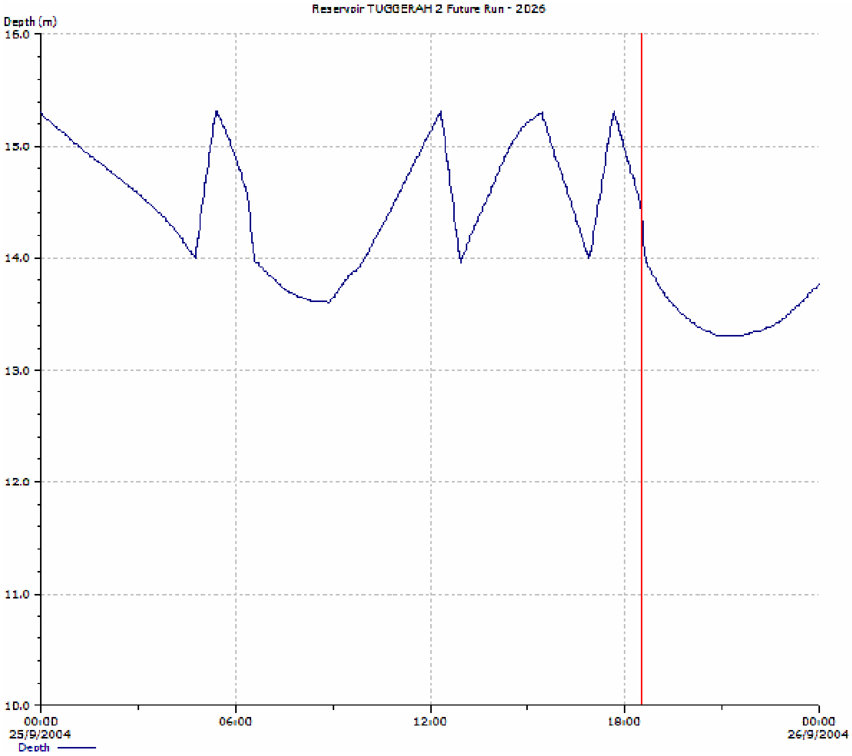
Customer Points

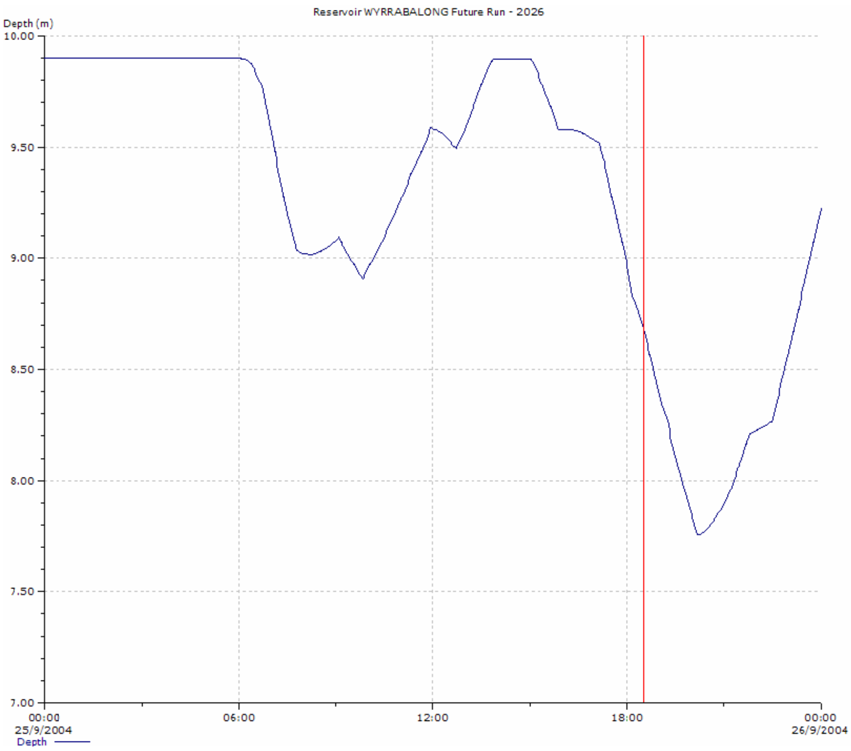


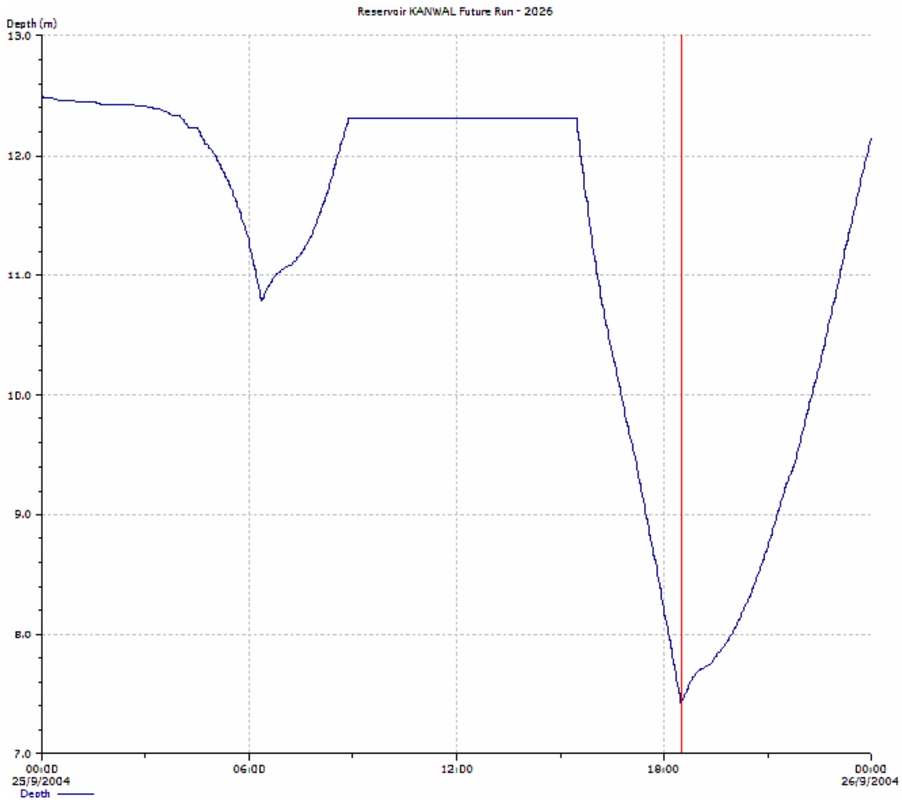
Simulated Head Conditions

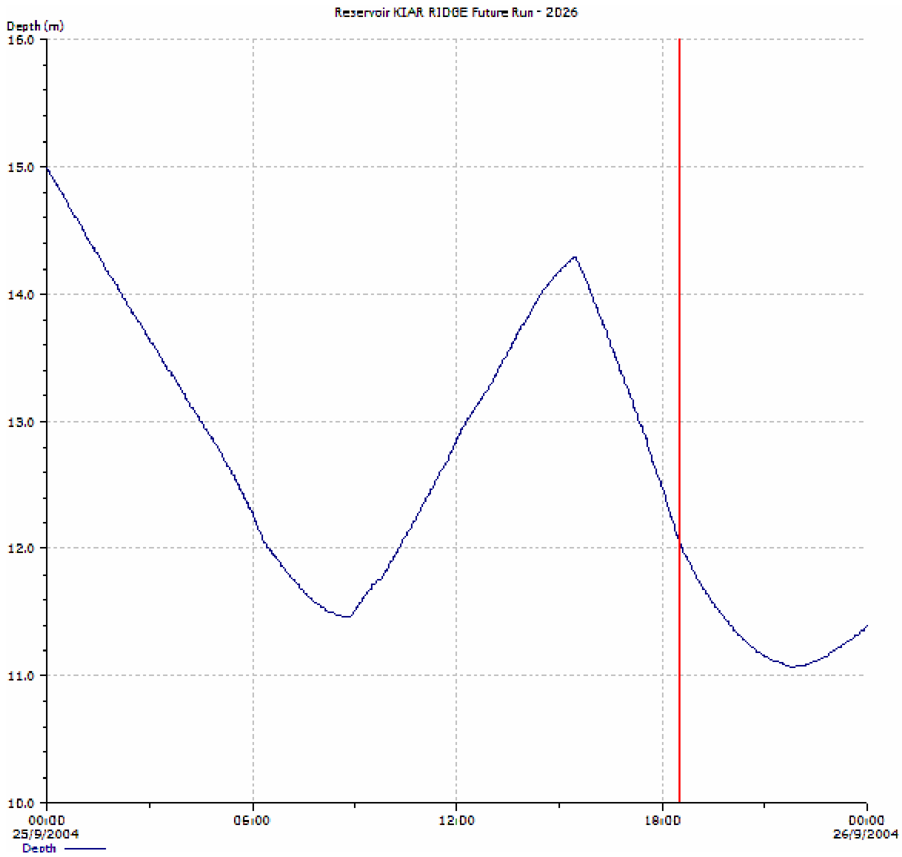


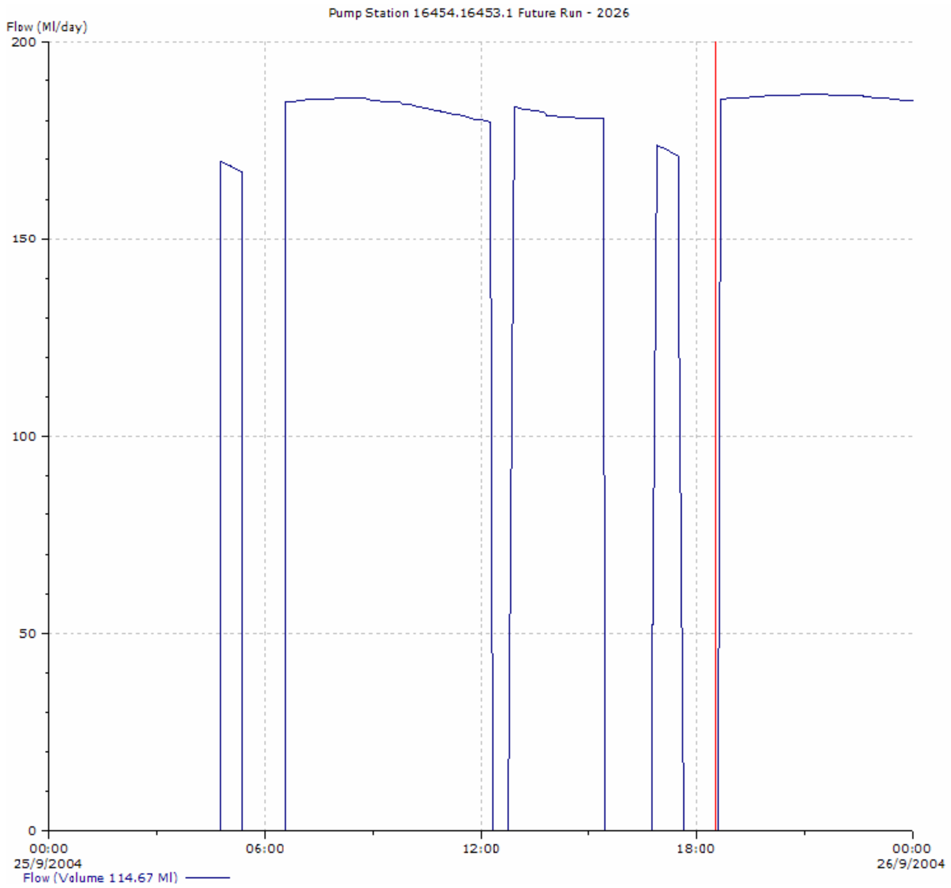
Reservoir Levels & MHLPS Performance



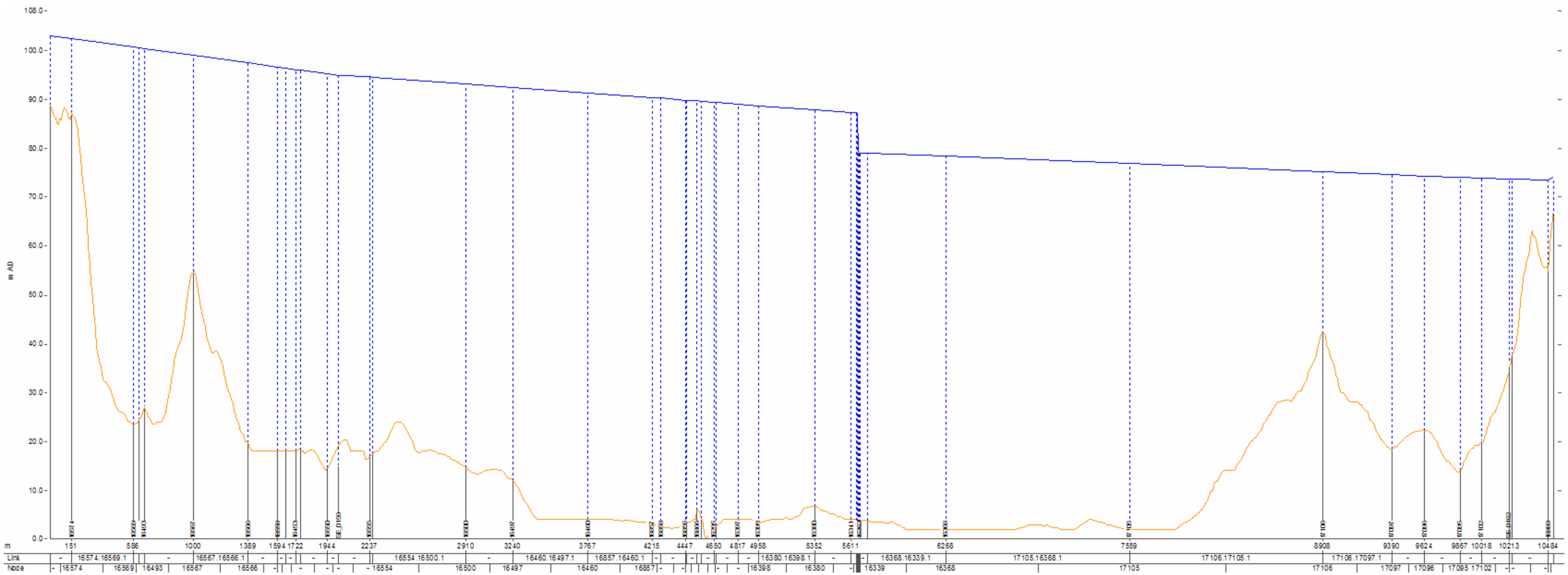



Reservoir KANWAL Future Run - 2026
Depth (m)
13.0
12.0
11.0
10.0
9.0
8.0
7.0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Depth

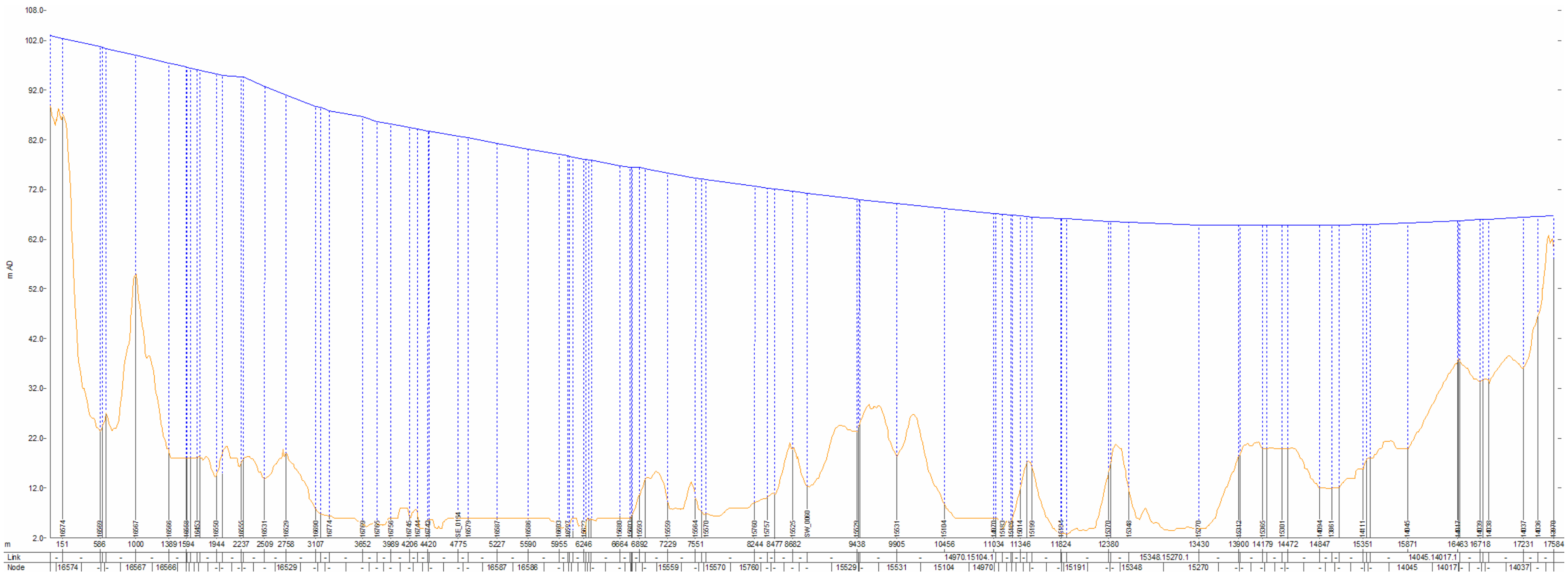

Reservoir KIAR RIDGE Future Run - 2026
Depth (m)
16.0
15.0
14.0
13.0
12.0
11.0
10.0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Depth


Pump Station 16454.16453.1 Future Run - 2026
Flow (Ml/day)
200
150
100
50
0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Flow (Volume 114.67 Ml)

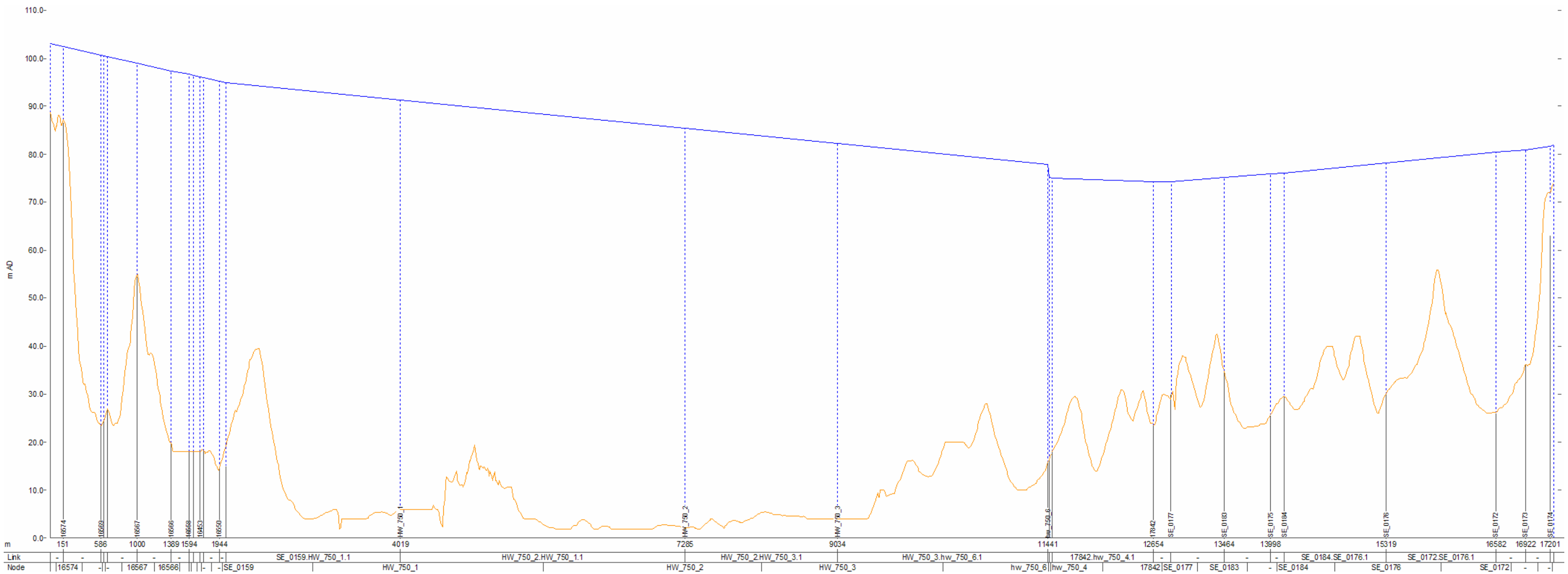
System Hydraulic Grade Lines (HGLs)



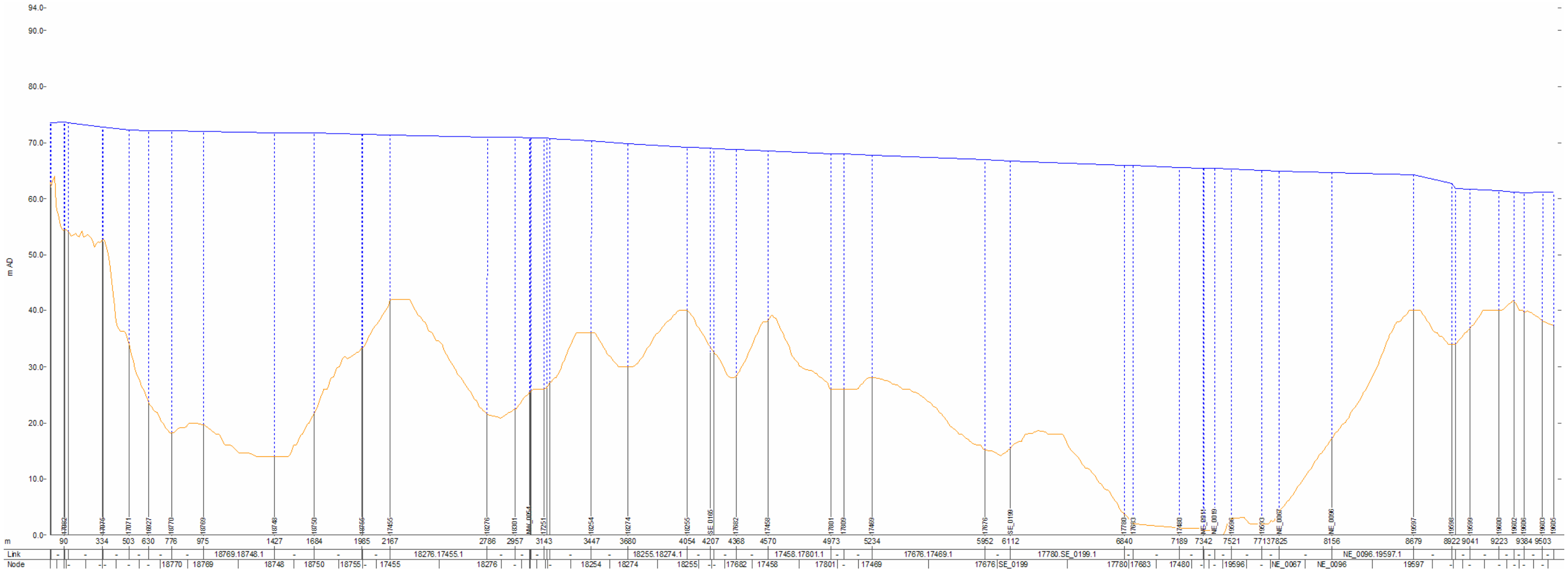
Tuggerah 2 Reservoir to Kanwal Reservoirs



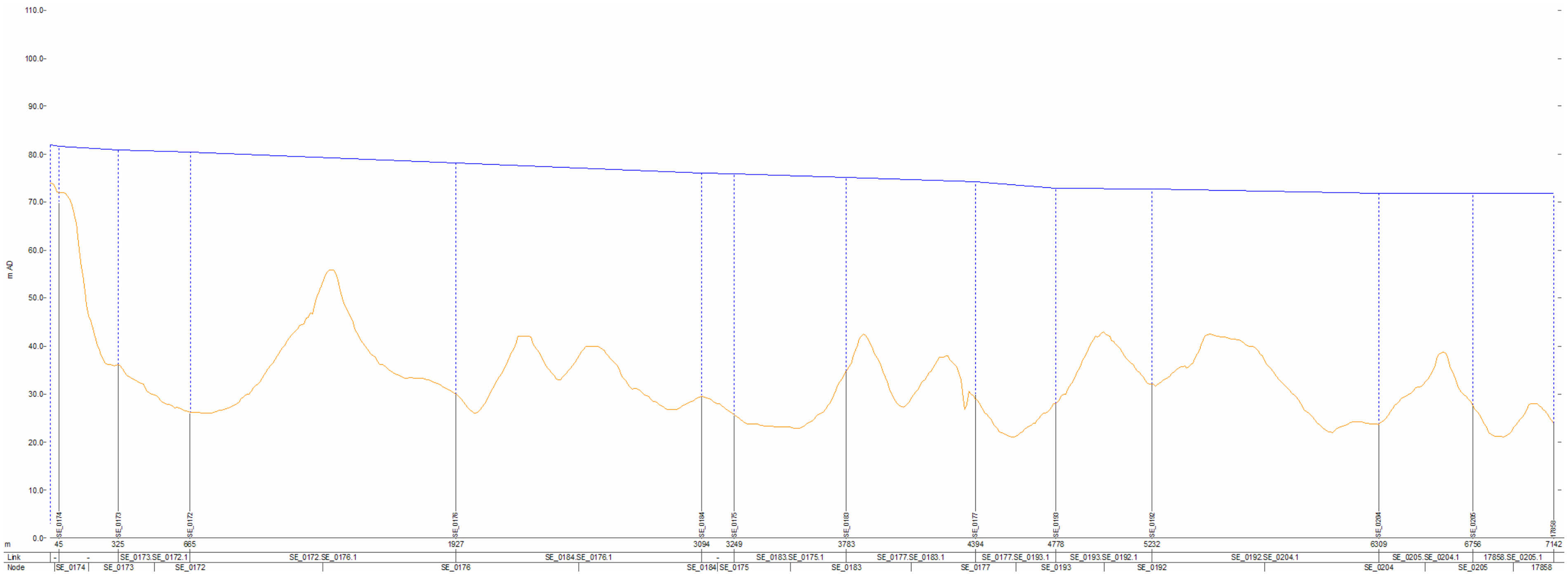
Tuggerah 2 Reservoir to Wyrrabalong Reservoir



Tuggerah 2 Reservoir to Kiar Ridge Reservoir



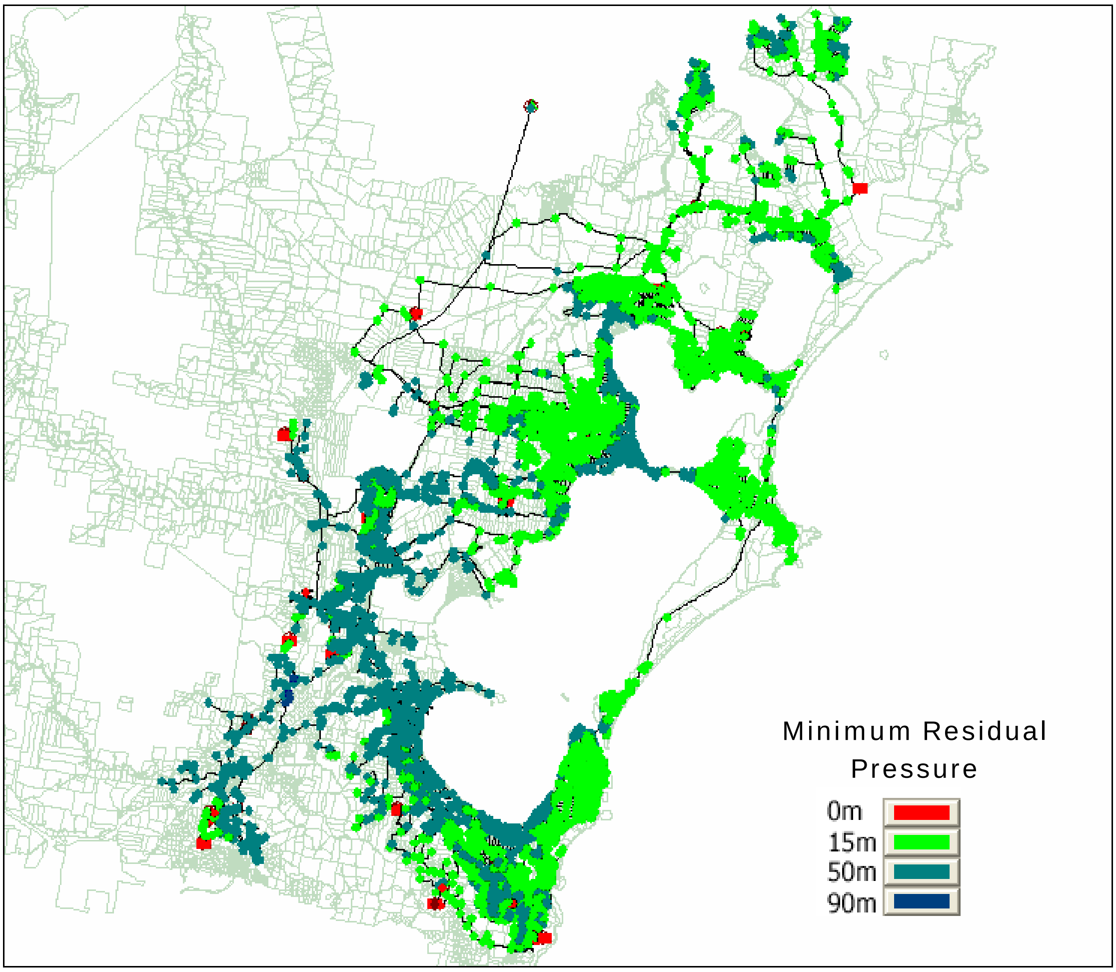
Kanwal Reservoirs to Bluehaven Area



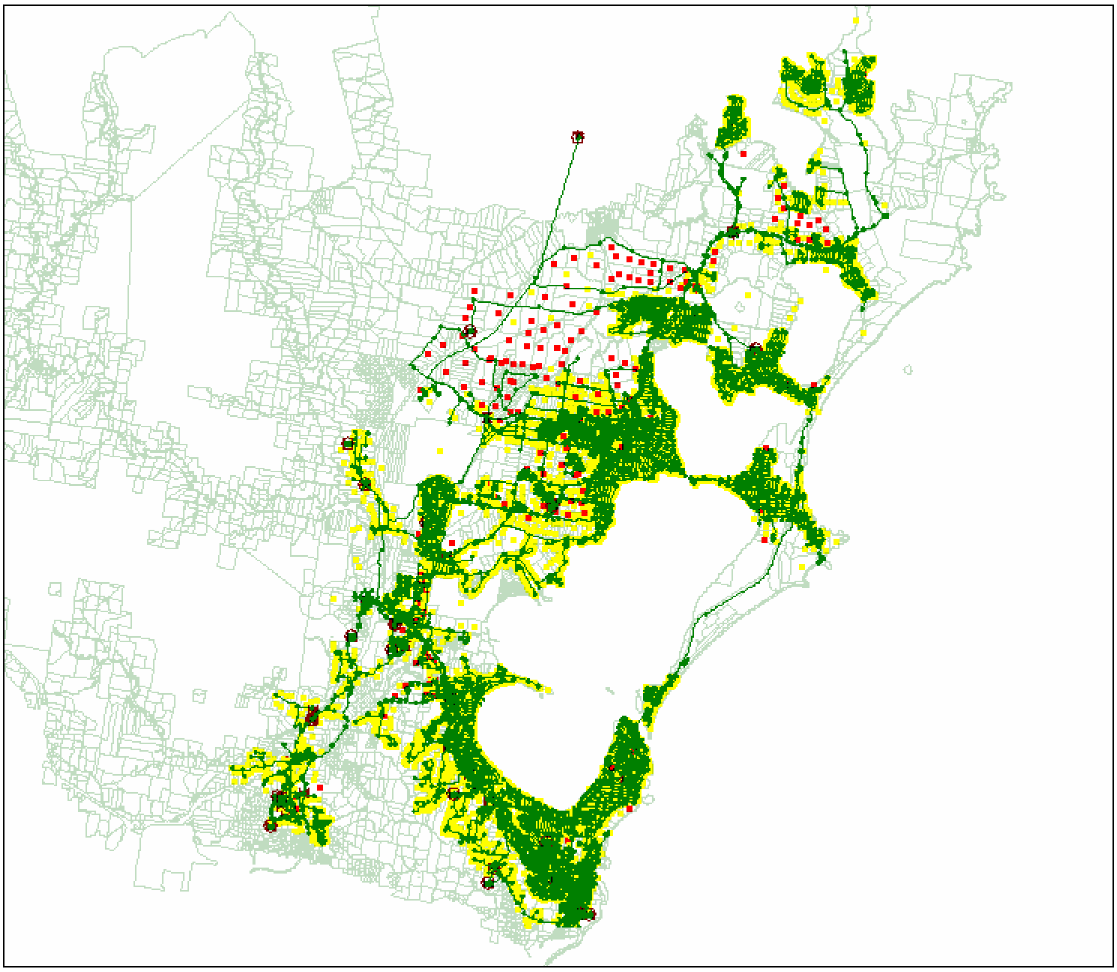
Kiar Ridge Reservoir to Warnervale High Level Zone

2031 SIMULATION RESULTS

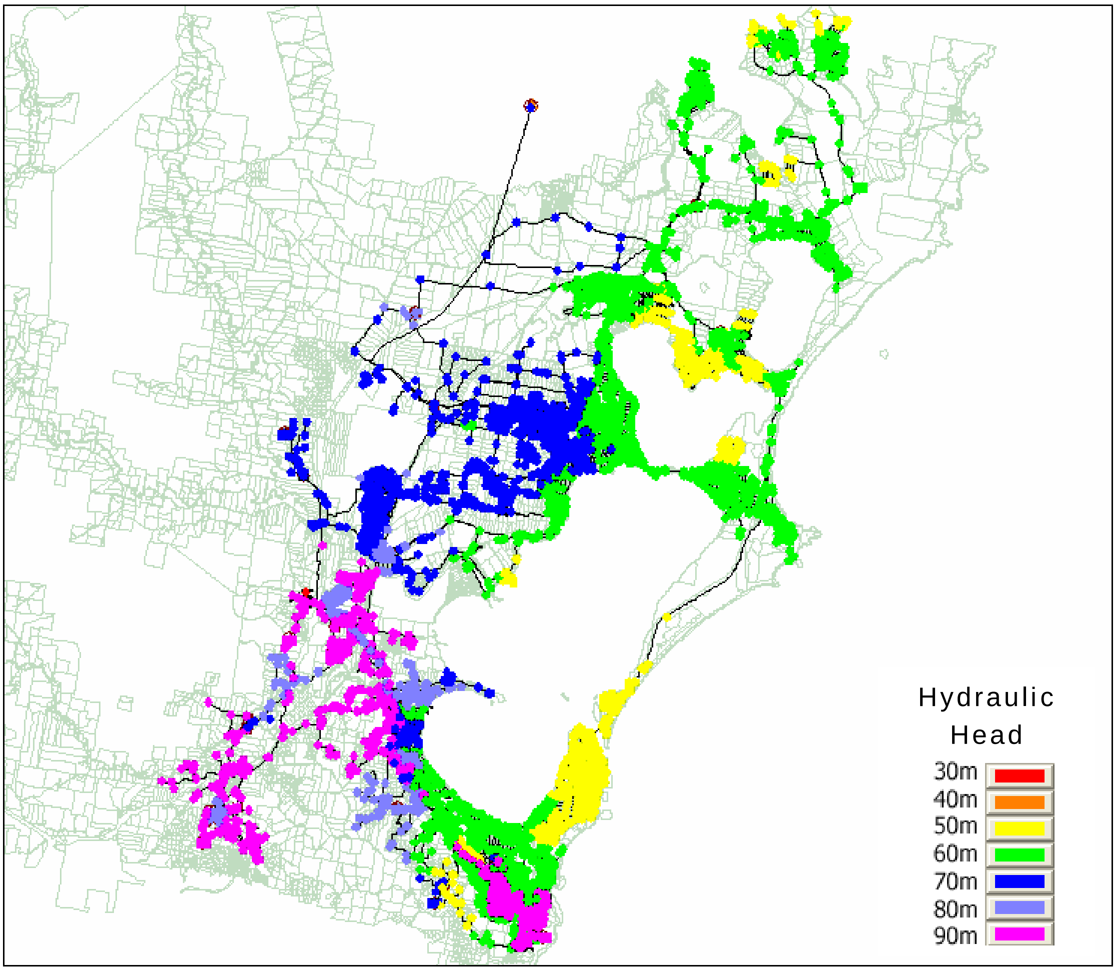
Minimum Residual Pressures



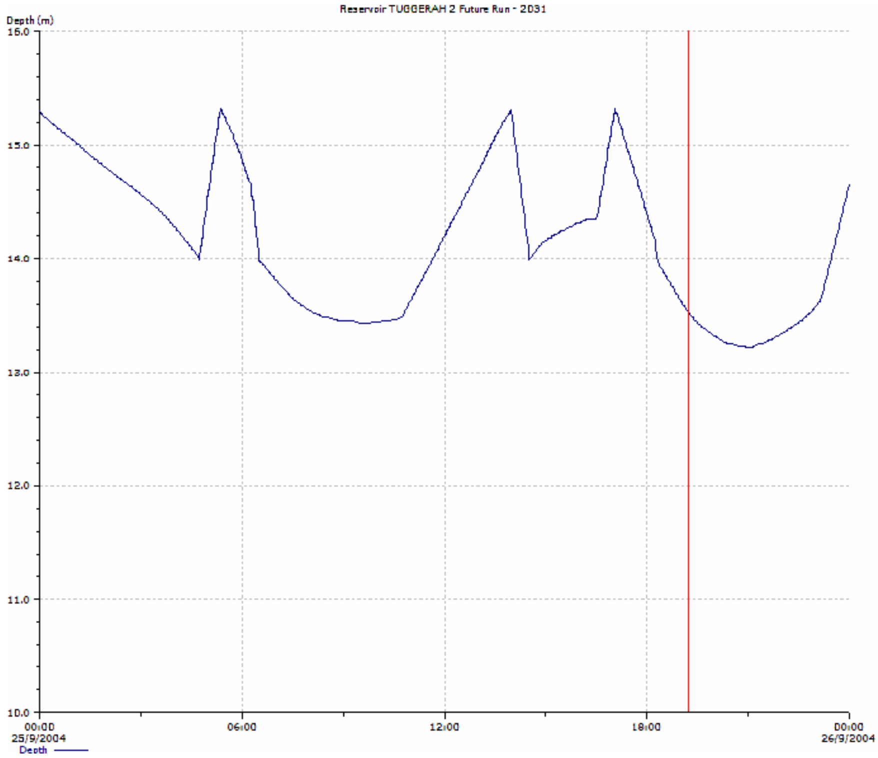
Customer Points

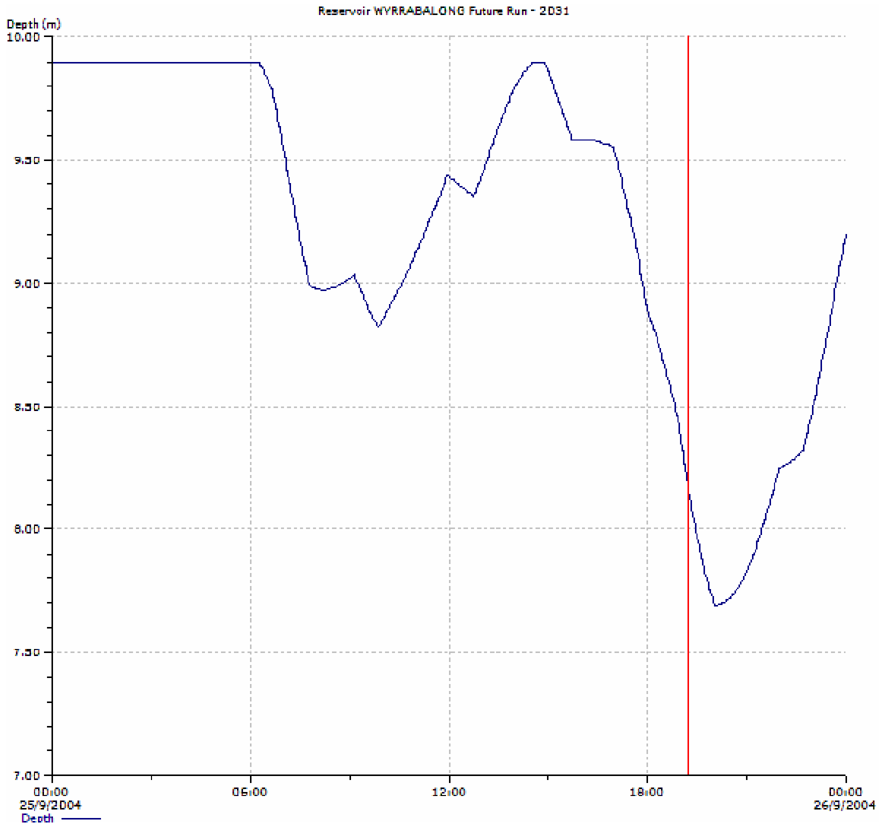


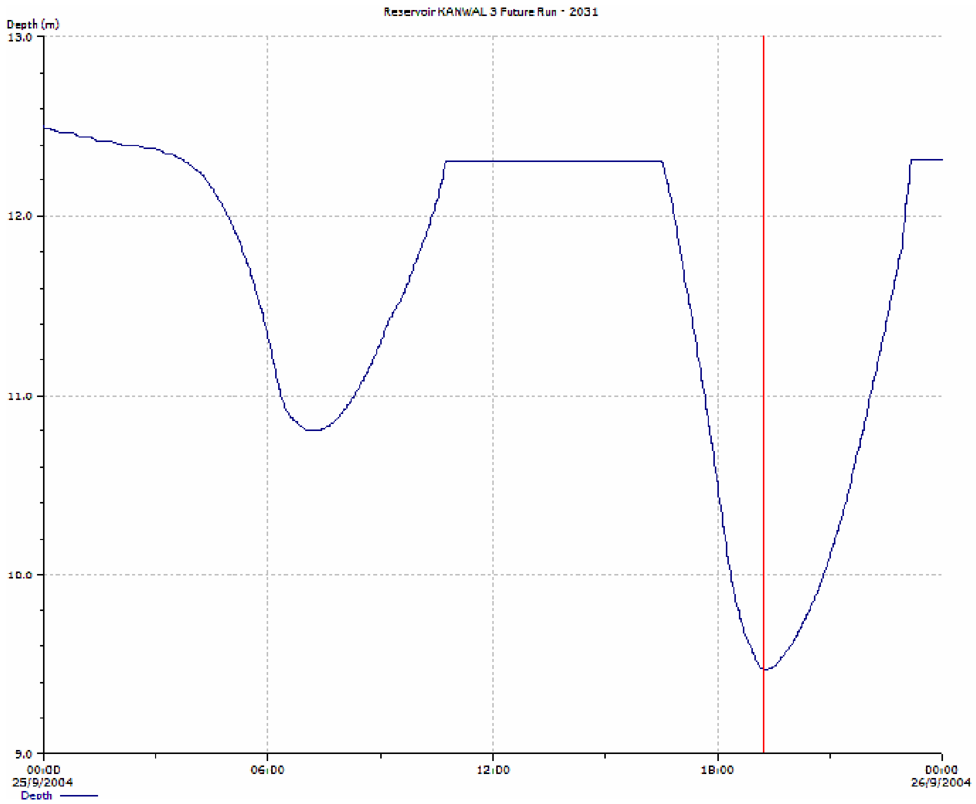
Simulated Head Conditions

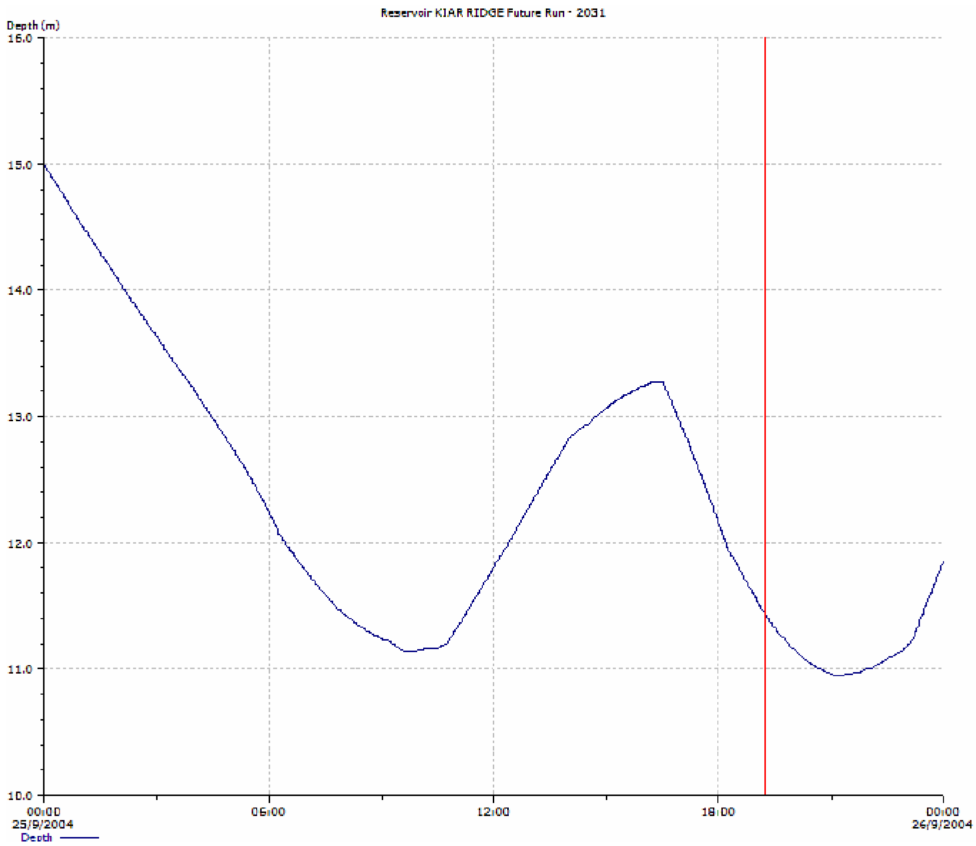


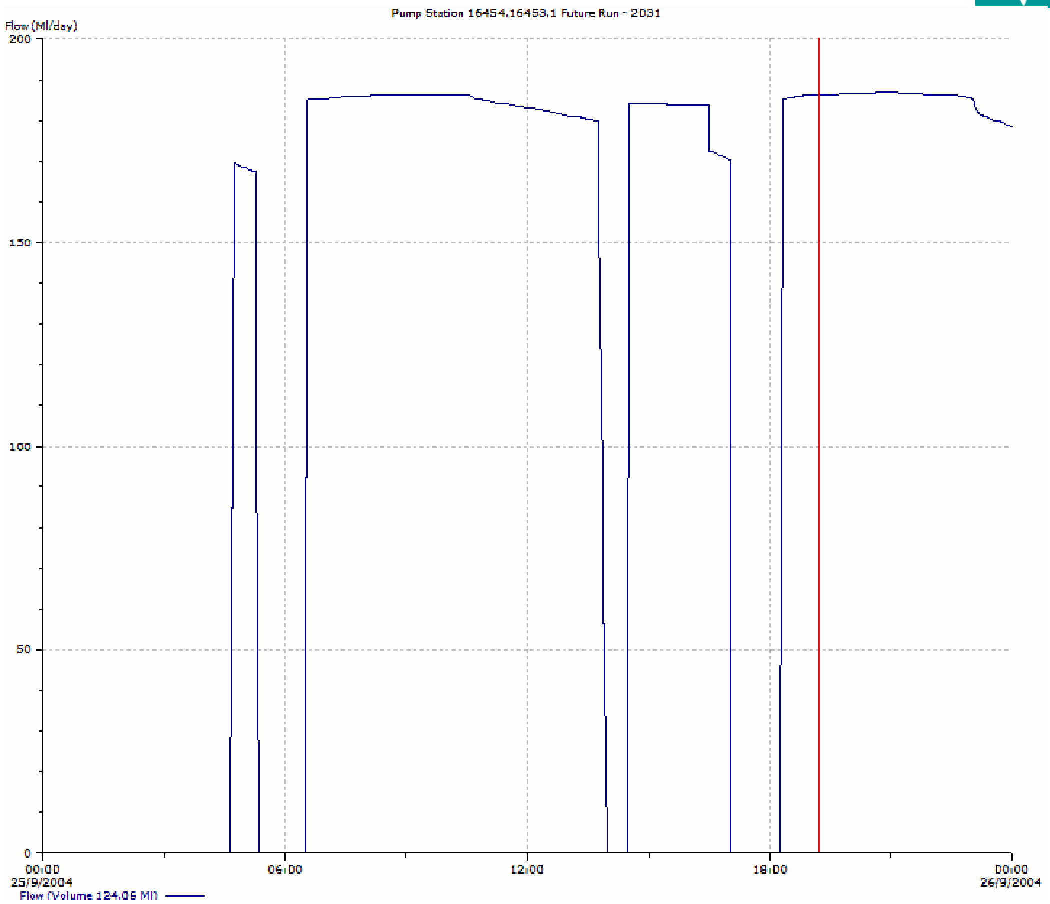
Reservoir Levels & MHLPS Performance



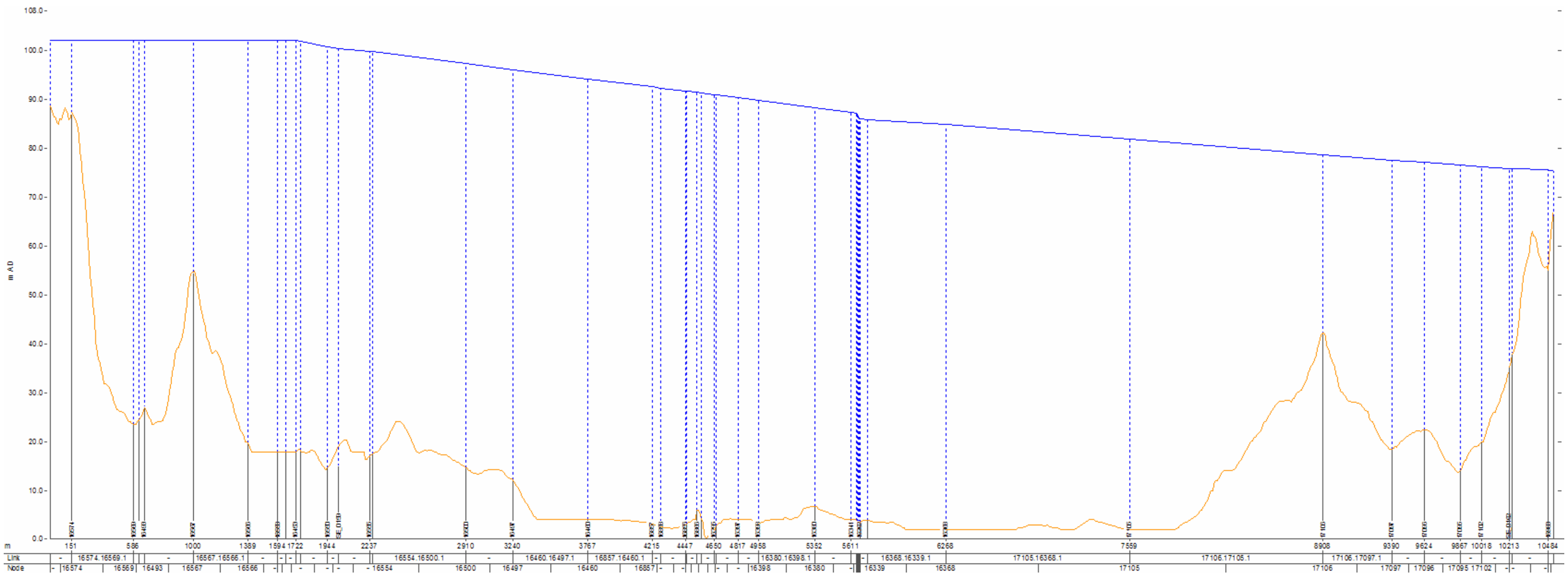



Reservoir KANWAL 3 Future Run - 2031
Depth (m)
13.0
12.0
11.0
10.0
9.0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Depth

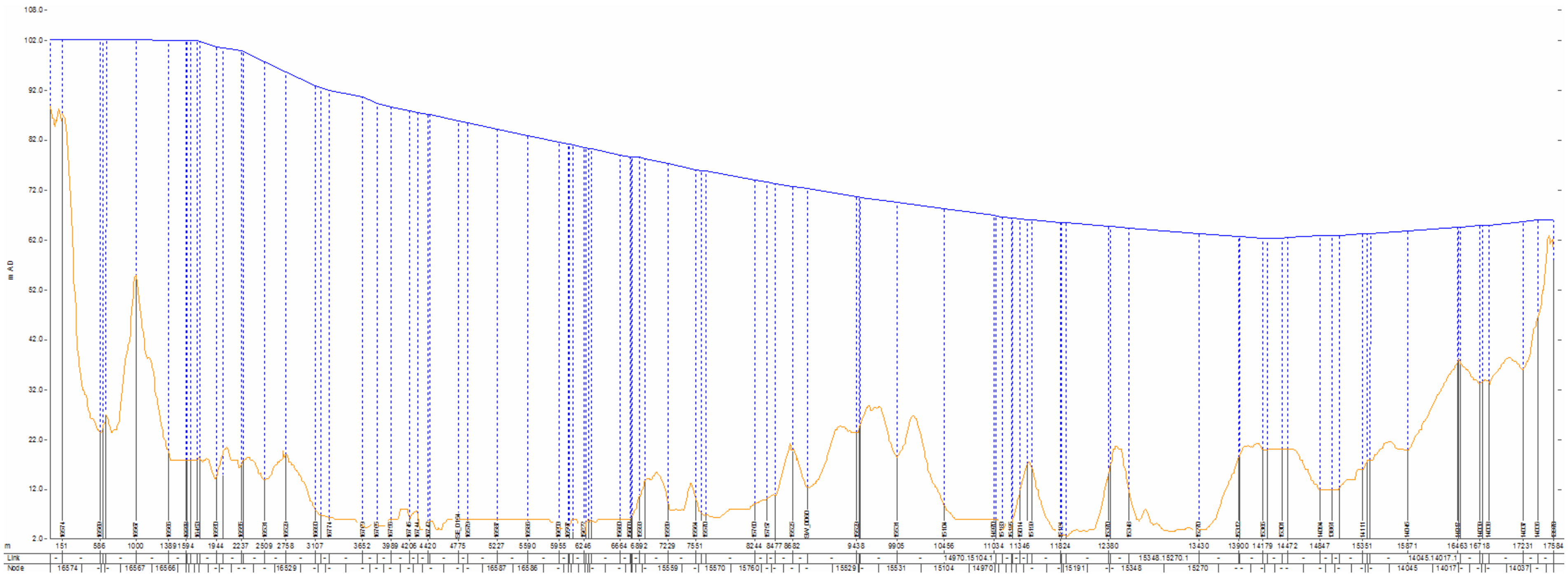

Reservoir KIAR RIDGE Future Run - 2031
Depth (m)
16.0
15.0
14.0
13.0
12.0
11.0
10.0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Depth


Pump Station 16454.16453.1 Future Run - 2031
Flow (Ml/day)
200
150
100
50
0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Flow (Volume 124.06 Ml)

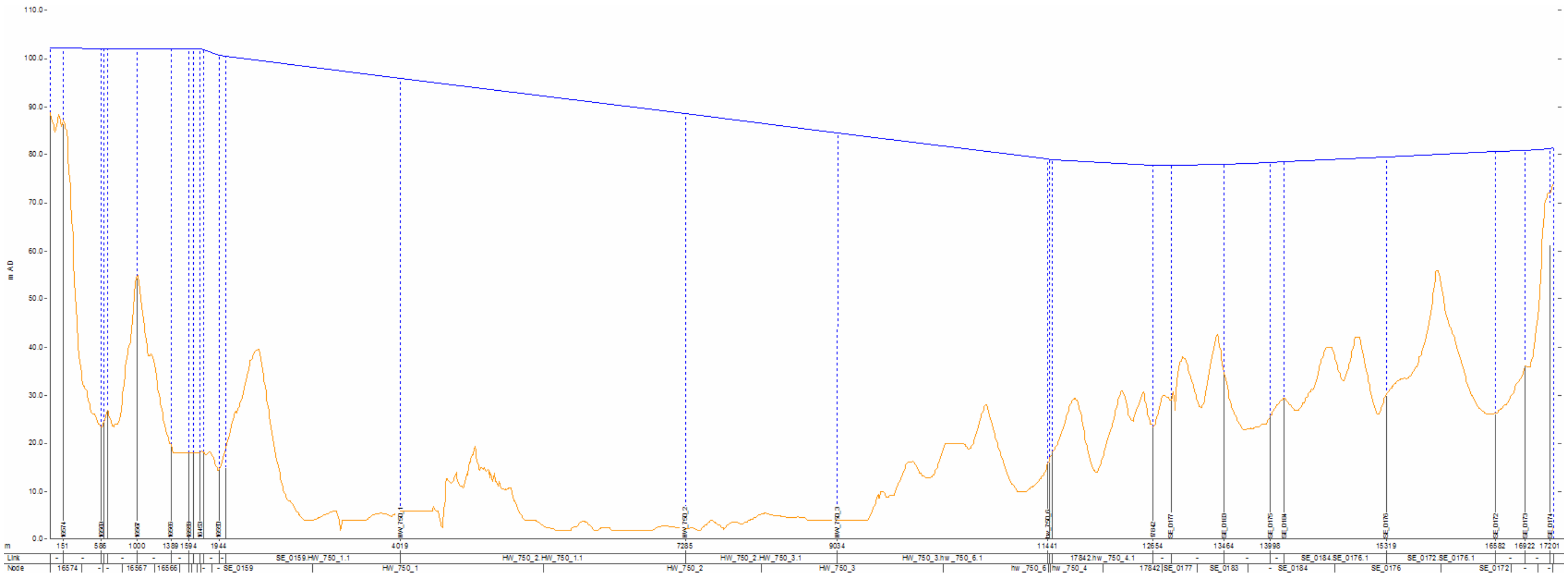
System Hydraulic Grade Lines (HGLs)



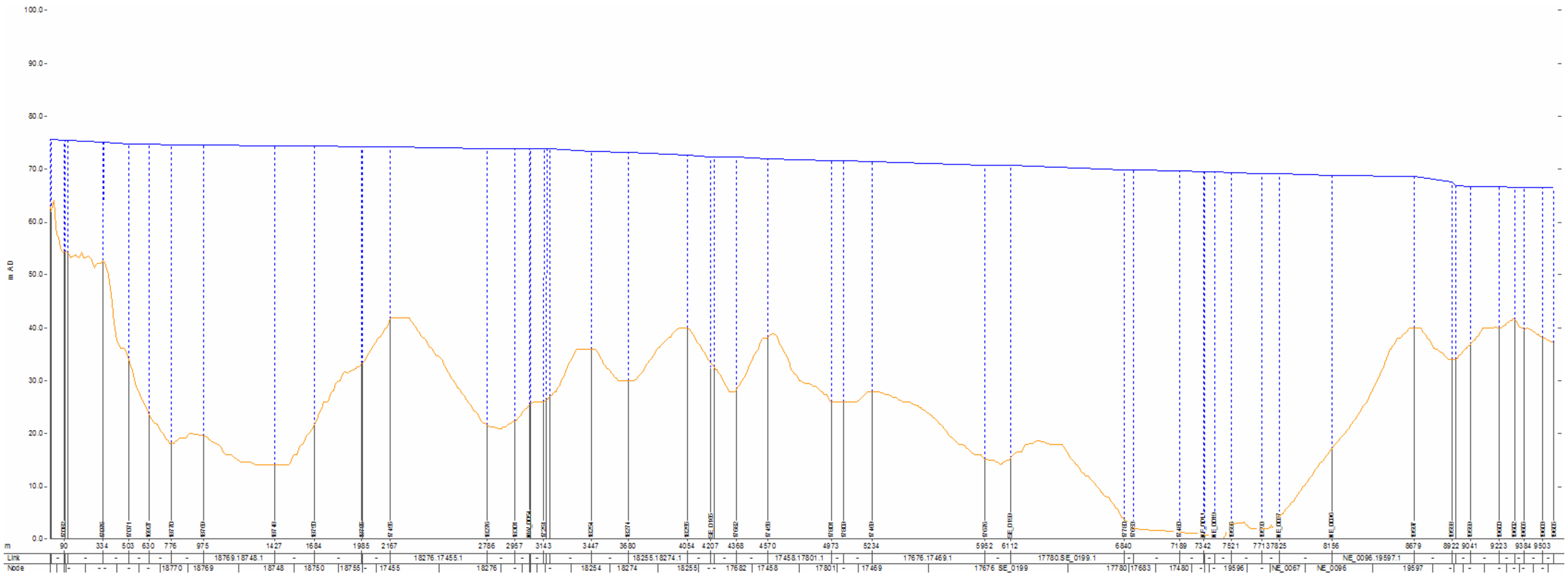
Tuggerah 2 Reservoir to Kanwal Reservoirs



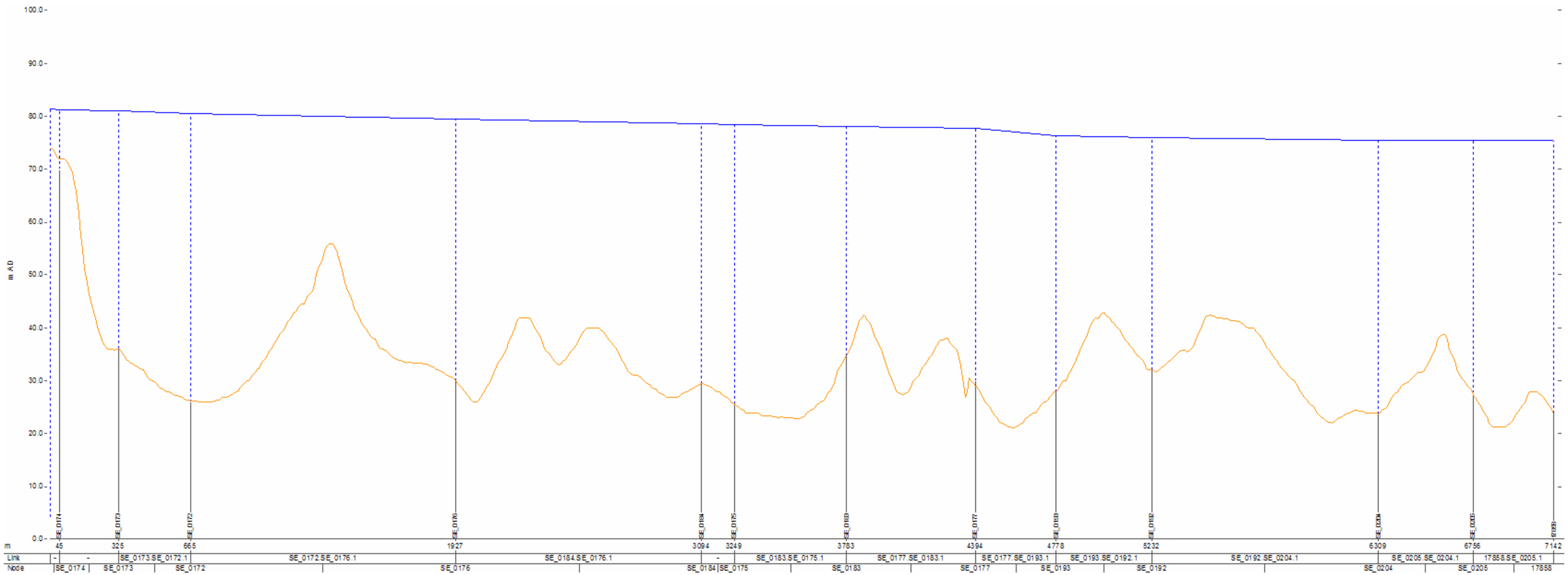
Tuggerah 2 Reservoir to Wyrrabalong Reservoir



Tuggerah 2 Reservoir to Kiar Ridge Reservoir



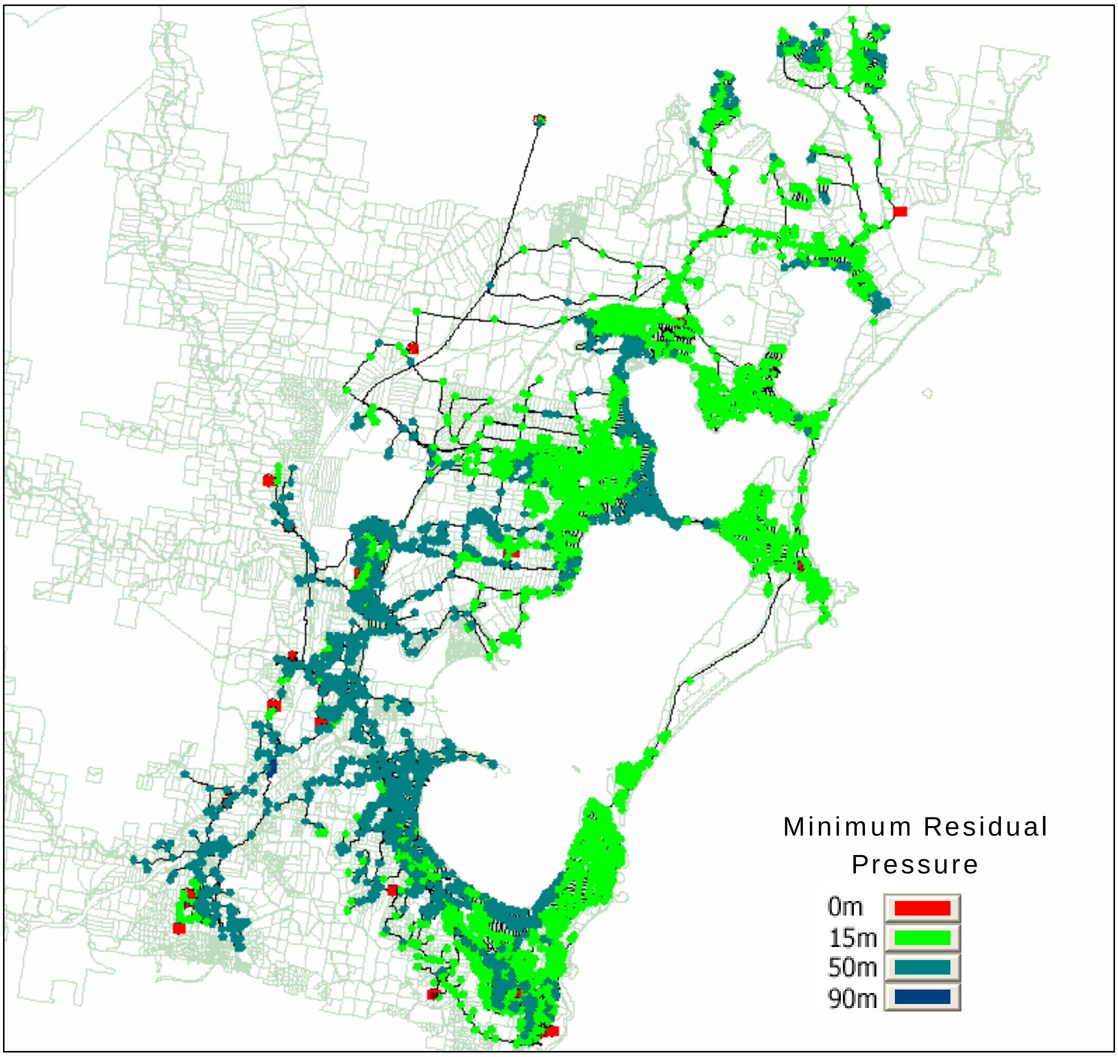
Kanwal Reservoirs to Bluehaven Area



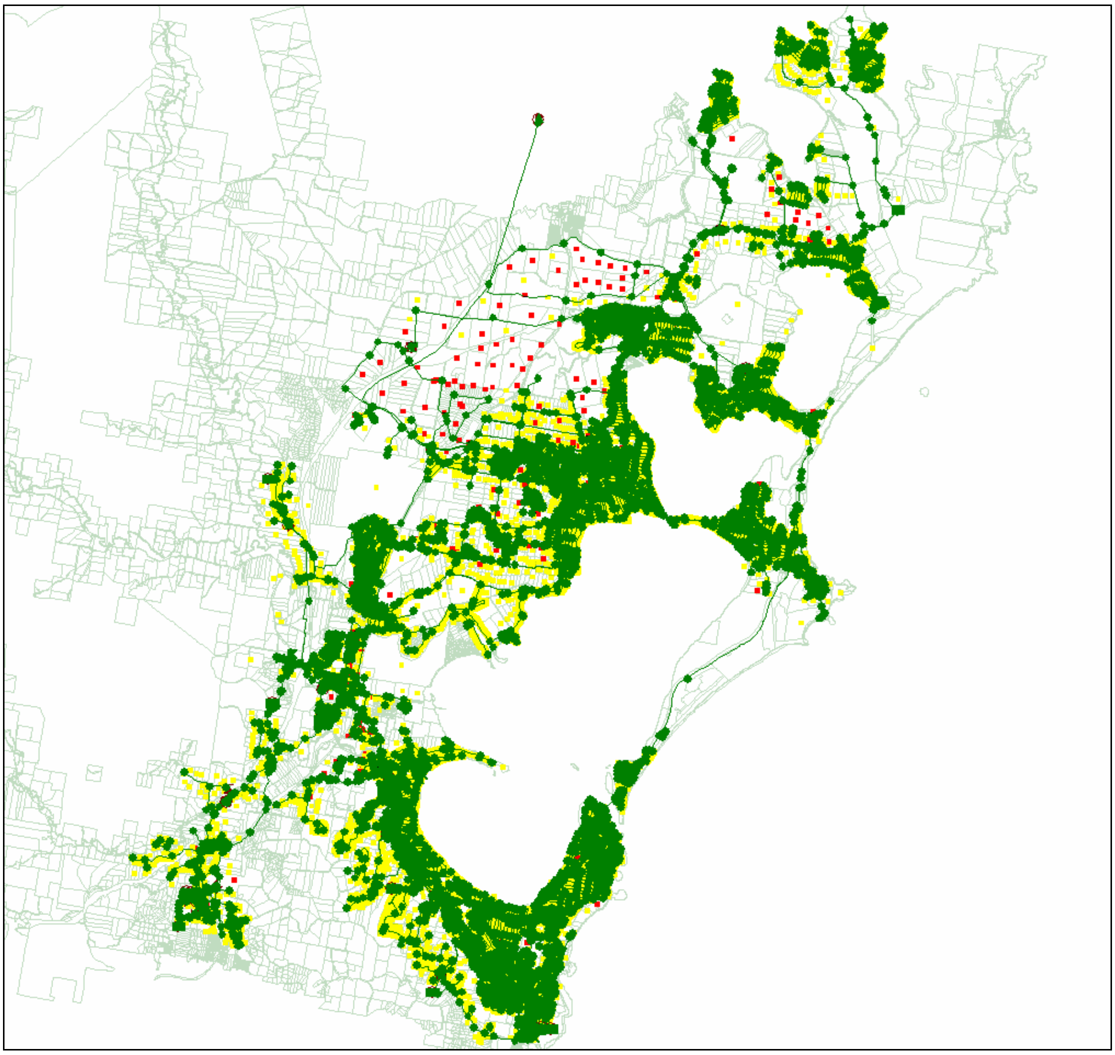
Kiar Ridge Reservoir to Warnervale High Level Zone

2036 Simulation Results

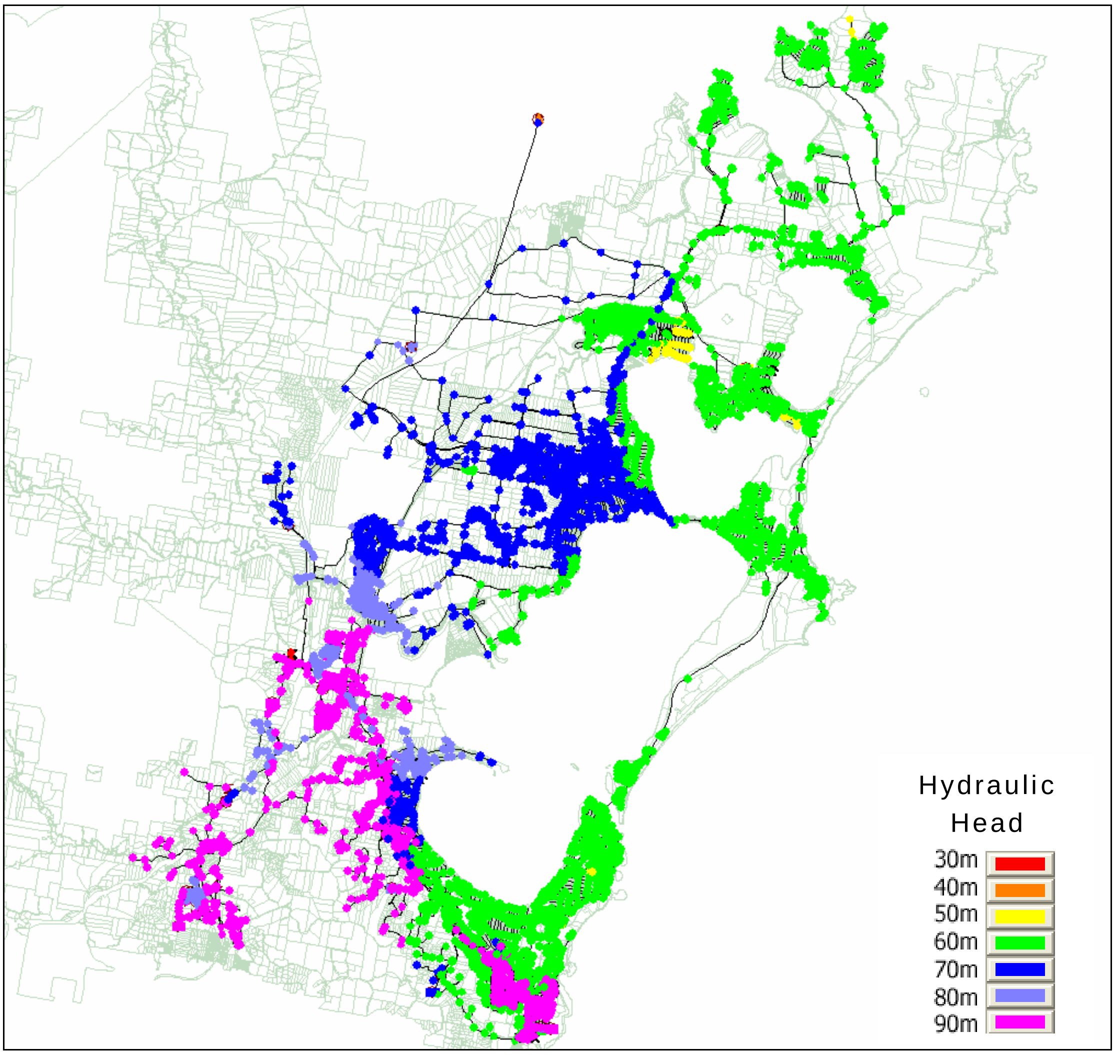
Minimum Residual Pressures



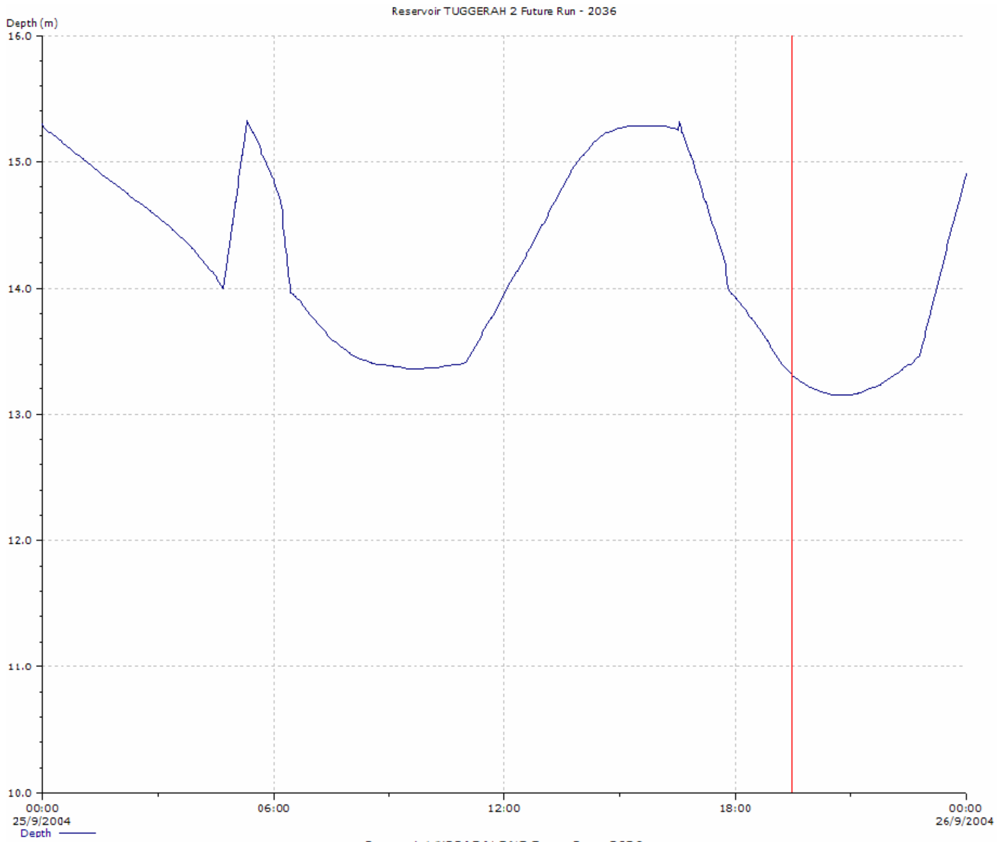
Customer Points

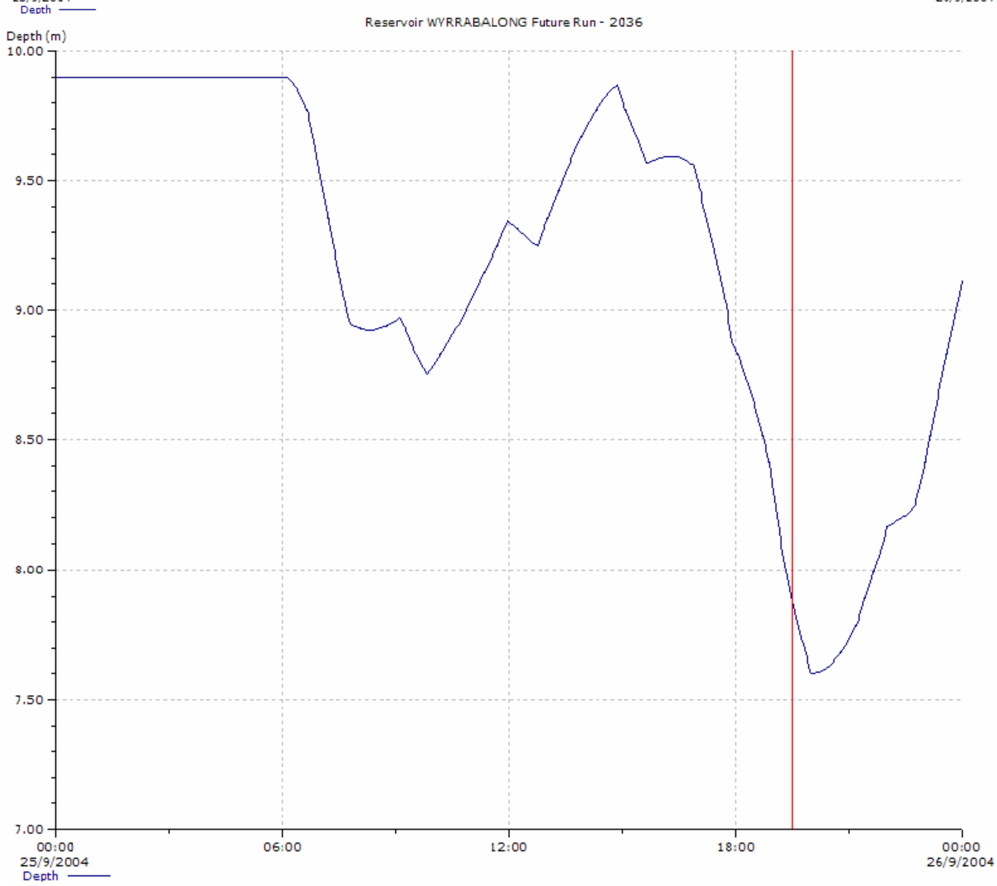


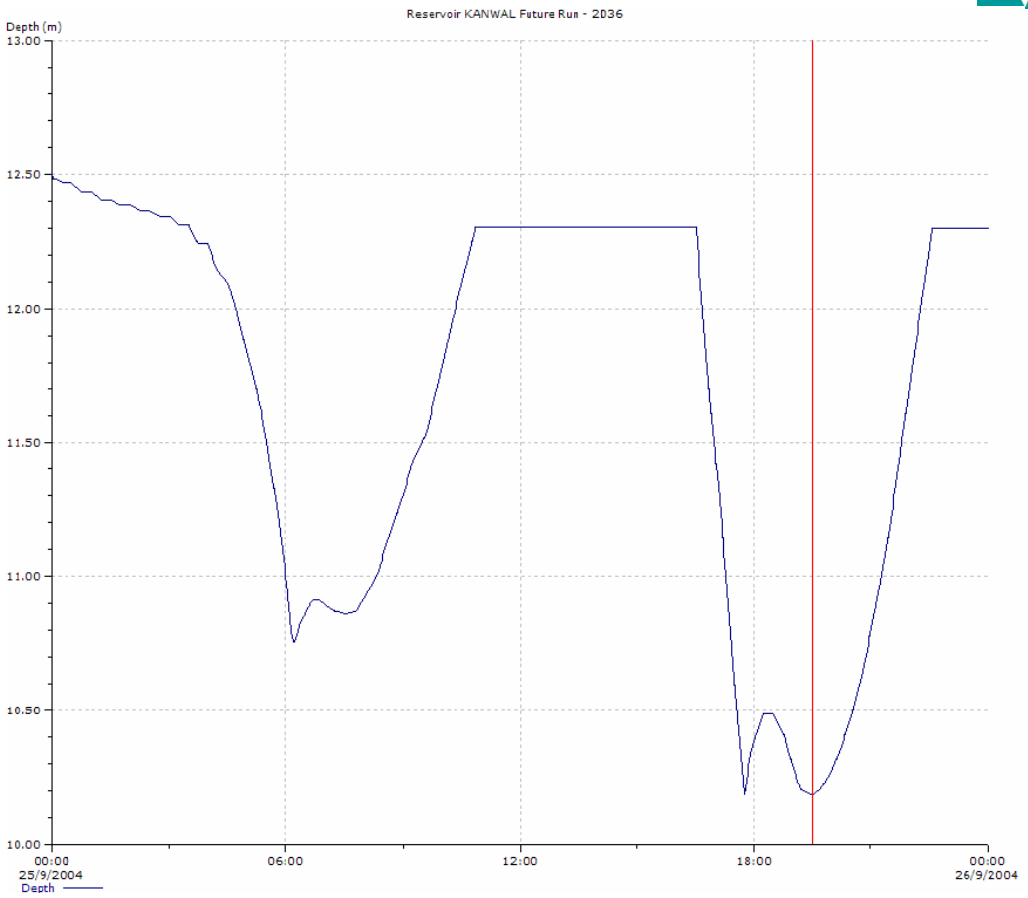
Simulated Head Conditions

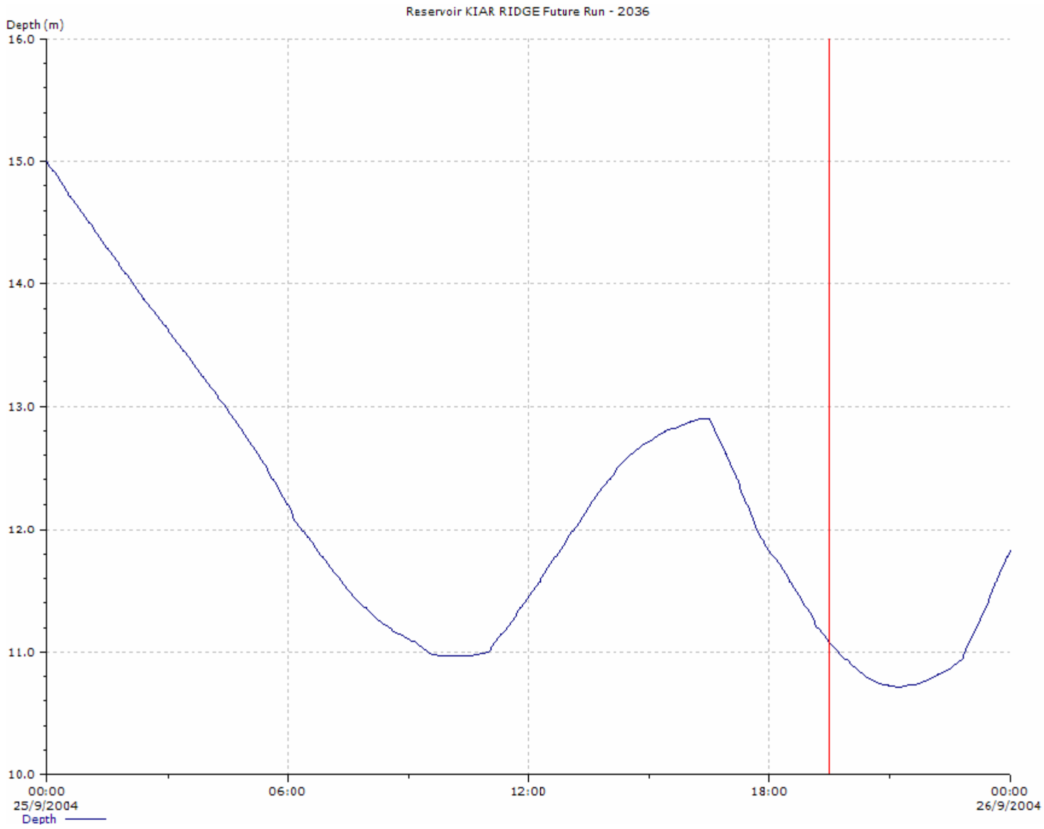


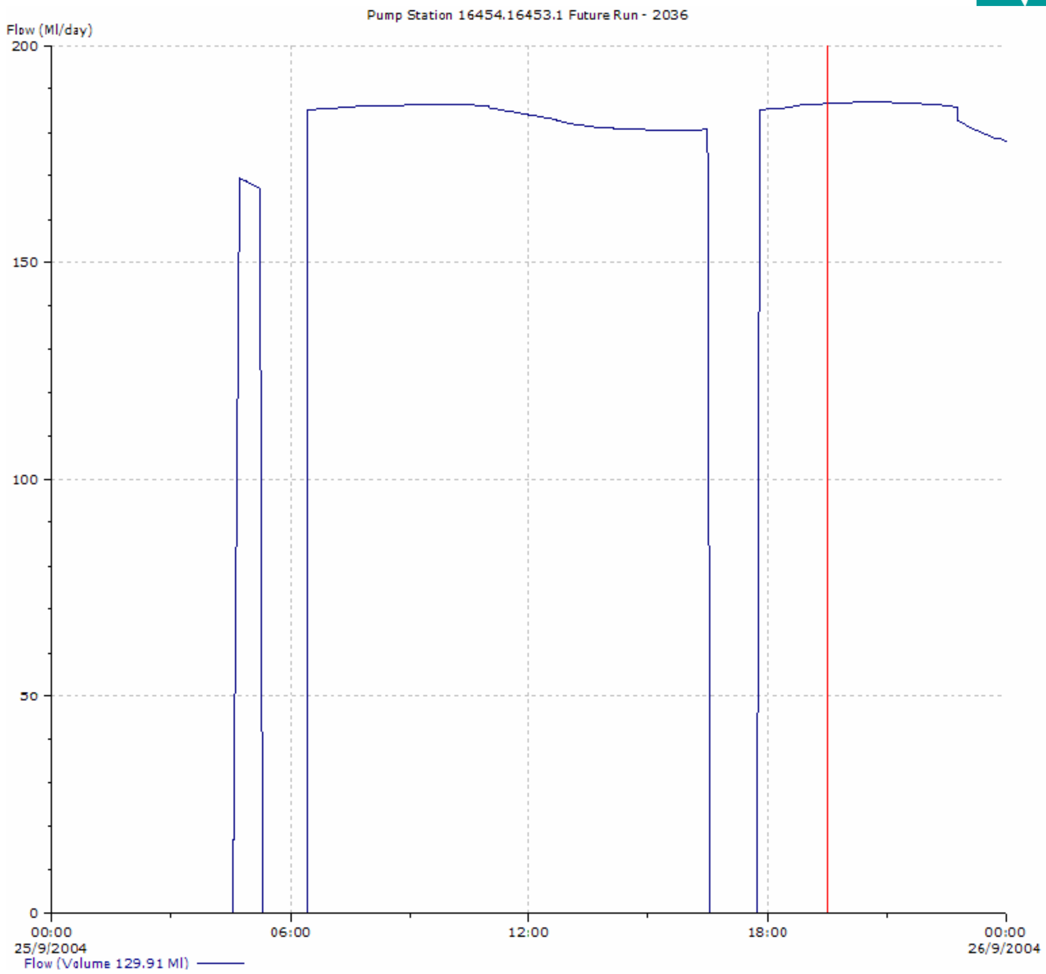
Reservoir Levels & MHLPS Performance





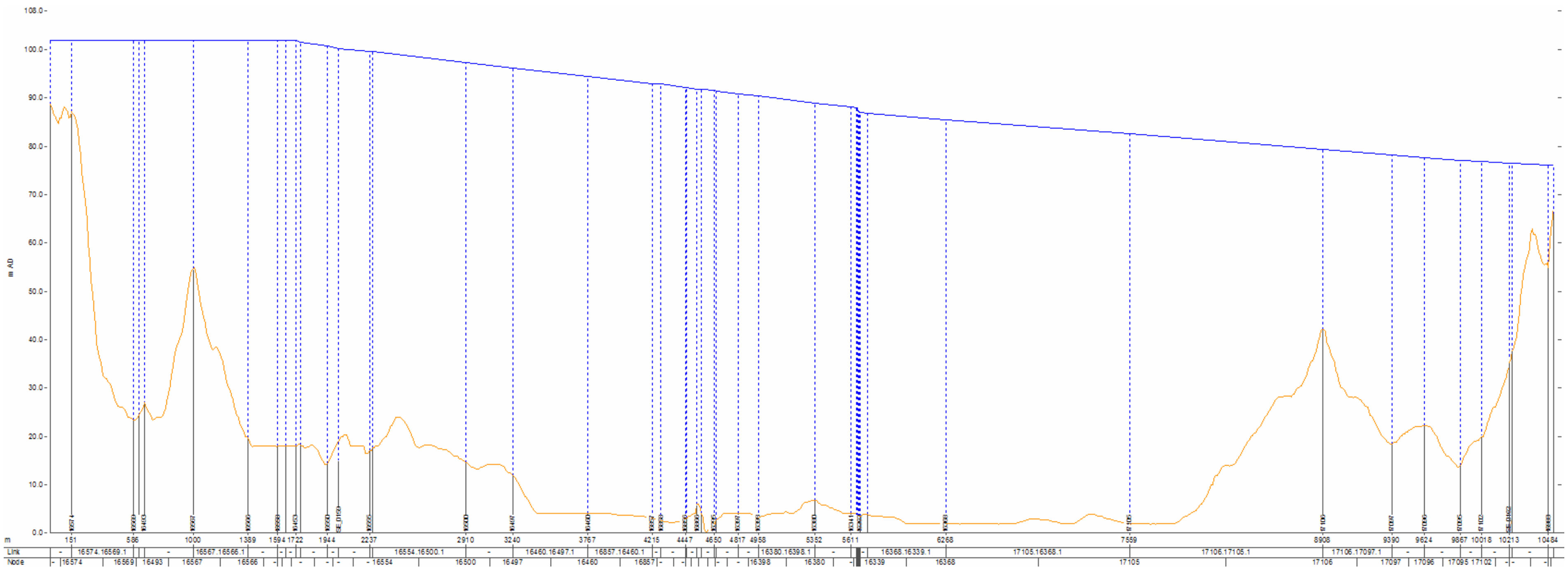

Reservoir KANWAL Future Run - 2036
Depth (m)
13.00
12.50
12.00
11.50
11.00
10.50
10.00
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Depth


Reservoir KIAR RIDGE Future Run - 2036
Depth (m)
16.0
15.0
14.0
13.0
12.0
11.0
10.0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Depth

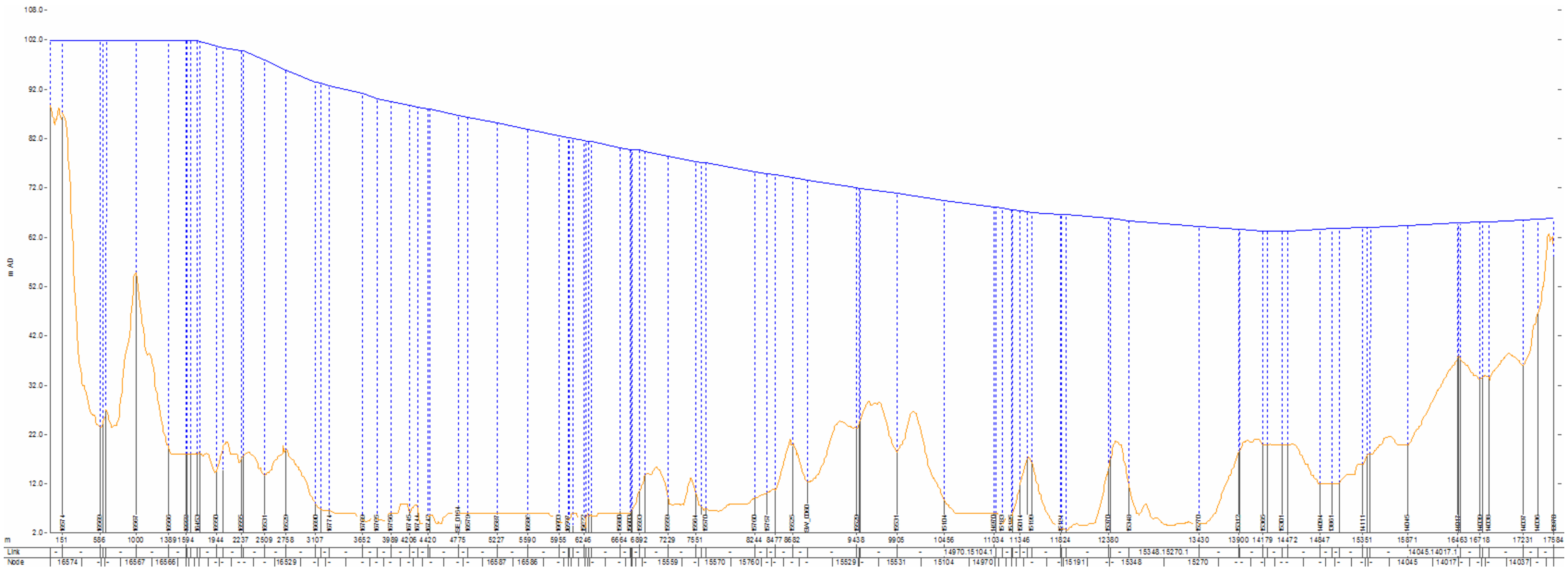


Pump Station 16454.16453.1 Future Run - 2036
Flow (Ml/day)
200
150
100
50
0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Flow (Volume 129.91 Ml)

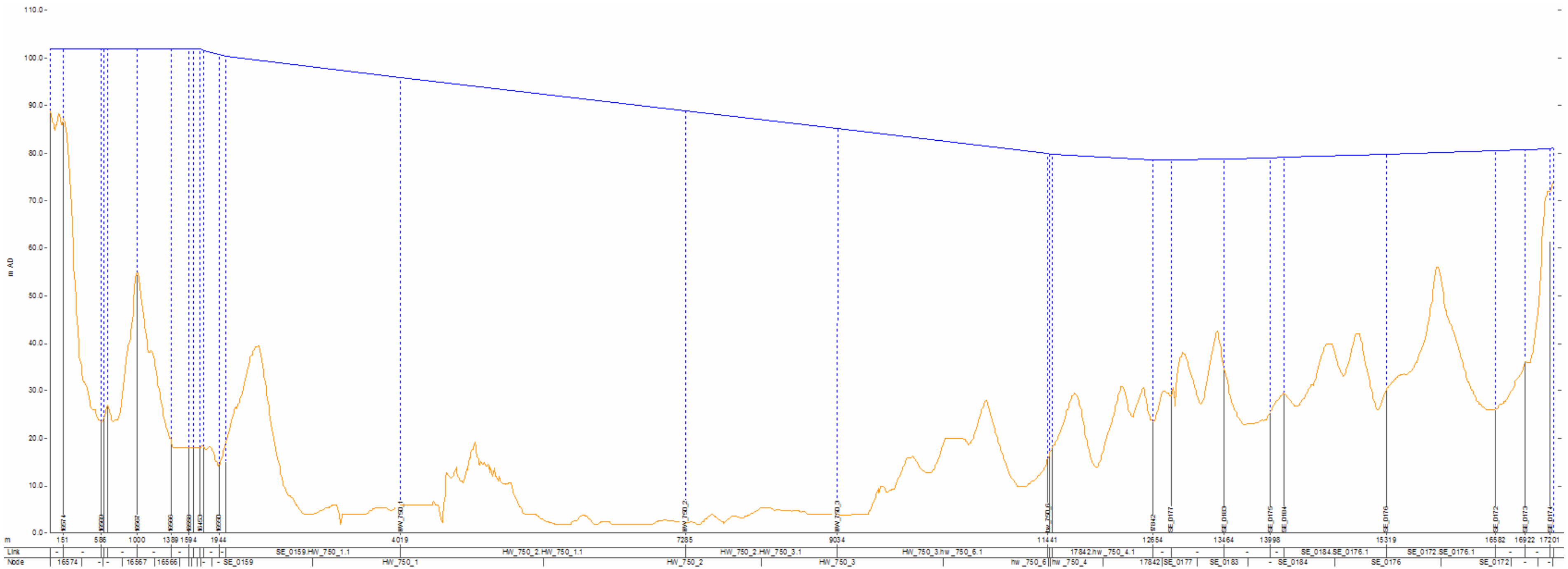
System Hydraulic Grade Lines (HGLs)



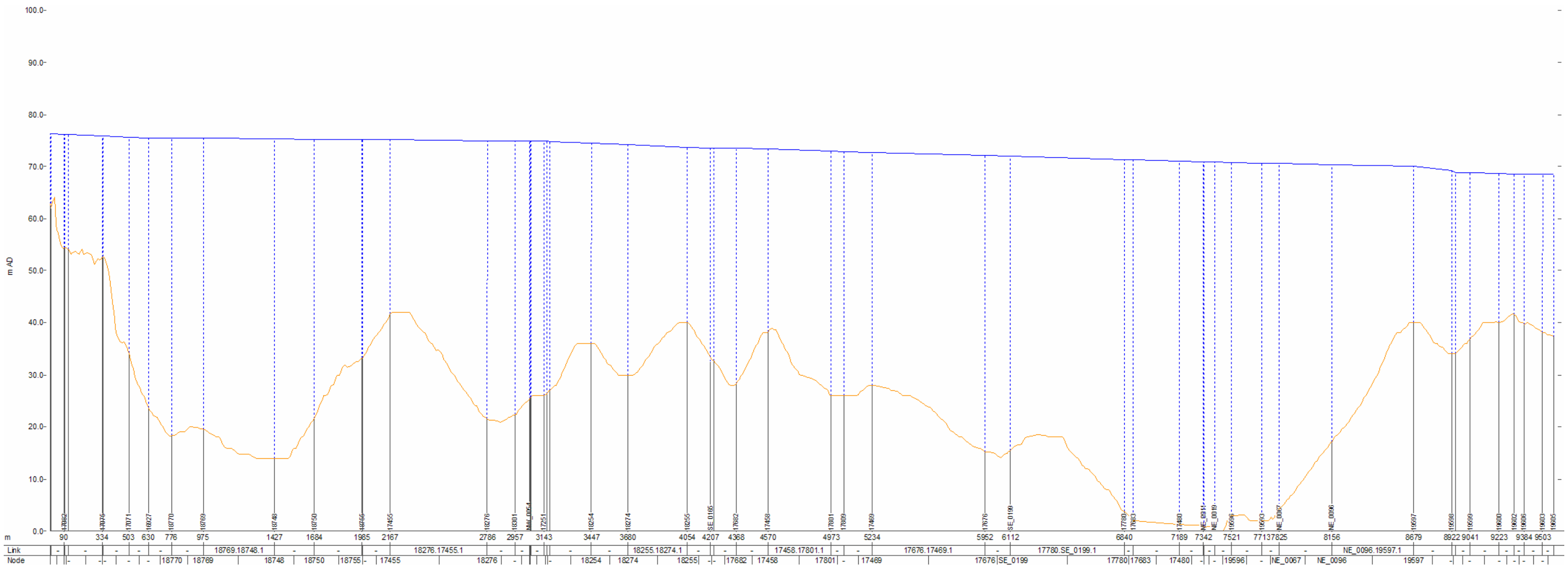
Tuggerah 2 Reservoir to Kanwal Reservoirs



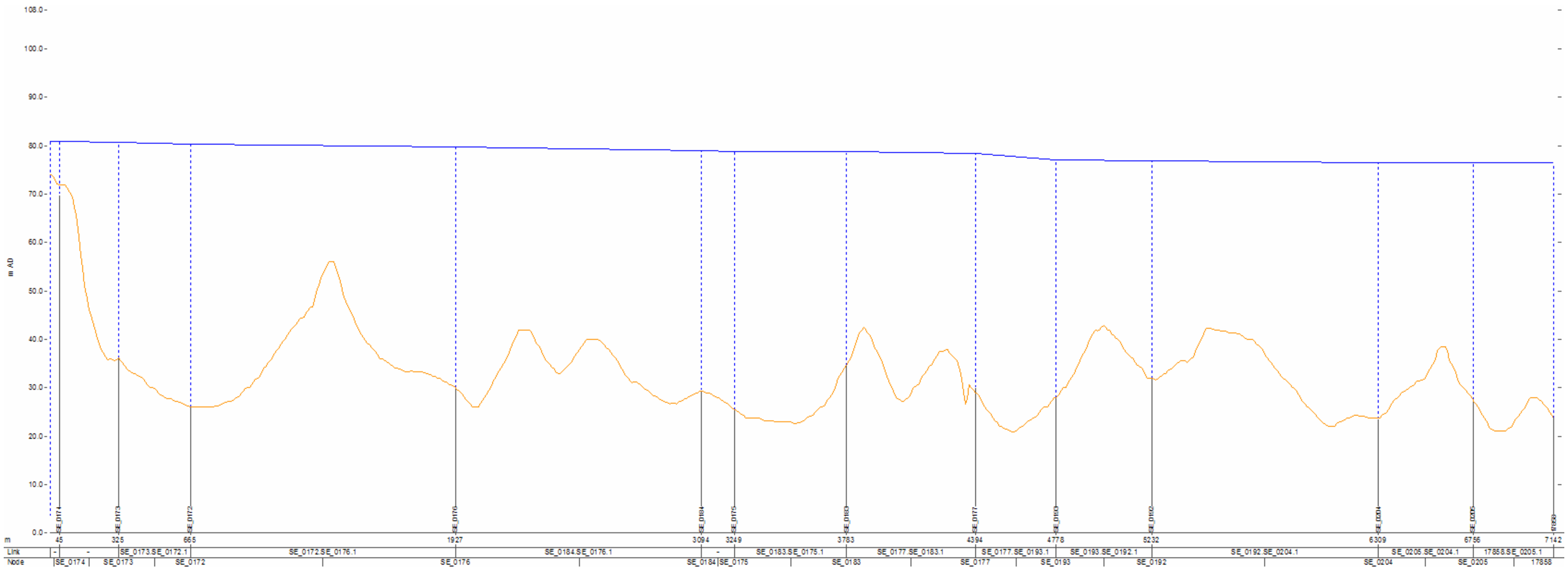
Tuggerah 2 Reservoir to Wyrrabalong Reservoir



Tuggerah 2 Reservoir to Kiar Ridge Reservoir



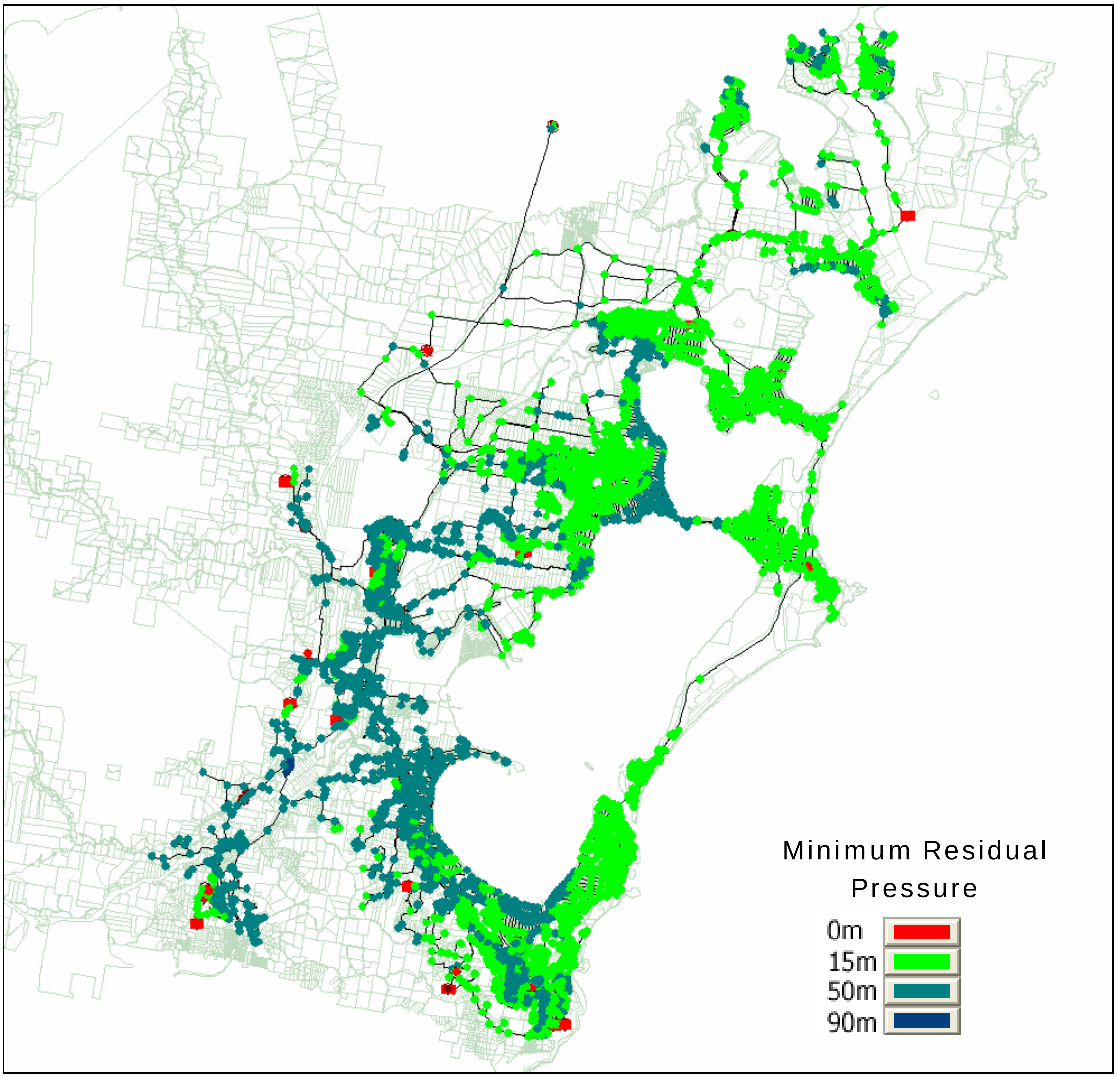
Kanwal Reservoirs to Bluehaven Area



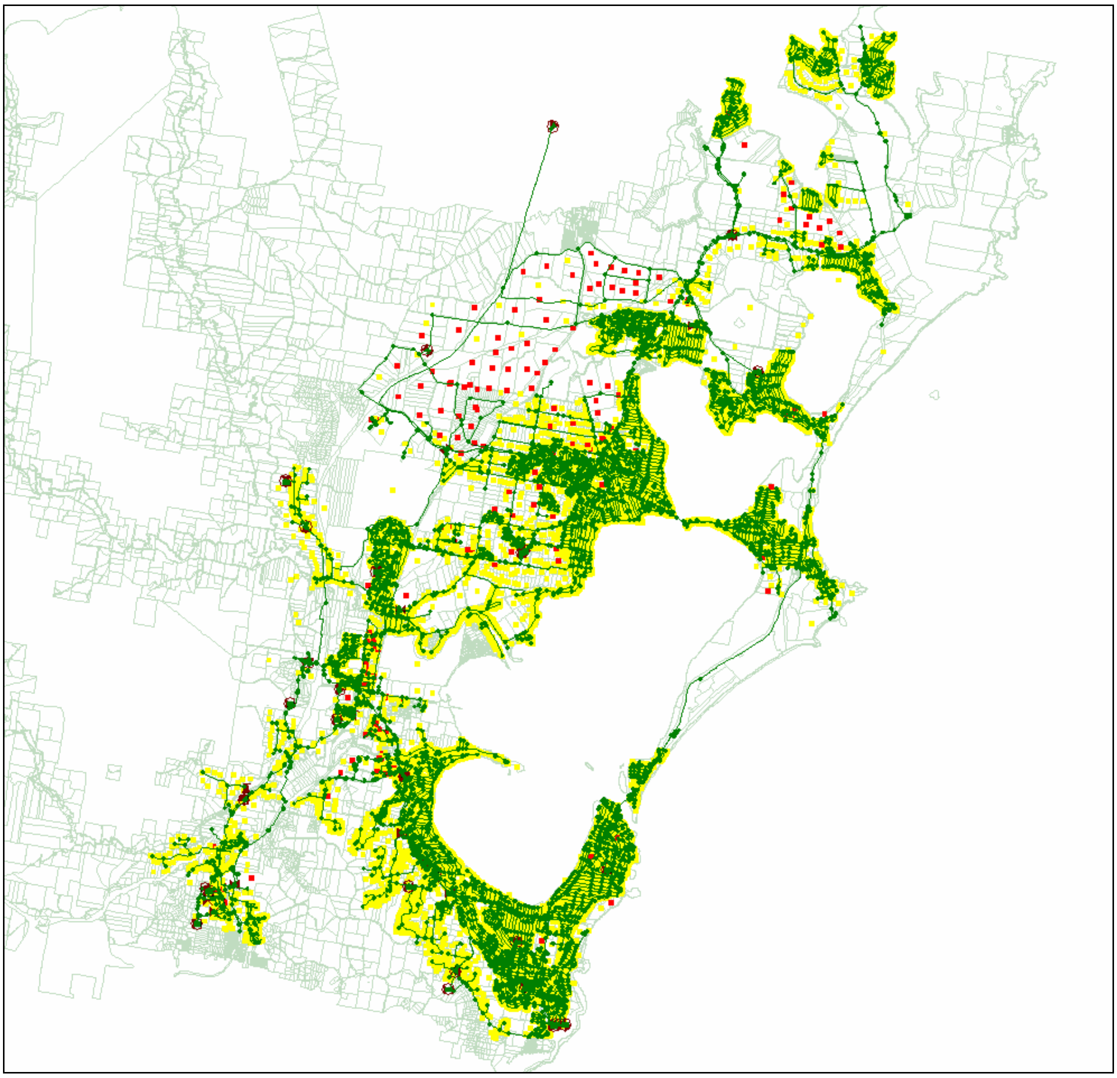
Kiar Ridge Reservoir to Warnervale High Level Zone

2041 Simulation Results

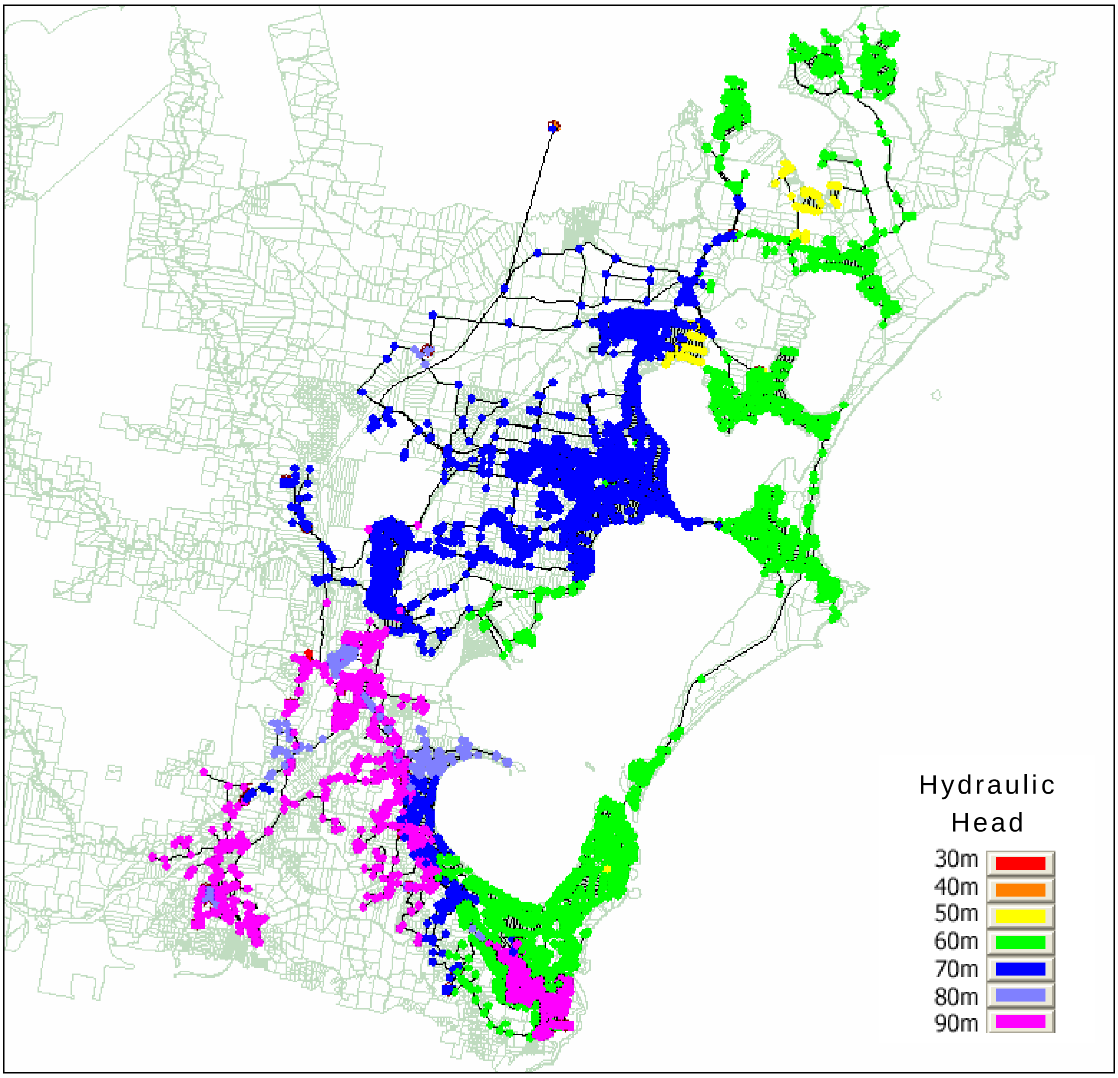
Minimum Residual Pressures



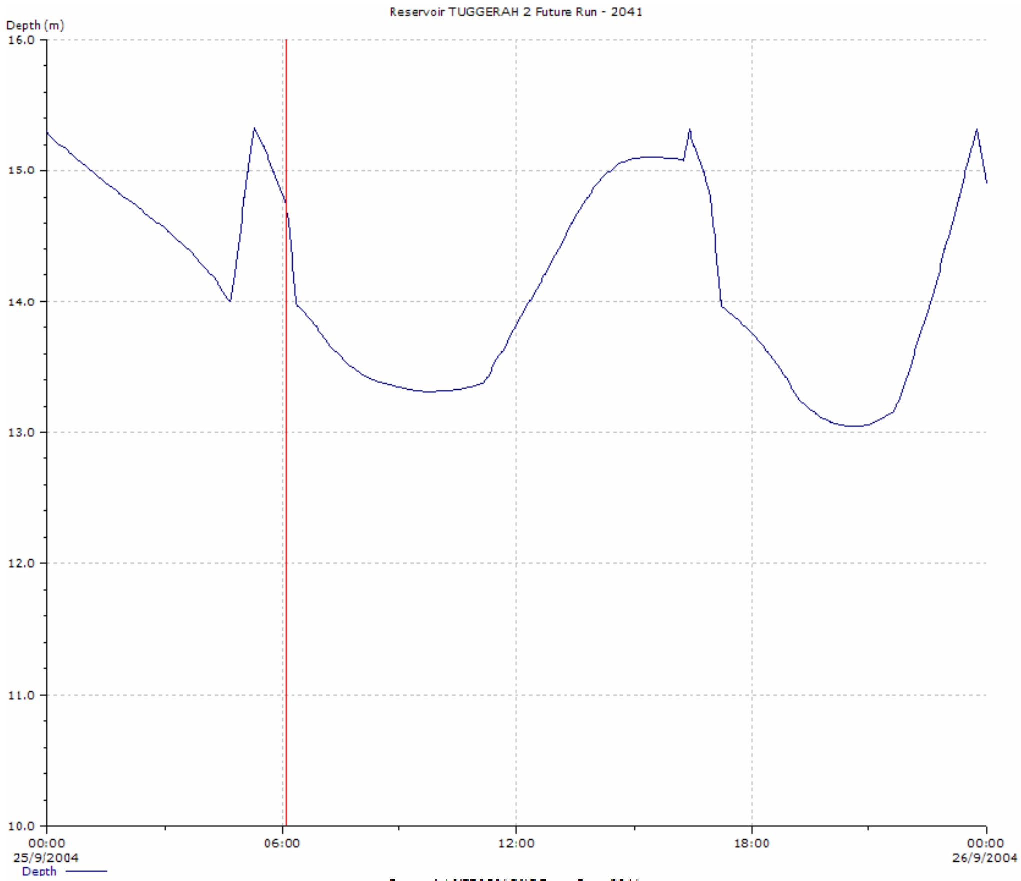
Customer Points

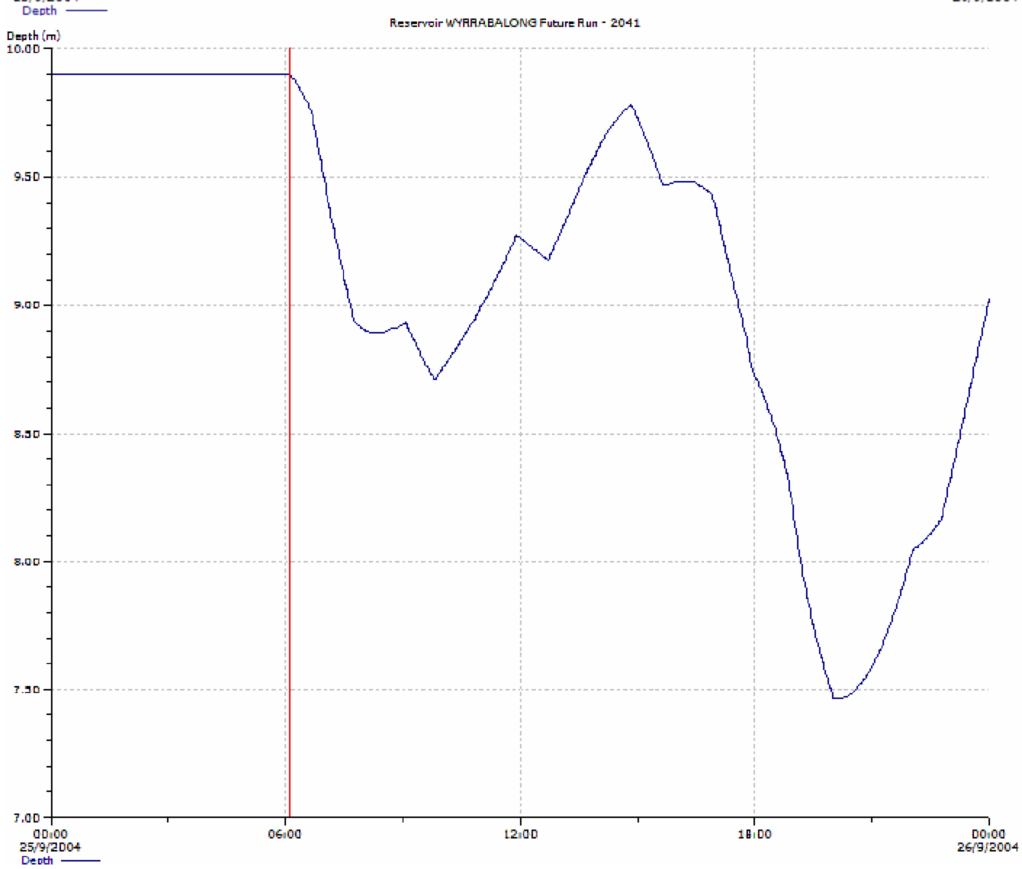


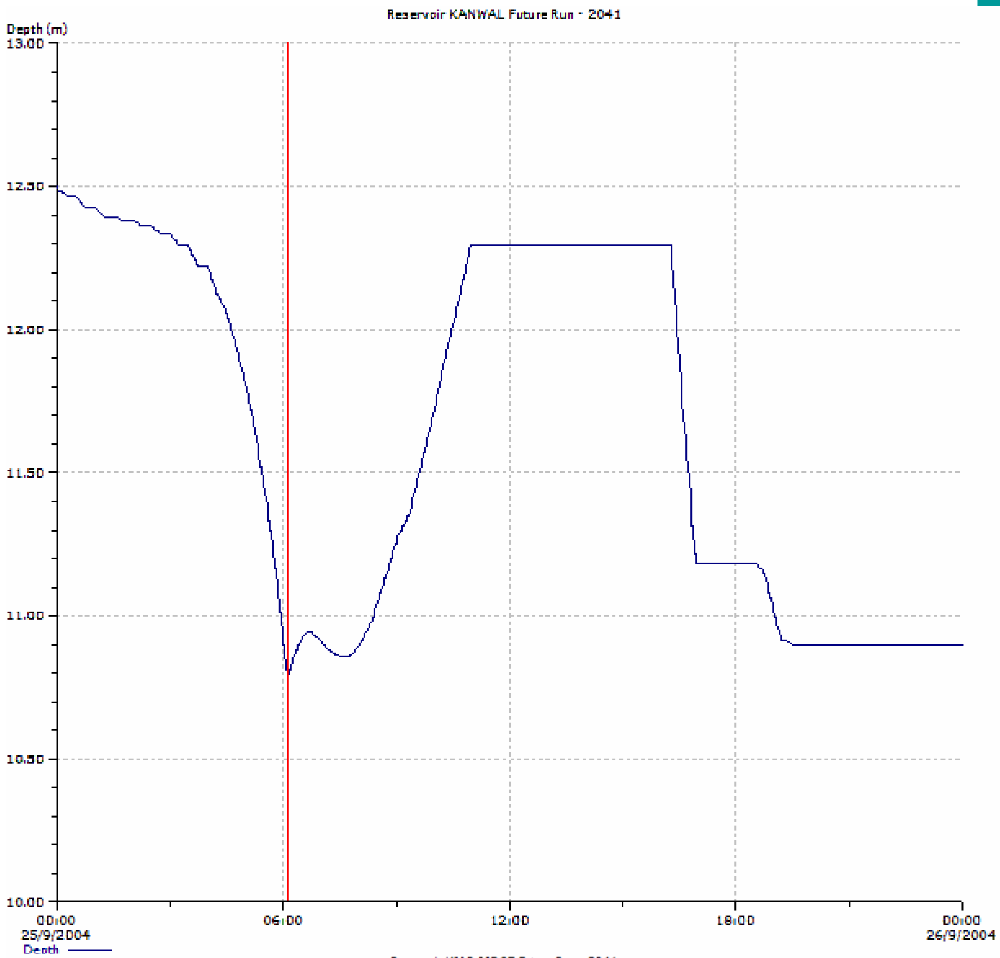
Simulated Head Conditions

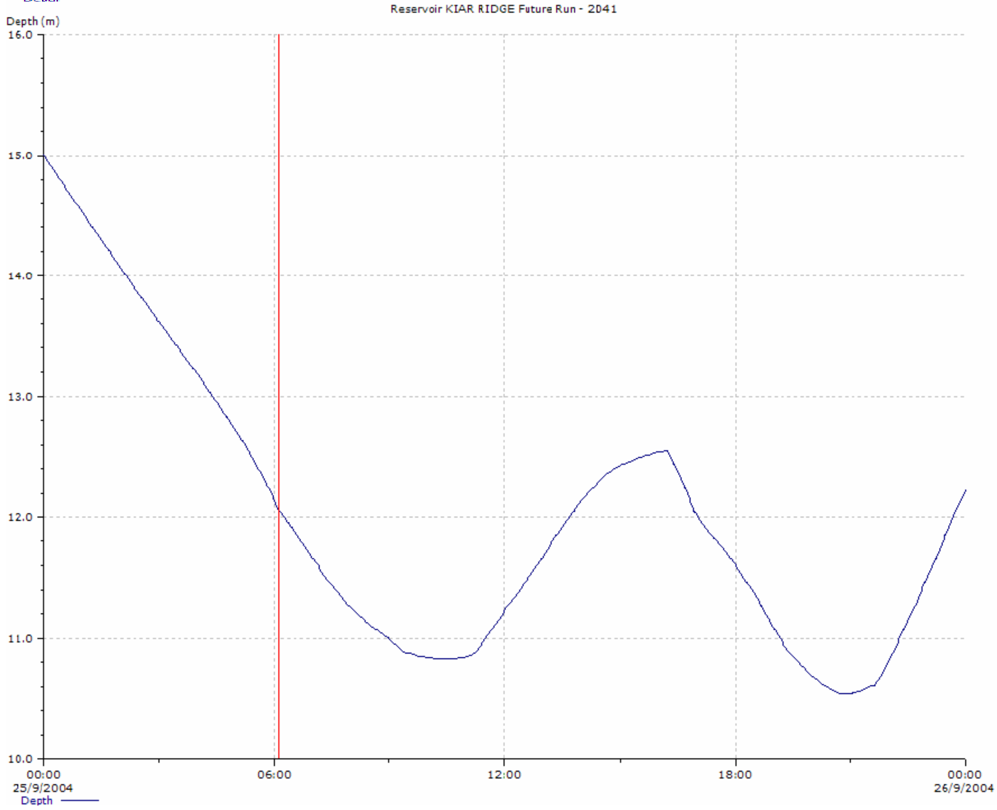


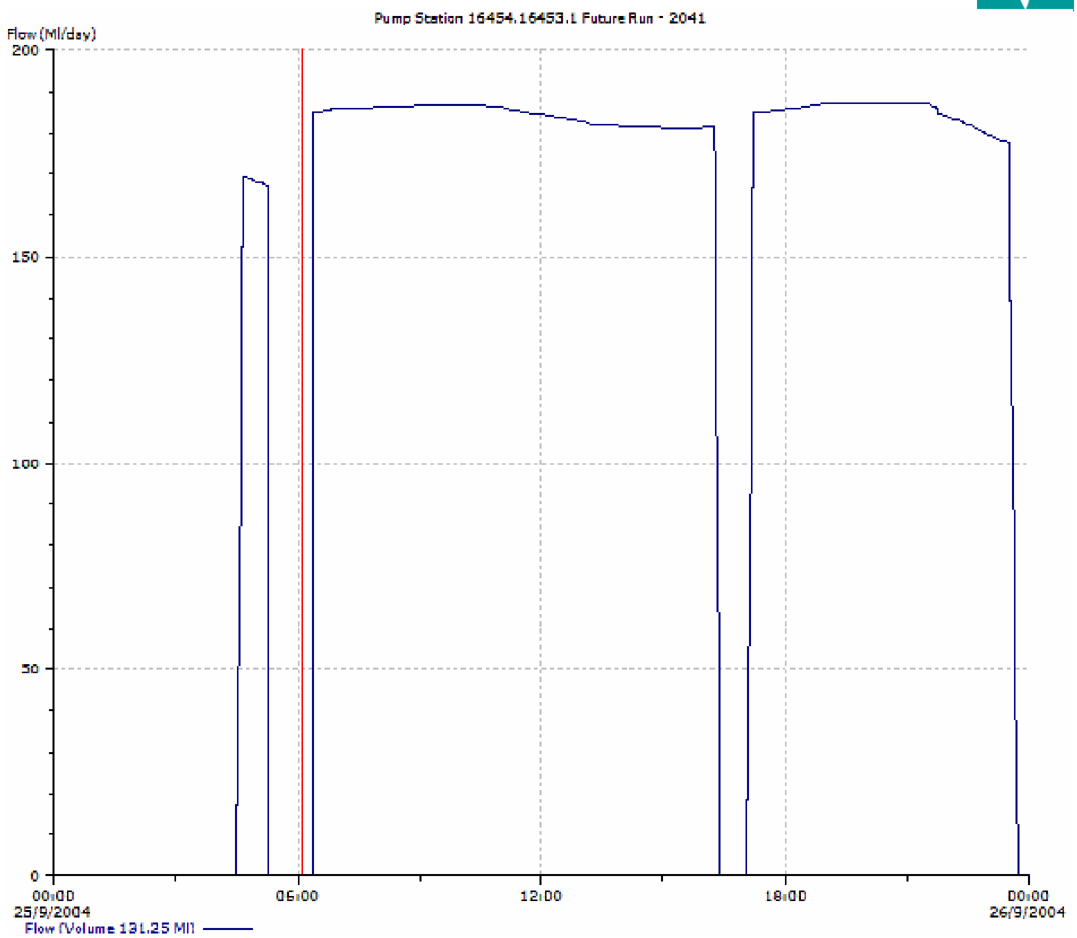
Reservoir Levels & MHLPS Performance



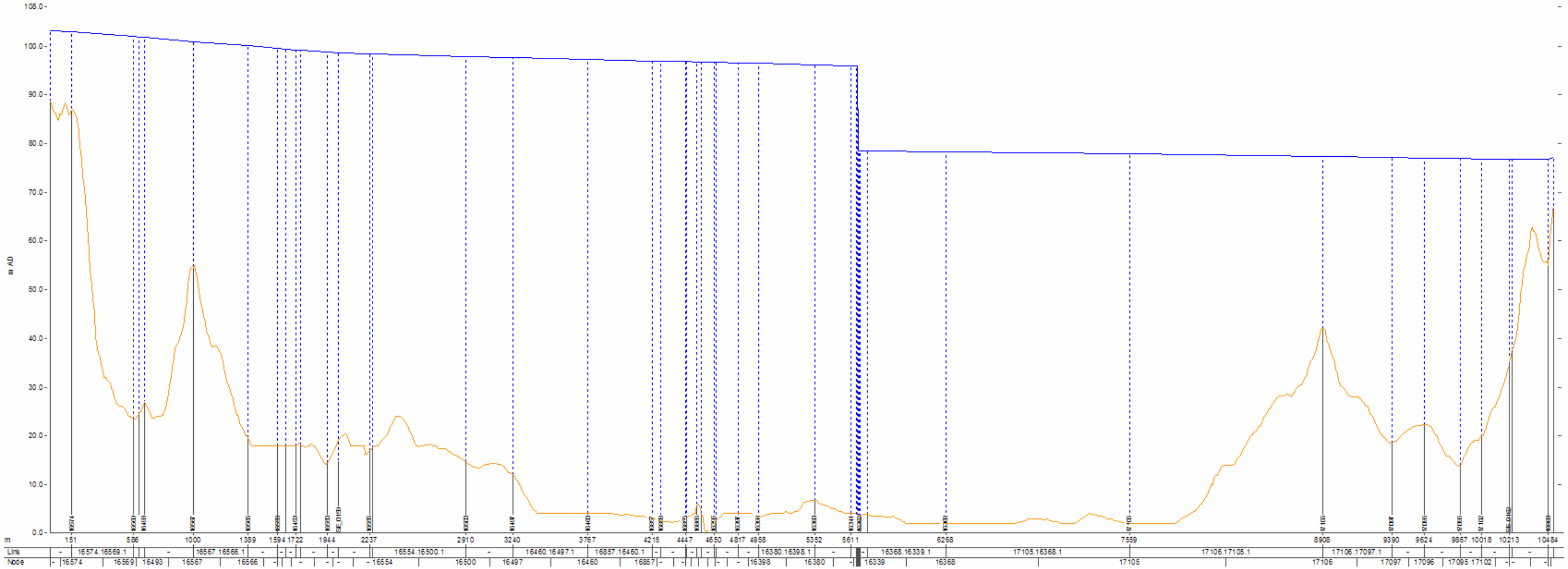



Reservoir KANWAL Future Run - 2041
Depth (m)
13.00
12.50
12.00
11.50
11.00
10.50
10.00
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Depth

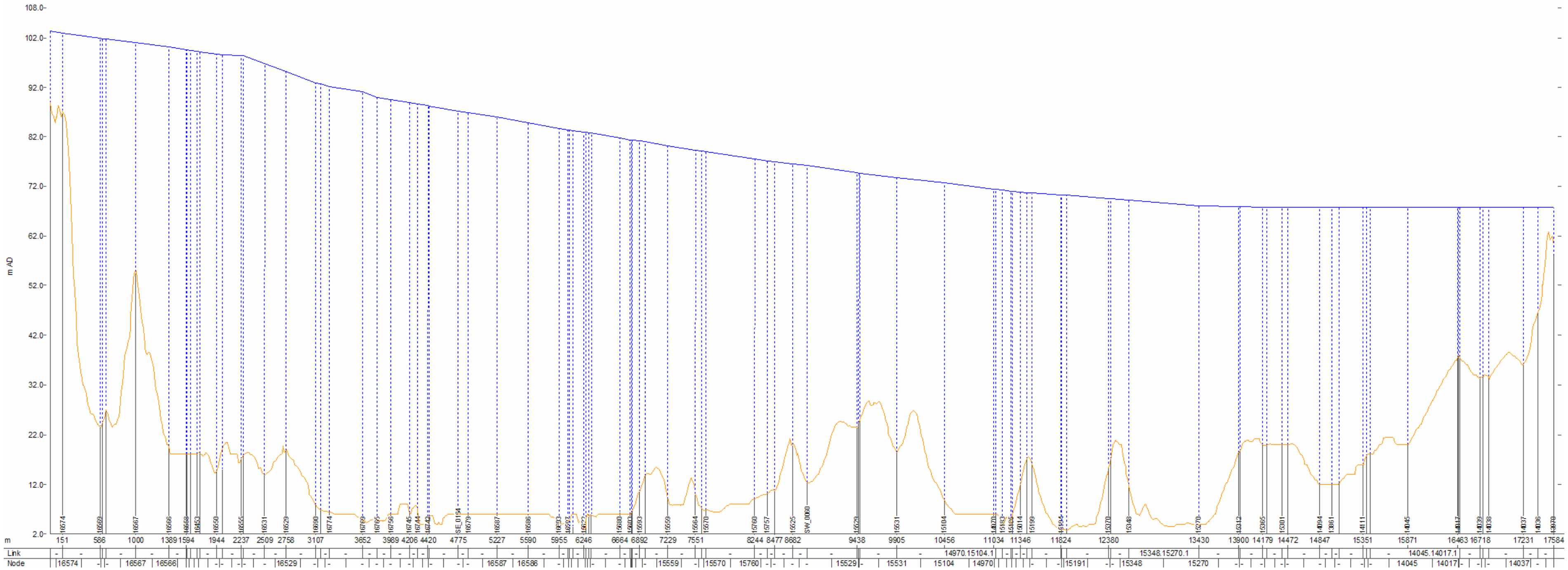

Reservoir KIAR RIDGE Future Run - 2041
Depth (m)
16.0
15.0
14.0
13.0
12.0
11.0
10.0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Depth


Pump Station 16454.16453.1 Future Run - 2041
Flow (Ml/day)
200
150
100
50
0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Flow (Volume 131.25 Ml)

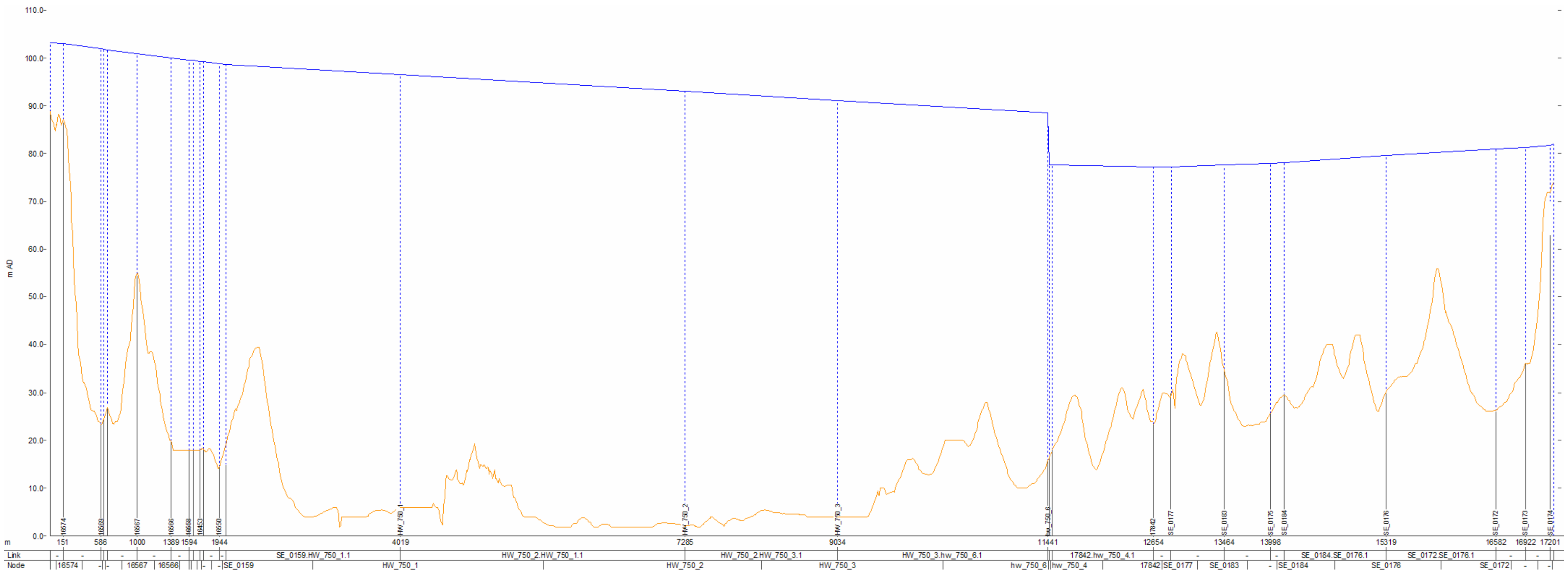
System Hydraulic Grade Lines (HGLs)



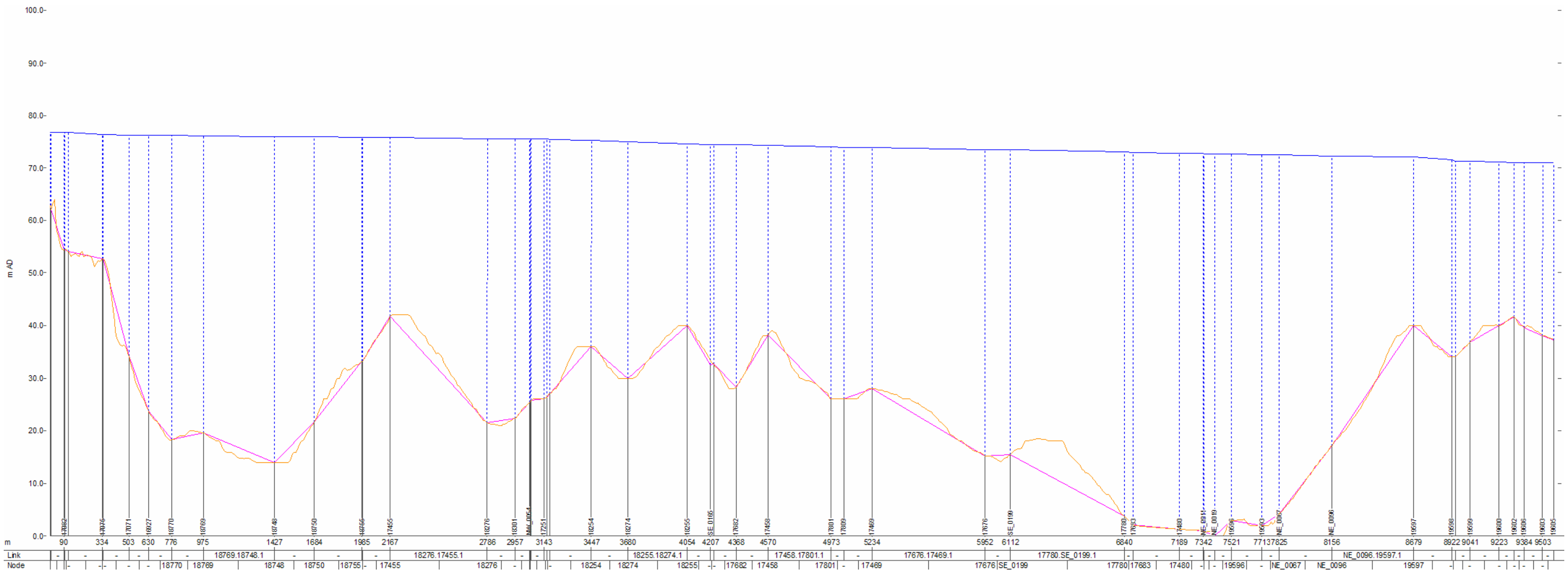
Tuggerah 2 Reservoir to Kanwal Reservoirs



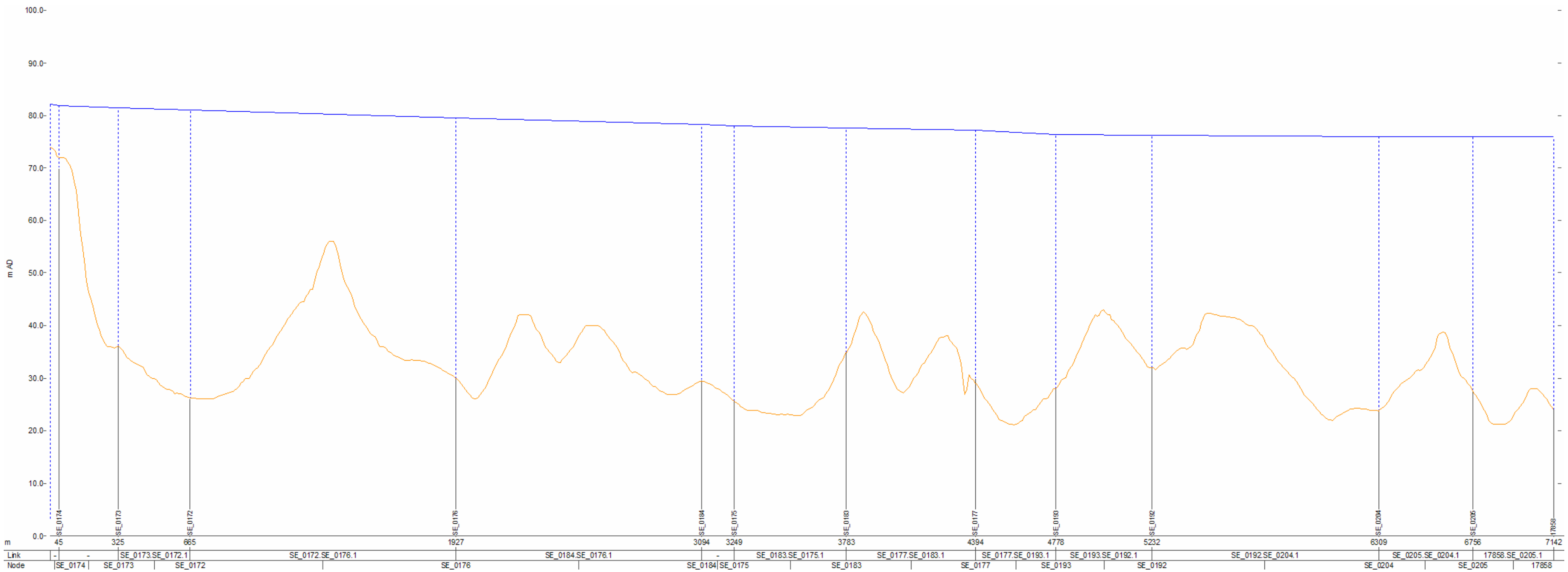
Tuggerah 2 Reservoir to Wyrrabalong Reservoir



Tuggerah 2 Reservoir to Kiar Ridge Reservoir



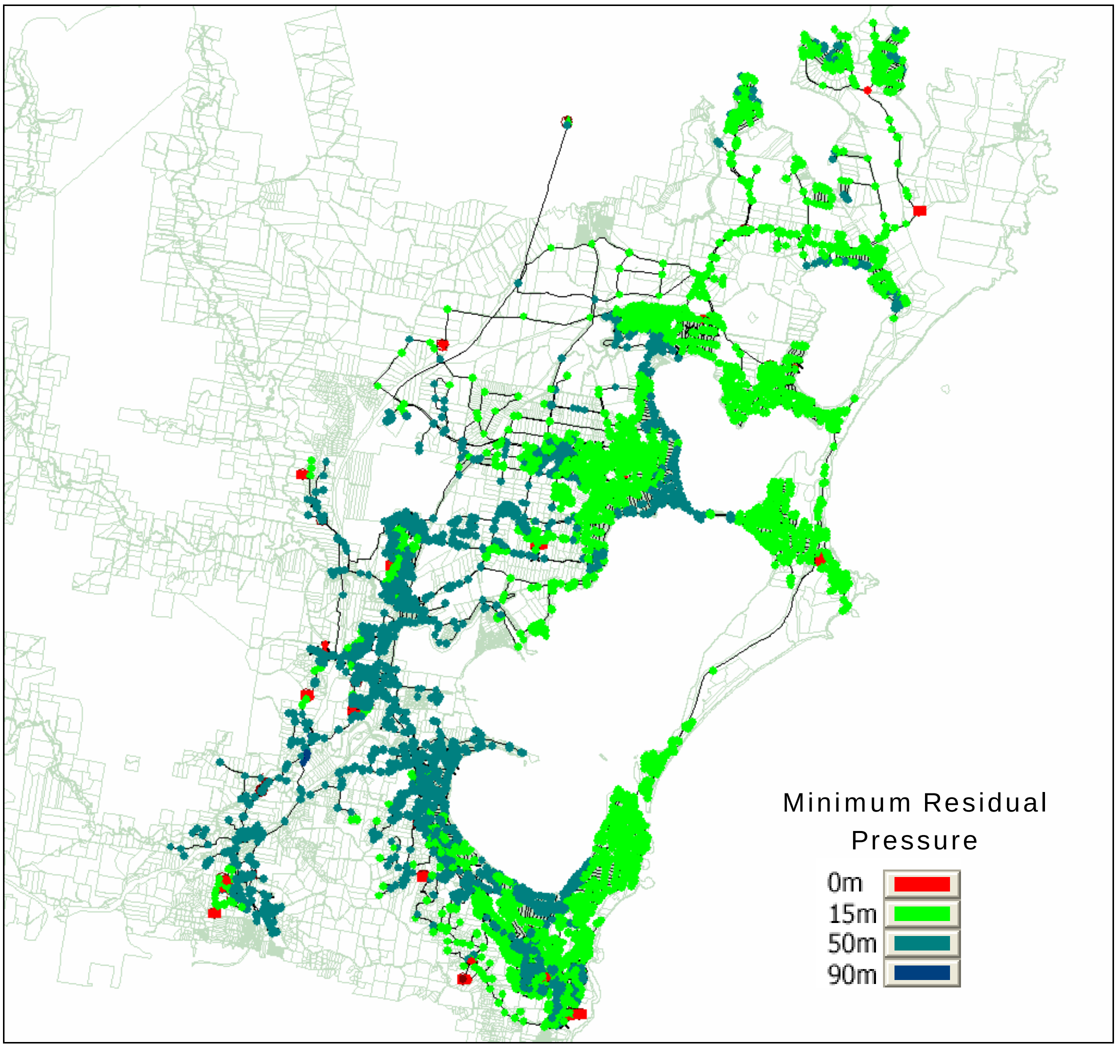
Kanwal Reservoirs to Bluehaven Area



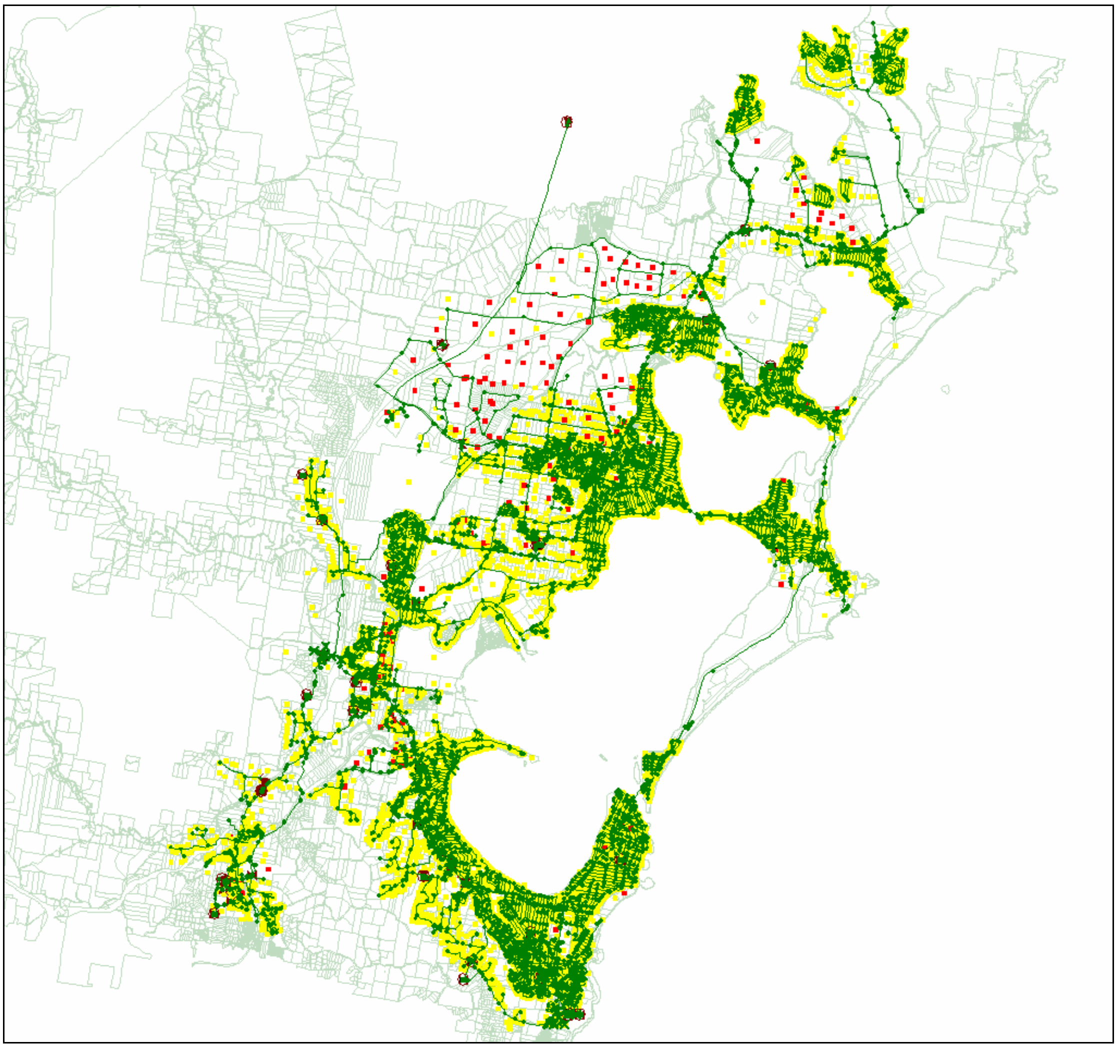
Kiar Ridge Reservoir to Warnervale High Level Zone

2046 Simulation Results

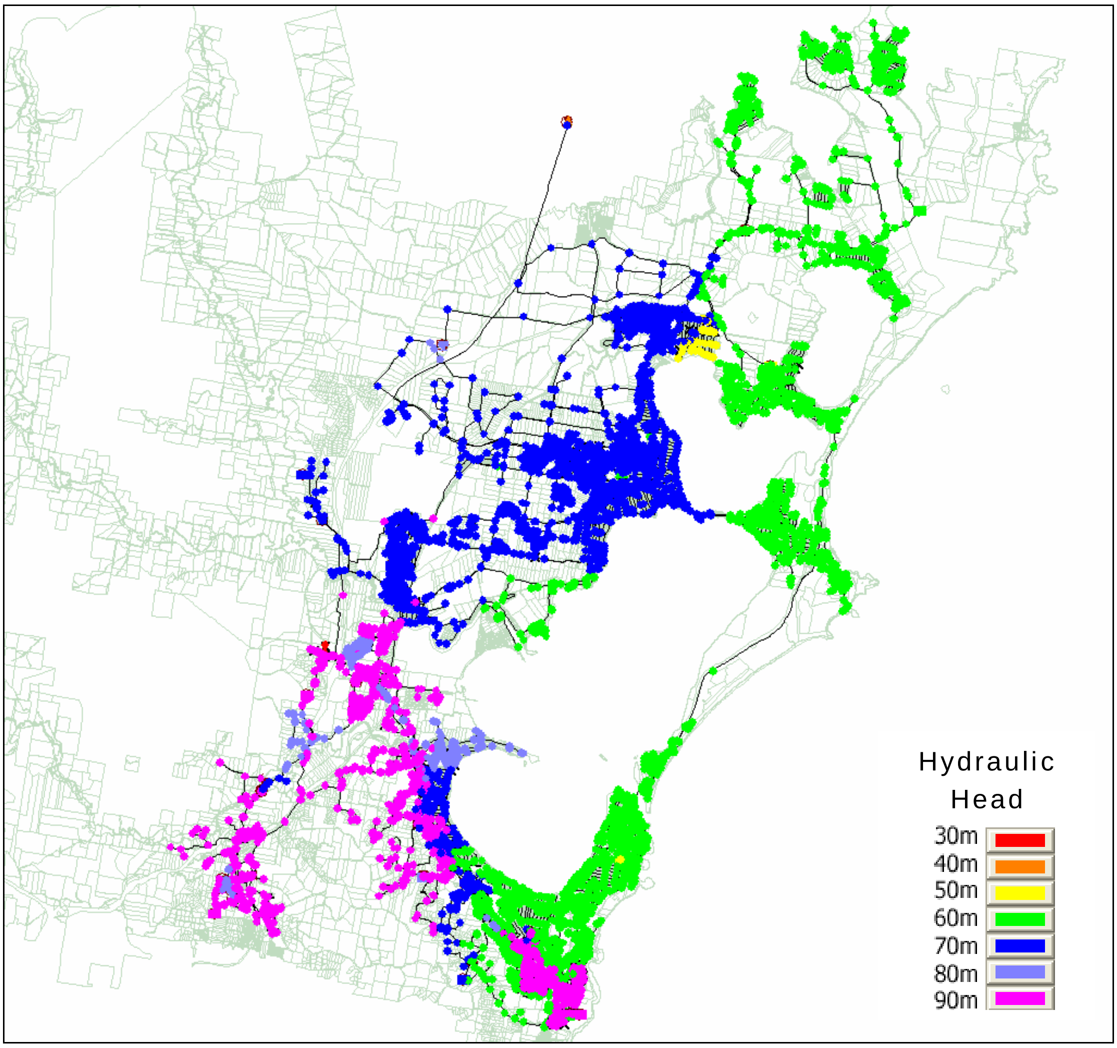
Minimum Residual Pressures



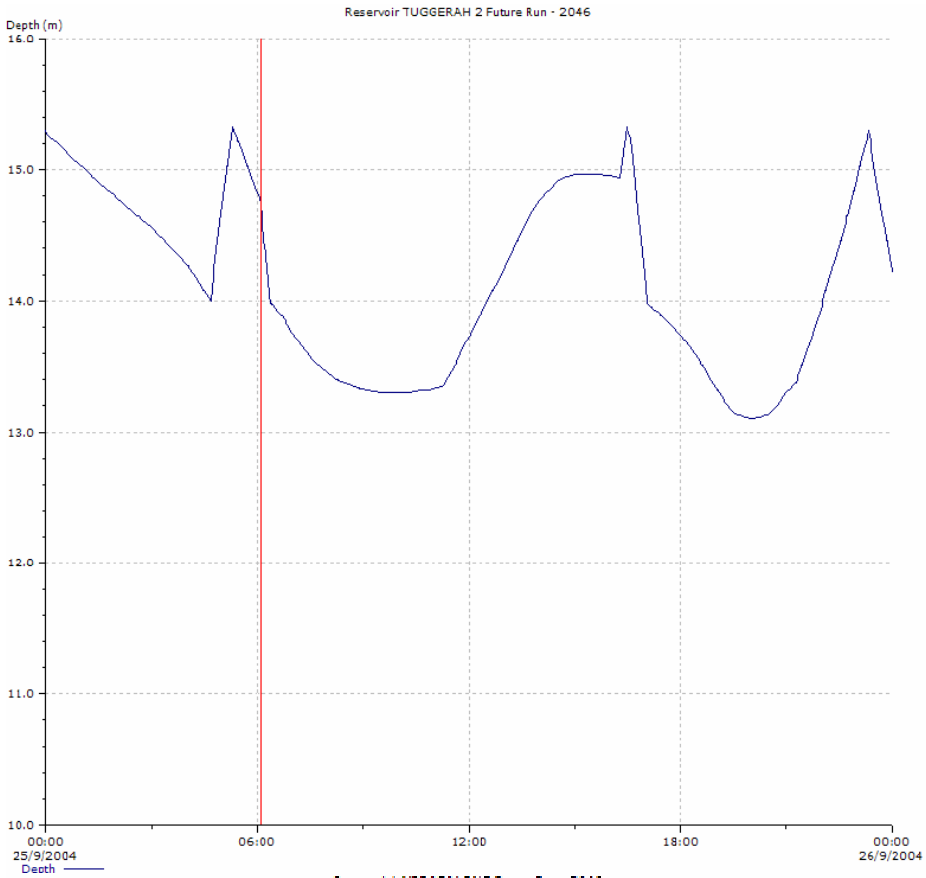
Customer Points

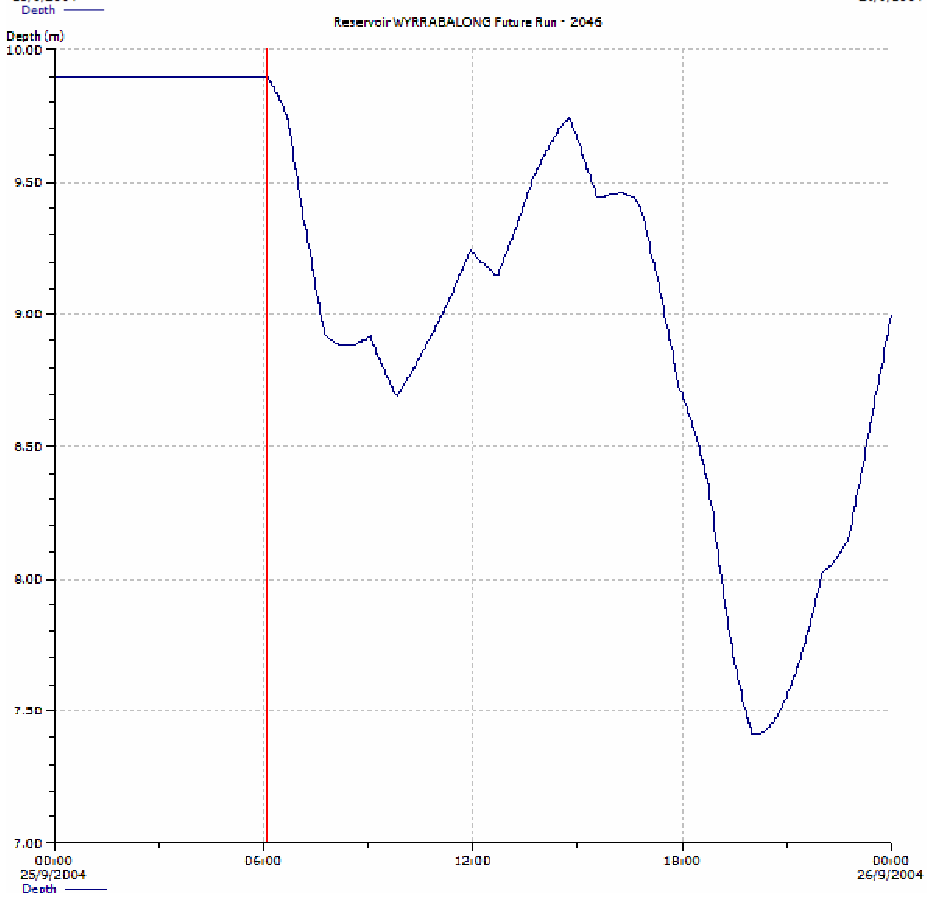


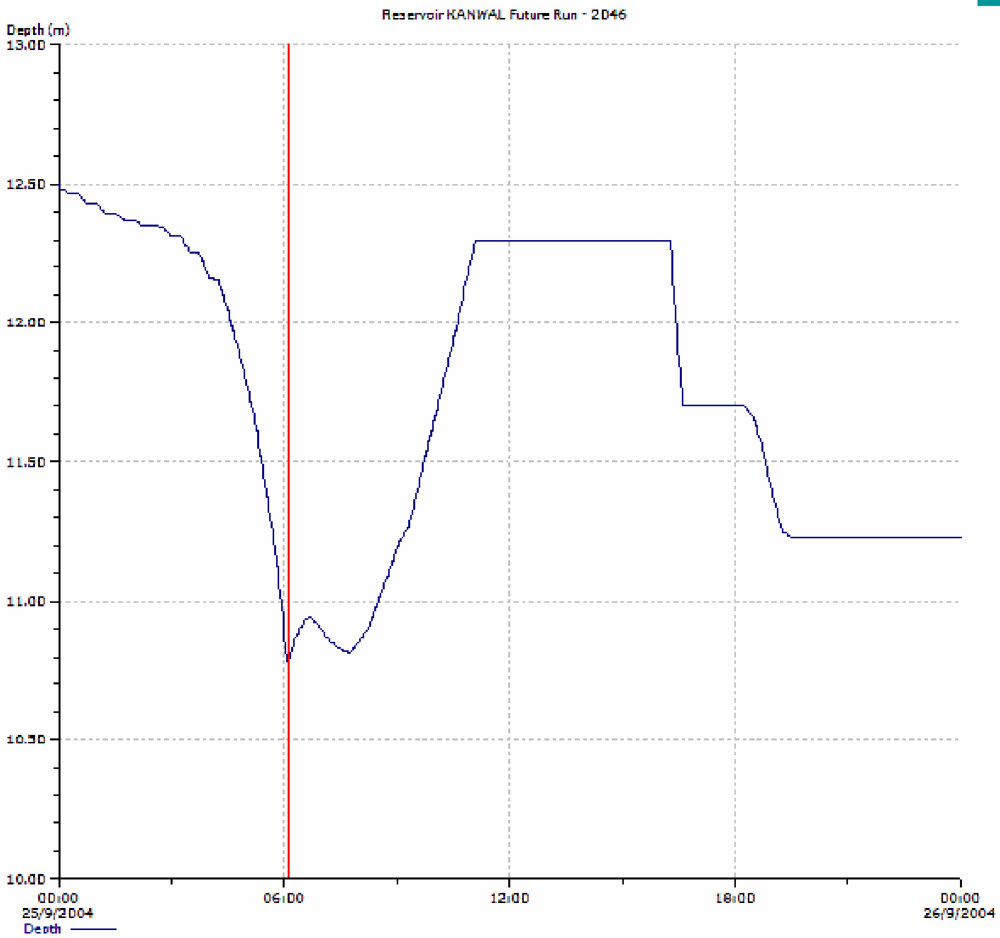
Simulated Head Conditions



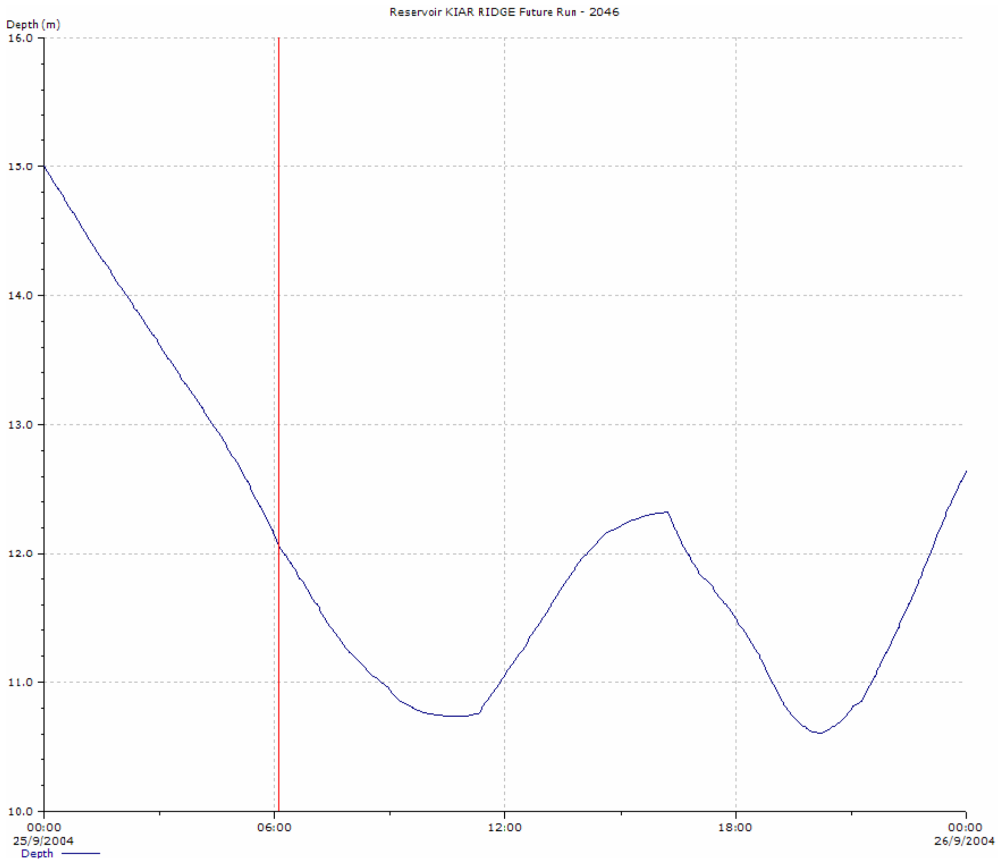
Reservoir Levels & MHLPS Performance



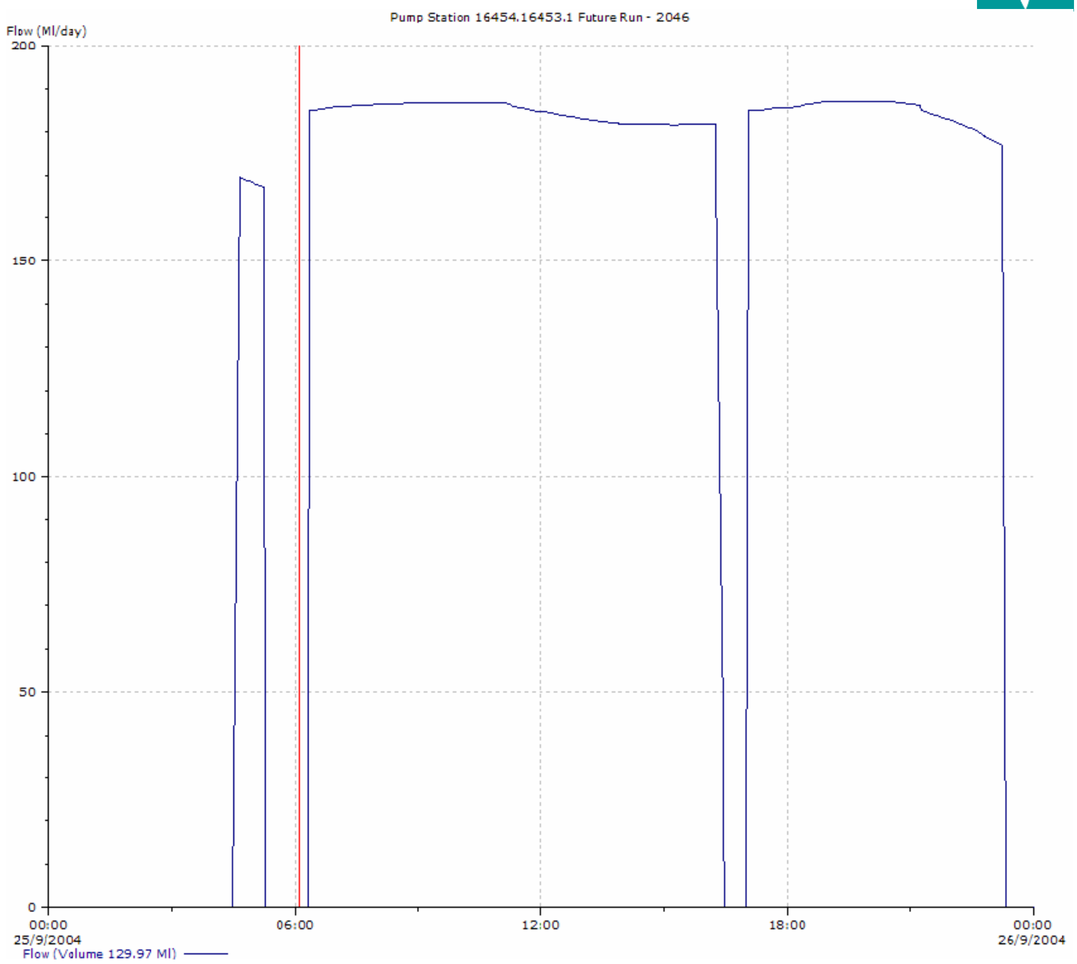




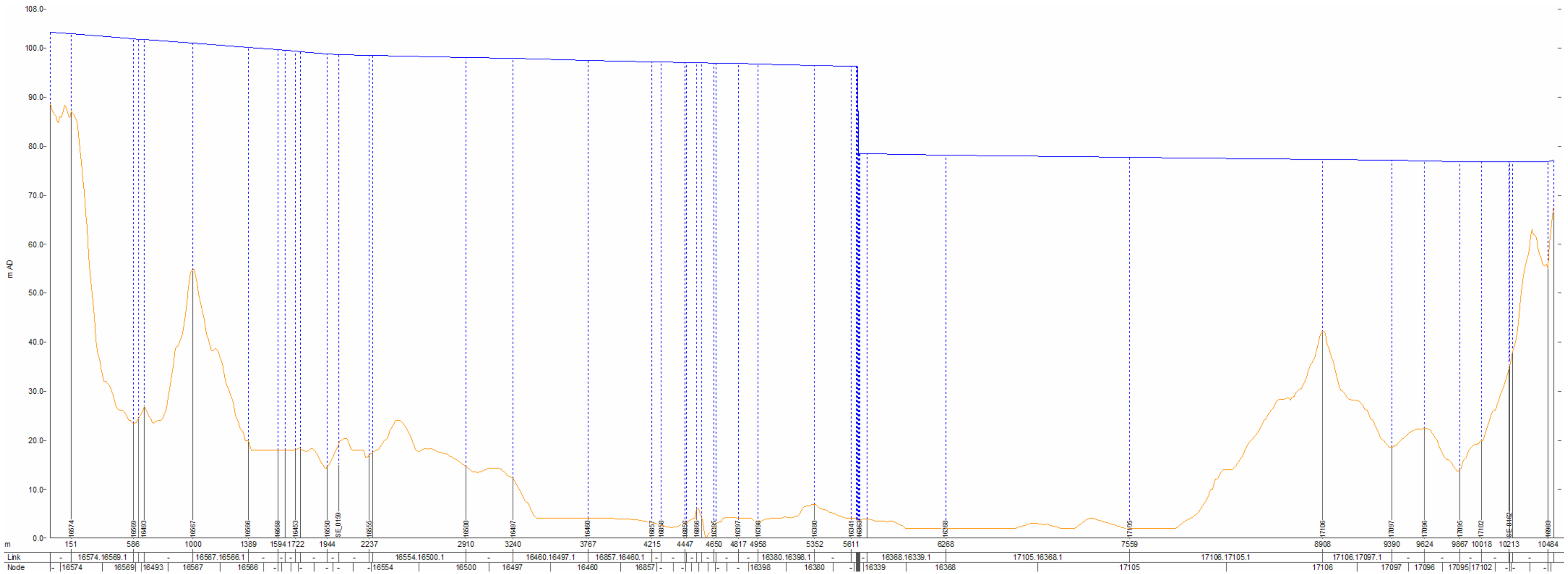
Reservoir KANWAL Future Run - 2046
Depth (m)
13.00
12.50
12.00
11.50
11.00
10.50
10.00
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Depth



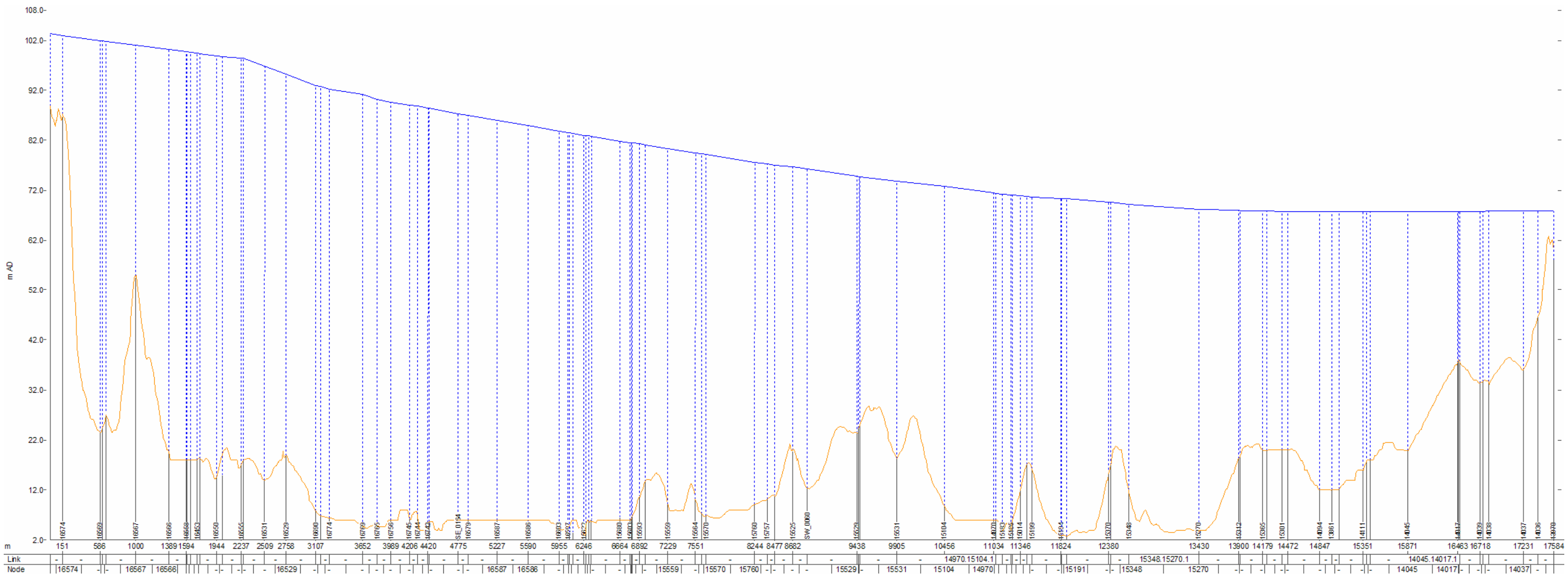
Reservoir KIAR RIDGE Future Run - 2046
Depth (m)
16.0
15.0
14.0
13.0
12.0
11.0
10.0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Depth


Pump Station 16454.16453.1 Future Run - 2046
Flow (Ml/day)
200
150
100
50
0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Flow (Volume 129.97 Ml)

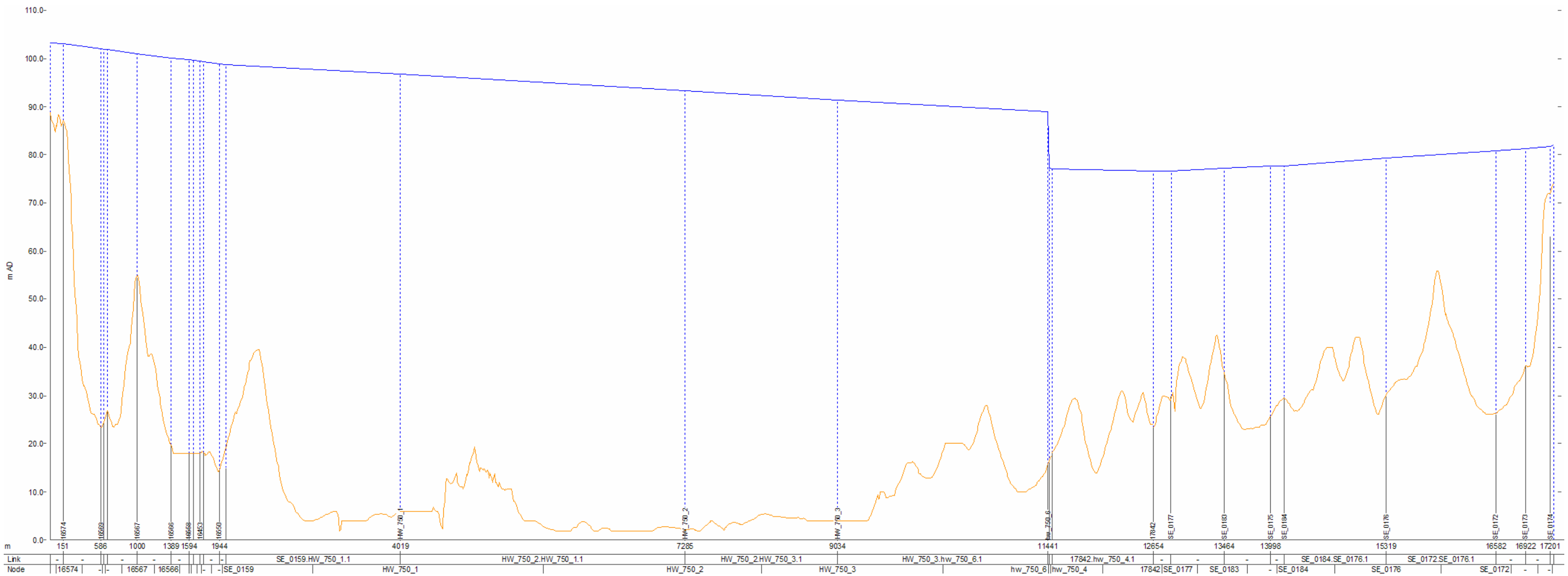
System Hydraulic Grade Lines (HGLs)



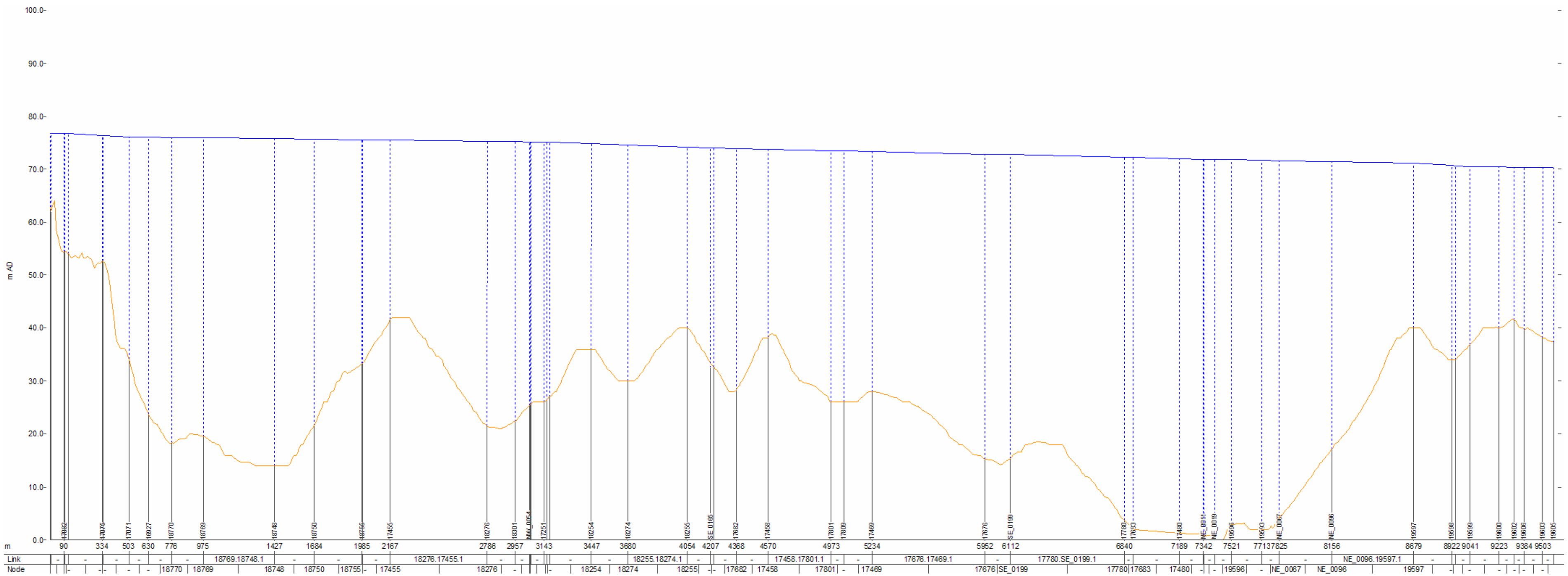
Tuggerah 2 Reservoir to Kanwal Reservoirs



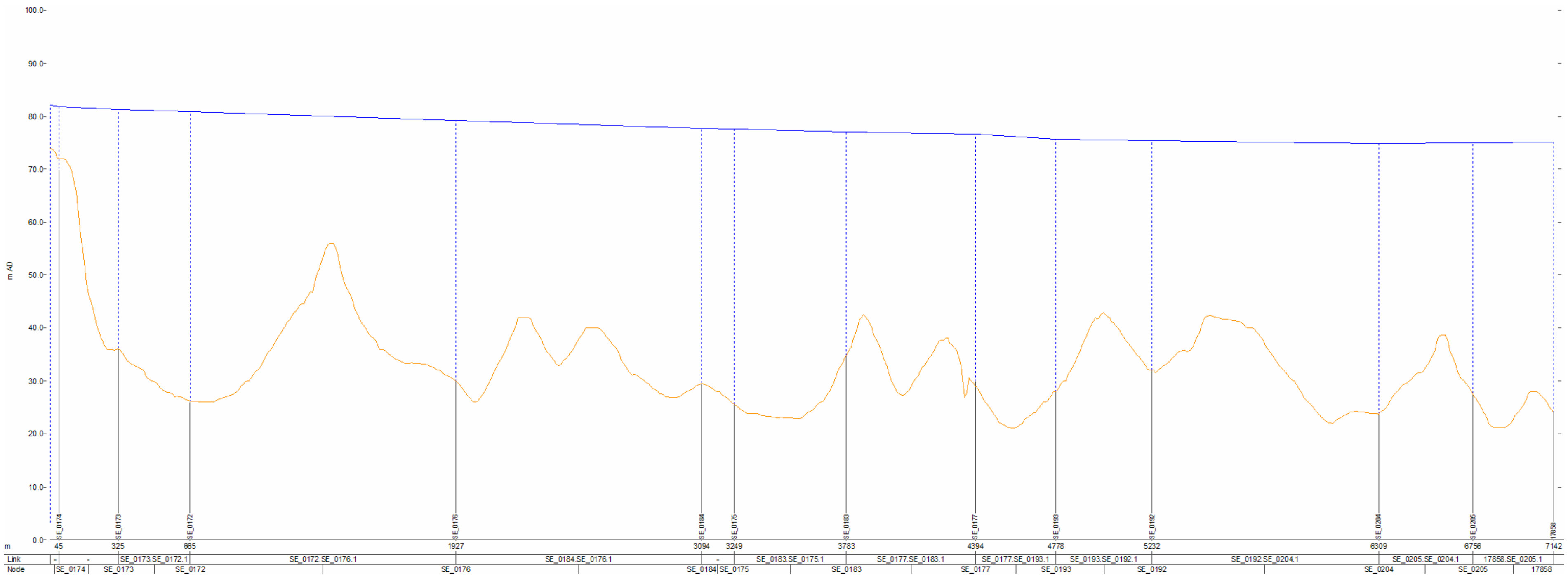
Tuggerah 2 Reservoir to Wyrrabalong Reservoir



Tuggerah 2 Reservoir to Kiar Ridge Reservoir



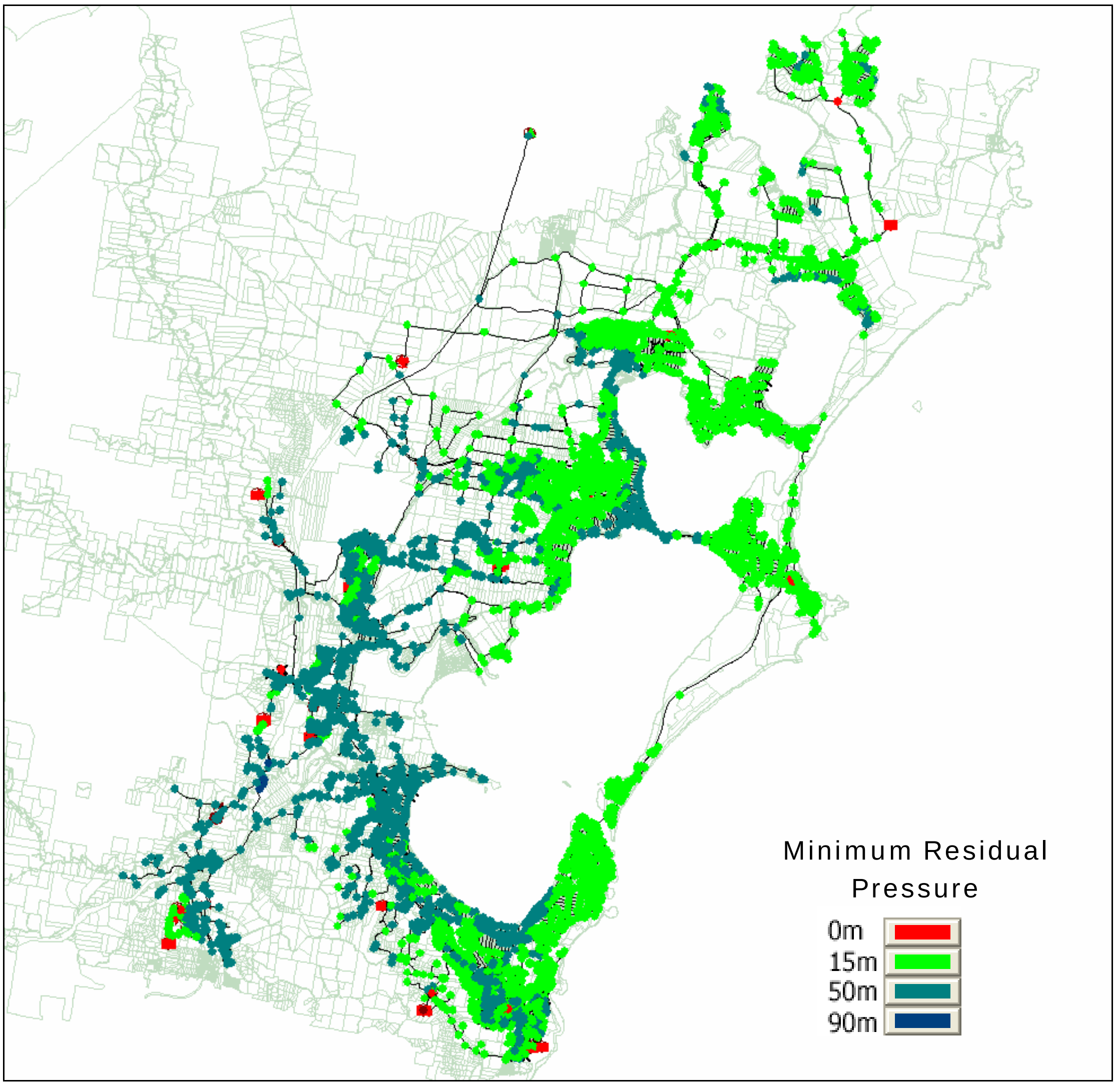
Kanwal Reservoirs to Bluehaven Area



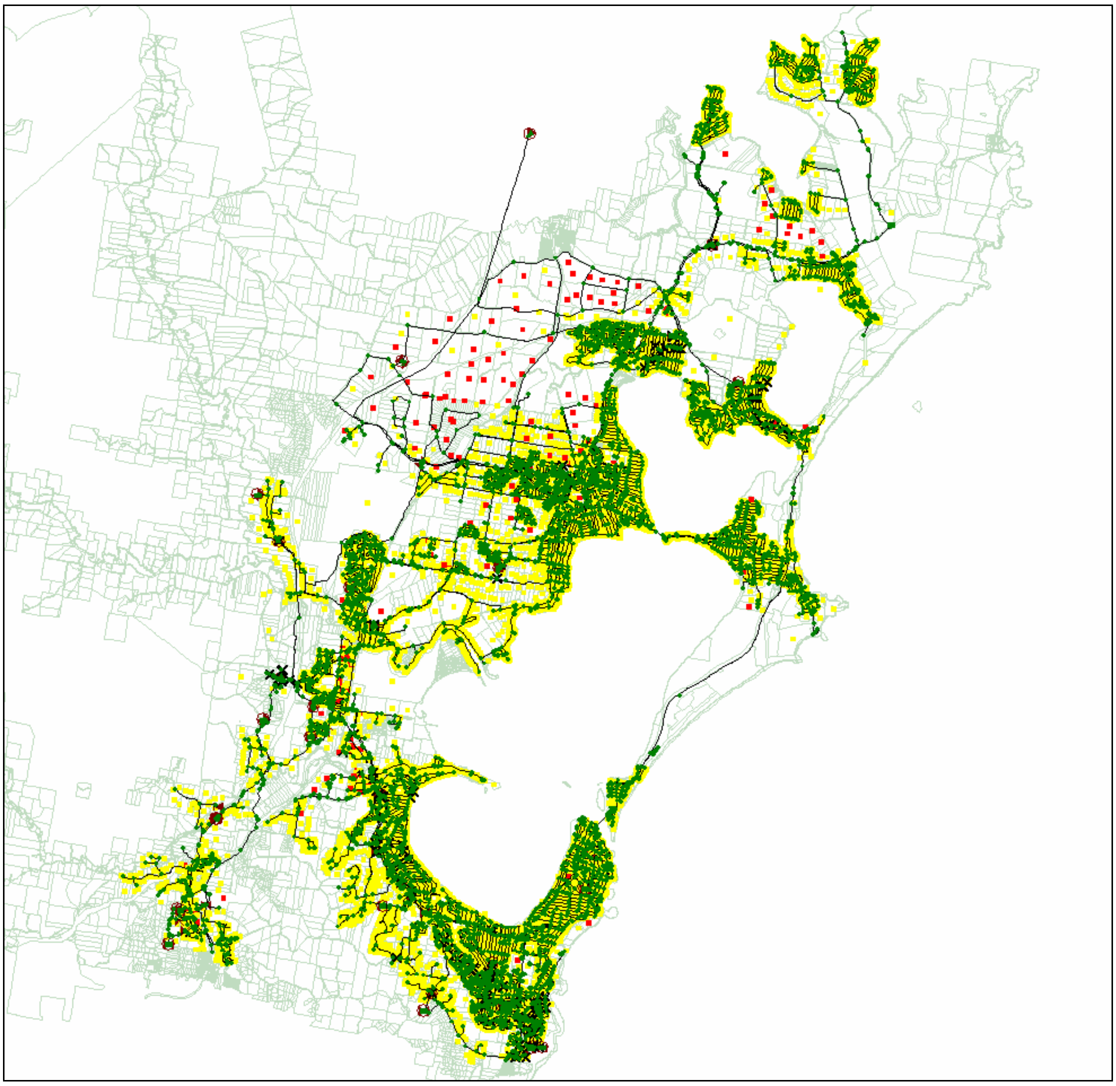
Kiar Ridge Reservoir to Warnervale High Level Zone

2051 Simulation Results

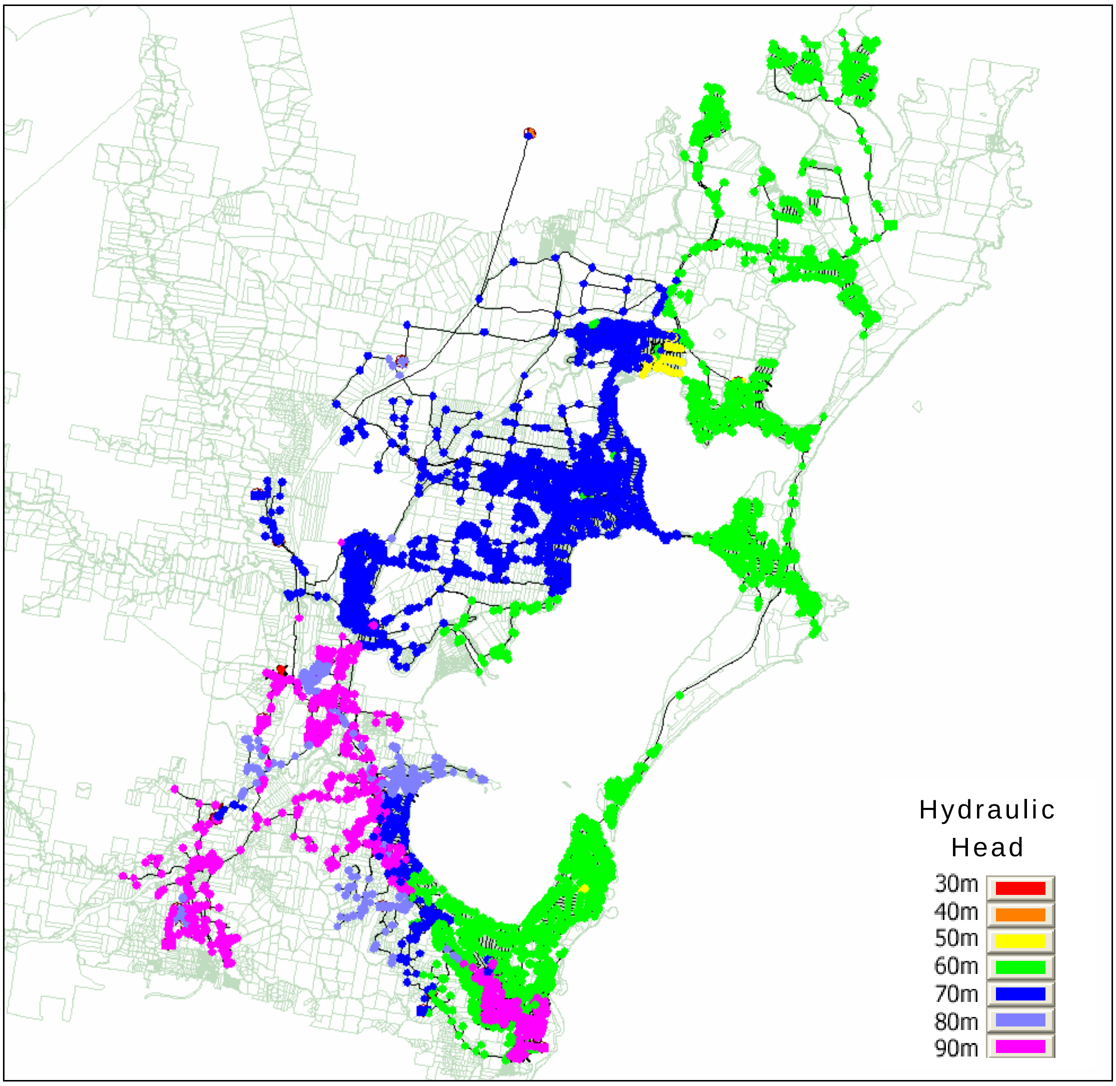
Minimum Residual Pressures



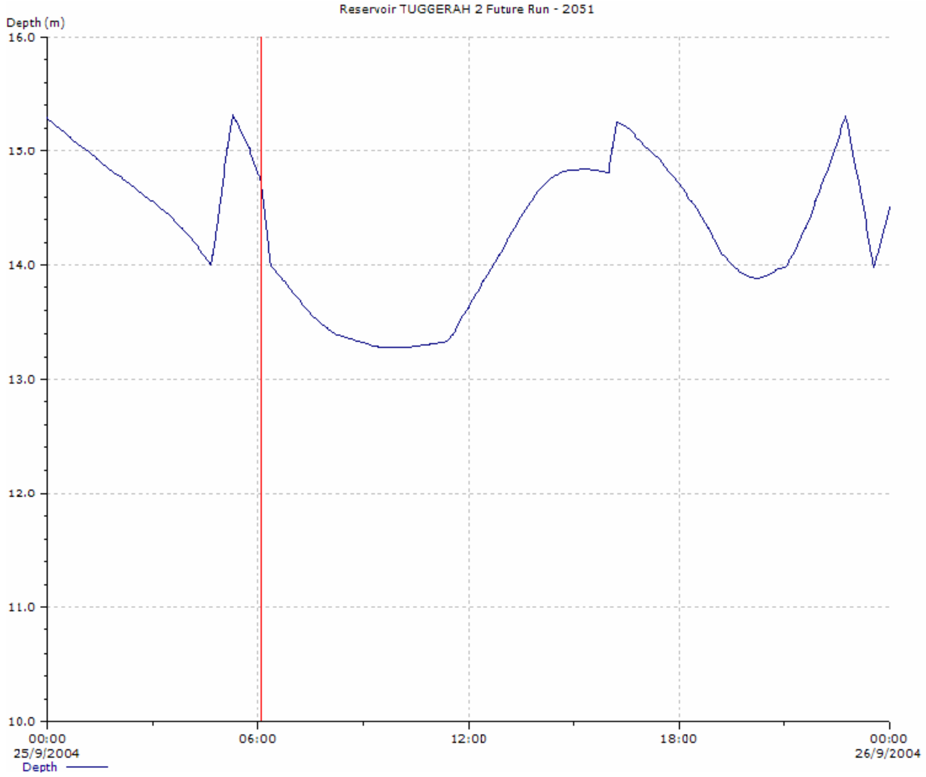
Customer Points

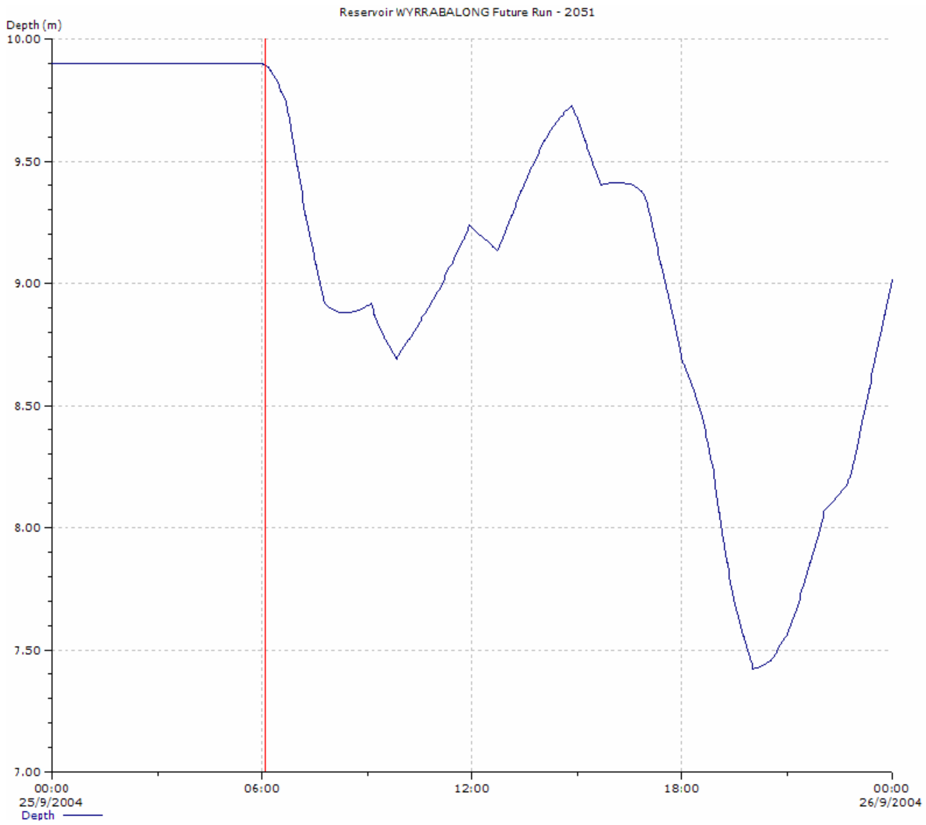


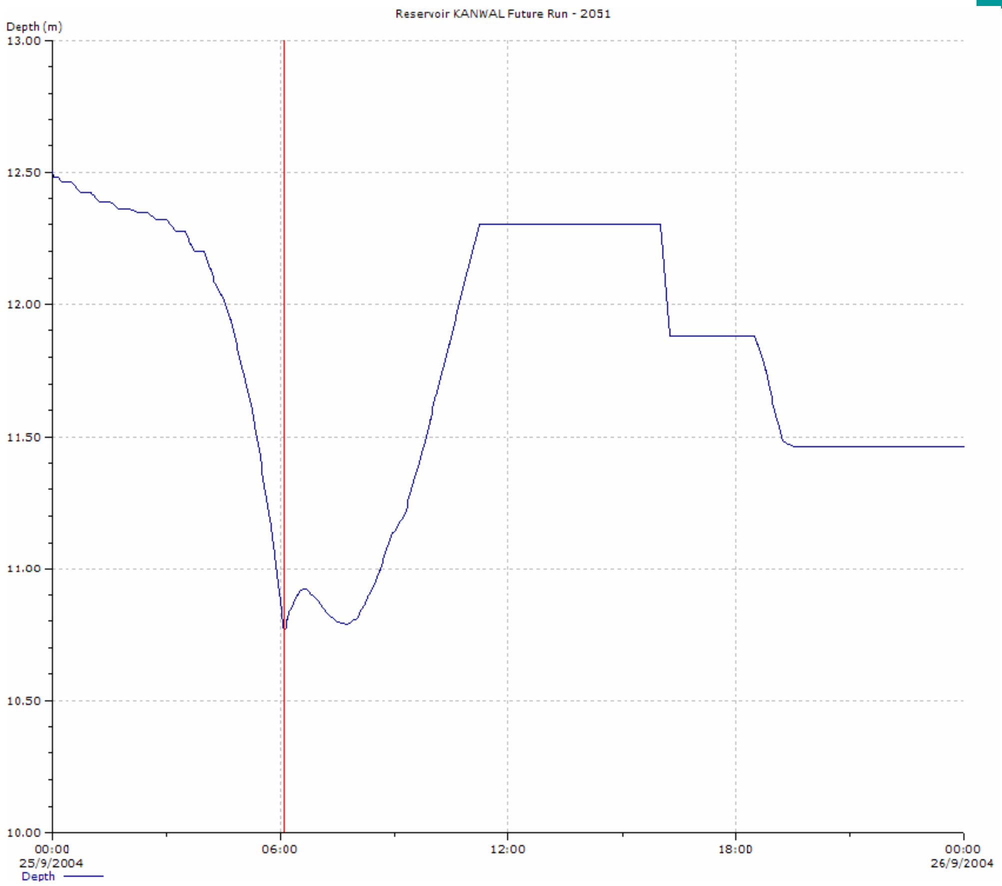
Simulated Head Conditions

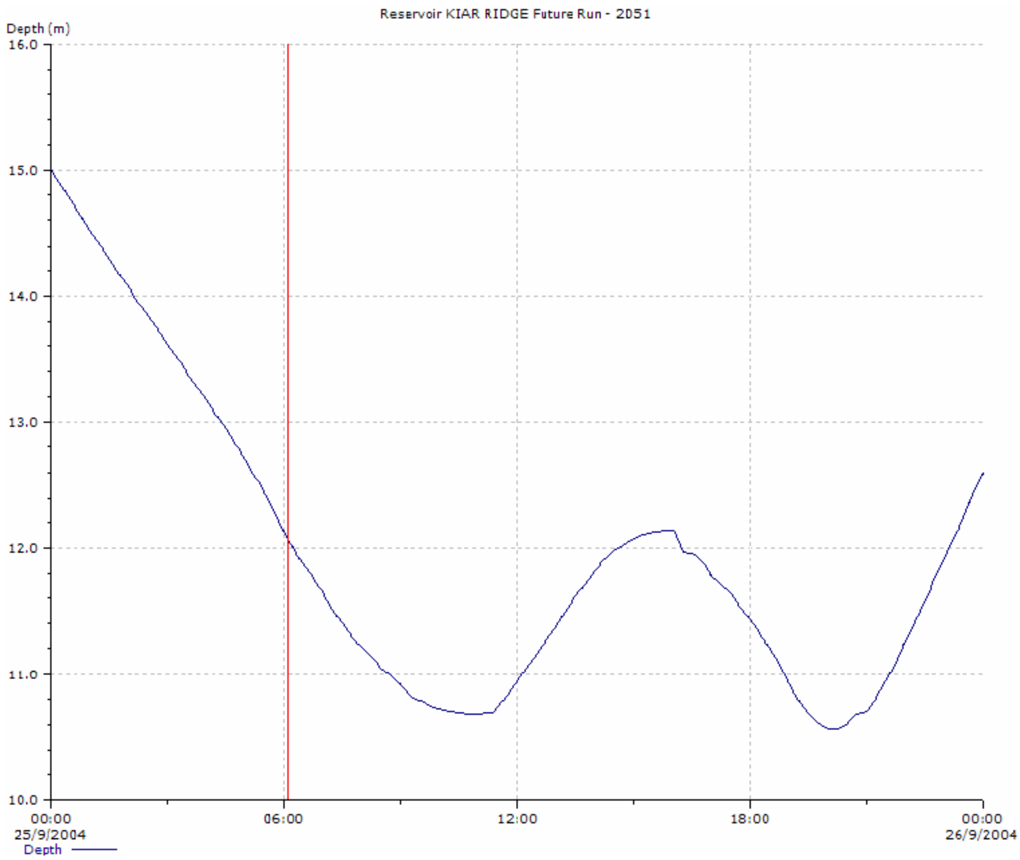


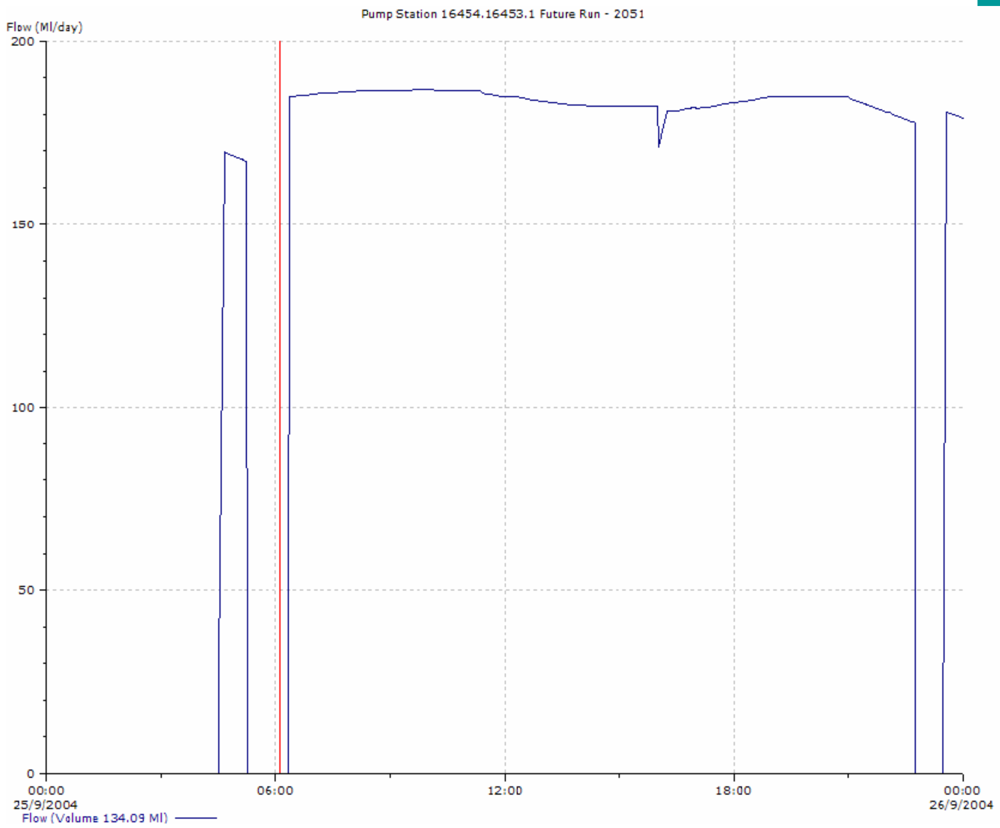
Reservoir Levels & MHLPS Performance





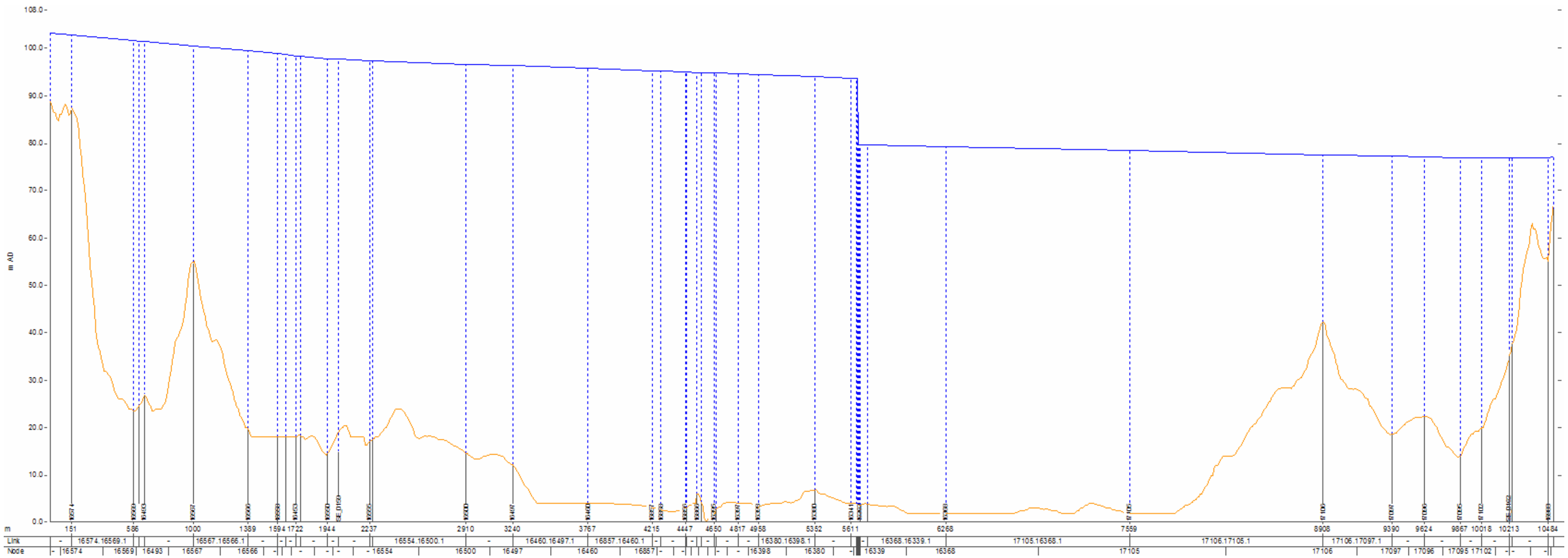

Reservoir KANWAL Future Run - 2051
Depth (m)
13.00
12.50
12.00
11.50
11.00
10.50
10.00
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Depth


Reservoir KIAR RIDGE Future Run - 2051
Depth (m)
16.0
15.0
14.0
13.0
12.0
11.0
10.0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Depth

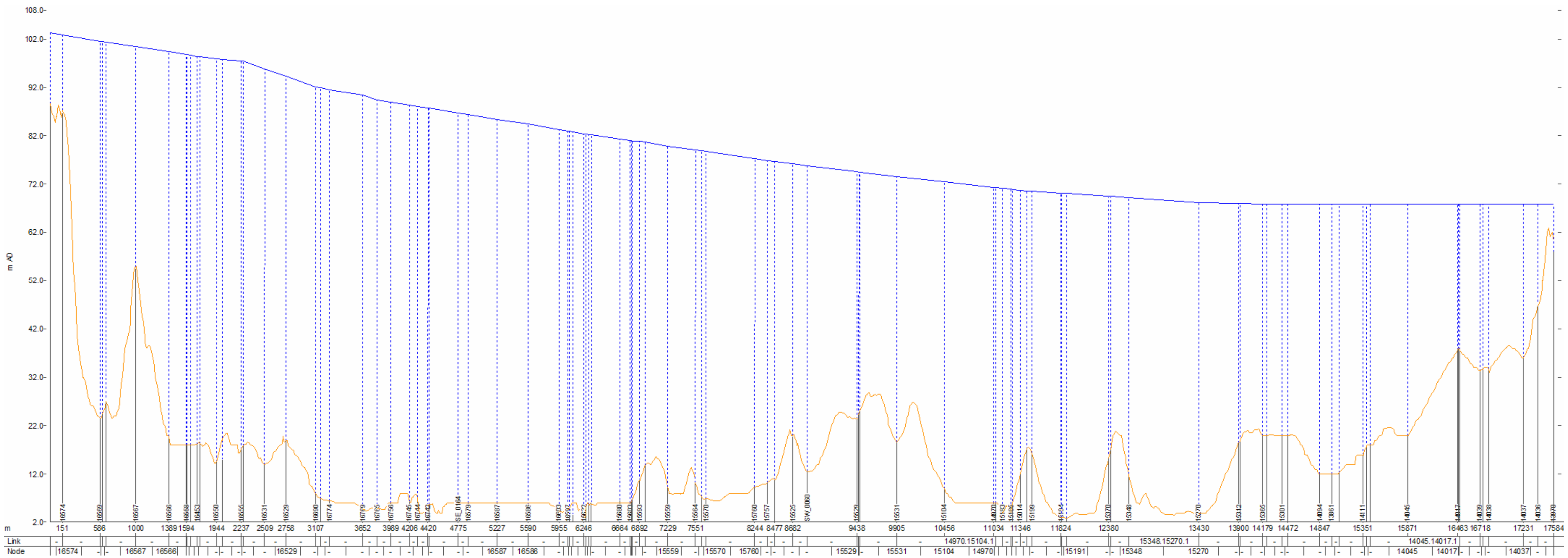


Pump Station 16454.16453.1 Future Run - 2051
Flow (Ml/day)
200
150
100
50
0
00:00
25/9/2004
06:00
12:00
18:00
00:00
26/9/2004
Flow (Volume 134.09 Ml)

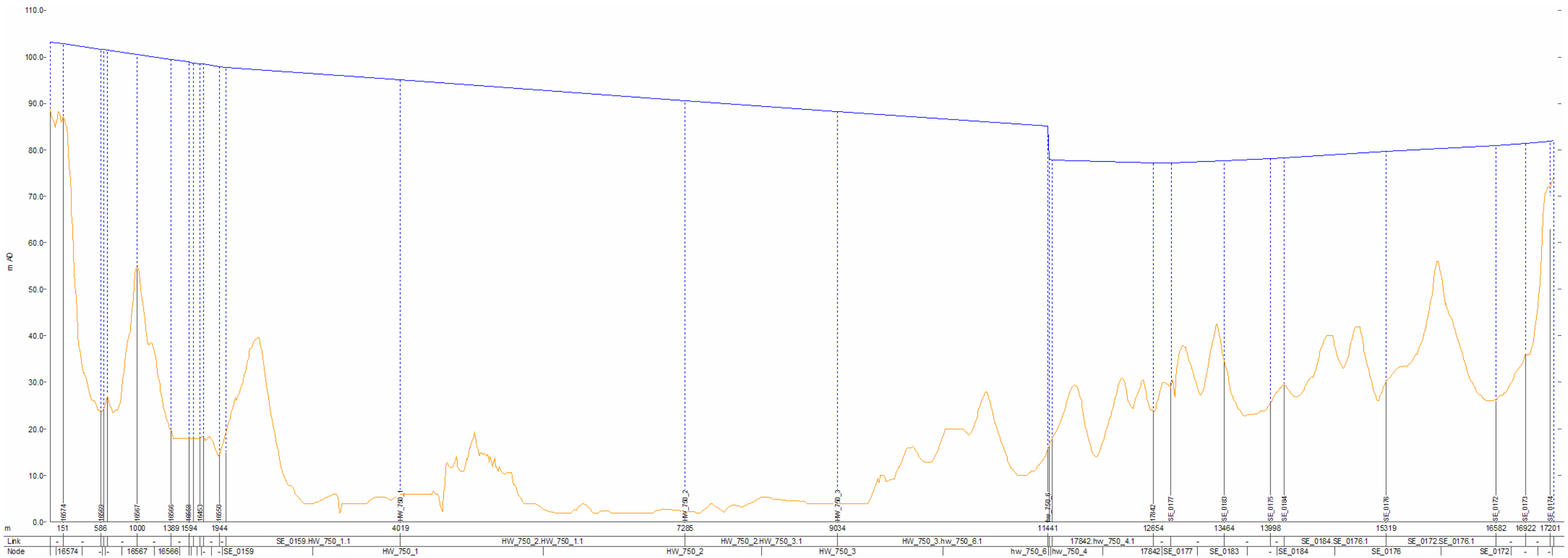
System Hydraulic Grade Lines (HGLs)



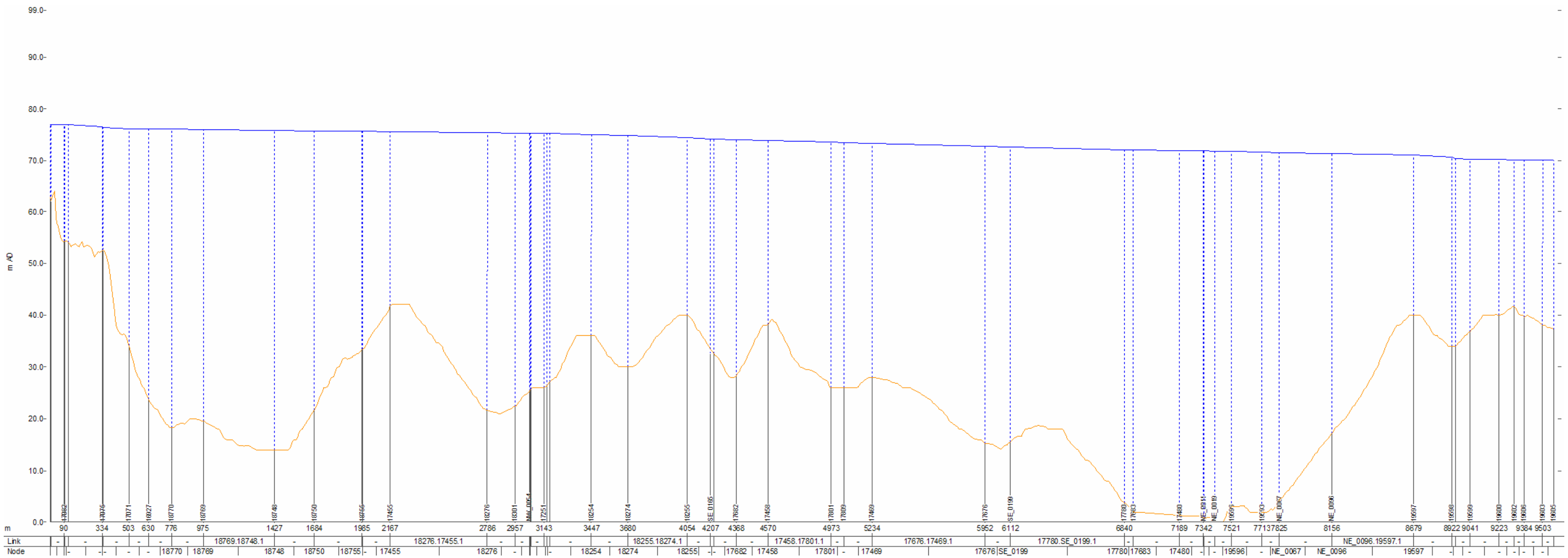
Tuggerah 2 Reservoir to Kanwal Reservoirs



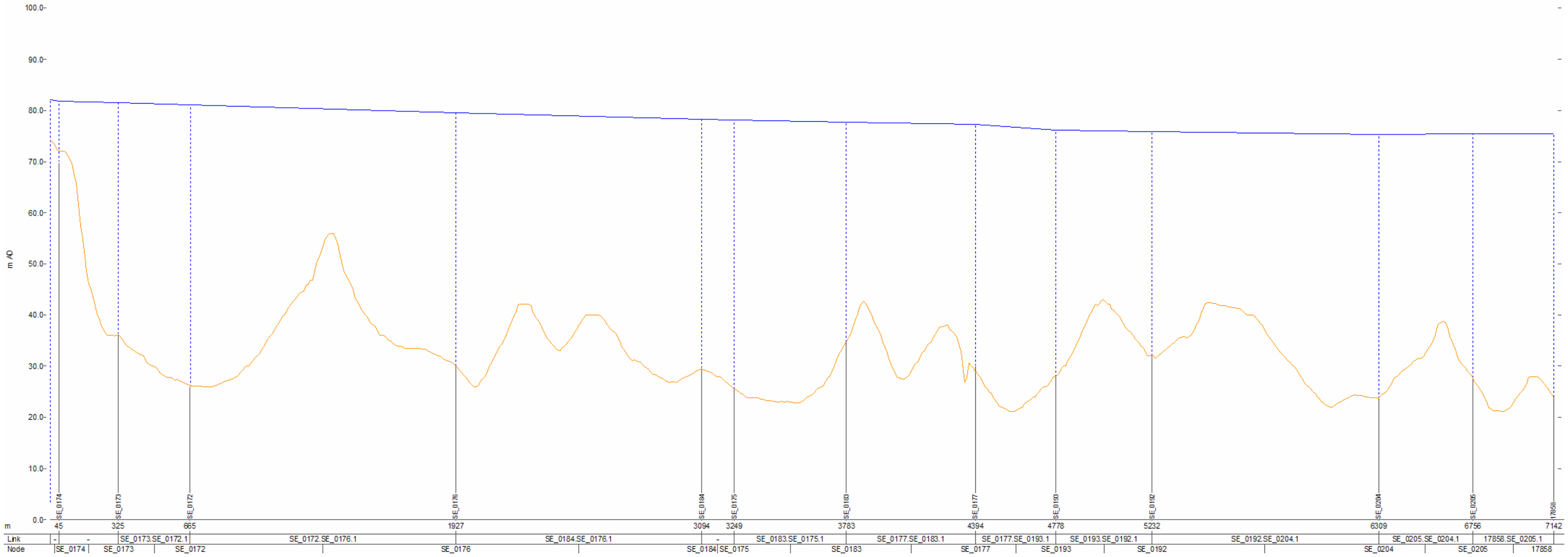
Tuggerah 2 Reservoir to Wyrrabalong Reservoir



Tuggerah 2 Reservoir to Kiar Ridge Reservoir



Kanwal Reservoirs to Bluehaven Area



Kiar Ridge Reservoir to Warnervale High Level Zone

APPENDIX B –HYDRAULIC MODEL OPERATING GUIDE

INTRODUCTION

The following is a brief user guide outlining key features and assumptions of the hydraulic model created in Infoworks WS created for Wyong Shire Council. The purpose of this guide is to summarise the key attributes of the model and to provide sufficient understanding of the modelling philosophy. It is assumed that the user has a competent knowledge of Infoworks WS and that this guide will only focus on model specific details.

SETUP OF THE MODEL

The electronic file containing the hydraulic simulations and data is labelled *Wyong Distribution Analysis.iwm*. From within this base file is stored all the network data and control data, and user groups created in establishing this hydraulic model. Key groups that are included within this electronic file include:

- "Deleted Items" - A network file containing all deleted items thought to be unnecessary following the importing of GIS data.
- "Missing Diameters" – A network file that contains all the pipeline sections that did not have pipeline sizes associated with them.
- "Wyong 2006 Calibration" – Network and control data used in the calibration of the model.
- "Networks – Future Runs" – The network files used in the 5 year staging analysis for the Distribution System Development Plan
- "Base Model Controls – Future Runs" – Control files for the future simulations
- "Demand Diagram Group" – demand profiles used for the various demand categories
- "Ground Model TIN Group" – contains the TIN data used to establish ground levels at nodes and along the entire network.
- "UPC Group" – Contains the User Programmable Controls used to coordinate the Kanwal MV operation for the calibration runs and the future runs.

KEY ATTRIBUTES OF THE MODEL

As outlined in the main report there are several operating modes that have been analysed in this model. Not withstanding the transfers from adjoining systems, there is the operating mode as established for the calibration and simulates current WSC system operating rules, there is the future operating mode where Kiar Ridge has not yet been introduced, then there is the final operating mode whereby Kiar Ridge has been constructed and operates in parallel with Kanwal reservoir to supply the northern system.

Current Operating Mode

Under the current operating mode the WSC system is fed directly from the Mardi CWT and distributed via the No.2 and No.4 PS South and North respectively. The CWT is modelled as an infinitely large object (fixed head) in Infoworks. As the Peak Day Demand is not expected to exceed the throughput of the WTP it was decided to simplify the modelling by not having to complicate the distribution system with the arrangements at the Mardi WTP.

In the south local booster pumping stations call for water when required and maintain levels in their respective service reservoirs.

The northern system is a little more complicated due to the large service area that Kanwal is expected to supply and maintain. It was found in the default operating mode that the throughput of No.4 PS was simply unable to supply the PDD event in the north. As such a low level trigger arrangement was modelled whereby Tuggerah 2 could bypass No.4 PS and supplement flow to Kanwal reservoirs. This is achieved in the model through the UPC Kanwal Valve. This UPC triggers the Kanwal MV, a valve at No.4 PS and another valve at the intersection of the 1050 and 600 Mardi Pipelines (as they diverge north and south). While these valves are not in actual fact motorised, to simulate the manual control they are incorporated in the model as motorised valves (MV).

However, even with these additional controls it was found that Kanwal struggled to maintain sufficient head in areas such as Bluehaven and central East Gorokan using low level trigger levels for Kanwal suggested by WSC (55% before switching to Tuggerah 2).

Future Simulation – Pre Kiar Ridge Reservoir

Under this operating scenario the WSC WS system is fed from the CWT but via the Mardi HLPS/Tuggerah 2 reservoir. The configuration of the pipework at Mardi HLPS enables the Mardi HLPS to deliver water to Tuggerah 2 when Tuggerah 2 is calling for it while also simultaneously charging lines downstream of the MHLPS with the head of the MHLPS pumps or exposing the system to the head of Tuggerah 2 on a permanent basis. With this operating regime there is no need for No.2 and No.4 PS, both of which are deactivated in the model. No.4 PS is replaced with the Kanwal MV (valve 16351.16355.1 in the Infoworks WS model) and a new MV is added to the Hunter Link just prior to its connection along sparks rd (valve hw_750_6.hw_750_5.1 in Infoworks WS). These two valves are linked via the UPC "Future Runs Kanwal MV – No Kiar". In essence these two valves replace No.4 PS and allow reservoirs in the north to be topped up by Tuggerah 2 when the level in Kanwal reservoirs falls.

Future Simulation – Post Kiar Ridge Reservoir

The introduction of Kiar Ridge to the system relieves the stress from Kanwal reservoir by providing additional head and new delivery mains to supply the new development areas in the northern precincts. The higher TWL of Kiar Ridge and the merged reservoir zone between Kiar Ridge and Kanwal reservoir, however, requires that the controls on the two MVs in the previous operating mode to be reprogrammed with an additional control requirement – the valves must open if either Kanwal or Kiar is low.

METHODOLOGY FOR IMPORTING OF DEMAND DATA

An outline of how demand data results from the demand model is to be imported into the hydraulic model is provideded below:

1. Demand data for each meter is generated in the demand model and tabulated in a csv file. The csv file lists the meter number and the corresponding demand in litres per second.

2. The locations of the meters were imported into the Infoworks WS model by importing a GIS layer which assigned the centre coordinate of individual lots as the meter locations. These meter locations are imported as "customer points" within Infoworks WS and assigned the corresponding meter number.

3. Using the Import Data Centre function in Infoworks WS the csv file containing the demands are then imported into the model.