JACKSON ENVIRONMENT AND PLANNING

INDUSTRIAL SUBDIVISION
AND GENERAL INDUSTRY DEVELOPMENT
2 BOWMAN ROAD, MOSS VALE
DEVELOPMENT ASSESSMENT REPORT
SEWER AND WATER MODELLING

urbanwater solutions

01 AUGUST 2023

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Description	Date	Prepared	Checked	Authorised
1	*Draft for WSC Review*	*08/02/2023*	*EW/JS*	*AP*	*AP*
1.1	*Fireflow update*	*13/02/2023*	*AP*		*AP*
2.0	*Final*	*20/02/2023*	*AP*		*AP*
3.0	*Updates to figures*	*21/04/2023*			*AP*
3.1	*Edit "warehouse:"*	*1/08/2023*	*AP*		*AP*

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1 Introduction

Urban Water Solutions (UWS) was commissioned by Jackson Environment and Planning Pty Ltd to assess the impact on the existing water and sewerage systems of a proposed industrial subdivision and general industrial development at 2 Bowman Road, Moss Vale.

Wingecarribee Shire Council (WSC) is the local water authority providing potable water supply and reticulated sewerage services.

This report details the impact of the proposed development on the existing WSC water and sewerage systems and is subject to approval by WSC.

1.1 Location

The development will consist of 3 large lots with a **gross area of approximately 8 ha**, each lot will contain an industrial building with office areas.

A locality plan is presented in Figure 1-1, the site is shown with a yellow outline. A proposed site plan provided in Figure 1-2.

Figure 1-1: Development Location

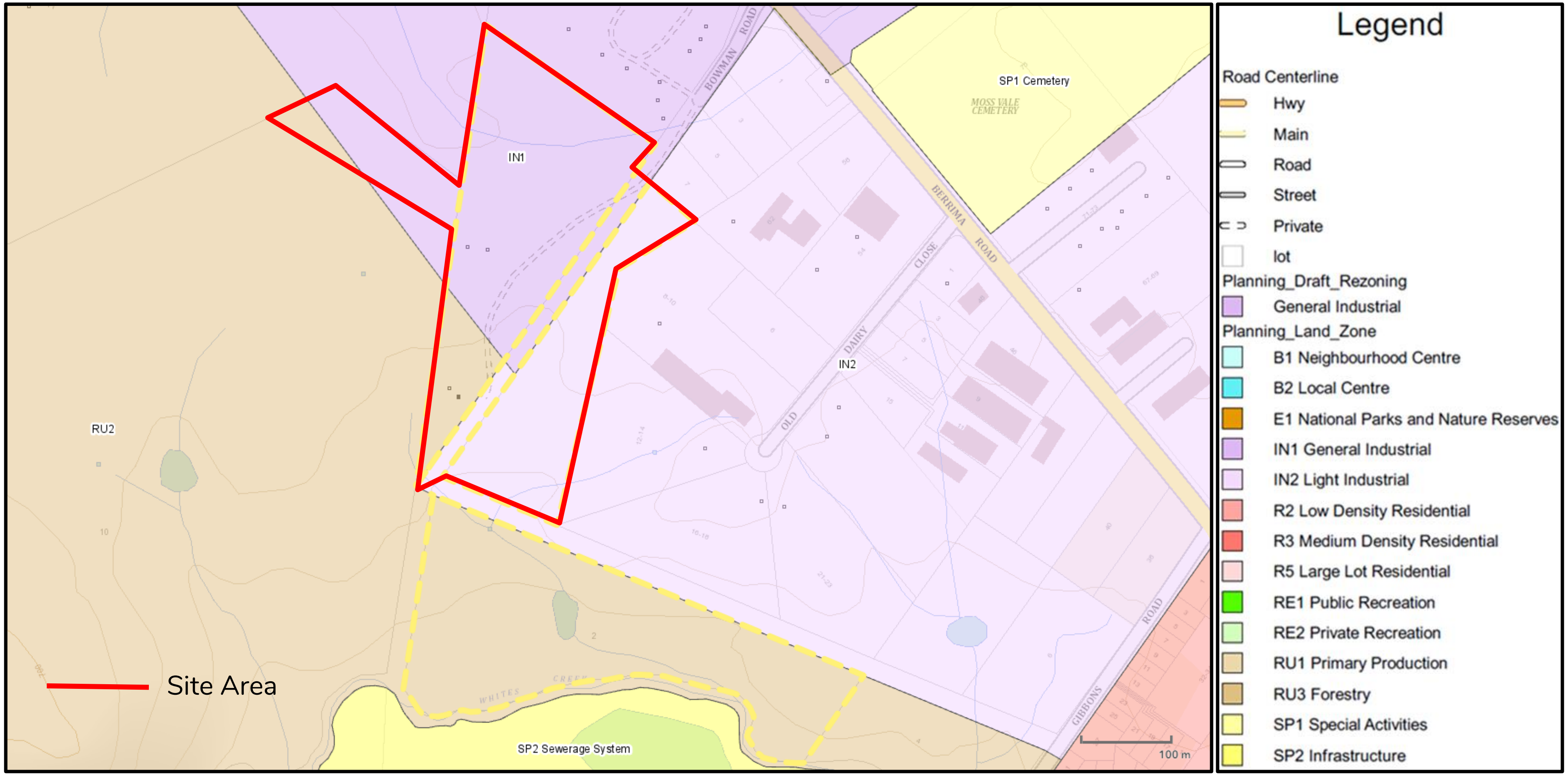
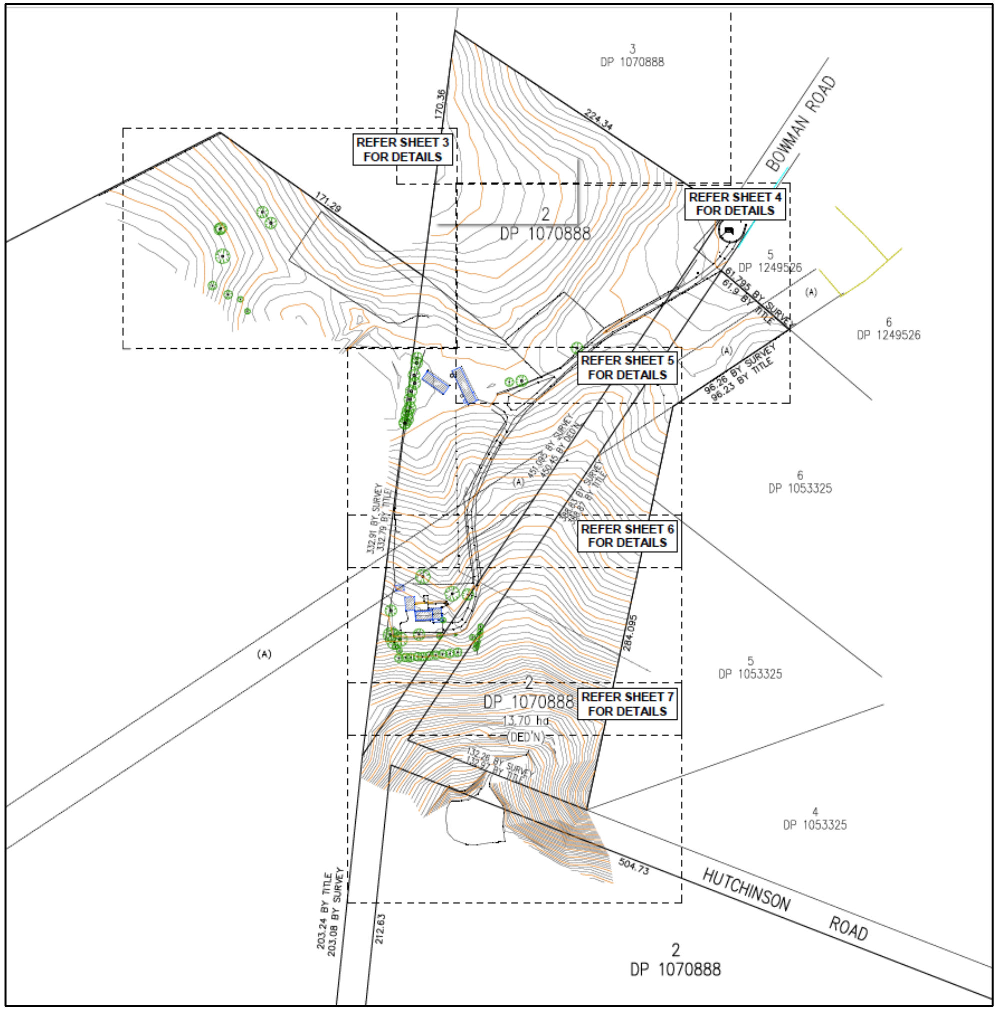


Figure 1-2: Site Plan



Source: Client

2 Sewerage System

2.1 Background

2.1.1 Model Configuration

The InfoWorks ICM version 10.5 hydraulic model of the Moss Vale sewerage network was used to assess the system performance and effects from the new development.

The model was updated to include:

- Young Road development - 496 residential lots connecting into SPS MV18 plus emergency storage
- Darraby Estate – 305 lot estate located on the southwest fringe of Moss Vale, plus the associated infrastructure e.g., the reticulation network, sewer pumping station and emergency storage (SPS MV19)
- Fairfax Estate development – 96 residential lots at Farnborough Drive, plus associated upgrades at Church Rd (SPS MV12).
- Chelsea Gardens Development – 1074 residential lots connected to Moss Vale sewerage by a 35L/s pump, 515m of rising main (ID130mm), and dedicated gravity sewer to the Sewage Treatment Plant (STP) pump station (SPS MV17)
- Upgrade of pumps at SPS MV17 to 45L/s and inclusion of 105 kL emergency storage tank.

2.1.2 Development Servicing

Under the proposed plan, 3 industrial lots will be constructed over parcel Lot 1/D103123, Lot 2/DP1070888 and part of Lot 51/DP130176.

Flows from the development will connect into WSC's network at manhole GH07306, from where flows will gravitate via two sections of DN150 UPVC to a DN225 main (both constructed in 2007). Flows are then pumped southwest from SPS-MV13 to SPS-MV17 which in turn pumps to the Moss Vale Sewage Treatment Plant (STP). Figure 2-1 displays the development area.

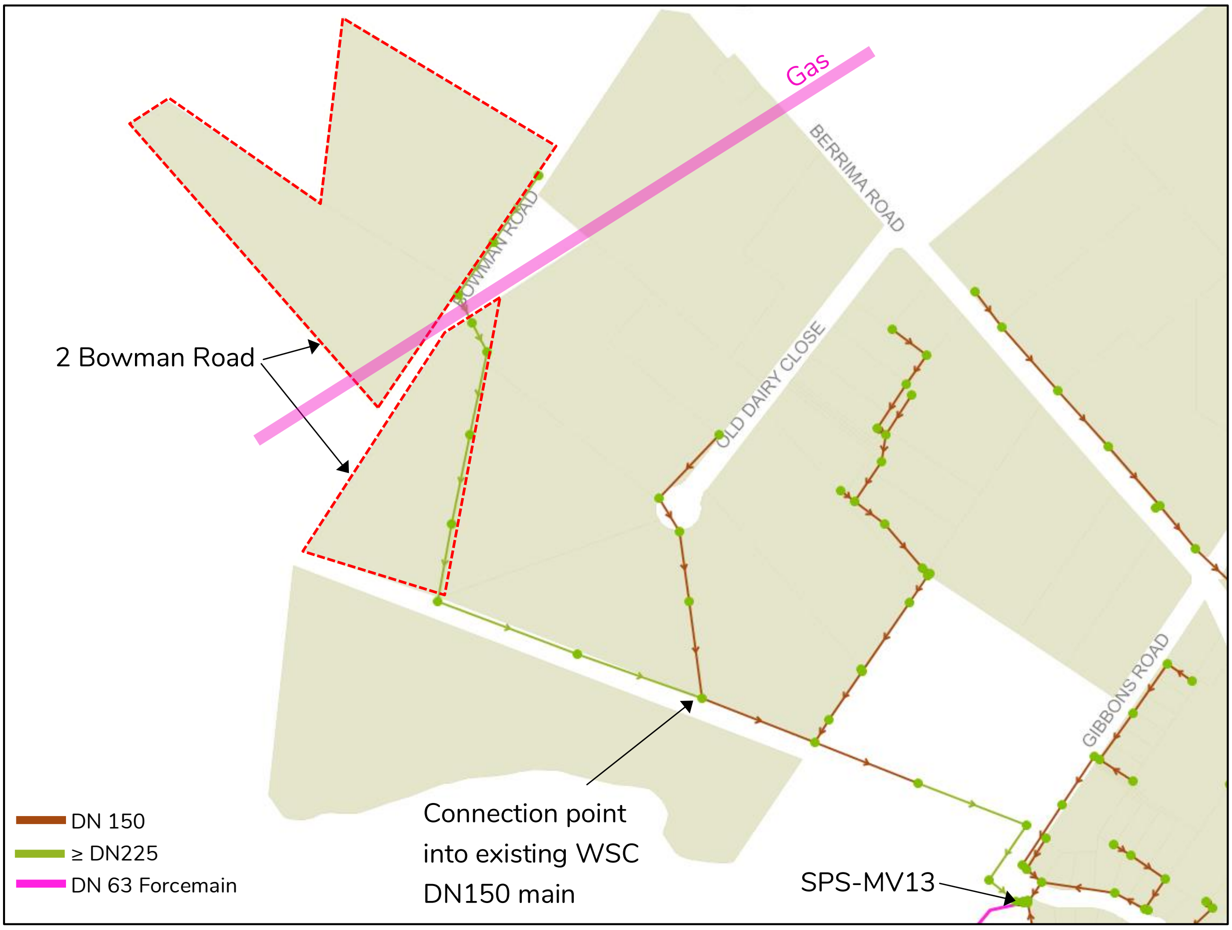
The site is traversed by two high pressure gas pipelines easement shown in Figure 1-2. The exact alignment and depth of the pipelines is not known. It has been assumed that servicing is possible across the pipeline easement as there are no WSC sewer assets north of gas pipeline.

This report presents two options for servicing this development.

- Option 1 is to service the development with gravity mains
- Option 2 is to use a pumped system.

The new gravity sewer is DN225 to be in compliance with Table 5.5 of the WSAA Gravity Sewerage Code of Australia, which states that industrial and commercial lots >300m^2 requires a connection to a minimum of a DN225 pipe. It should be noted that there are DN150 pipes in the gravity network downstream of the proposed connection point.

Figure 2-1: Development Site Servicing and Sewer Connection Point



2.2 WSC Design Standards

The Wingecarribee Shire Council (WSC) design standards applied in the assessment are shown in Table 2-1 and the calculation of the additional sewer load is shown in Table 2-2.

Table 2-1: Sewerage Design Standards

Sewer Loading		
Average sewer loading	*230*	*L/person/day*
Equivalent Person (EP) per Equivalent Tenement (ET)	*3.5*	
Light Industrial (ET per ha)	*15*	
Pumping Station		
Emergency storage detention time	*8 hr Average Dry Weather Flow (ADWF) as per WSA 02 code*	
Connection Size as per WSAA Gravity Sewerage Code of Australia v3.2 Table 5.5		
Other Requirements 1. There should be no dry weather overflow from the system 2. There should be no dry or wet weather overflow from a pumping station 3. The WSC level of service standard for Moss Vale is that sewerage infrastructure must have the hydraulic capacity to contain all flows associated with a 1 in 2-year rainfall event		

Table 2-2: Additional Sewer Loading

Additional Sewer Load (2 Bowman Road, Moss Vale)	
Category – Light Industrial[1] (7.9 ha x 15 ET)	*118.5 ET*
Total	*118.5 ET*
Dry Weather Flow	
Sewage Loading (kL/d)	95.39
Sewage Loading (L/s)	1.10
Wet Weather Flow *An inflow/infiltration (I/I) allowance of 2% runoff of the development area was used to provide a notional wet weather contribution to the sewerage system.*	

[1] The land is zoned General Industrial and Light Industrial. The Light Industrial category was chosen from section 64 Determinations of Equivalent Tenements Guidelines.

2.3 *Baseline WSC System Performance*

The wet weather baseline performance of the Moss Vale Sewer Model was assessed with a suite of 1 in 2-year design storms with durations ranging from 30-minutes to 24-hours being applied to average dry weather flow conditions.

2.3.1 Manhole Overflows

Five manholes are predicted to overflow in the catchment during the 24-hour 1-in 2-year design storm. The results are summarised in Table 2-3. The 24-hour duration storm has been deemed the critical event as this is the only event predicted to cause overflow.

Three of the manhole overflows are in parts of the catchment which are hydraulically independent from the proposed development and will not be affected by this proposal.

- Manhole GN00054 is predicted to overflow 2.8 kL during the 24-hour storm. It is located at the corner of an industrial area and is the first manhole upstream of Lackey Road (SPS-MV4) Sewage Pumping Station (SPS). It is at a corner of the network with the potential for overflows to end up in the field next to the industrial area.
- SPS-MV18 Wet Well (P00246) and MV18 Storage area are predicted to overflow by a combined 4.5 kL during the 24-hour storm. This location is part of the Young Road development (SPS MV18) and suggests a future problem rather than a current issue. The model has approximately 500 equivalent persons (EP) discharging into this pump station. The 2022 model build project indicates that the current population connected to this part of the sewerage network is approximately 210 EP. The sewage from the proposed development at 2 Bowman Road will not pass through this SPS.

There is overflow predicted at SPS MV17 and at the MV17 Storage. This pump station is located at the downstream end of the catchment at the Sewage Treatment Plant (STP). Flows from Bowman Road flow through this SPS to reach the STP. This overflow is as a result of current limitations at the STP.

Table 2-3: Baseline System Performance

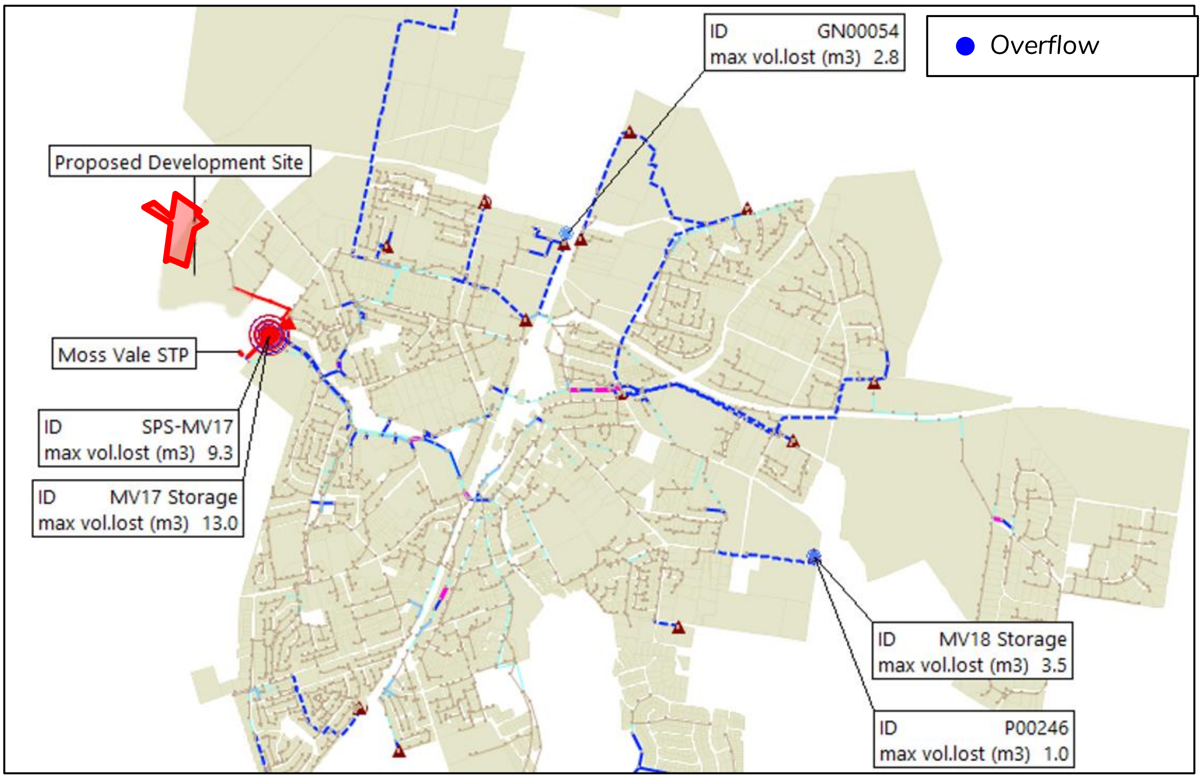
Node ID	ARI 2-year storm – Predicted Overflow Volume (kL)						
	0.5hr	1.0hr	2.0hr	3.0hr	6.0hr	12.0hr	24.0hr
SPS-MV17							9.3
MV17 Storage							13.0
GN00054							2.8
P00246							1.0
MV18 Storage							3.5
Total	0	0	0	0	0	0	28.6

Figure 2-2 displays the locations of predicted manhole overflows from all the design storms with the overflow volumes labelled for the 24-hour storm.

The design storms reveal that the current sewerage network does not meet the WSC sewer design standards.

Overflows at SPS-MV17 and MV17 Storage will be directly impacted by this development. It should be noted that these results include the future upgrade of MV-SPS17 to 45 L/s.

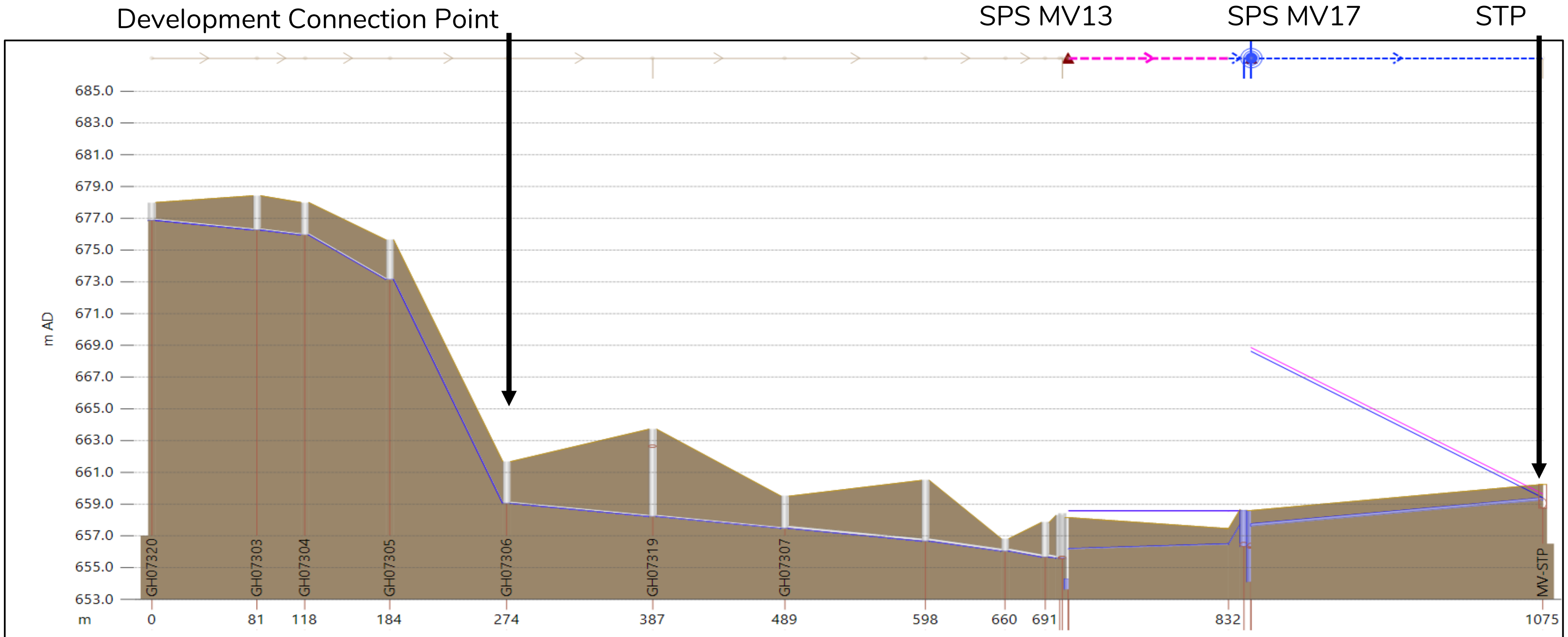
Figure 2-2: Manhole Overflow Locations – 1 in 2-year 24-hr (Base)



2.3.2 Surcharge

There is no predicted surcharge in the gravity network downstream of the proposed development location. The surcharge levels during the 24-hour 1 in 2-year design storm is shown in Figure 2-3.

Figure 2-3: Surcharge Downstream of Proposed Connection Point – 1 in 2-year 24-hr (Base)



Link	GH07320.1	-	GH07304.1	GH07305.1	GH07306.1	GH07319.1	GH07307.1	-	-	SPS-MV13A.1	-	MV17 Dummy.1
width (mm)	150	150	150	150	150	150	225	225	225	50	-	163
us inv (m AD)	676.850	-	675.930	673.125	659.020	658.190	657.440	656.640	-	656.155	-	657.600
ds inv (m AD)	676.240	-	673.125	659.020	658.190	657.440	656.640	656.010	-	656.459	-	659.242

Node	-	-	-	GH07305	GH07306	GH07319	GH07307	GH07308	-	-	-	-	MV17 Dummy	MV-STP
ground (m AD)	-	678.420	-	675.640	661.680	663.720	659.500	660.500	-	-	658.155	657.459	658.600	660.242

2.3.3 Emergency Storage

This section summarises the emergency storage available in the downstream SPS. The calculations of storage volume are available in Appendix A – Sewage Pump Station Storage Calculations.

Table 2-4: Summary of Pre-Development Storage Requirement SPS-MV13

Storage in Wet Well (kL)	17.1
Additional Storage (kL)	0
Average Dry Weather Flow (ADWF) (L/s)	0.44
ADWF (kL/day)	37.8
8 hours ADWF (kL)	12.6
Adequate >8 hours storage	

2.4 *WSC System Performance Including the Development*

As there are high pressure gas pipelines traversing the development two servicing scenarios were developed for this proposed development. One model uses a gravity sewer system (DN225), including a syphon to cross the gas pipelines, to service the development. This is shown in Figure 2-4.

The second option uses two pressure sewer units north of the gas pipeline with a shallow pressure main connecting into a gravity sewer connecting the third property. This servicing strategy is shown in Figure 2-5.

The impact of both servicing options on the system performance of the WSC network was reassessed for the suite of 1 in 2-year design storms. The results are presented in Table 2-5 and Table 2-6.

Figure 2-4: Option 1 – Gravity Sewer

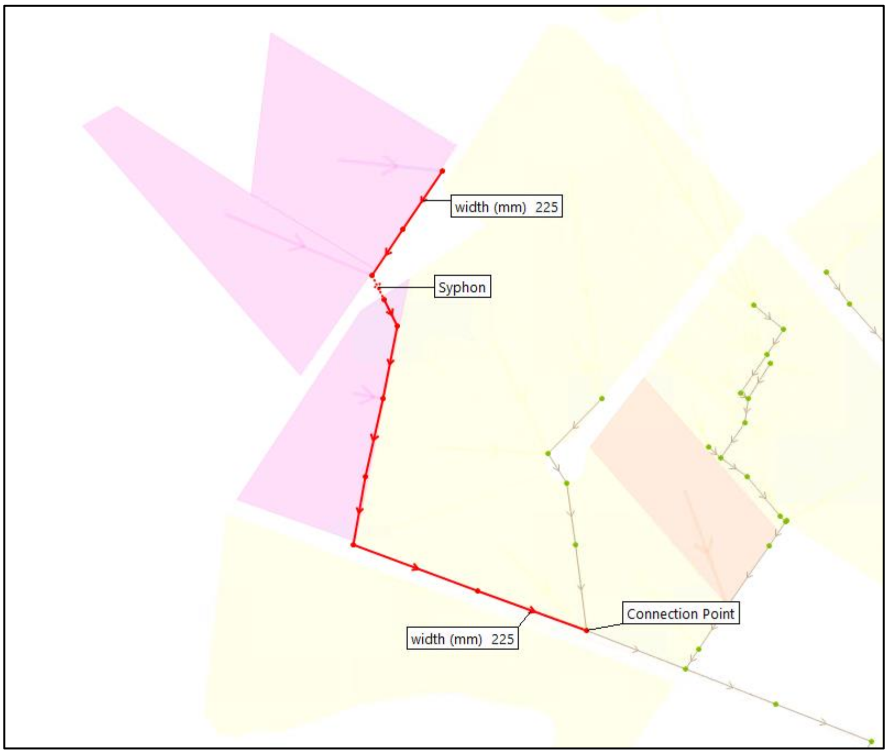
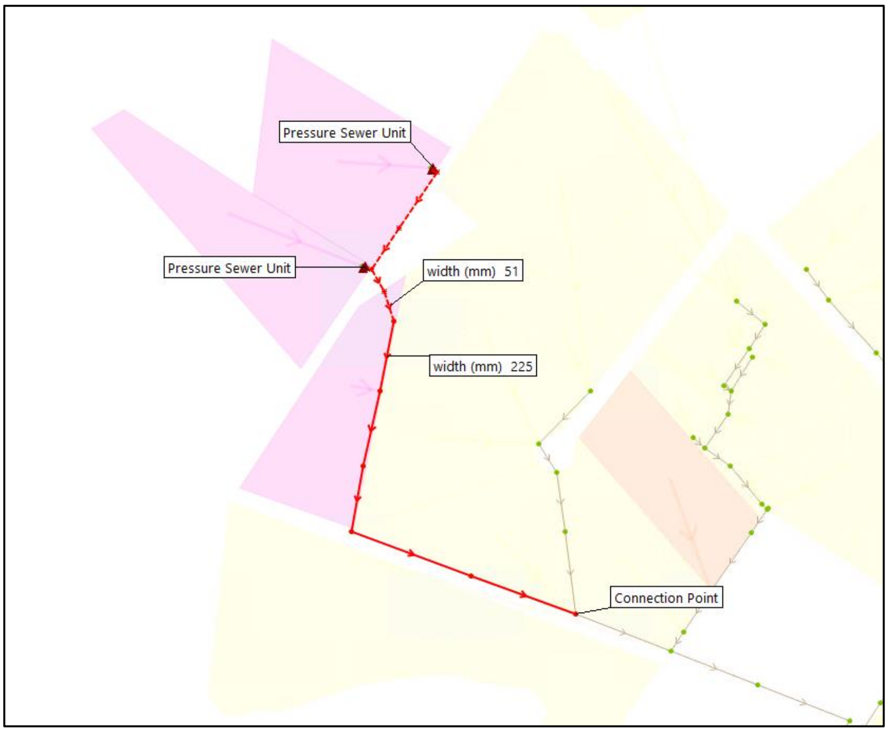


Figure 2-5: Option 2 – Pressure Sewer



2.4.1 Manhole Overflows

The critical duration storm duration remains the 24-hour storm.

Both the gravity and pressure sewer servicing options increase the predicted overflow volumes at SPS-MV17 and MV17 storage. This is expected as these locations were already at capacity. The modelling assumes that the planned upgrade of SPS-MV17 to 45 L/s has occurred.

Overflow is predicted to occur at manhole GH07309. This manhole is located upstream of SPS MV13. SPS MV13 has a duty flow rate of approximately 4.3 L/s and the estimated peak wet weather entering this SPS after development exceeds 6.0 L/s.

The predicted overflow volumes (Table 2-5 and Table 2-6) have a similar magnitude for both options. The pressure sewer option has a lower overflow volume due to flow attenuation in the individual wet wells.

Table 2-5: System Performance – Option 1 - Gravity Sewer

Node ID	ARI 2-year storm – Predicted Overflow Volume (kL)						
	0.5hr	1.0hr	2.0hr	3.0hr	6.0hr	12.0hr	24.0hr
GH07309		0.9	11.0	19.5	31.3	33.9	41.9
SPS-MV17					5.4	8.8	37.5
MV17 Storage					8.0	12.1	47.3
GN00054							2.8
P00246							1.0
MV18 Storage							3.6
Total	**0**	**0.9**	**11**	**19.5**	**44.7**	**54.8**	**134.1**

Table 2-6: System Performance – Option 2 - Pressure Sewer

Node ID	ARI 2-year storm – Predicted Overflow Volume (kL)						
	0.5hr	1.0hr	2.0hr	3.0hr	6.0hr	12.0hr	24.0hr
GH07309			0.1	4.1	9.3	9.6	11.9
SPS-MV17					4.6	8.7	36.3
MV17 Storage					6.6	12.0	45.6
GN00054							2.8
P00246							1.0
MV18 Storage							3.5
Total	**0**	**0**	**0.1**	**4.1**	**20.5**	**30.3**	**101.1**

Preferred Option

WSC prefer the adoption of Option 2. This is the construction of a DN225 gravity sewer to approximately the location of the gas pipeline. The properties north of the gas pipeline can be connected via a pumped system. The indicative layout is shown in Figure 2-6. To contain wet weather flows additional storage is required at SPS-MV13. 28 kL storage was included at SPS-MV13.

Figure 2-6: Preferred Option

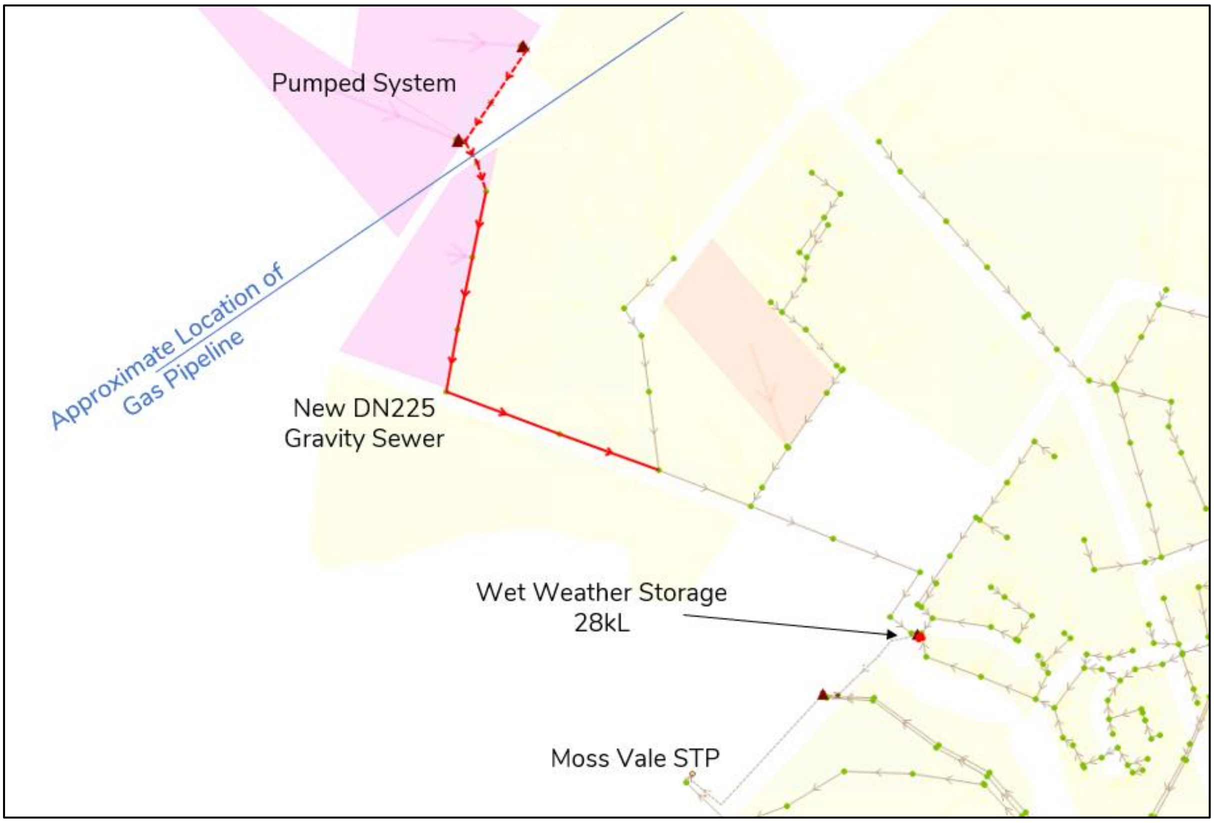


Table 2-7 summarises the System Performance. To remove the predicted overflow at SPS-MV17 the pump flow rate needs to be increased from 45 L/s to 50 L/s.

Table 2-7: System Performance – Preferred Option

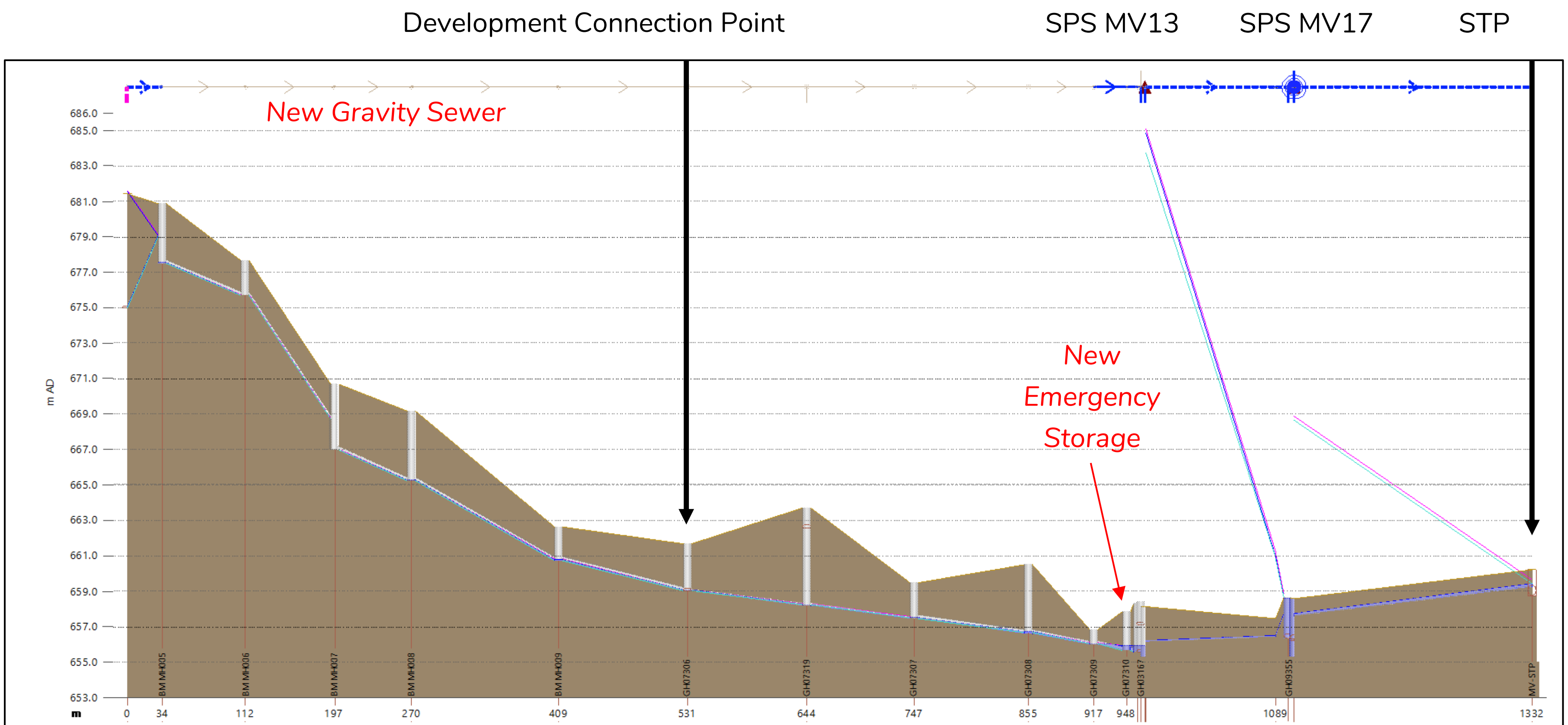
Node ID	ARI 2-year storm – Predicted Overflow Volume (kL)						
	0.5hr	1.0hr	2.0hr	3.0hr	6.0hr	12.0hr	24.0hr
SPS-MV17					4.3	8.3	35.3
MV17 Storage					6.1	11.2	44.6
GN00054							2.8
P00246							1.0
MV18 Storage							3.5
Total	**0**	**0**	**0**	**0**	**10.4**	**19.5**	**87.2**

2.4.2 Surcharge

The post-development (preferred option) design storm results show no significant increase in surcharge levels in the pipes directly downstream of the development location.

Figure 2-7 displays the long section of the main sewer downstream of the proposed development during the 1 in 2-year 24-hour design storm. The peak hydraulic grade line (HGL) under post-development conditions is shown as the blue shaded area within the pipes. For comparison the peak HGL from the pre-development simulation is displayed as the red line.

Figure 2-7: HGL Long Section During the 1 in 2-year 24-hour Design Storm – Preferred Option



Link	-	BM MH005.1	BM MH006.1	BM MH007.1	BM MH008.1	BM MH009.1	GH07306.1	GH07319.1	GH07307.1	GH07308.1	-	-	SPS-MV13A.1	-	MV17 Dummy.1
width (mm)	51	225	225	225	225	225	150	150	225	225	225	-	50	-	163
us inv (m AD)	-	677.500	675.676	666.953	665.227	660.751	659.020	658.190	657.440	656.640	-	-	656.155	-	657.600
ds inv (m AD)	-	675.676	668.693	665.227	660.751	659.020	658.190	657.440	656.640	656.010	-	-	656.459	-	659.242
User number 3															
US depth (m)	6.551	0.036	0.034	0.041	0.039	0.045	0.060	0.074	0.063	0.059	0.057	-	28.683	-	11.065
US flow (l/s)	2.32	2.32	3.72	3.72	3.72	3.72	4.59	6.89	6.88	6.88	6.87	-	4.27	-	45.00

Node	-	BM MH006	BM MH007	BM MH008	BM MH009	GH07306	GH07319	GH07307	GH07308	-	-	-	-	MV17 Dummy	MV-STP
ground (m AD)	680.892	677.676	670.693	669.181	662.618	661.680	663.720	659.500	660.500	-	-	658.155	657.459	658.600	660.242
vol.lost (m3)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	

2.4.3 Emergency Storage

This section summarises the emergency storage available in the downstream SPS. The calculations of storage volume are available in Appendix A – Sewage Pump Station Storage Calculations.

Table 2-8: Summary of Post-Development Storage Requirement SPS-MV13

Storage in Wet Well (kL)	17.1
New Additional Storage (kL)	28.0
Average Dry Weather Flow (ADWF) (L/s)	1.54
ADWF (kL/day)	133.2
8 hours ADWF (kL)	44.4
Adequate – assuming construction of additional 28 kL	

2.5 *Sewage Treatment Plant Capacity*

The Moss Vale STP is in the design phase of being upgraded as it only has a capacity of 9,000 EP and is operating at its design capacity.

There are plans to increase the STP's treatment capacity to cater for approximately 20,000 EP.

2.6 *Sewer Assessment Summary*

The Moss Vale sewer model was updated for use as the baseline model in this assessment. This includes a future upgrade at SPS-MV17, increasing the pump duty rate to 45 L/s.

The new gravity sewer is DN225 to be in compliance with Table 5.5 of the WSAA Gravity Sewerage Code of Australia. It should be noted that there are DN150 pipes in the gravity network downstream of the proposed connection point, however these do not appear to be creating hydraulic restrictions.

The inclusion of the proposed development at 2 Bowman Road will increase average dry weather flows by approximately 1.1 L/s but will not create any dry weather pipe capacity issues within the gravity sewer reticulation network.

Additional emergency storage of 28kL is required at SPS-MV13 because of this proposed development.

The model predicts that the current sewer network is unable to contain the 24-hour storm. The addition of this development increases the predicted overflow volumes in several locations impacted by this development.

WSC's preferred option is for the construction of a new DN225 gravity sewer to the gas pipeline. The properties north of the pipeline will be connected by a pumped system. The construction of additional storage at SPS-MV13 will be required.

The upgrade of SPS MV17 from 45 L/s to 50 L/s will be required to resolve all the predicted overflow issues caused by this development. The upgrade of SPS-MV17 will be included in WSC's project.

The Moss Vale STP is operating at its design capacity of 9,000 EP with plans for it to be upgraded soon.

3 Water Supply System

3.1 *Introduction*

WSC provided a calibrated InfoWorks WS Pro hydraulic model of the water supply system to assess the impact of the additional demand from the development at 2 Bowman Road, Moss Vale on the water supply network.

Analysis of the existing and future network including the proposed development was undertaken for the Peak Day Demand (PDD) scenario.

3.2 *WSC Design Standards*

The following WSC design standards were applied in this assessment.

Table 3-1: Water Design Standards

Water		
Demand		
Average Day Demand (ADD)	260	*L/person/day*
ADD (per dwelling)	684	*L/dwelling/day*
Peak Day Demand (PDD) (per dwelling)	3000	*L/dwelling/day*
Max Hour / PDD Factor	2.76	
Pressure		
Minimum required at the domestic meter	12	*m*
Maximum should be less than	90	*m*
Fire flow - Residential	*10 L/s*	*at 15 m residual pressure in the water main*
Fire flow – Commercial/Industrial	*20 L/s*	
Velocity & Headloss		
Maximum velocity in mains	*2* [2]	*m/s*
Target maximum[3] *head loss in mains*	*5 m/km*	*for reticulation mains*
Target maximum[2] *head loss in mains*	*3 m/km*	*for trunk mains*
Reservoir		
Total storage	*24hr PDD*	*ML*
At the lowest operating range	*12hr PDD*	*ML*

[2] Velocities in the reticulation network < 2 m/s. Velocities exceeding this value should be approved by WSC. For firefighting, velocities up to 4.0 m/s are acceptable.

[3] These are target values and can be exceeded in certain circumstances in consultation with WSC.

The development demand was estimated using information provided by the client to determine the equivalent tenement (ET) loading.

Table 3-2: Water Demand Estimate

Additional Water Demand Estimate	
Category – Light Industrial *7.9 ha lot area (15 ET/ha)*	118.5 ET
Total Number of ET	*118.5 ET*
Average Day Demand (ADD) Total	81.0 kL/d 0.9 L/s
Peak Day Demand (PDD) Total	355.5 kL/d 4.1 L/s
Max Hour Demand (MHD) Total	40.9 kL/hr 11.3 L/s

Category from the Water Directorate Report: Section 64 Determinations of Equivalent Tenements Guidelines (2017)

3.3 Hydraulic Modelling

The development at 2 Bowman Road is supplied by a combination of RES-BU5 and the Wingecarribee Water Treatment Plant depending on the time of day.

The schematic diagram below (Figure 3-1) provides a general overview of the flow directions, zones, and key assets affected by this development with an overview of the water network presented in Figure 3-2.

Figure 3-1: Network Schematic

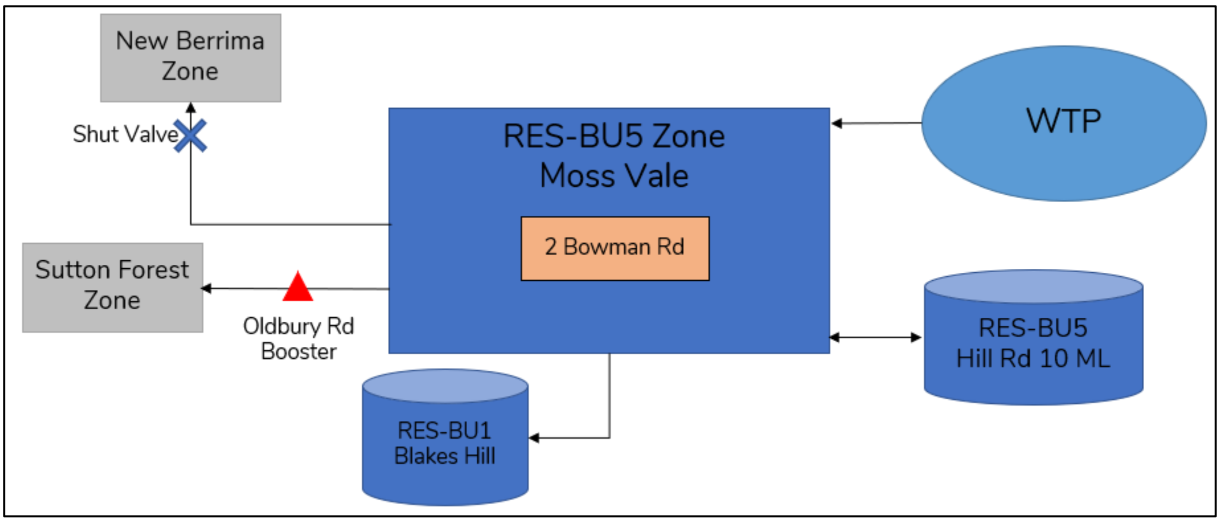
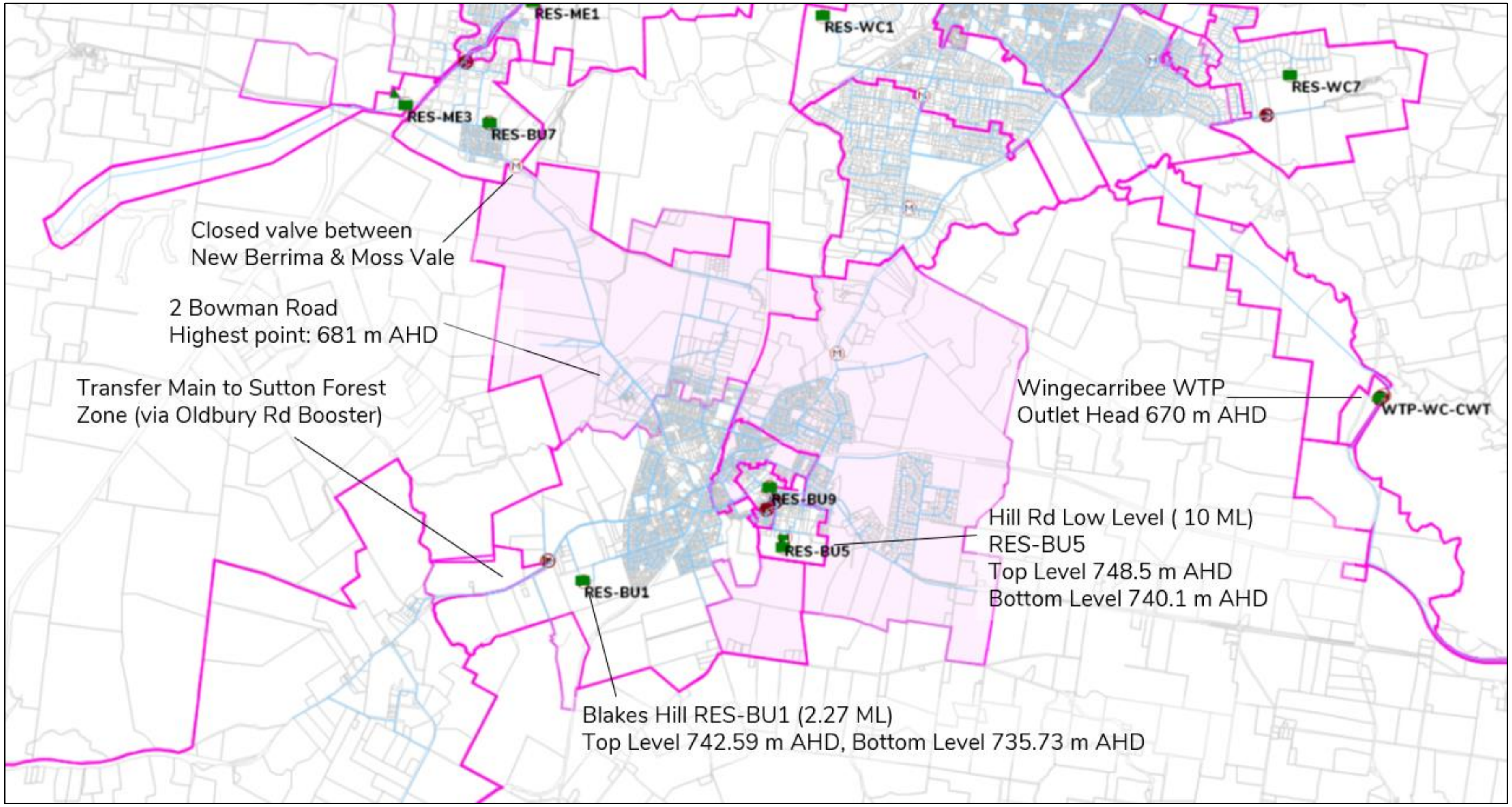


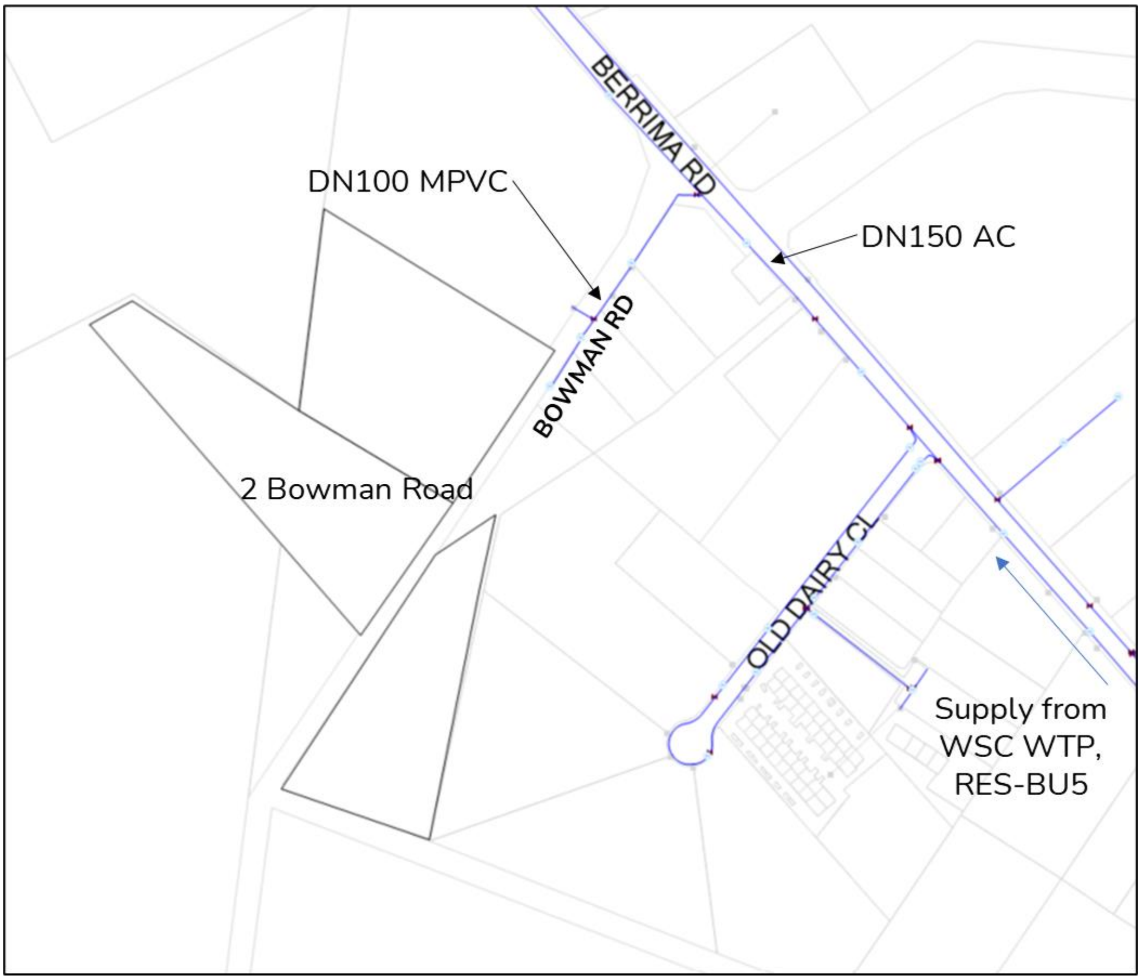
Figure 3-2: Overview of the Development and Water Supply Network



3.3.1 Development Servicing

The development will connect to the existing DN100 MPVC main at Bowman Road which is supplied by a DN150 AC main along Berrima Road.

Figure 3-3: Development Layout and Water Supply Connection



3.3.2 Model Configuration

InfoWorks WS Pro v2021.11.3 was used to perform the development assessment.

A 72-hour duration simulation (representing three consecutive peak demand days) was adopted for the modelled scenarios, except where otherwise indicated.

The base model provided to UWS contained modelling for non-revenue water (NRW) in the Alternative Demand function. The NRW modelling was equally applied, without any changes, to the development assessment simulation to ensure a fair comparison between pre- and post- development network performance.

As previously advised by WSC, valve NV00204 has been closed in the base and development scenarios to reflect the updated network zoning for New Berrima.

Model Items

Model items used in this assessment are:

- Network – WSC Water Supply Network CAL 0.04 SPA 0.04,
- Control – WSC Water Supply Control CAL 0.04 SPA 0.03 - New Berrima Update,
- Demand Diagram – UWS Default MDD PHF 3.0 + Growth 0.01 DevAss,
- Demand Scaling – MDD 2.0xADD Category Only 0.1 + DevAss & DevAss-COM x1, and
- Alternative Demand item – Alt Dem 2020 Master Plan ADD 2021 0.2 + development demand.

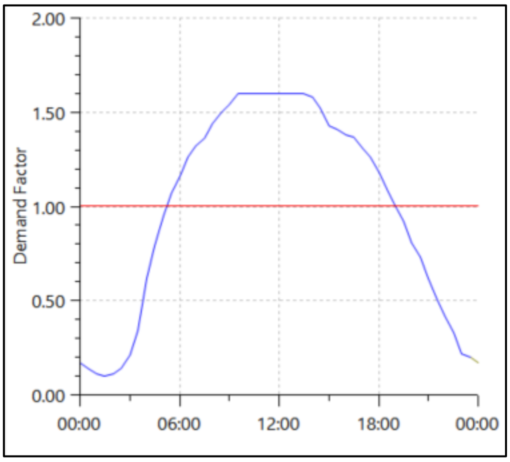
Three customer points (one for each of the three lots) were added to represent the development at 2 Bowman Road. The loading on each of those three customer points was determined by the lot floor area quoted in the engineering drawings provided to UWS pro-rated against the consumption rate of 15 ET/ha. Table 3-3 summarises the peak demand day loading simulated on the three customer points.

Table 3-3: Loading on Development Assessment Customer Points

Customer Point	Lot Area (ha)	Avg Demand (L/s) PDD	Avg Demand (kL/day) PDD
Lot 1	3.0	1.58	136.4
Lot 2	2.7	1.40	121.1
Lot 3	2.1	1.11	96.3
Total	7.8	4.09	353.8

All three customer points have been allocated to the nearest existing node (NH07693) along Bowman Road. Demand has been simulated with a commercial diurnal profile to model the impact of this development (Figure 3-4).

Figure 3-4: Consumption Profile for Commercial Development Assessment



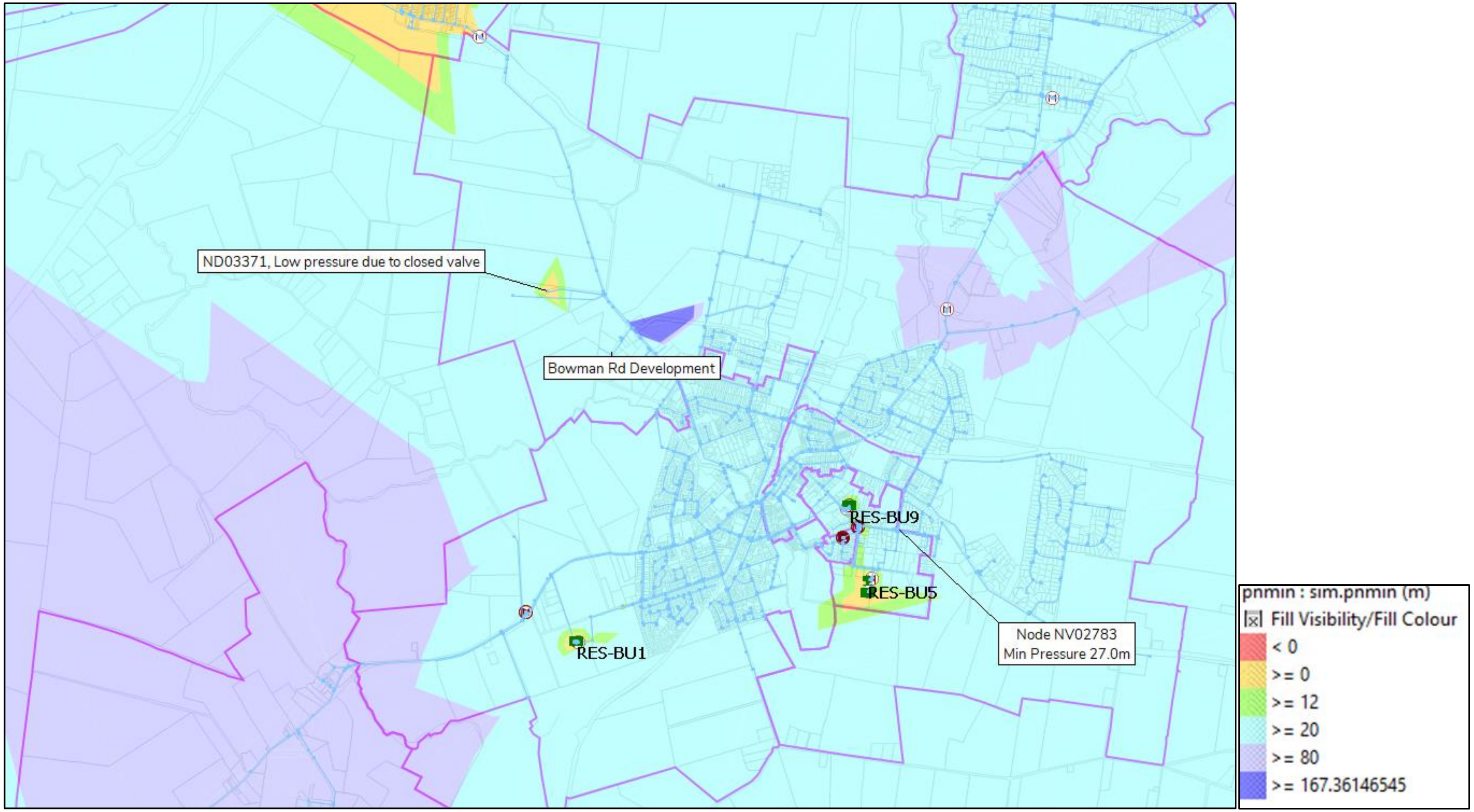
3.3.3 Base Case System Performance

Minimum Pressures

The proposed development is located within the Hill Road Reservoir (RES-BU5) zone. Within this zone, all demand nodes have a predicted minimum pressure above 20 m. The lowest predicted pressure is 27.0 m at node NV02783. This node is located on the DN375 AC main near Moss Vale High School.

Figure 3-5 shows the minimum pressure contours in the network base case.

Figure 3-5: Minimum Pressure Contours – Base Case



Maximum Pressures

181 nodes and 443 fire hydrants with demand within zone RES-BU5 are predicted to experience maximum pressures exceeding 90 m.

The highest pressure experienced at a node with demand attached is 134.9 m at ND04305 (653.7 m AD) which also experiences a minimum pressure of 86.9 m. This node is just north of the Wingecarribee River at Loyalty Lane.

Reservoir Storage

This development will draw water from reservoir RES-BU5 which is one of several reservoirs supplied by the Wingecarribee Water Treatment Plant.

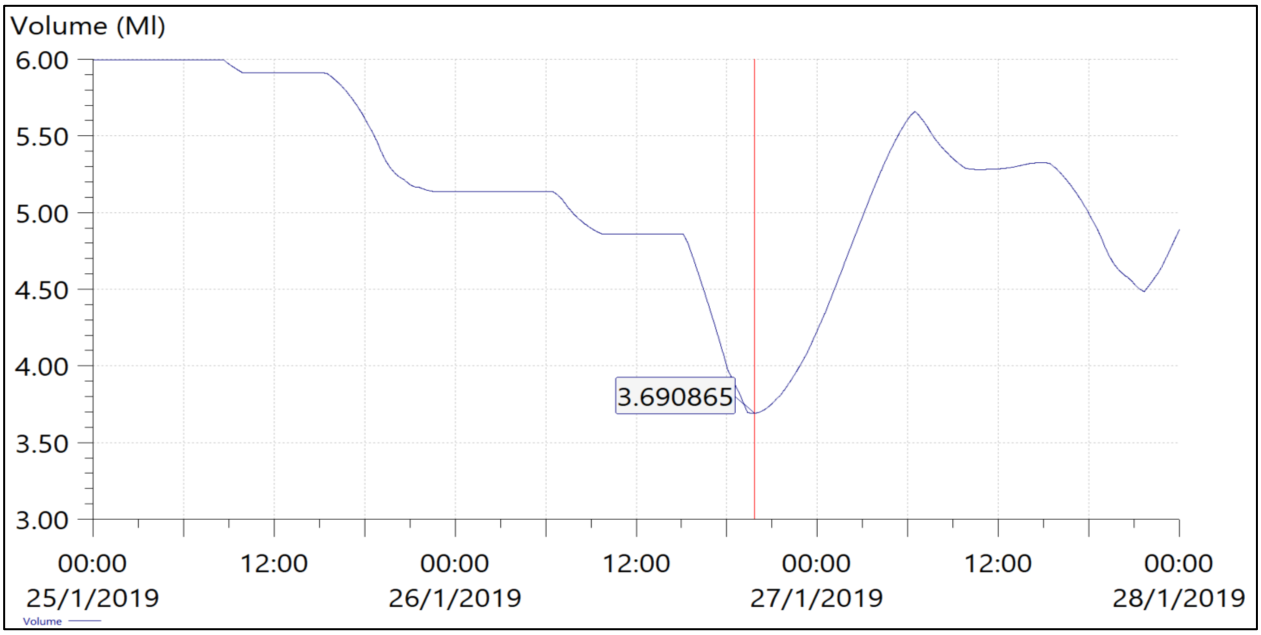
Reservoir RES-BU5 has a storage volume of 10 ML.

The PDD zone consumption for polygon RES-BU5 is 4.0 ML/day pre-development which means the WSC requirement of having a reservoir sized for 24 hours of PDD is met.

The minimum volume reached over the simulation period is 3.7 ML which is more than 12 hours of PDD (2.0 ML). This satisfies the minimum volume requirement.

Figure 3-6 shows that over three consecutive PDD days of RES-BU5 will deplete to about 3.7 ML before recovering.

Figure 3-6: Reservoir RES-BU5 Storage Volume (ML) – Base Case



Peak Velocity and Headloss

There are 81 pipes and 46 valves with a diameter of 300 mm or less in zone RES-BU5 that are predicted to experience a maximum headloss greater than 5 m/km.

There are 31 pipes and 5 valves with a diameter greater than 300 mm in zone RES-BU5 that are predicted to experience a maximum headloss greater than 3 m/km.

4 pipes and 4 valves are predicted to experience velocities above 2 m/s in zone RES-BU5 in the Base Case scenario. The highest velocity predicted in this zone is 14.8 m/s at valve NV001725 which results in a predicted headloss of 3.1 m.

3.3.4 System Performance Including Development

Minimum Pressures

Post development minimum pressures at all demand nodes within zone RES-BU5 are predicted to be above 20 m.

The lowest pressure is still predicted to be at node NV02783, as in the pre-development scenario. The minimum pressure at this node post-development is 25.5 m compared to 27.0 m pre-development.

Figure 3-7 shows the minimum pressure contours with the inclusion of the additional development.

Figure 3-8 shows the difference in minimum pressures caused by the development. Within zone RES-BU5, the largest decrease in minimum pressure is 3.3 m at node NV04659Y. This node is on the existing dead-end line that services Bowman Road and the proposed development. The predicted minimum pressure at node NV04659Y decreases from 50.8 m to 47.5 m.

Figure 3-9 shows the predicted minimum pressures at individual customer points.

Figure 3-7: Minimum Pressure Contours – Base Case + Development

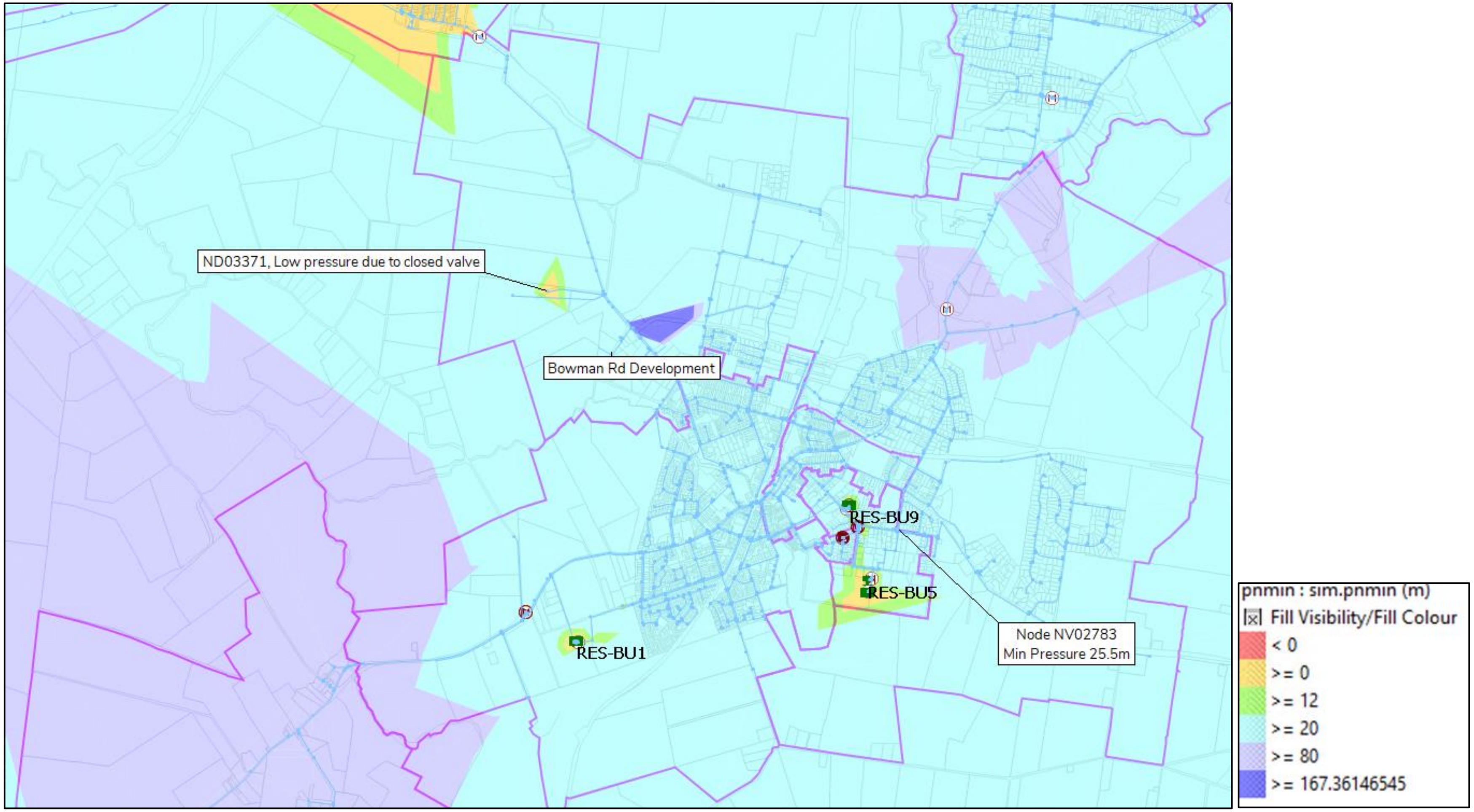


Figure 3-8: Difference in Pre- and Post-Development Minimum Water Pressure

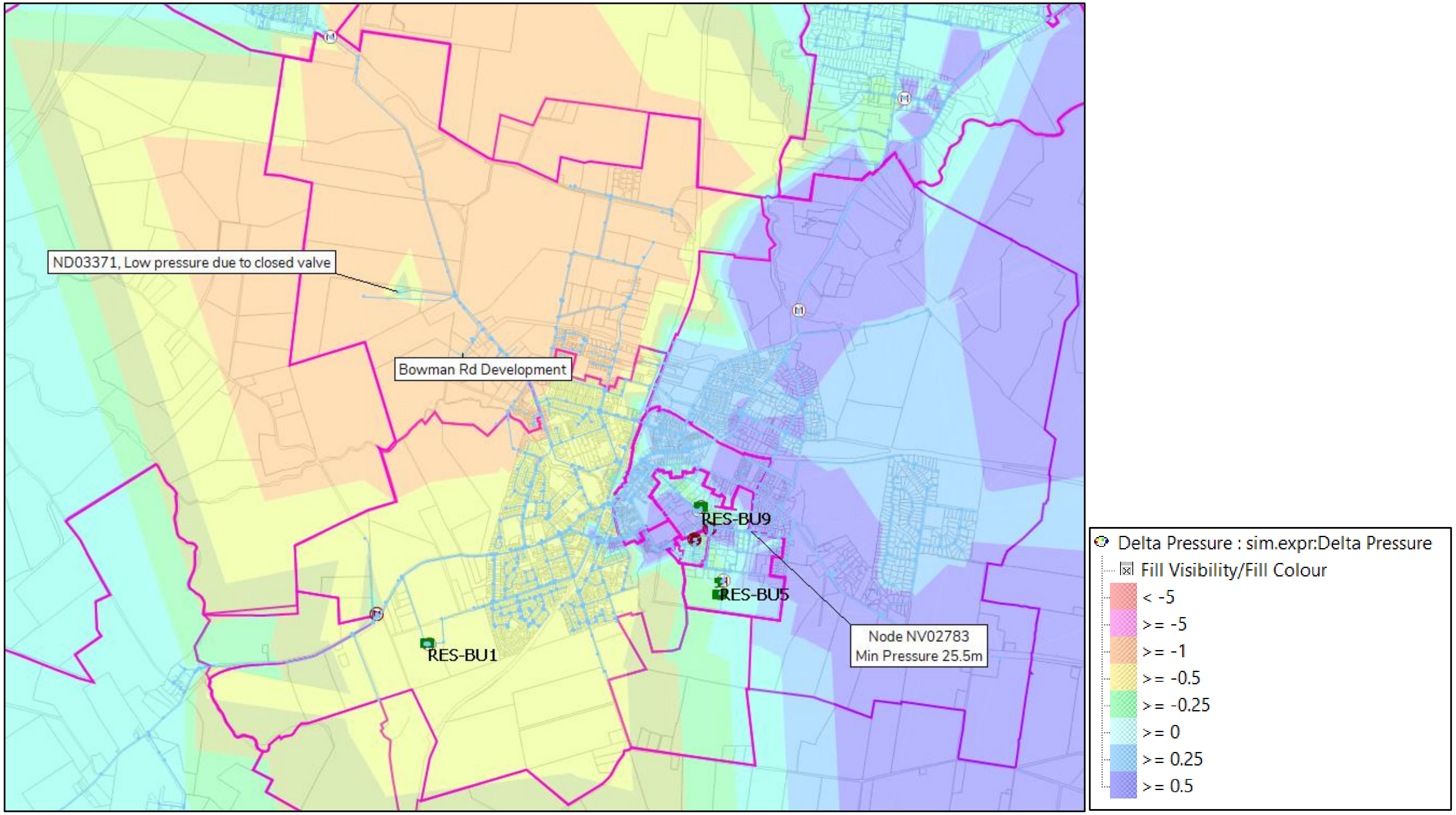
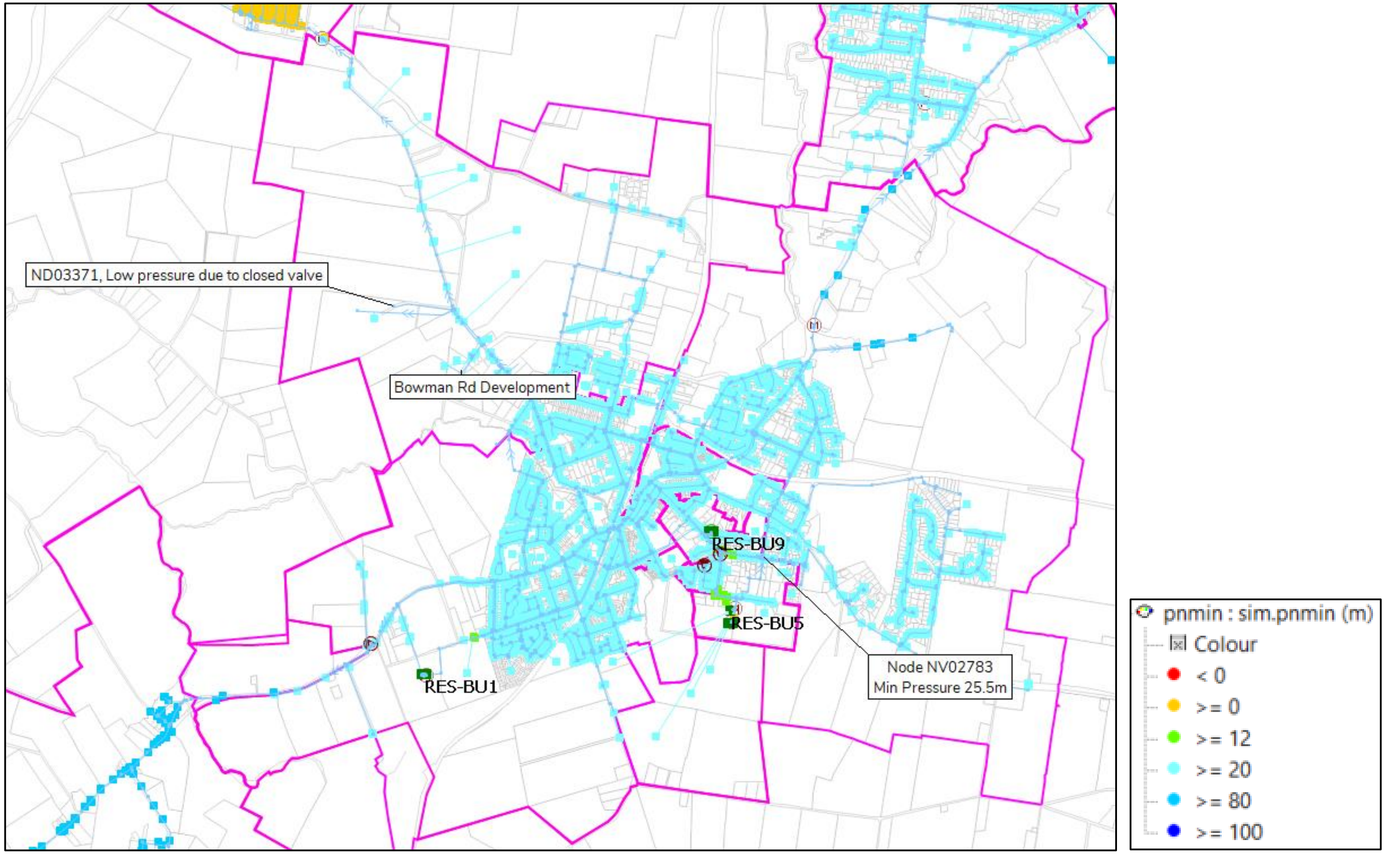


Figure 3-9: Minimum Pressure Customer Points – Base Case + Development



Maximum Pressures

181 nodes and 444 hydrants within zone RES-BU5 (with demand allocated to these nodes) are predicted to experience maximum pressures exceeding 90 m post-development. This is only 1 hydrant more than the pre-development analysis.

This additional hydrant is NH07693 which is the near the proposed development site. It has no demand allocated in the pre-development model but has the future consumption from 2 Bowman Road assigned to it.

The highest pressure experienced at a node (post-development) with demand attached continues to be node ND04305. It recorded a maximum pressure of 134.9 m pre-development and is expected to reach a maximum pressure of 134.8 m post-development.

Reservoir Storage

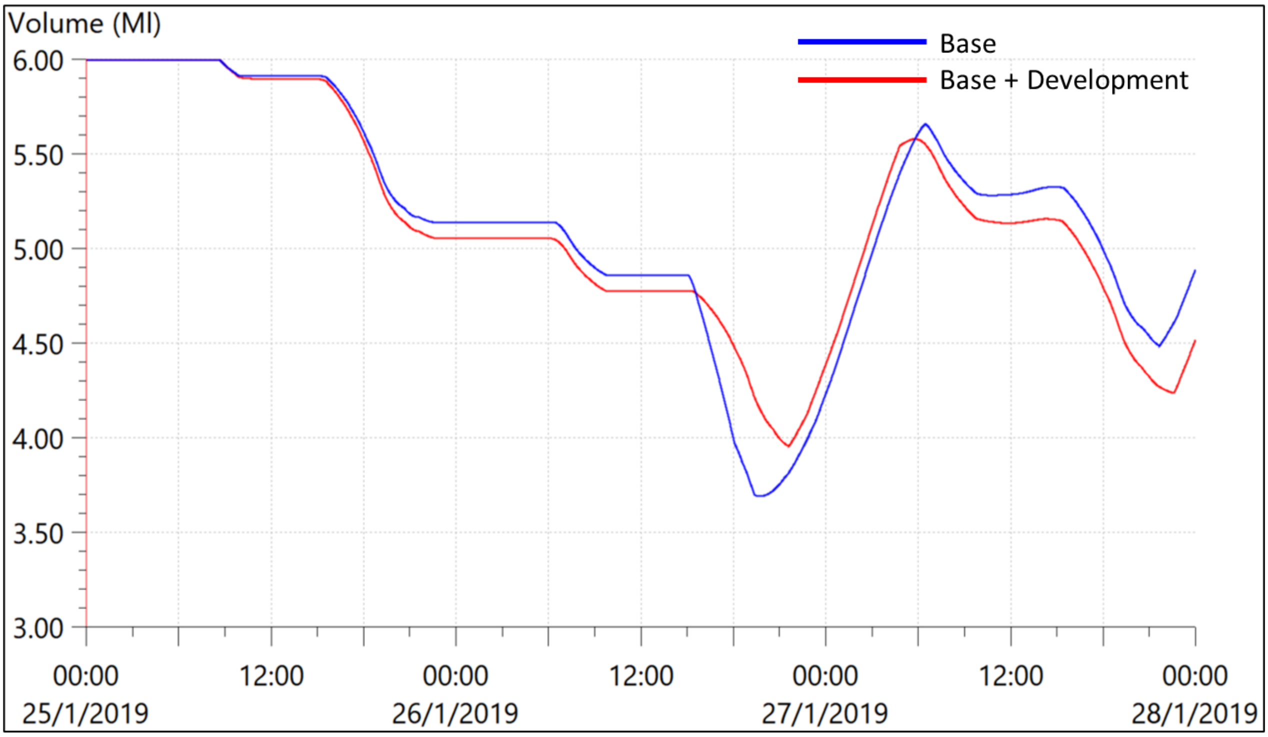
The modelled post-development PDD consumption in zone polygon RES-BU5 is 4.4 ML/day.

The post-development daily PDD zone consumption is less than reservoir RES-BU5's storage capacity (10 ML) and so, the WSC requirement for a minimum of 24 hours of PDD is met.

The requirement for a reservoir minimum depth exceeding 12 hours of PDD (2.2 ML) is also met.

Figure 3-10 shows the impact of the development on the predicted volume in reservoir RES-BU5. The increase in demand at RES-BU5 triggers a reservoir fill cycle earlier post-development which results in less drawdown during the peak hours of the second day.

Figure 3-10: Reservoir RES-BU5 Depth



Pipe Velocity & Headloss

There are 90 pipes and 51 valves with a diameter of 300 mm or less in zone RES-BU5 that are predicted to experience a maximum headloss greater than 5 m/km. This is an increase of 9 pipes and 5 valves from the pre-development scenario.

There are 31 pipes, 5 valves and 1 meter with a diameter greater than 300 mm in zone RES-BU5 that are predicted to experience a maximum headloss greater than 3 m/km. This is an increase of 1 meter.

The same 4 pipes and 4 valves predicted to experience velocities above 2 m/s in the pre-development scenario.

A summary of pipes exceeding the target maximum headloss is shown in Appendix B.

Table 3-4 shows the predicted maximum pipe velocities for the pre and post-development scenarios.

Table 3-4: Velocity Summary Results

Model ID	Type	Diameter (mm)	Maximum Velocity (m/s)	
			Base	+ Dev
NP00908 (ND00327.ND00328.1)	Pipe	96.50	2.17	2.17
NP00908 (ND00328.NH06849.1)	Pipe	96.50	2.17	2.17
NP00908 (NH06849.NV01781X.1)	Pipe	96.50	2.17	2.17
NP00908 (NV01781Y.ND00326.1)	Pipe	96.50	2.17	2.17
NV01725 (NV01725X.NV01725Y.1)	Valve	100.00	-14.84	-15.07
NV01743 (NV01743X.NV01743Y.1)	Valve	200.00	-3.31	-3.34
NV01781 (NV01781X.NV01781Y.1)	Valve	100.00	2.02	2.02
NV04394 (NV04394X.NV04394Y.1)	Valve	100.00	12.11	-8.97

3.4 *Fire Flow*

Fire flow simulations were run to determine if the existing reticulation network and the proposed pipes within the development site could meet the 20 L/s flow requirement for firefighting for industrial lots while maintaining 15 m of residual pressure at 19:00 hours (peak demand time).

The hydrants tested are shown in Figure 3-11.

Initial simulations showed that there is insufficient pressure and pipe capacity in the local network to supply 20 L/s of water through the single existing DN100 pipe along Bowman Road while maintaining 15 m of residual head. The headloss through the existing pipe is too high.

The hydraulic performance of the hydrants used in fire flow testing are shown in Table 3-5. These are unsatisfactory and network augmentations were investigated.

Figure 3-11: Fire Hydrant Test Locations

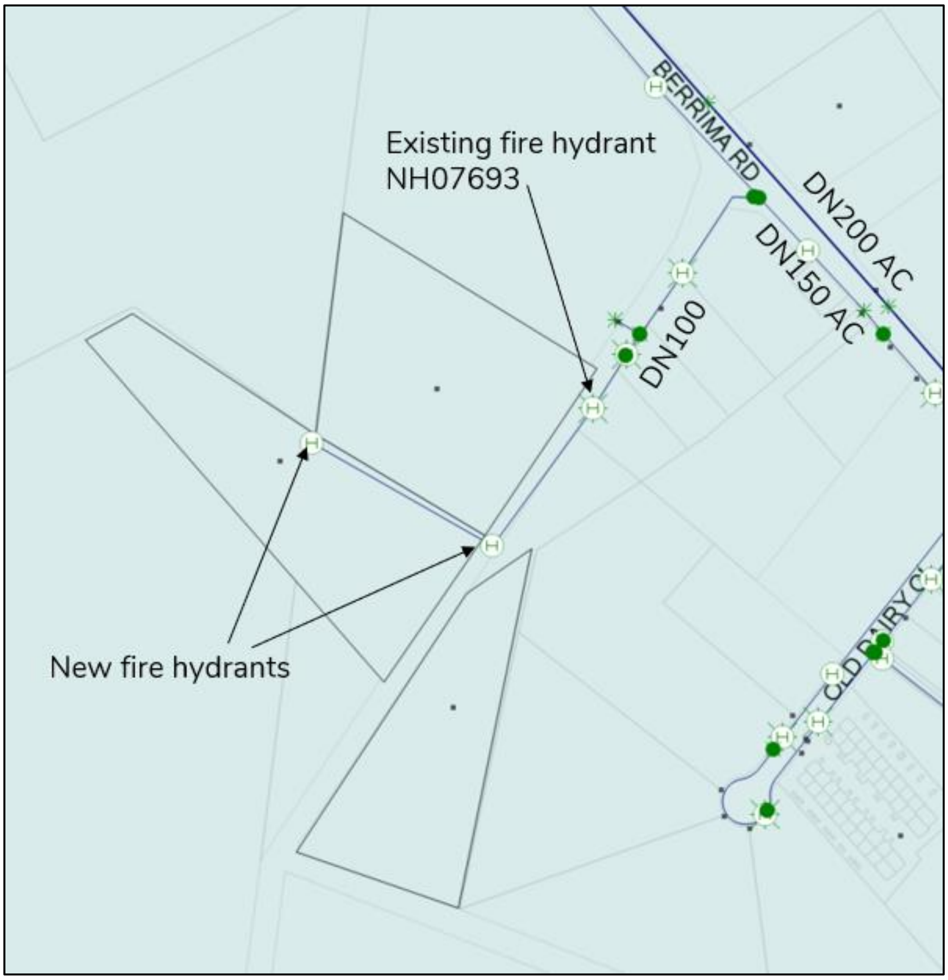


Table 3-5: Fire Flow Summary Results

Node Tested	Location	Results
Bowman_Rd_1	Hydrant within proposed development	18.1 L/s with 4.9 m residual pressure
Bowman_Rd_2	Hydrant within proposed development	16.3 L/s with 4.2 m residual pressure
NH07693	Existing hydrant along Bowman Road	20.0 L/s with 17.6 m residual pressure 23.1 L/s with 7.5 m residual pressure

3.4.1 Fireflow Augmentations

As the proposed DN100 water main is unable to achieve 20 L/s it will be necessary at a minimum to upgrade or duplicate the water main in Bowman Road.

Incremental increases of the diameter of the proposed connection from DN100 to DN150 were trialled. To achieve the required fire flow it is necessary to:

- the diameter of the proposed assets needs to be at least DN150,
- increase the existing water main in Bowman Rd from DN100 to at least DN150 (upsize or duplication would work), and
- install a DN150 cross connection between the DN150 and DN200 AC mains in Berrima Rd.

These changes are shown in Figure 3-12. The predicted result for this configuration is shown in Table 3-6.

Figure 3-12: Required Augmentation

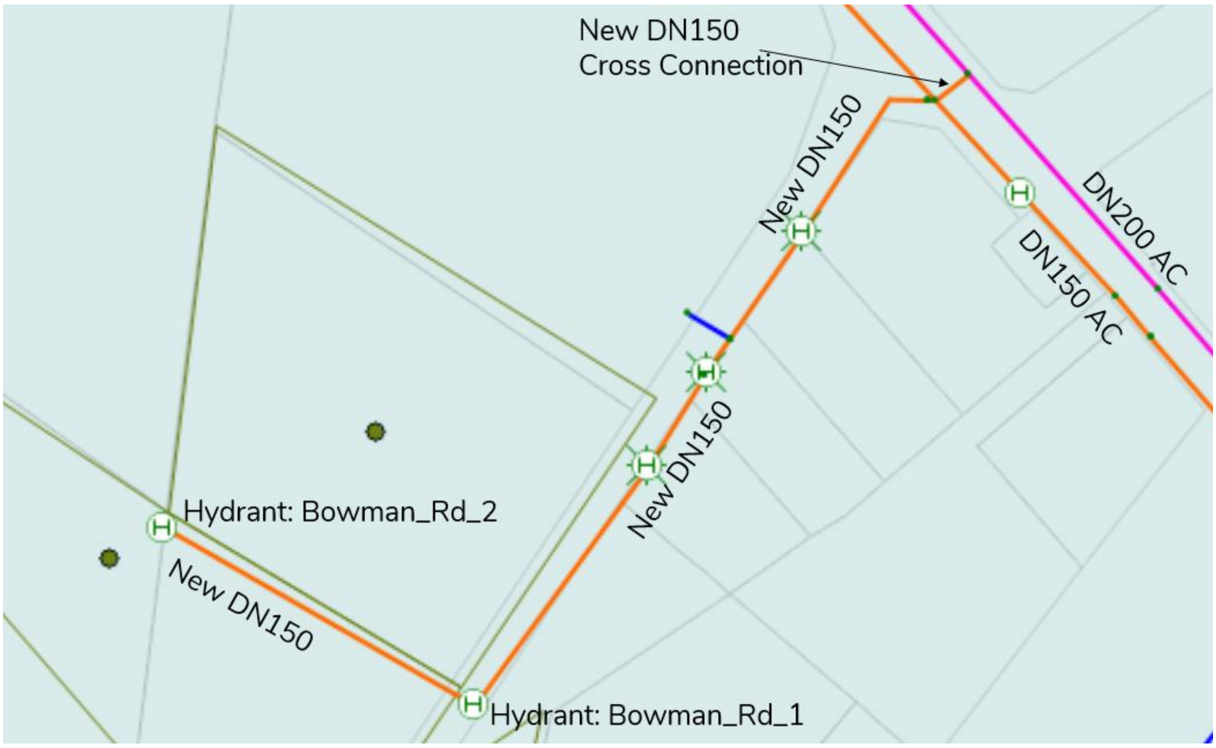


Table 3-6: Fire Flow Summary Results – Augmentation

Node Tested	Location	Results
Bowman_Rd_1	New Hydrant within proposed development	20.0 L/s with 35.1 m residual pressure 32.2 L/s with 15.0 m residual pressure
Bowman_Rd_2	New Hydrant within proposed development	20.0 L/s with 33.4 m residual pressure 29.9 L/s with 15.0 m residual pressure
NH07693	Existing hydrant on Bowman Road	20.0 L/s with 38.2 m residual pressure 36.1 L/s with 15.0 m residual pressure

3.5 *Water Supply Assessment Summary*

The results of the hydraulic modelling indicate that the additional demand from this development has a minor impact on the overall performance of the water supply network during PDD.

However, to achieve compliance with fireflow requirements the following network augmentation will be required.

- New DN150 connection,
- DN150 cross connection between DN150AC and DN200AC mains in Berrima Rd, and
- Upsize or duplicate existing DN100 water main in Bowman Road to a minimum of DN150.

Appendix A – Sewage Pump Station Storage Calculations

Summary of Storage Availability SPS-MV13

Detail	**Value**	**Source**
Ground Level	RL 658.155 m	Hydraulic Model
Overflow Level	N/A	
Wet Well Diameter (Shaft)	2400 mm	Hydraulic Model
Storage in Wet Well above Cut In	17.1 kL	
Cut In Level	RL 654.380 m	Hydraulic Model
Incoming Sewer IL	RL 655.405 m	Hydraulic Model
Wet Well Diameter (Chamber)	2400 mm	Hydraulic Model
Cut Out Level	RL 654.065 m	Hydraulic Model
Manhole Floor Level	RL 653.615 m	Hydraulic Model
Additional Storage	0 kL	

Summary of Storage Availability SPS-MV17

Detail	Formatted	Source
Ground Level	RL 658.600 m	Hydraulic Model
Overflow Level	N/A	
Wet Well Diameter (Shaft)	3000 mm	Hydraulic Model
Storage in Wet Well above Cut In	27.4 kL	
Cut In Level	RL 654.720 m	Hydraulic Model
Incoming Sewer IL	RL 656.270 m	Hydraulic Model
Wet Well Diameter (Chamber)	3000 mm	Hydraulic Model
Cut Out Level	RL 654.280 m	Hydraulic Model
Manhole Floor Level	RL 654.090 m	Hydraulic Model
Additional Storage	105.0 kL	Hydraulic Model

Appendix B – Pipe Headloss Results

Asset ID	Model ID	Diameter (mm)	Max Headloss (m/km)	
			Pre	Post
Target maximum headloss in reticulation mains (≤ 300 mm) of 5 m/km				
NP01382 (Pipe)	ND00049.NV01840X.1	96.50	6.27	6.27
NP01304 (Pipe)	ND00085.ND00084.1	96.50	5.04	7.66
NP00507 (Pipe)	ND00132.NV02177X.1	96.50	14.03	14.03
NP00610 (Pipe)	ND00294.NH02742.1	96.50	7.90	7.90
NP00611 (Pipe)	ND00299.NV01665X.1	96.50	9.09	9.10
NP00903 (Pipe)	ND00307.ND04369.1	96.50	5.65	5.65
NP00917 (Pipe)	ND00310.ND00319.1	96.50	6.42	6.41
NP00904 (Pipe)	ND00310.NH02862.1	96.50	5.02	5.02
NP00907 (Pipe)	ND00313.NV01721X.1	96.50	16.89	16.90
NP00597 (Pipe)	ND00316.ND00315.1	96.50	9.30	9.31
NP00597 (Pipe)	ND00317.ND00316.1	96.50	9.30	9.31
NP00917 (Pipe)	ND00319.NV01685X.1	96.50	5.66	5.66
NP00597 (Pipe)	ND00325.NV01757X.1	96.50	9.30	9.31
NP00598 (Pipe)	ND00325.NV01758X.1	96.50	11.46	11.48
NP00908 (Pipe)	ND00327.ND00328.1	96.50	67.57	67.57
NP00908 (Pipe)	ND00328.NH06849.1	96.50	67.57	67.57
NP01382 (Pipe)	ND00343.NV01836X.1	96.50	14.05	14.05
NP01382 (Pipe)	NH02176.ND00343.1	96.50	9.87	9.87
NP01382 (Pipe)	NH02177.NH02176.1	96.50	9.77	9.77
NP01382 (Pipe)	NH02178.NH02177.1	96.50	9.14	9.14
NP01382 (Pipe)	NH02179.NH02178.1	96.50	7.86	7.86
NP01382 (Pipe)	NH02180.NH02179.1	96.50	7.07	7.07
NP01382 (Pipe)	NH02181.NH02180.1	96.50	7.03	7.03
NP01382 (Pipe)	NH02182.NH02181.1	96.50	6.94	6.94
NP01382 (Pipe)	NH02183.NH02182.1	96.50	6.79	6.79
NP01382 (Pipe)	NH02184.NV01839X.1	96.50	6.52	6.51
NP01382 (Pipe)	NH02185.NH02184.1	96.50	6.34	6.34
NP00907 (Pipe)	NH02738.ND00299.1	96.50	16.89	16.90
NP00610 (Pipe)	NH02739.ND00298.1	96.50	8.74	8.74
NP00610 (Pipe)	NH02741.NH02739.1	96.50	8.43	8.43
NP00610 (Pipe)	NH02742.NH02741.1	96.50	8.08	8.09
NP00904 (Pipe)	NH02862.NV01738X.1	96.50	5.02	5.02
NP00908 (Pipe)	NH06849.NV01781X.1	96.50	67.57	67.57
NP00507 (Pipe)	NV00160.NV03889.1	96.50	13.91	13.91
NP00507 (Pipe)	NV00161.NV03890.1	96.50	9.31	9.31
NP00611 (Pipe)	NV01665Y.ND00298.1	96.50	9.09	9.10

Asset ID	Model ID	Diameter (mm)	Max Headloss (m/km)	
			Pre	Post
Target maximum headloss in reticulation mains (≤ 300 mm) of 5 m/km				
NP00917 (Pipe)	NV01685Y.NH02861.1	96.50	5.44	5.44
NP00907 (Pipe)	NV01721Y.NH02738.1	96.50	16.89	16.90
NP00904 (Pipe)	NV01738Y.NH02863.1	96.50	5.02	5.02
NP00597 (Pipe)	NV01757Y.ND00317.1	96.50	9.30	9.31
NP00598 (Pipe)	NV01758Y.ND00324.1	96.50	11.46	11.48
NP00908 (Pipe)	NV01781Y.ND00326.1	96.50	67.57	67.57
NP01382 (Pipe)	NV01838Y.NH02183.1	96.50	6.65	6.65
NP01382 (Pipe)	NV01839Y.NV01838X.1	96.50	6.65	6.65
NP01382 (Pipe)	NV01840Y.NH02185.1	96.50	6.27	6.27
NP00507 (Pipe)	NV02177Y.NV00160.1	96.50	14.03	14.03
NP00507 (Pipe)	NV03889.NV00161.1	96.50	13.91	13.91
NV01649 (Valve)	NV01649X.NV01649Y.1	100.00	5.09	5.09
NV01665 (Valve)	NV01665X.NV01665Y.1	100.00	15.50	15.51
NV01685 (Valve)	NV01685X.NV01685Y.1	100.00	9.56	9.56
NV01699 (Valve)	NV01699X.NV01699Y.1	100.00	14.81	14.81
NV01700 (Valve)	NV01700X.NV01700Y.1	100.00	5.19	5.19
NV01721 (Valve)	NV01721X.NV01721Y.1	100.00	29.09	29.11
NV01725 (Valve)	NV01725X.NV01725Y.1	100.00	6306.87	6505.19
NV01733 (Valve)	NV01733X.NV01733Y.1	100.00	5.13	5.13
NV01738 (Valve)	NV01738X.NV01738Y.1	100.00	8.46	8.46
NV01742 (Valve)	NV01742X.NV01742Y.1	100.00	8.14	8.14
NV01745 (Valve)	NV01745X.NV01745Y.1	100.00	5.91	5.91
NV01750 (Valve)	NV01750X.NV01750Y.1	100.00	7.30	7.30
NV01757 (Valve)	NV01757X.NV01757Y.1	100.00	15.85	15.88
NV01758 (Valve)	NV01758X.NV01758Y.1	100.00	19.62	19.66
NV01775 (Valve)	NV01775X.NV01775Y.1	100.00	9.48	9.48
NV01781 (Valve)	NV01781X.NV01781Y.1	100.00	118.13	118.13
NV01836 (Valve)	NV01836X.NV01836Y.1	100.00	24.14	24.13
NV01838 (Valve)	NV01838X.NV01838Y.1	100.00	11.28	11.27
NV01839 (Valve)	NV01839X.NV01839Y.1	100.00	11.28	11.27
NV01840 (Valve)	NV01840X.NV01840Y.1	100.00	10.62	10.61
NV01841 (Valve)	NV01841X.NV01841Y.1	100.00	6.40	6.40
NV02177 (Valve)	NV02177X.NV02177Y.1	100.00	24.09	24.09
NV04394 (Valve)	NV04394X.NV04394Y.1	100.00	4199.37	2303.49
NV04668 (Valve)	NV04668X.NV04668Y.1	100.00	8.14	8.17
NV04669 (Valve)	NV04669X.NV04669Y.1	100.00	7.99	8.02
NV04718 (Valve)	NV04718X.NV04718Y.1	100.00	8.07	8.10
NV04719 (Valve)	NV04719X.NV04719Y.1	100.00	8.03	8.06

Asset ID	Model ID	Diameter (mm)	Max Headloss (m/km)	
			Pre	Post
Target maximum headloss in reticulation mains (≤ 300 mm) of 5 m/km				
NP03380 (Pipe)	ND05055.NV05105X.1	101.70	6.04	6.04
NP03380 (Pipe)	ND05056.NH07876.1	101.70	6.04	6.04
NP03380 (Pipe)	NH07876.NH07877.1	101.70	6.04	6.04
NP03380 (Pipe)	NH07877.NH07878.1	101.70	6.04	6.04
NP03380 (Pipe)	NH07878.NH07879.1	101.70	6.04	6.04
NP03380 (Pipe)	NH07879.NH07880.1	101.70	6.04	6.04
NP03380 (Pipe)	NH07880.NV05106X.1	101.70	6.04	6.04
NP03380 (Pipe)	NV05105Y.ND05056.1	101.70	6.04	6.04
NP03380 (Pipe)	NV05106Y.ND05057.1	101.70	6.04	6.04
NP00913 (Pipe)	ND00055.ND00332.1	146.30	27.08	27.08
NP00916 (Pipe)	ND00311.ND00312.1	146.30	5.13	5.13
NP00916 (Pipe)	ND00312.ND05049.1	146.30	6.91	6.91
NP00906 (Pipe)	ND00324.NV01722X.1	146.30	8.25	8.26
NP00916 (Pipe)	ND00327.ND00333.1	146.30	7.74	7.74
NP00913 (Pipe)	ND00332.NV01776X.1	146.30	27.08	27.08
NP00916 (Pipe)	ND00333.NV01777X.1	146.30	6.22	6.22
NP00916 (Pipe)	ND00354.NH02928.1	146.30	5.78	5.78
NP00916 (Pipe)	NH02926.ND00311.1	146.30	5.72	5.72
NP00916 (Pipe)	NH02927.NH02926.1	146.30	5.72	5.72
NP00916 (Pipe)	NH02928.NH02927.1	146.30	5.76	5.76
NP00916 (Pipe)	NH02929.ND00354.1	146.30	6.22	6.22
NP00916 (Pipe)	NH02939.NH02929.1	146.30	6.22	6.22
NP00906 (Pipe)	NV01722Y.ND00313.1	146.30	8.25	8.26
NP00913 (Pipe)	NV01776Y.ND00333.1	146.30	27.08	27.08
NP00916 (Pipe)	NV01777Y.NH02939.1	146.30	6.22	6.22
NP00984 (Pipe)	ND00054.NV01779X.1	147.00	6.06	6.06
NP00984 (Pipe)	ND00061.NV01763X.1	147.00	5.39	5.38
NP00984 (Pipe)	NH02941.NH02942.1	147.00	6.06	6.06
NP00984 (Pipe)	NH02942.NH02943.1	147.00	5.97	5.97
NP00984 (Pipe)	NH02943.NV01765X.1	147.00	5.96	5.96
NP00984 (Pipe)	NH06850.NH02941.1	147.00	6.06	6.06
NP00984 (Pipe)	NV01763Y.NH02917.1	147.00	5.27	5.26
NP00984 (Pipe)	NV01765Y.ND00061.1	147.00	5.96	5.96
NP00984 (Pipe)	NV01779Y.NH06850.1	147.00	6.06	6.06
NV00327 (Valve)	NV00327X.NV00327Y.1	150.00	5.81	5.81
NV00328 (Valve)	NV00328X.NV00328Y.1	150.00	5.76	5.76
NV01526 (Valve)	NV01526X.NV01526Y.1	150.00	5.14	5.14
NV01684 (Valve)	NV01684X.NV01684Y.1	150.00	6.80	6.80

Asset ID	Model ID	Diameter (mm)	Max Headloss (m/km)	
			Pre	Post
Target maximum headloss in reticulation mains (≤ 300 mm) of 5 m/km				
NV01696 (Valve)	NV01696X.NV01696Y.1	150.00	6.81	6.81
NV01698 (Valve)	NV01698X.NV01698Y.1	150.00	6.81	6.81
NV01722 (Valve)	NV01722X.NV01722Y.1	150.00	19.15	19.17
NV01724 (Valve)	NV01724X.NV01724Y.1	150.00	6.15	6.16
NV01761 (Valve)	NV01761X.NV01761Y.1	150.00	8.56	8.55
NV01762 (Valve)	NV01762X.NV01762Y.1	150.00	8.77	8.77
NV01763 (Valve)	NV01763X.NV01763Y.1	150.00	10.77	10.76
NV01765 (Valve)	NV01765X.NV01765Y.1	150.00	11.92	11.92
NV01776 (Valve)	NV01776X.NV01776Y.1	150.00	63.90	63.90
NV01779 (Valve)	NV01779X.NV01779Y.1	150.00	12.14	12.13
NV01780 (Valve)	NV01780X.NV01780Y.1	150.00	8.85	8.86
NV02804 (Valve)	NV02804X.NV02804Y.1	150.00	6.80	6.80
NV01723 (Valve)	NV01723X.NV01723Y.1	200.00	11.43	11.44
NV01737 (Valve)	NV01737X.NV01737Y.1	200.00	11.62	11.63
NV01743 (Valve)	NV01743X.NV01743Y.1	200.00	207.61	211.20

Asset ID	Model ID	Diameter (mm)	Max Headloss (m/km)	
			Pre	Post
Target maximum headloss in reticulation mains (> 300 mm) of 3 m/km				
NP01386 (Pipe)	bmm000051.ND04304.1	363.20	3.48	3.59
NP01386 (Pipe)	bmm000315.NV03947X.1	363.20	3.48	3.59
NP00974 (Pipe)	ND00010.ND00348.1	363.20	3.11	3.12
NP01386 (Pipe)	ND00056.ND03515.1	363.20	3.48	3.59
NP00622 (Pipe)	ND00314.NV01719.1	363.20	3.48	3.59
NP01386 (Pipe)	ND00417.NV02820.1	363.20	3.53	3.61
NP01386 (Pipe)	ND03514.NV01716.1	363.20	3.48	3.59
NP01386 (Pipe)	ND03515.ND03514.1	363.20	3.48	3.59
NP01386 (Pipe)	ND04304.NV02194X.1	363.20	3.48	3.59
NP01386 (Pipe)	ND04305.NV02193.1	363.20	3.48	3.59
NP00622 (Pipe)	ND04938.NV01725X.1	363.20	3.48	3.59
NP01386 (Pipe)	NV01716.NV01717.1	363.20	3.48	3.59
NP01386 (Pipe)	NV01717.bmm000315.1	363.20	3.48	3.59
NP00622 (Pipe)	NV01719.NV01734.1	363.20	3.48	3.59
NP00622 (Pipe)	NV01720.ND04938.1	363.20	3.48	3.59
NP00622 (Pipe)	NV01725Y.NV01729.1	363.20	3.48	3.59
NP01385 (Pipe)	NV01729.NV02767.1	363.20	3.48	3.59

Asset ID	Model ID	Diameter (mm)	Max Headloss (m/km)	
			Pre	Post
Target maximum headloss in reticulation mains (> 300 mm) of 3 m/km				
NP01385 (Pipe)	NV01731.NV02766.1	363.20	3.48	3.59
NP00622 (Pipe)	NV01734.NV01720.1	363.20	3.48	3.59
NP01386 (Pipe)	NV02192Y.NV02818.1	363.20	3.52	3.61
NP01386 (Pipe)	NV02193.NV02192X.1	363.20	3.49	3.59
NP01386 (Pipe)	NV02194Y.ND04305.1	363.20	3.48	3.59
NP01385 (Pipe)	NV02766.ND00056.1	363.20	3.48	3.59
NP01385 (Pipe)	NV02767.NV01731.1	363.20	3.48	3.59
NP01386 (Pipe)	NV02818.ND00417.1	363.20	3.53	3.61
NP01386 (Pipe)	NV02820.NV02821.1	363.20	3.53	3.61
NP01386 (Pipe)	NV02821.NV02823.1	363.20	3.53	3.61
NP01386 (Pipe)	NV02822.NV02824.1	363.20	3.53	3.61
NP01386 (Pipe)	NV02823.NV02822.1	363.20	3.53	3.61
NP01386 (Pipe)	NV02824.NV02825.1	363.20	3.53	3.61
NP01386 (Pipe)	NV03947Y.bmm000052.1	363.20	3.48	3.59
NV01772 (Valve)	NV01772X.NV01772Y.1	375.00	13.58	13.81
NV01811 (Valve)	NV01811X.NV01811Y.1	375.00	13.90	13.96
NV02192 (Valve)	NV02192X.NV02192Y.1	375.00	17.28	17.70
NV02194 (Valve)	NV02194X.NV02194Y.1	375.00	17.06	17.59
NV03947 (Valve)	NV03947X.NV03947Y.1	375.00	17.06	17.59