

Taupo District Council

KINLOCH SEVEN OAKS STAGE 2 DEVELOPER QUERY - WATER SUPPLY MODELLING ASSESSMENT

Project NO -3-39692.01

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CONFIDENTIAL



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This report ('Report') has been prepared by WSP New Zealand Limited ('WSP') exclusively for Taupō District Council ('Client') in relation to investigate if the existing water supply network can meet the LOS and fire flow requirements for the next stage of proposed Seven Oaks Development, and in accordance with the Offer of Service – Kinloch Seven Oaks dated 2nd October 2023. The findings in this Report are based on and are subject to the assumptions specified offer of services dated 2nd October 2023. WSP accepts no liability whatsoever for any use or reliance on this Report, in whole or in part, for any purpose other than the Purpose or for any use or reliance on this Report by any third party.

30 January
2024

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1 PROJECT BACKGROUND

A new development is currently in progress to the west of Kinloch, Taupō. This development is to be constructed in 14 stages and will be accessed from Okaia Drive and Kahikatea Drive and connected to the Central Kinloch water supply. An overview of the Seven Oaks Development is shown below in Figure 1-1.

WSP has been engaged by Taupō District Council (TDC) to perform modelling/ hydraulic analysis for Kinloch water supply network. This report discusses the Stage 2 investigation involving hydraulic analysis of Seven Oaks development with permitted/consented and proposed developments to analyse if the existing network is capable enough to meet the Level of Services (LoS) and firefighting Requirements.

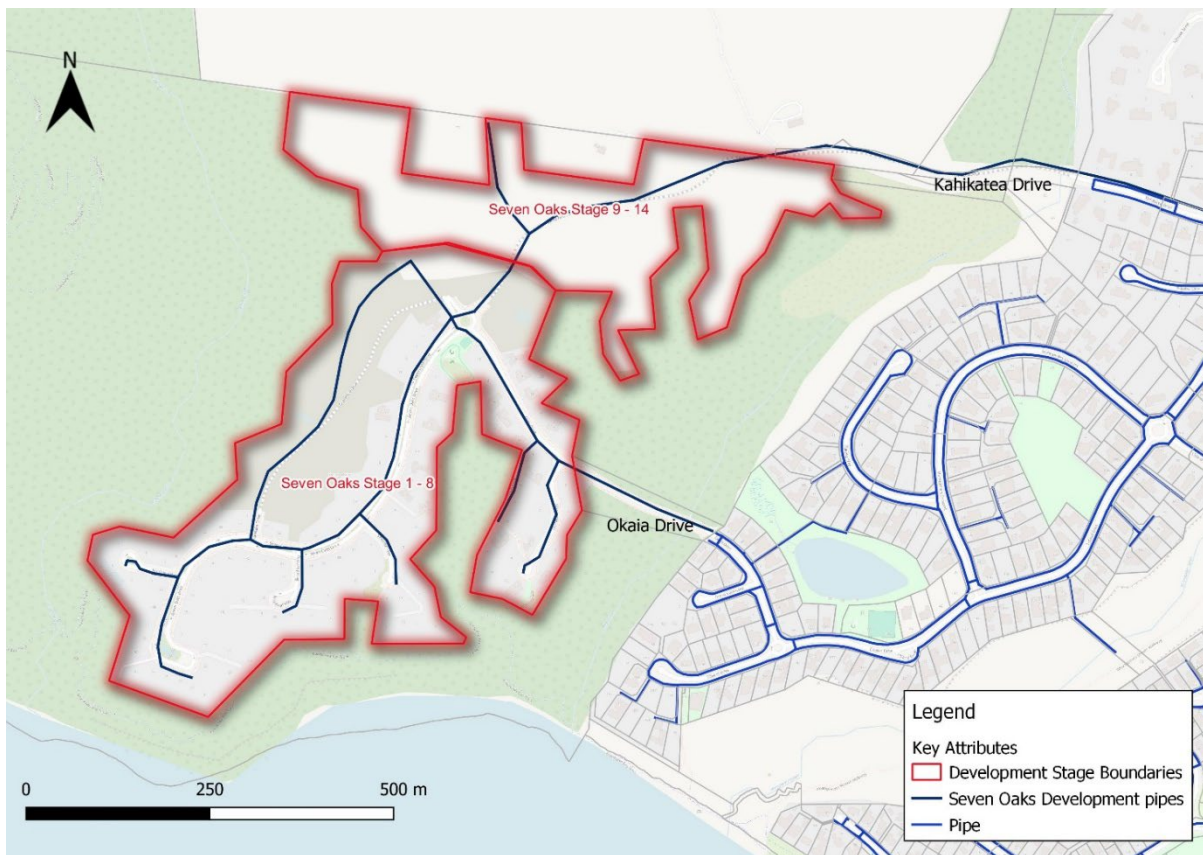


Figure 1-1: Overview of the Seven Oaks Development

1.1 SCOPE

The main scope of Stage 2 water supply assessment is to investigate if the existing water supply network can meet the LoS and fire flow requirements for the next stages of the proposed Seven Oaks development. In addition to the Stages 1-9 of Seven Oaks development, this study also includes other development areas such as the Balance Land, the Terraces, Te Tuhi and Hunt Club.

Figure 1-2 shows the overview of the developments for Seven Oaks and the Balance Land, and Figure 1-3 shows the Terraces, Hunt Club and Te Tuhi development areas considered in this study.

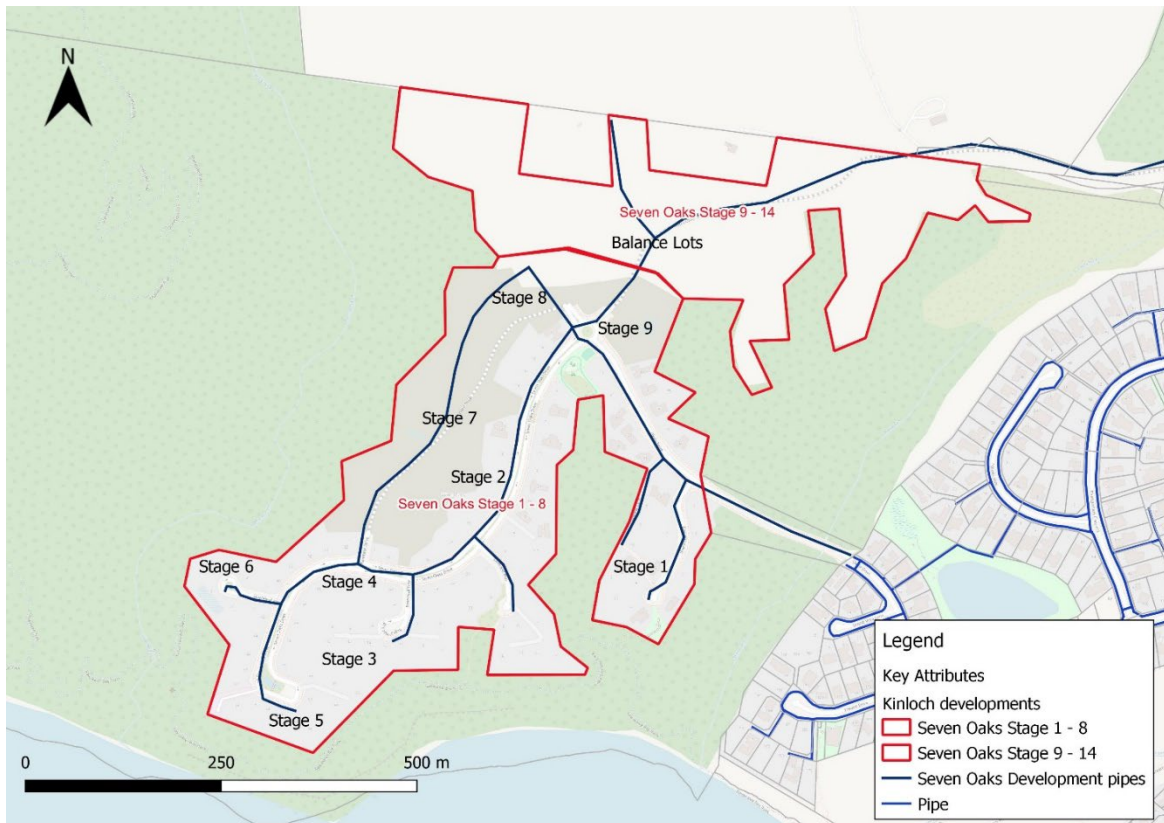


Figure 1-2: Overview of the Seven Oaks & Balance Lot Developments

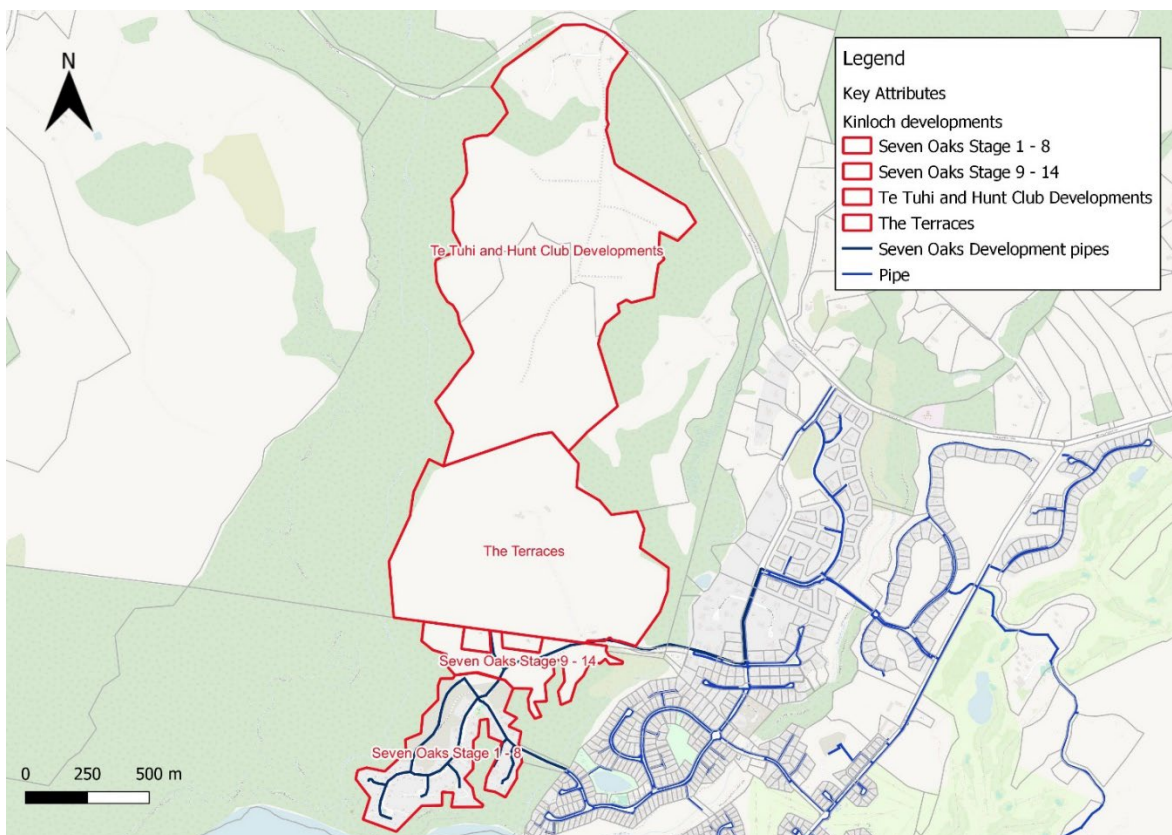


Figure 1-3: Overview of the Terraces, Hunt Club & Te Tuhi Development Areas

2 ACCEPTANCE CRITERIA

The hydraulic analysis was conducted in accordance with the TDC Code of Practice (CoP). During the analysis, the following acceptance criteria were considered:

Table 2-1 Acceptance Criteria for the LoS

Level of Services	Acceptance Criteria
Minimum Pressure	300 kPa (30 m) pressure at every connection point as per TDC CoP
Unit Headloss	<p>Unit Headloss (m/km) of the proposed pipe and the existing supply pipe as per NZS 4404:2010</p> <ul style="list-style-type: none"> • 5 m/km for DN ≤ 150 diameter. • 3 m/km for DN ≥ 200 diameter.
Fire flow	<p>New Zealand Fire Service CoP; Standards New Zealand (SNZ) PAS 509:2008 and subsequent amendments, to the satisfaction of the New Zealand Fire Service</p> <p>Due to limitations in the hydraulic modelling (WS Pro) software, exceptional flow method has been used to assess the fire flow performance of the Seven Oaks network. In this methodology, an exceptional flow of 25 L/s has been allocated at each selected critical hydrants for 30 minutes at 60% peak day demand. The hydrants are evaluated one at a time for required fire flow (25 L/s) and minimum residual pressure (10 m).</p>

3 METHODOLOGY

The methodology used for this assessment is as follows:

- Use the Kinloch Stage 1 model (including the solutions developed in Stage 1) with the currently established Seven Oaks development demand.
- The model is digitised for the proposed water network in the Terraces development.
- Demand is allocated based on the Lot numbers for Stages 1-9, Balance Land, Terraces, Hunt Club and Te Tuhi developments (refer to Table 3-1).

Table 3-1 Lots numbers for Development Areas

Developments	Permitted/Consented Lots	Proposed Lots
Stages 1-7	131 Lots	131 Lots
Stages 8 & 9	28 Lots	20 Lots
Balance Land	6 Lots	100 Lots
Terraces	55 Lots (15 Residential & 40 Rural Residential)	
Te Tuhi	47 Lots rural residential (restricted to 1.2 L/min each)	
Hunt Club	30 Lots rural residential (restricted to 1.2 L/min each)	

- Run the models and confirm if the existing development meets TDC’s LoS requirements. The following run scenarios were required for the hydraulic assessment:
 - **Scenario 1** - Kinloch model, with the **permitted** Seven Oaks development.
 - **Scenario 2** - Kinloch model with **permitted** Seven Oaks development as well as other **permitted** developments (Terraces, Te Tuhi, and Hunt Club).
 - **Scenario 3** - Kinloch model with the **proposed** developments, which also includes the other **permitted** developments (Terraces, Te Tuhi and Hunt Club).
- Conduct a fire flow analysis to see if the selected hydrants meet the minimum fire flow and residual pressure criteria set out in SNZ PAS 4509:2008.
- Provide a short technical report of the model results.

4 MODEL ASSUMPTIONS

- 1 WSP used the Kinloch model Stage 1 (including the solutions developed in Stage 1) with the currently established Seven Oaks development demand.
- 2 The model analysis utilized a unique model database named Seven Oaks development Stage 2, which comprised of the following:
 - a. **Network:** Seven Oaks Stage 2
 - b. **Control:** Seven Oaks Stage 2 - Control
 - c. **Run Group:** Seven Oaks Development Developer Query
- 3 Scenario 1 was setup using the Permitted/Consented Lots of Stages 1-9 and Balance Land of Seven Oaks along with the Terraces development.
- 4 Scenario 2 includes Te Tuhi and Hunt Club development in addition to the Lots under Scenario 1.
- 5 Scenario 3 contains the total proposed Lot count for Seven Oaks Stages, Balance Land, Terraces, Te Tuhi and Hunt Club development as mentioned in Table 3-1.
- 6 Domestic demand for the Te Tuhi and Hunt Club development having 47 Lots and 30 Lots respectively was calculated at a rate of 1.2 L/min/lot as per the information received from TDC via email on 24/10/2023.
- 7 The peak domestic demand for stages and development wherever property count is updated is calculated based on the master planning water consumption rate of 1362.58 L/property/day as previously agreed with TDC in the offer of service.
- 8 A value pertaining to 10% of the consumption rate was used as leakage for the freshly added properties/lots.
- 9 In the absence of contour data for Terraces development, the ground level is assumed using the most appropriate data available from Land Information New Zealand (LINZ).
- 10 Also, due to the absence of hydrant location data for Te Tuhi and Terraces development, two hydrants were assumed at the highest elevation and at the furthest location within each development area.
- 11 The internal pipe network of the Terraces was digitised as per the Figure 4-1 sent by TDC via email on 08/09/2023.

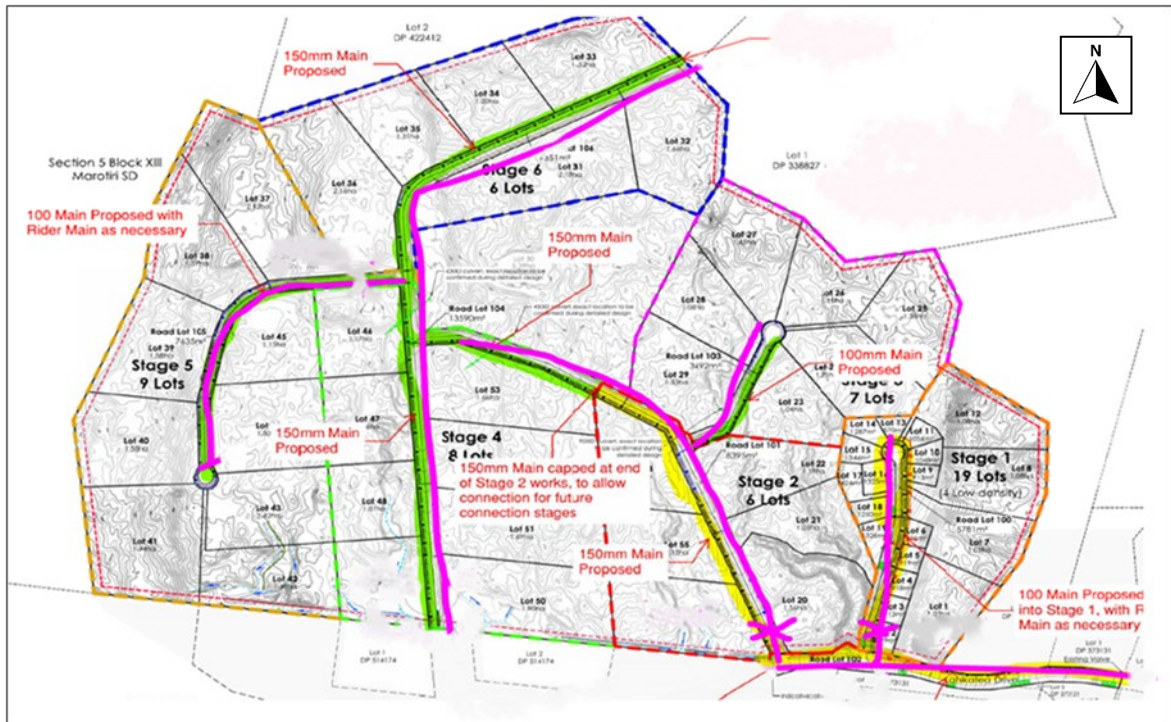


Figure 4-1 Terraces Development

5 MODELLING SCENARIOS

Table 5-1 summarises the modelled scenarios, which have been discussed and confirmed with TDC. The permitted and proposed lots for Seven Oaks and other development are available in Table 3-1.

Table 5-1 WS Modelling Scenarios

Scenario	Description	Model
1	Kinloch model, with the permitted Seven Oaks and the Terraces developments	Stage 1 Kinloch Model
2	Scenario 1, plus other permitted developments (Te Tuhi and Hunt Club)	Stage 1 Kinloch Model
3	Kinloch model, with Proposed Seven Oaks lots which also includes the other permitted developments (Te Tuhi/Hunt Club)	Stage 1 Kinloch Model
Provisional Scenario (if required)		
4	Scenario 2 + recommended network upgrades	Stage 1 Kinloch Model
5	If Seven Oaks provide contour information for the Stage 8 Lots (not constructed yet), WSP will connect Stage 8 to the lower zone network as per stage 1-7 and check the minimum and maximum pressures within the stage 8 lots.	Stage 1 Kinloch Model

6 MODEL RESULTS

This section discusses the LoS and fire flow results of the development in Seven Oaks and other proposed development including Terraces, Hunt Club and Te Tuhi and the impact of the proposed development on the overall Kinloch network.

6.1 SCENARIO 1: KINLOCH MODEL WITH PERMITTED LOTS FOR SEVEN OAKS AND TERRACES

In this scenario, the Stages 1 to 9 of Seven Oaks containing 159 Lots, Balance Land with 6 Lots, and Terraces with 55 Lots (15 residential and 40 rural residential) were integrated into the existing Kinloch network.

This section discusses the minimum pressure and maximum headloss results for Seven Oaks and Terraces development and their impact on to the existing High and Low Zones of Kinloch.

Figure 6-1 shows the results in terms of minimum pressure (m) and maximum headloss (m/km) for this Scenario 1.

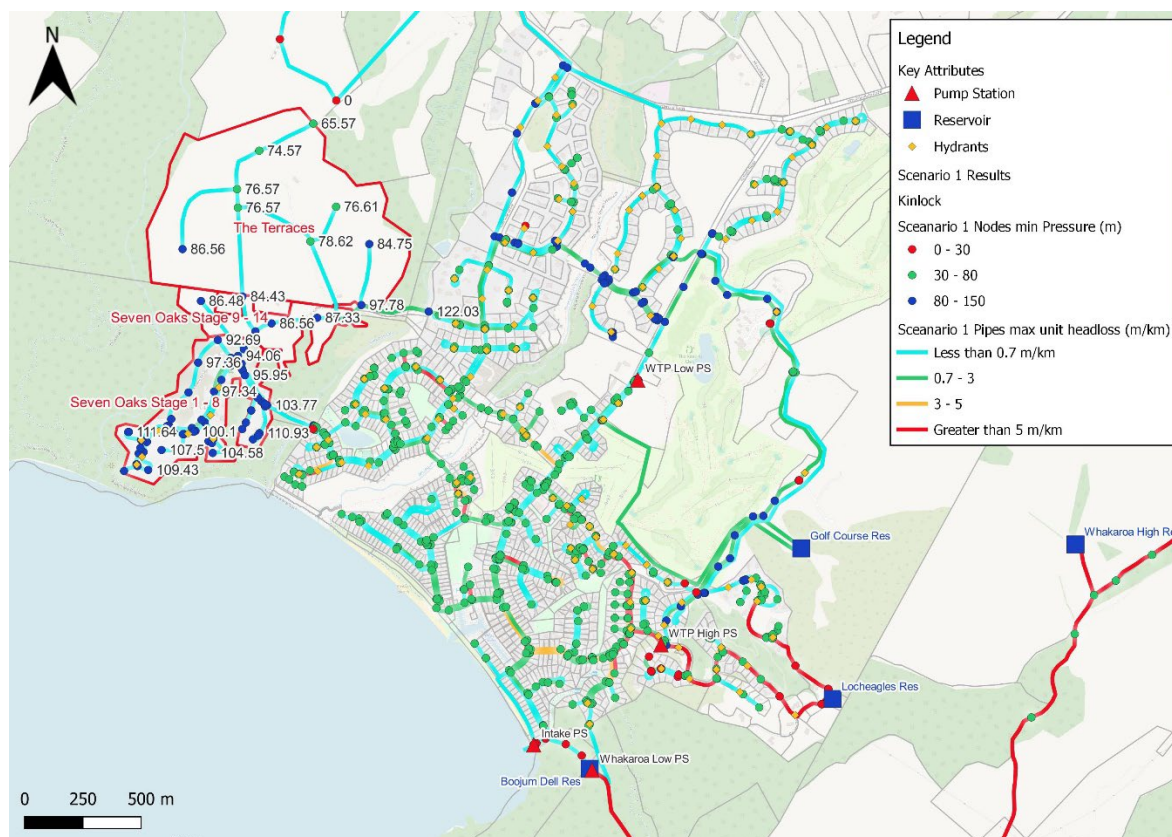


Figure 6-1 LoS Results for Scenario 1

The LoS results for Scenario 1 are summarised in Table 6-1.

Table 6-1 Scenario 1 LoS Results

Location	Minimum Pressure range (m)	Maximum unit headloss (m/km)
Stages 1-9 and Balance Land lots in the Seven Oaks Development.	84 - 135	Less than 3
Terraces Development	65 - 86	Less than 3

The above results align with the TDCs CoPs as the minimum pressure is above 30 m. The maximum headloss of the pipes within the development areas are below 3 m/km.

There is a section of pipe along Locheagles Rise as shown in Figure 6-1 (closer to Locheagles reservoir) where the headloss is greater than 5 m/km. However, as shown in Figure 6-2, there is minimal variation between the base model and Scenario 1 maximum headloss results.

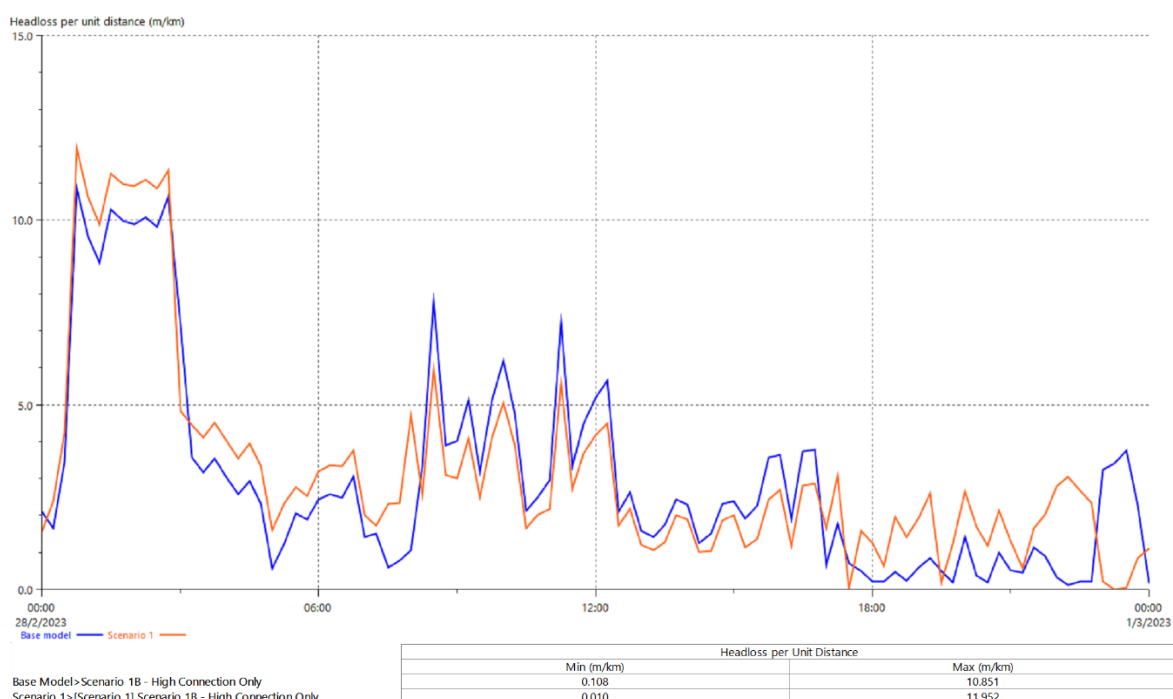


Figure 6-2: Unit Head Losses Comparison

Moreover, since all Seven Oaks development area and the Terraces are now connected to the high zone, no variation in the low zone was found.

6.2 SCENARIO 2: KINLOCH MODEL WITH PERMITTED LOTS FOR SEVEN OAKS AND TERRACES WITH OTHER DEVELOPMENTS

In Scenario 2, the other development (Te Tuhi and Hunt Club) has been added to Scenario 1. This section describes the impact of these additional developments.

The LoS results for Scenario 2 are summarised in the Table 6-2 .

Table 6-2 Scenario 2 Los Results

Location	Minimum pressure range (m)	Maximum unit headloss (m/km)
Stages 1-9 and Balance Land lots in the Seven Oaks development.	82 - 114	Less than 3
Terraces development	63 - 84	Less than 3

These LoS results are like Scenario 1. The minimum pressure in both Seven Oaks and the Terraces has reduced compared to Scenario 1, however, still well within the TDC CoP acceptance criteria. The maximum headloss of the pipes are still below 3 m/km like Scenario 1.

Figure 6-3 illustrates the minimum pressure (m) and maximum headloss (m/km) for Te Tuhi and Hunt Club.

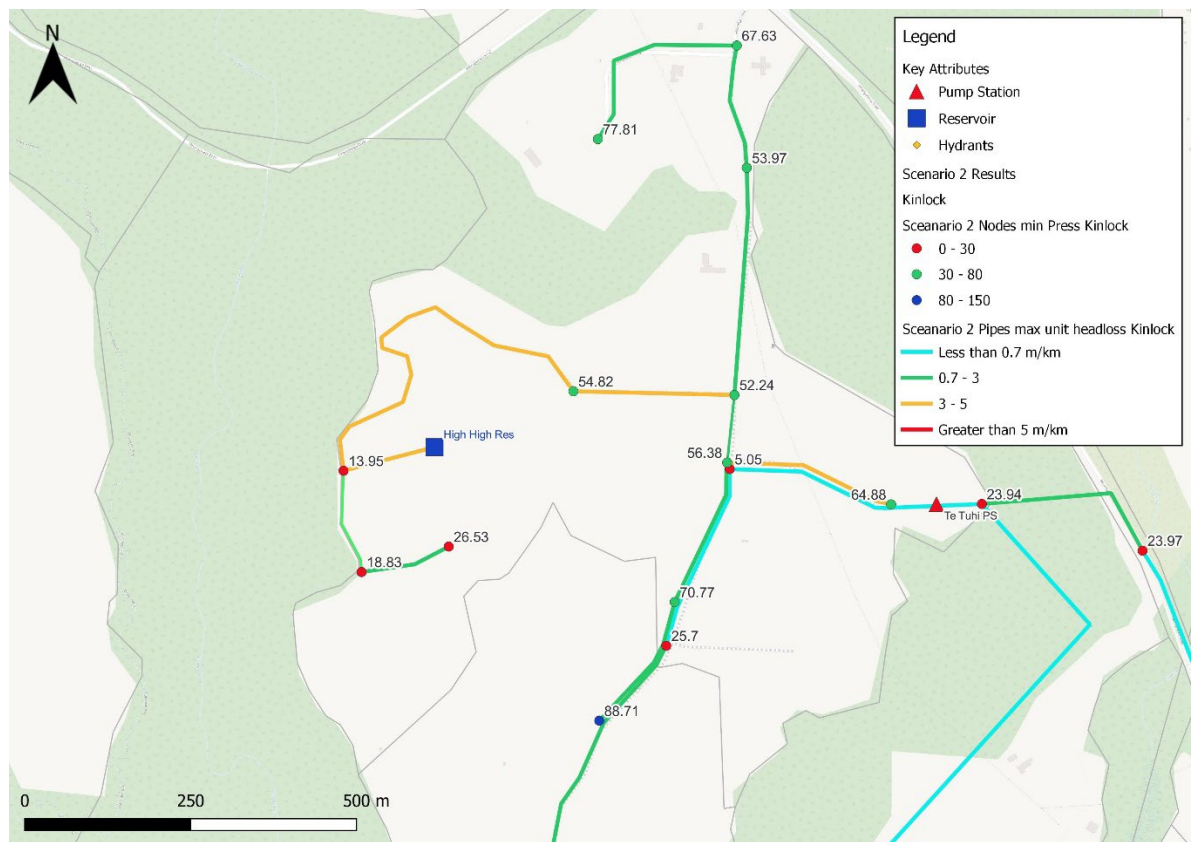


Figure 6-3 LoS Results for Te Tuhi Under Scenario 2

The demand for Hunt Club development is assigned to a single node and the minimum pressure is found to be 63 m, this is significantly higher than the minimum pressure guidelines stipulated by TDC.

The minimum pressure is found to be less than 30 m for the area along Lochridge Drive as shown in Figure 6-4. This is an elevated area where the elevations range from 490 – 530 m, whereas the average elevation for the entire network is found to be 410 m. The properties on Lochridge Drive can be transferred to the High-High zone, and supply through the Lochridge pump station as a solution. This option will be further investigated in the next stage (Stage 3) of this assessment.

The maximum unit headloss is seen to be within the TDC CoPs and is found to be less than 5 m/km for pipes with diameters less than, or equal to, 150 mm.

The pipe headloss issues around along Locheagles Rise remains in this scenario. The maximum unit headloss varies in the range of 1-2 m/km and seen to peak up to 10.86 m/km as shown in Figure 6-4. However, the variations are very minimum compared to the base model.

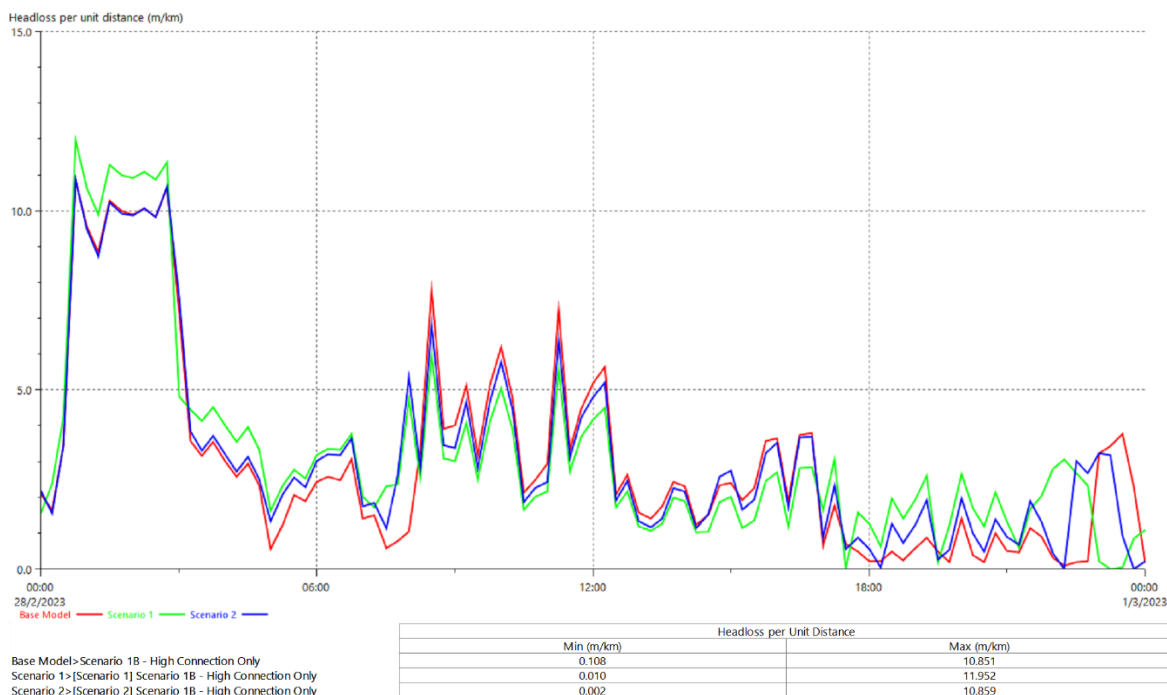


Figure 6-4 LoS Results for Existing Network Under Base and Scenario 2

The developments do not have any other significant impact on High Zone.

6.3 SCENARIO 3: KINLOCH MODEL WITH PROPOSED LOTS FOR SEVEN OAKS AND TERRACES WITH OTHER DEVELOPMENTS

Under this Scenario, the number of lots under the Stages 1-9 of Seven Oaks was modified to 149 (from 159 Lots). For Balance Land, the lot numbers changed from 6 to 100 Lots while the lot numbers remain the same for the Terraces. Moreover, the other development including Te Tuhi and Hunt Club are also a part of the model like Scenario 2 with the same lot numbers.

This section narrates the minimum pressure (m) and maximum headloss (m/km) results for Seven Oaks and other development including the Terraces, Te Tuhi and Hunt Club and their impact on the existing high and low zones of Kinloch.

Figure 6-5 describes the LoS results for Scenario 3.

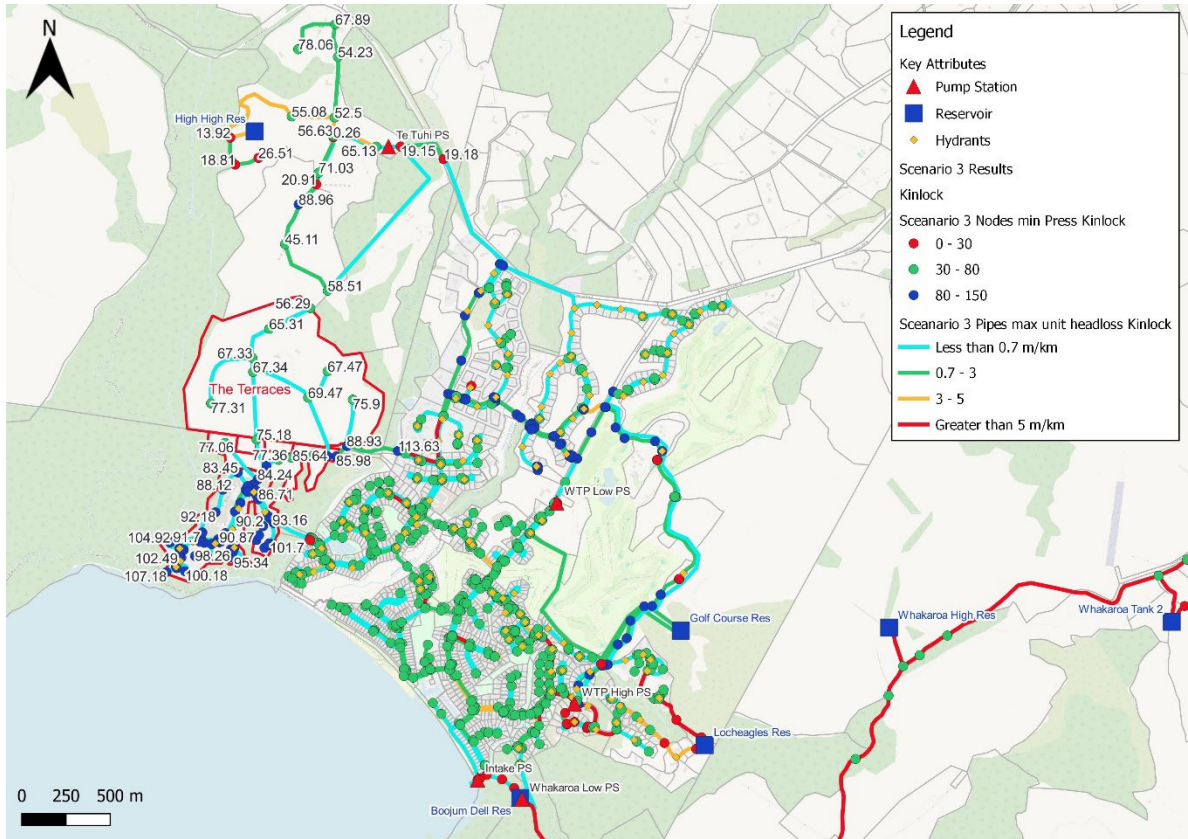


Figure 6-5 LoS Results for Scenario 3

The LoS results for Scenario 3 are summarised in the Table 6-3.

Table 6-3 LoS Results for Scenario 3

Location	Minimum Pressure range (m)	Maximum unit headloss (m/km)
Stages 1-9 and Balance Land lots in the Seven Oaks Development.	75 - 107	Less than 3
Terraces Development	56 - 77	Less than 3

The minimum pressure results in Seven Oaks development and the Terraces have decreased compared to Scenario 1 and 2, however, still well within the TDC CoP acceptance criteria. The maximum unit headloss of the pipes are below 3 m/km.

Figure 6-6 shows the minimum pressure (m) and maximum headloss (m/km) for Te Tuhi and Hunt Club.

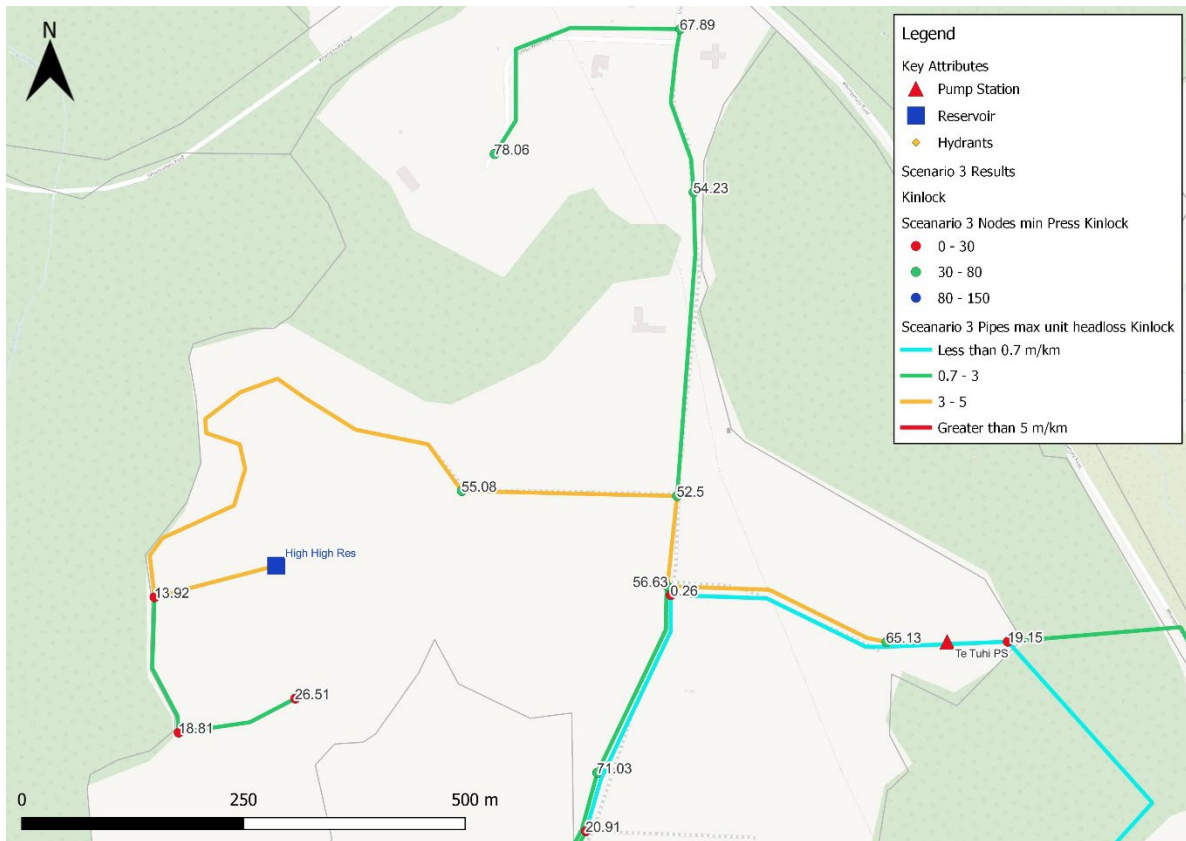


Figure 6-6 Te Tuhi Development Area Under Scenario 3

Hunt Club meets the required minimum pressure targets. The area along Lochridge Drive still fails to achieve a minimum pressure of 30 m, due to higher elevations. As mentioned in Scenario 2, the properties on the Lochridge Drive can be transferred to the High-High zone as a solution. This option will be further investigated in the next stage (Stage 3) of this assessment.

The pipe headloss issues along Locheagles Rise are still greater than 5 m/km which is like other two scenarios and not significantly vary from the base model.

The developments included in Scenario 3 do not have any other significant impact on High Zone.

6.4 FIRE FLOW

6.4.1 OVERVIEW

An assessment was required to confirm if the Seven Oaks and other developments meet FW2 (residential) firefighting requirements as detailed in Table 2-1. All critical hydrants within the proposed developments, including Seven Oaks, the Terraces, Te Tuhi and Hunt Club, were evaluated for fire flow under FW2 specified criteria using the “Exceptional Flow Methodology”. However, the hydrants within Te Tuhi and Hunt Club are not required to meet FW2 fire flow criteria, as these two developments are within rural residential areas. However, the critical hydrants within Te Tuhi and Hunt Club are tested for the completeness of this assessment. Figure 6-7 shows the hydrants within Seven Oaks and other developments used for the fire flow assessment.

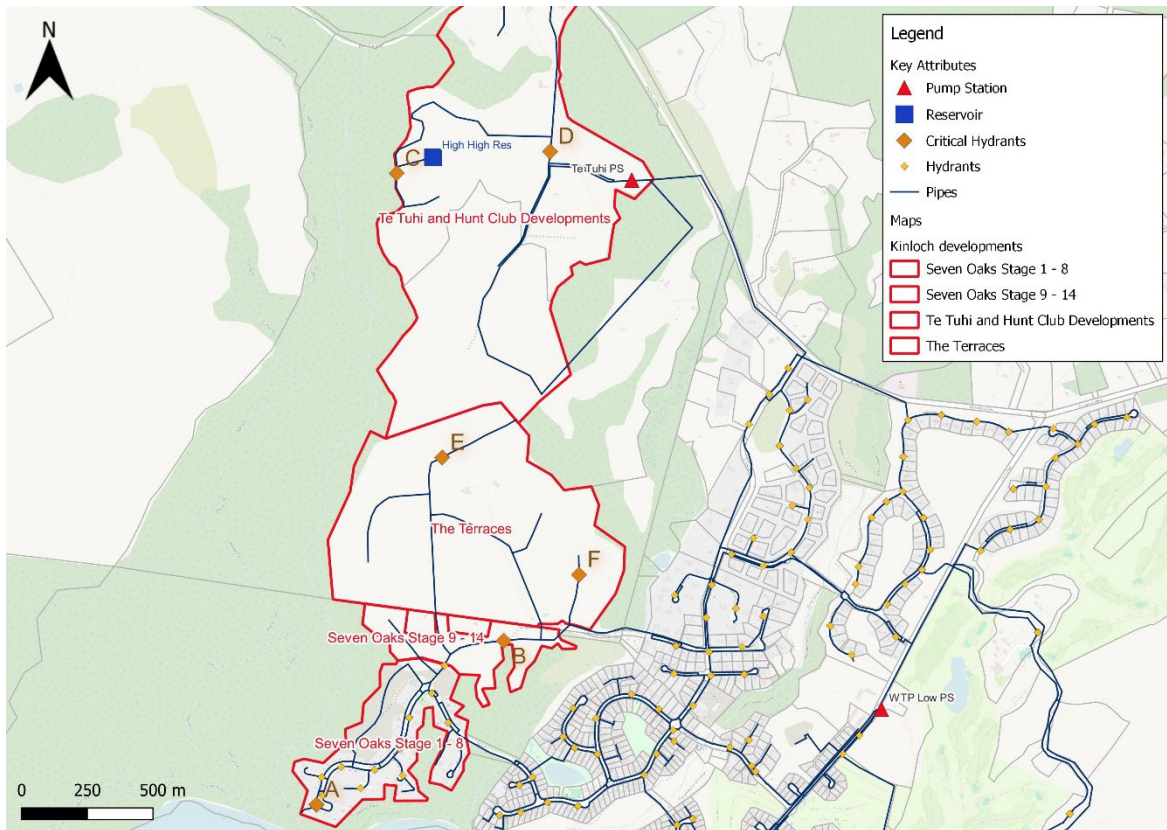


Figure 6-7 Hydrants Tested for Fire Flow Within Each Development

6.4.2 METHODOLOGY

To verify the network's ability to meet fire flow requirements, an exceptional flow of 25 L/s for 30 minutes at the 60% peak day demand was simulated at all the hydrants shown in Figure 6-7. This assumption is based on the condition that if these critical hydrants maintain the minimum residual pressure criteria under this exceptional scenario, all other hydrants in the developments will be capable of meeting the criteria.

6.4.3 HYDRANT LOCATIONS

There are six critical hydrants (A-F) for all the three scenarios. These hydrants represent the most critical points in the network due to their location and elevation, making them particularly susceptible to insufficient pressure during fire events. Further analysis and investigation will be focused on these hydrants to ensure adequate fire protection throughout the developments.

6.4.4 FIRE FLOW RESULTS

Table 6-4 shows the fire flow results of the critical hydrants within Seven Oaks and the Terraces in Scenario 1.

Table 6-4 Simulation Results for Fire Flow Analysis Under Scenario 1

Hydrant	Hydrant ID	Exceptional demand/ required fire flow (L/s)	Residual pressure (m)
A	SO_03	25	51.43
B	SO_02	25	53.50
E	TS_01	25	33.18
F	TS_02	25	41.10

As shown in the table, all four hydrants meet the specified FW2 criteria.

Table 6-5 shows the fire flow results of the critical hydrants within Seven Oaks, the Terraces, Te Tuhi and Hunt Club in Scenario 2.

Table 6-5 Simulation Results for Fire Flow Analysis Under Scenario 2

Hydrant	Hydrant ID	Exceptional demand/ required fire flow (L/s)	Residual pressure (m)
A	SO_03	25	57.51
B	SO_02	25	59.64
C	TT_01	25	0
D	TT_02	25	0
E	TS_01	25	38.79
F	TS_02	25	47.73

Table 6-6 shows the fire flow results of the critical hydrants within Seven Oaks, the Terraces, Te Tuhi and Hunt Club in Scenario 3.

Table 6-6 Simulation Results for Fire Flow Analysis Under Scenario 3

Hydrant	Hydrant ID	Exceptional demand/ required fire flow (L/s)	Residual pressure (m)
A	SO_03	25	50.97
B	SO_02	25	53.24
C	TT_01	25	0
D	TT_02	25	0
E	TS_01	25	32.33
F	TS_02	25	44.25

As shown in the Table 6-5 and Table 6-6, critical hydrants in Seven Oaks and the Terraces meet FW2 specified criteria. However, in both Scenarios 2 and 3, hydrants C and D located

within the Te Tuhi development cannot achieve a residual pressure of greater than 10 m during the simulated fire flow period. The significant drop in the residual pressure is due to higher elevations in the reaches of Te Tuhi development. As mentioned earlier, the hydrants within Te Tuhi and Hunt Club are not required to achieve FW2 fire flow requirements as the developments are located within rural residential area.

Appendix A contains the graphical representation of residual pressure for the identified critical hydrants (A-F) for all the three Scenarios.

7 CONCLUSIONS

The hydraulic performance of all the development areas (Seven Oaks, Terraces, Te Tuhi and Hunt Club) were evaluated, wherein the demand was associated with the various stages and areas based on the lot numbers assigned to the permitted and proposed development scenarios.

The findings from the analysis are summarised below:

- The analysis revealed that all development area including Seven Oaks, the Terraces and Hunt Club meet the minimum pressure requirements in all scenarios.
- However, the elevated properties along Lochridge Drive within Te Tuhi development fails to meet the minimum pressure criteria. We recommend transferring these properties to High-High zone and supplying through the Lochridge booster pump. This option is to be further investigated in Stage 3 of this assessment.
- Maximum unit headlosses of the pipes within the development are within the TDC CoP limits.
- Using the exceptional flow methodology, all critical hydrants within Seven Oaks and the Terraces meet the FW2 criteria.
- Due to the higher elevations, the critical hydrants in Te Tuhi development fail to meet FW2 requirements. However, hydrants in Te Tuhi and Hunt Club are not required to meet FW2 criteria as these developments are located in rural residential area.
- The impact of setting up the demand on to the Seven Oaks and other development is very minimalistic for the Low Zone as the entire network is now connected to the High Zone.
- The maximum unit headloss exceeds the acceptance criteria on Locheagles Rise. This applies to all three scenarios; however, this is not a significant variation compared to the base model.
- We recommend installing PRVs to resolve the high pressures in the Seven Oaks and the Terraces developments. The exact locations of the PRVs to optimise the resulting pressures will be further investigated in Stage 3 of this assessment.

8 LIMITATIONS

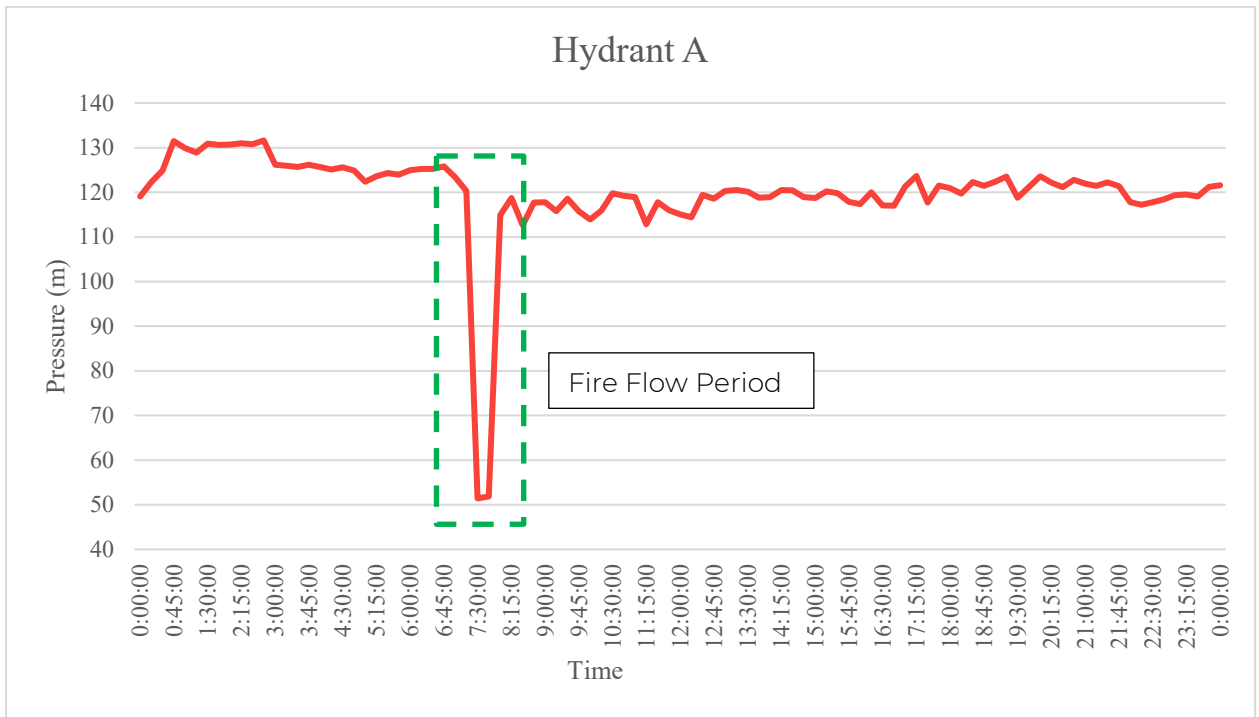
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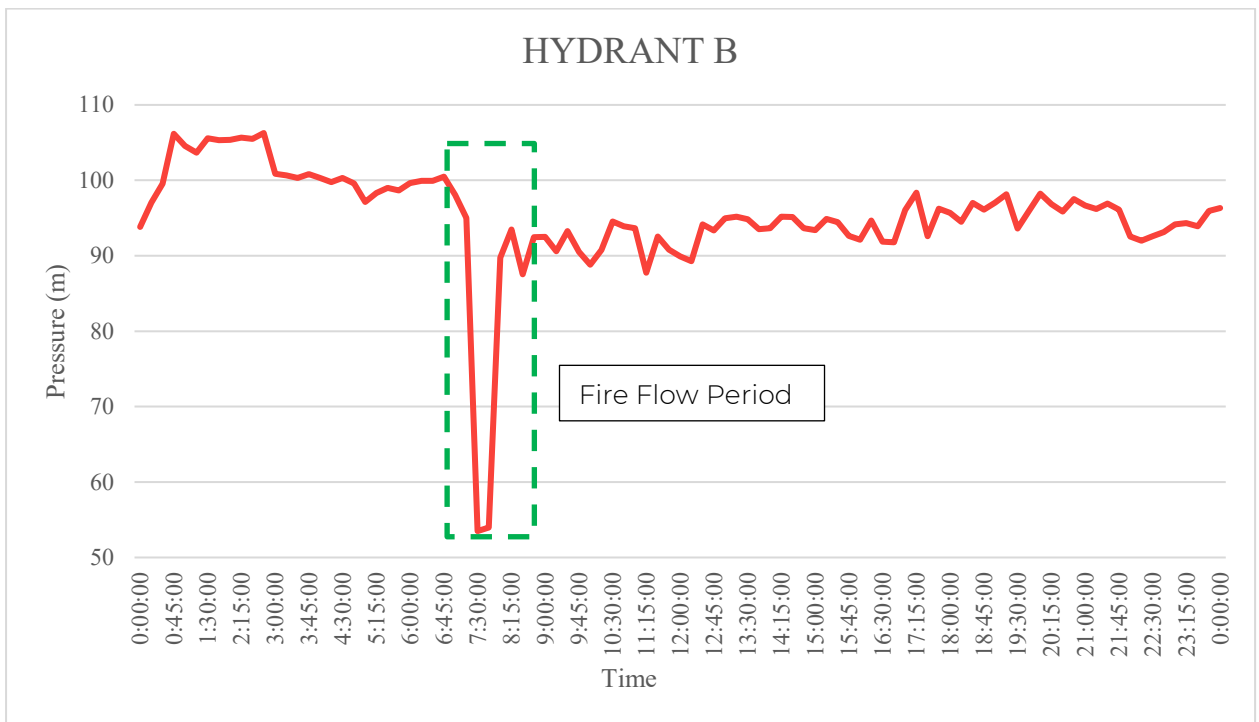
Appendix A

Fire flow results

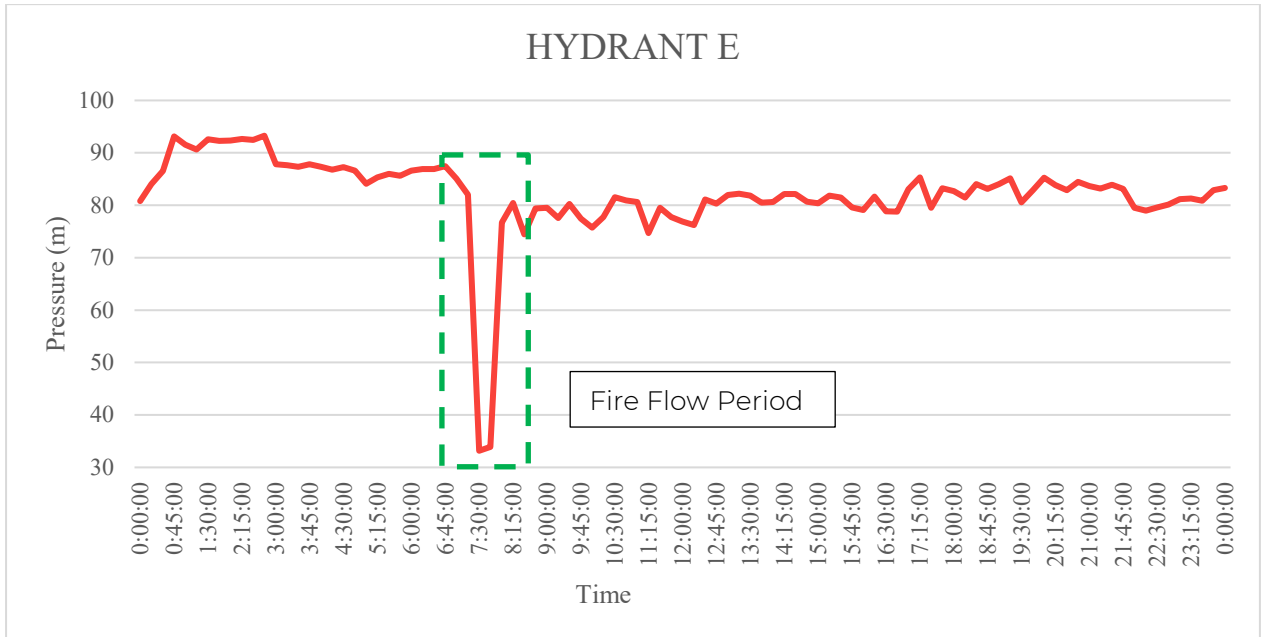
SCENARIO 1



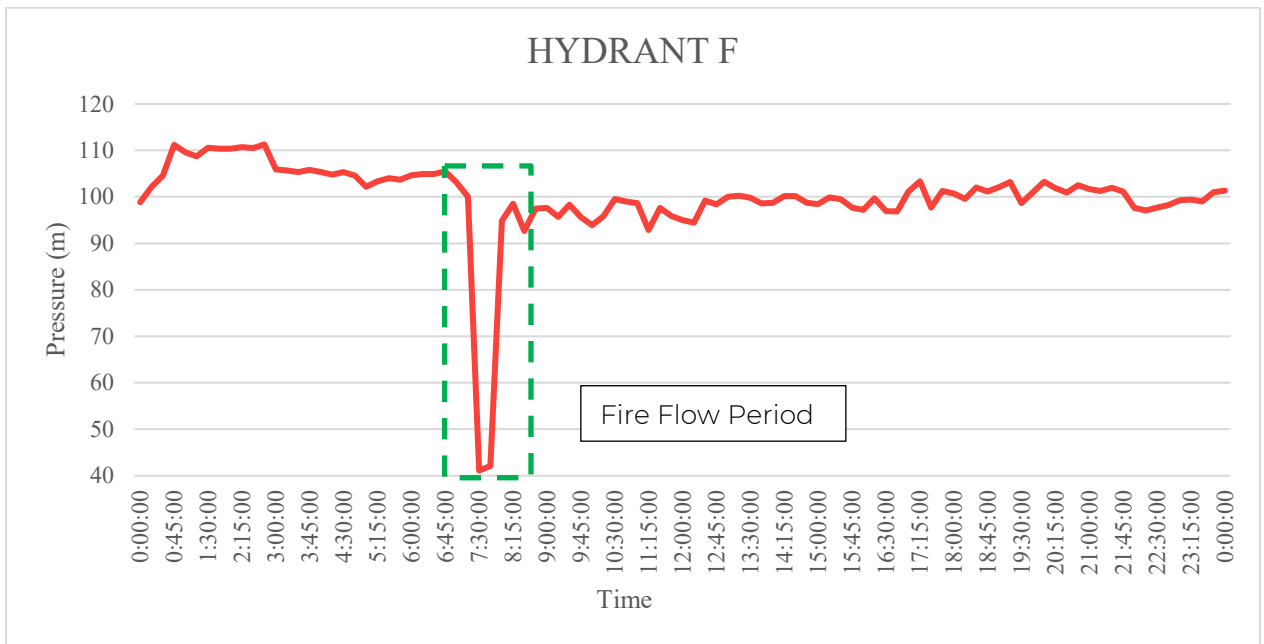
Residual pressure at Critical Hydrant A



Residual pressure at Critical Hydrant B

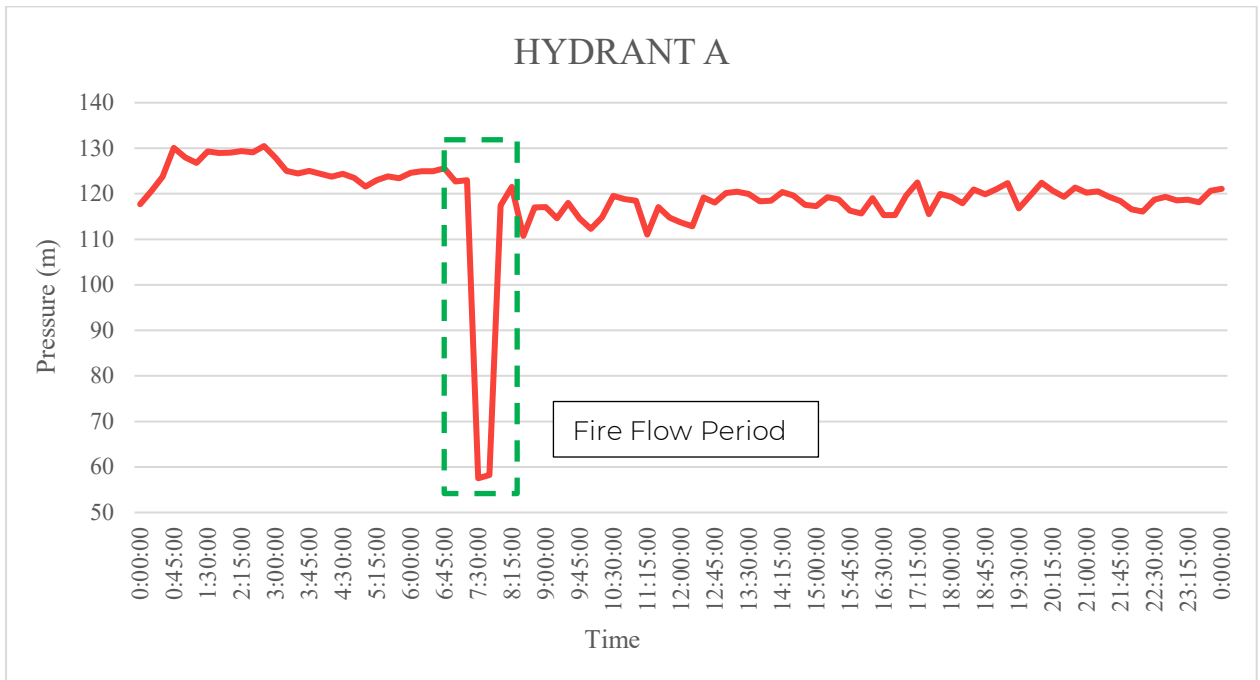


Residual pressure at Critical Hydrant E

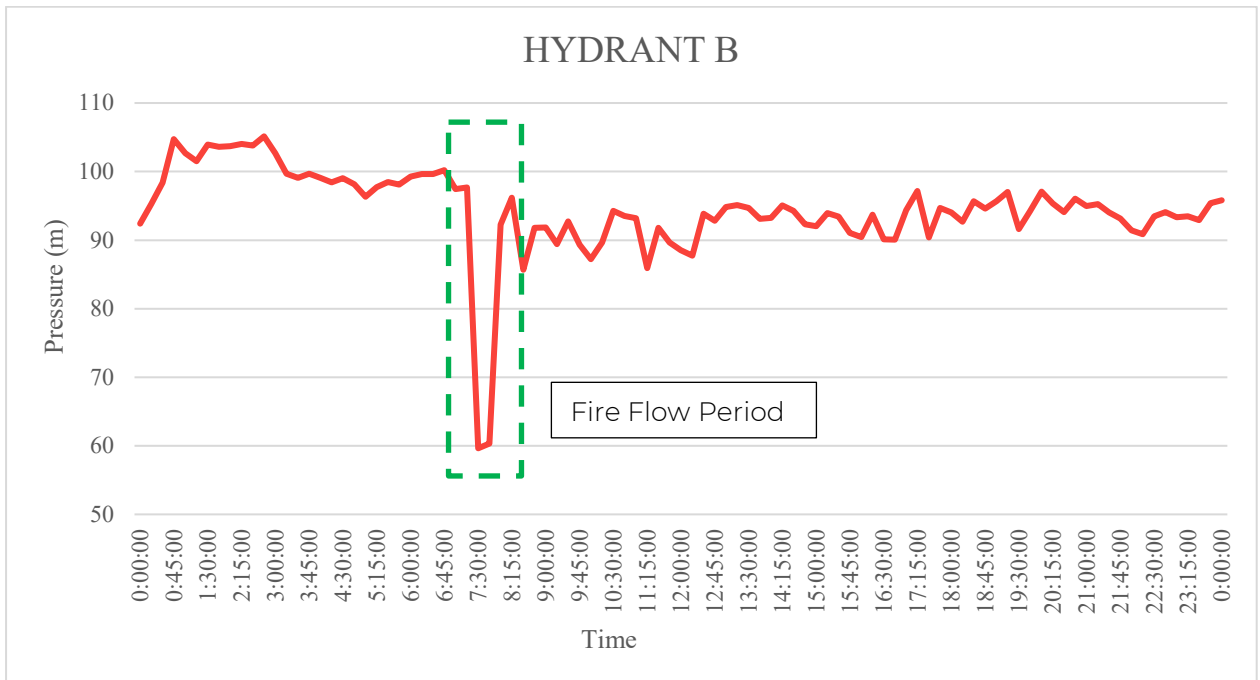


Residual pressure at Critical Hydrant F

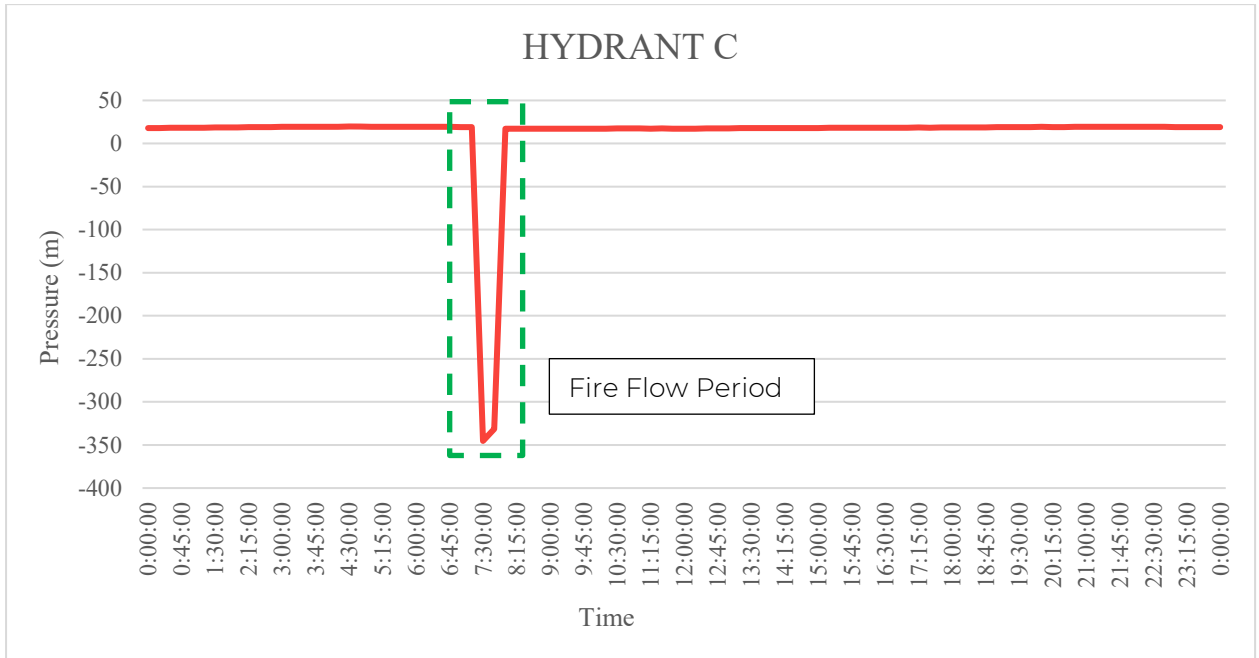
SCENARIO 2



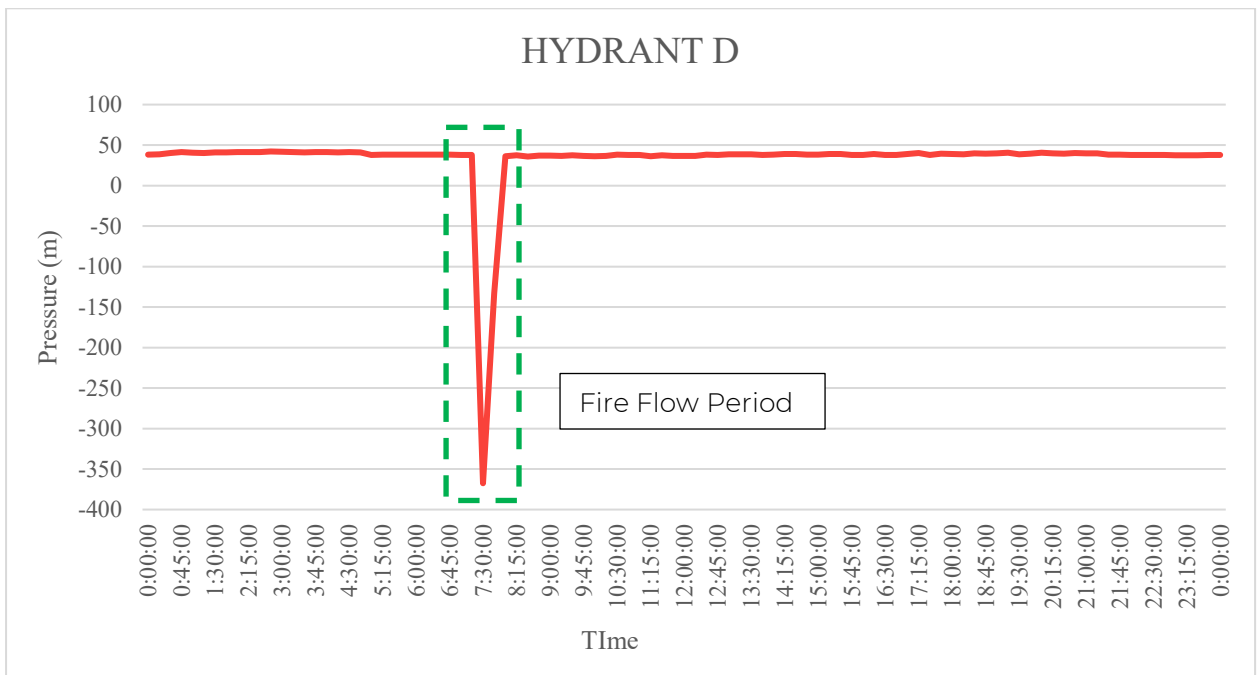
Residual pressure at Critical Hydrant A



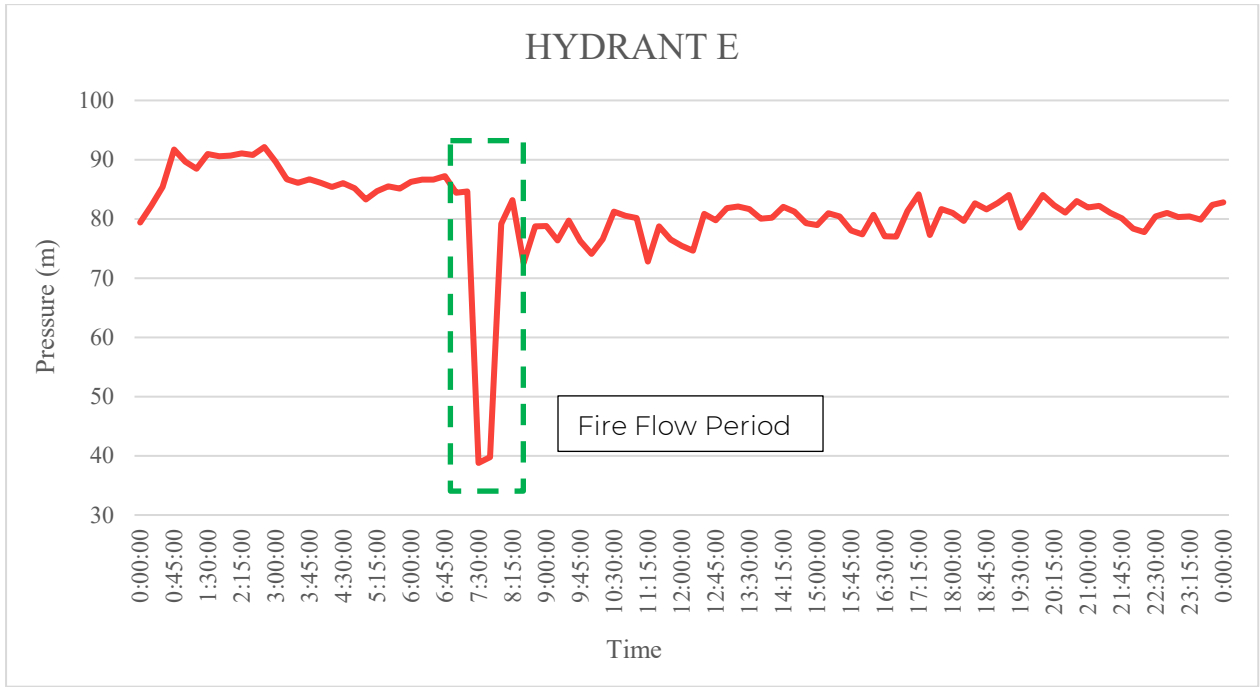
Residual pressure at Critical Hydrant B



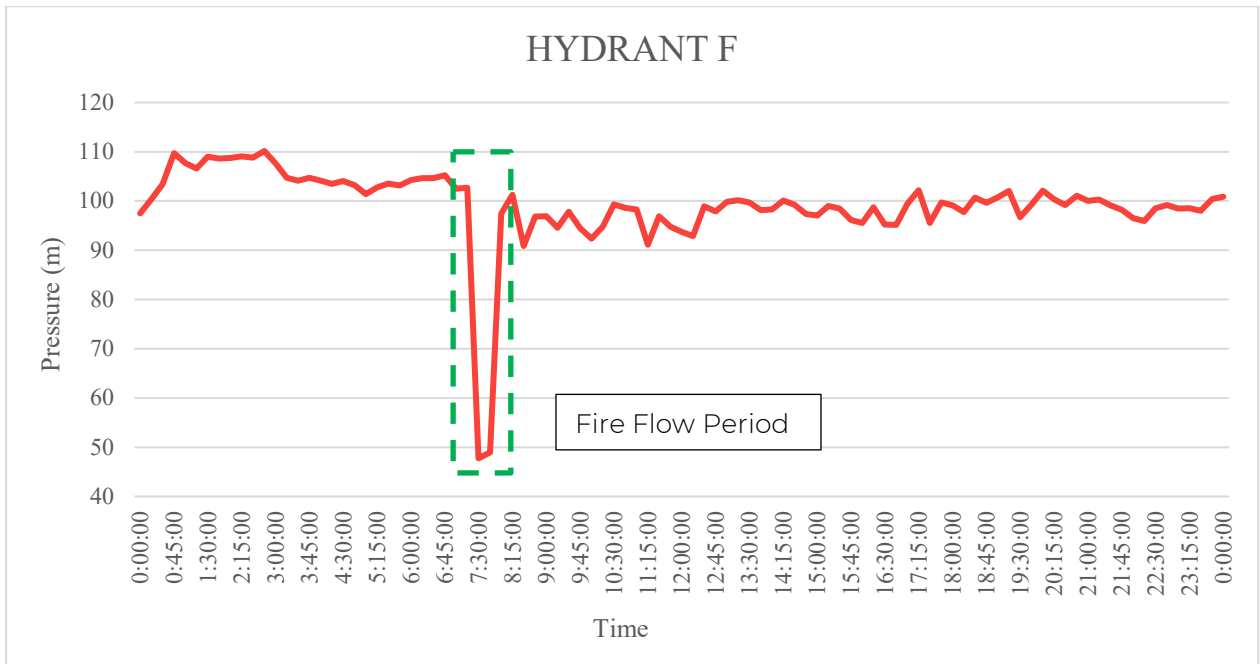
Residual pressure at Critical Hydrant C



Residual pressure at Critical Hydrant D

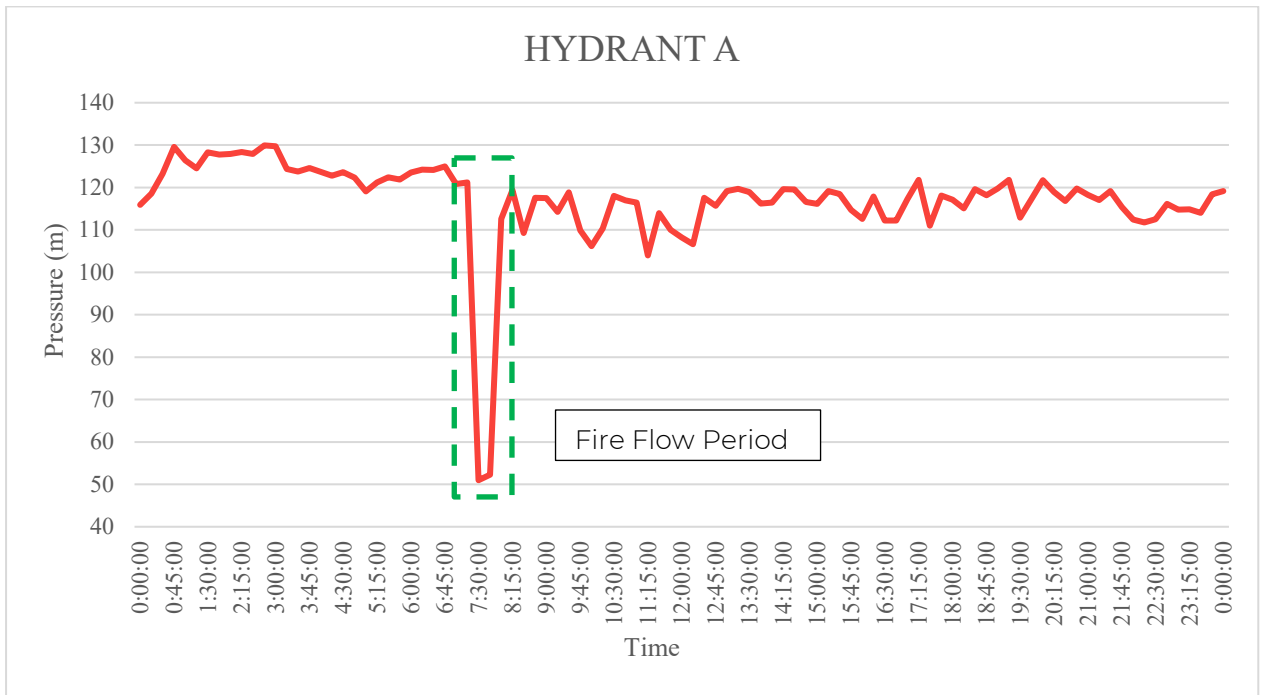


Residual pressure at Critical Hydrant E

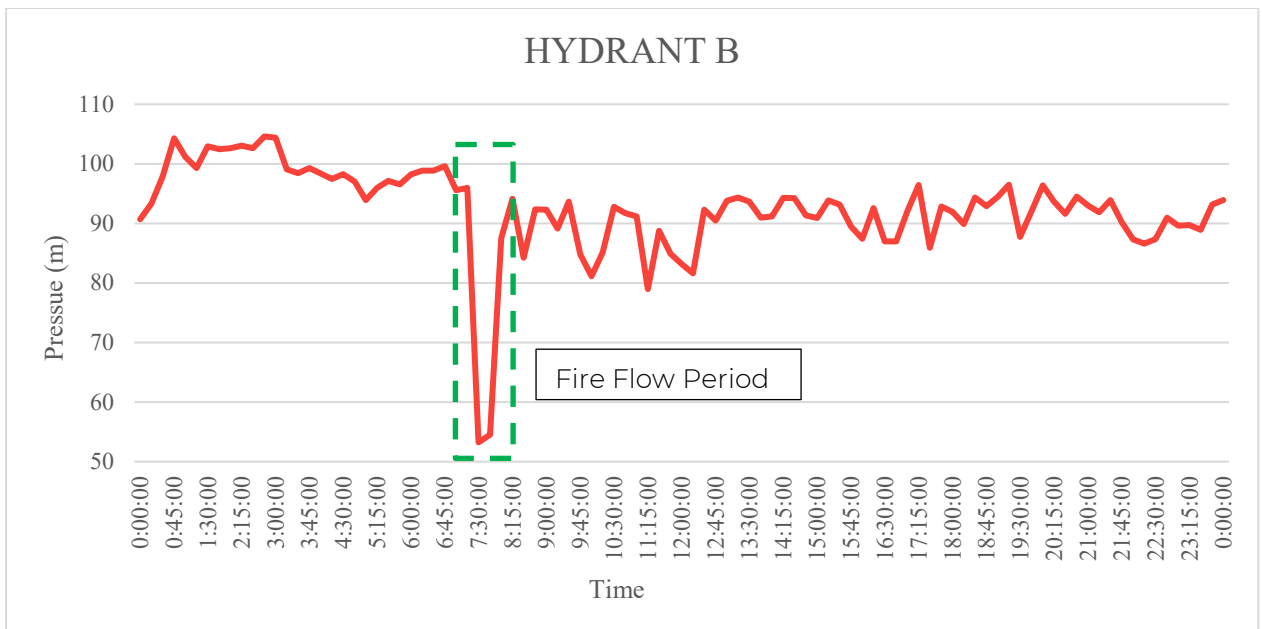


Residual pressure at Critical Hydrant F

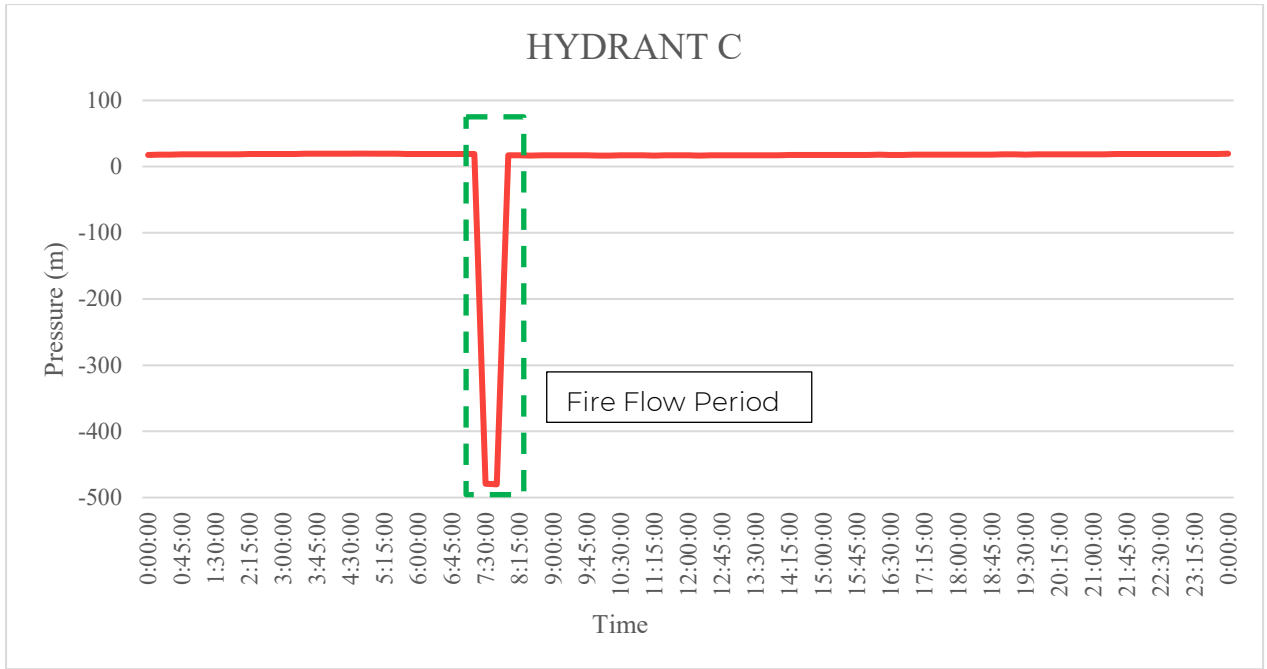
SCENARIO 3



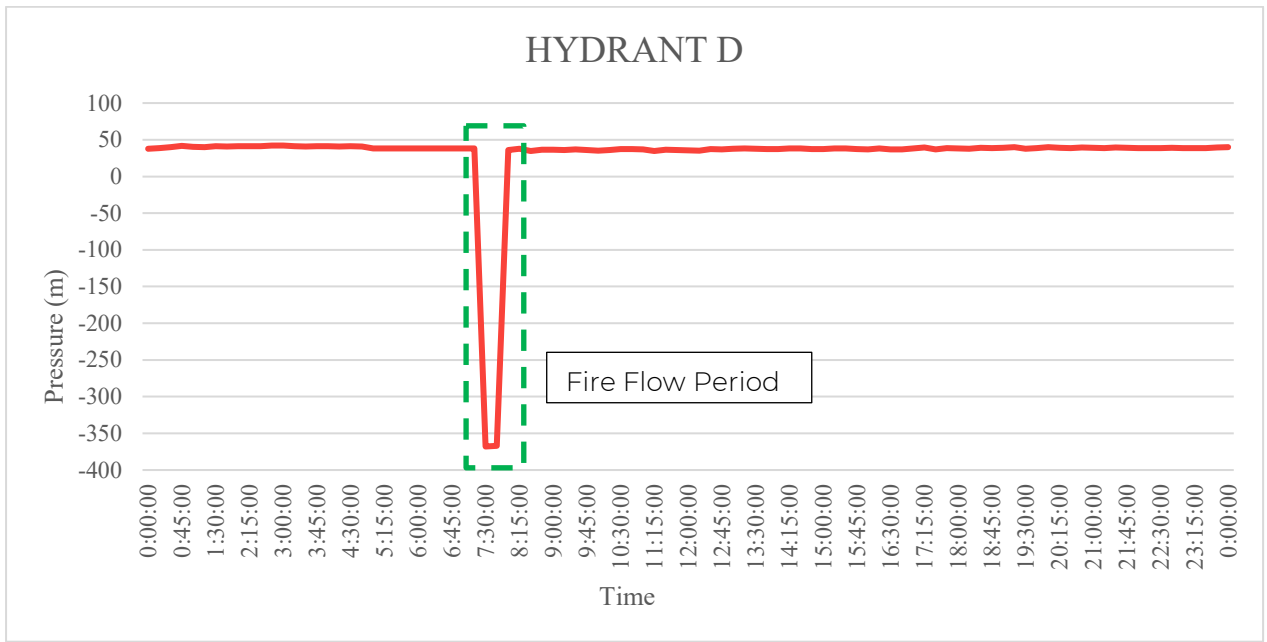
Residual pressure at Critical Hydrant A



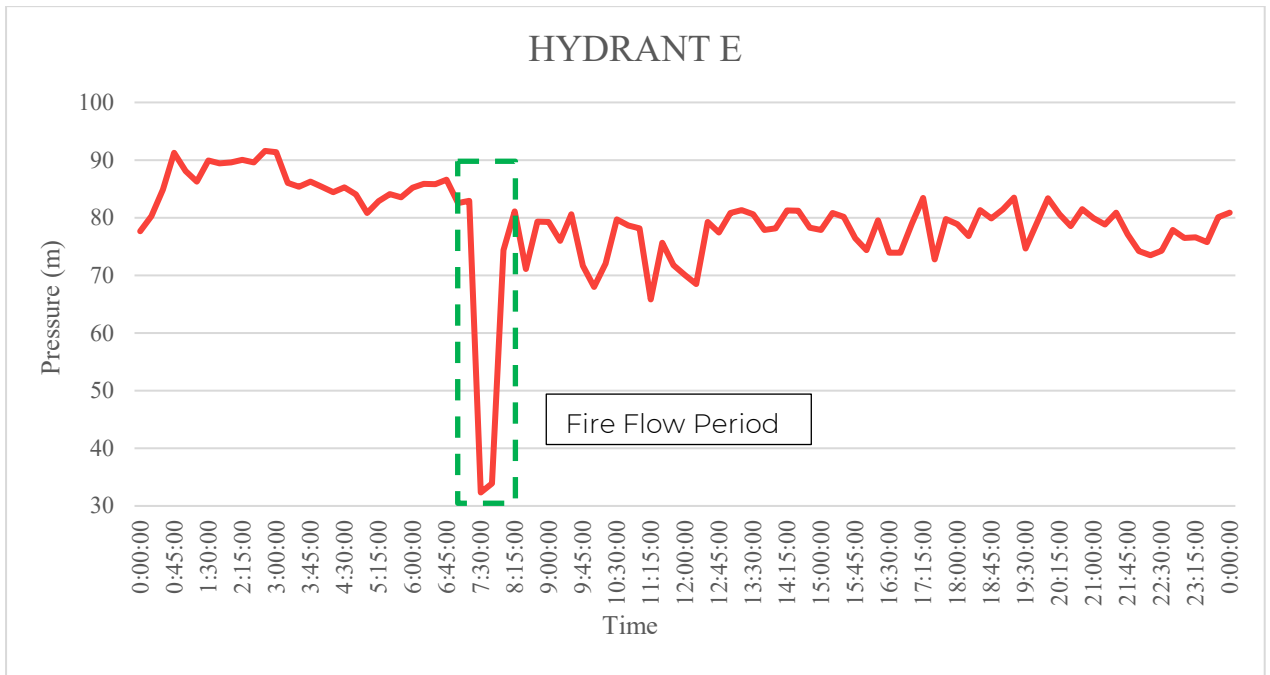
Residual pressure at Critical Hydrant B



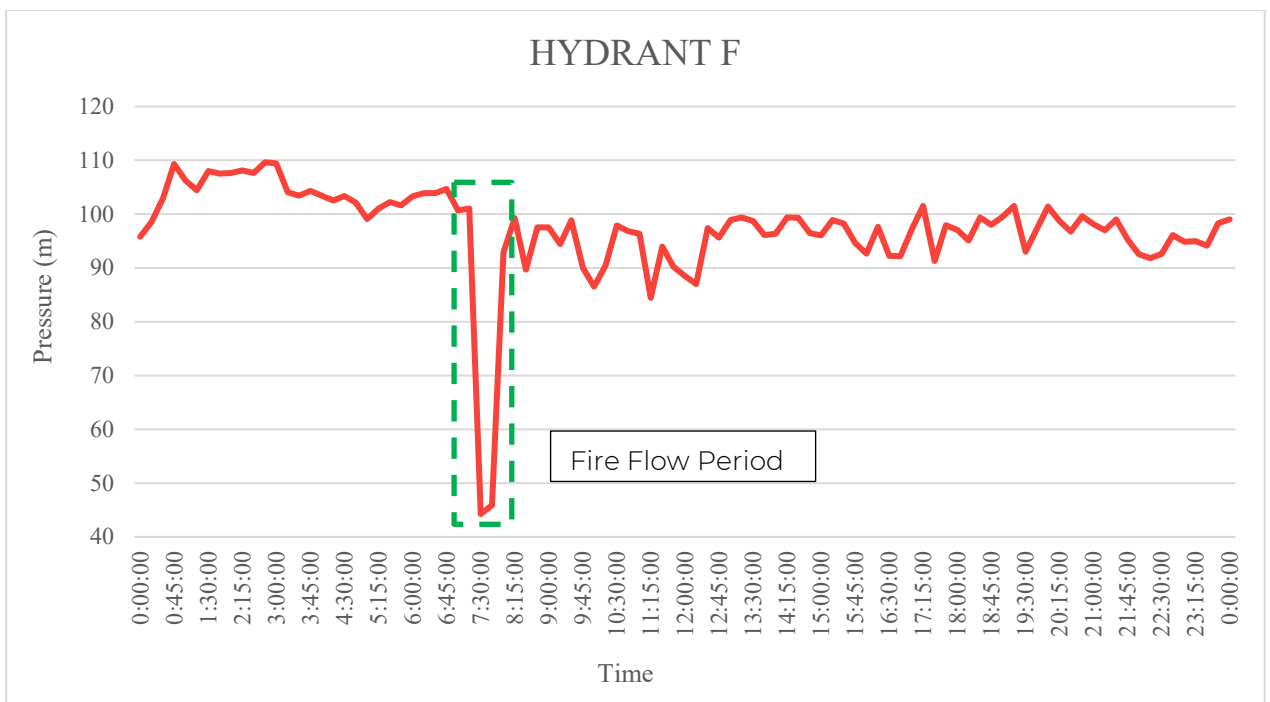
Residual pressure at Critical Hydrant C



Residual pressure at Critical Hydrant D



Residual pressure at Critical Hydrant E



Residual pressure at Critical Hydrant F