MEMO

TO: Murray Amirault, P.Eng., Senior Advisor of Engineering and Capital Projects

FROM: Camilo Marquez, M.Eng., P.Eng., PMP; Uzair Mannan, M.Eng.

SUBJECT: **Hydraulic Assessment: Impact of Future Developments on Iqaluit's Water Distribution System**

DATE: **March 31, 2025**

1 INTRODUCTION

This memorandum presents the results of a hydraulic assessment conducted for the City of Iqaluit's water distribution system. The study evaluates the impacts of future developments under different demand scenarios.

The key focus areas include assessing the existing system performance under Pre-Development conditions and evaluating the impacts of future developments under Average Day Demand (ADD), Maximum Day Demand (MDD), and Peak Hour Demand (PHD) conditions. The preliminary study also determines the necessity of any upgrades required to meet municipal guidelines and identifies hydraulic deficiencies and corrective actions.

2 MUNICIPAL GUIDELINES – CITY OF IQALUIT

The calculation of flow requirements for the water demand of future subdivisions was conducted in accordance with the municipal guidelines set by the City of Iqaluit. These guidelines establish the criteria for determining peak and average water demands, ensuring that infrastructure planning meets regulatory standards and supports long-term sustainability. The water demands were evaluated to simulate system performance under various operating conditions using WaterGEMS. This approach allowed for a detailed analysis of pressure zones, pipe sizing, and overall network efficiency, ensuring that the proposed subdivisions would be adequately serviced while adhering to the City's engineering standards. **Table 1** outlines the flow requirements per the City standards.

Table 1: Water Flow Requirements – per City of Iqaluit

A.3.1 FLOW REQUIREMENTS

1. Average Daily Demand	400 L/person/day
2. Population Density (Residential)	3.5 persons/residence
3. Maximum Daily Demand	2 * Average Demand

4. Peak Hourly Demand	4 * Average Demand
5. Minimum Residual Water Pressure During Peak Hour Flow	350 Kpa (50 psi)
6. Minimum Residual Water Pressure During Maximum Day + Fire Flow	140 Kpa (20 psi)
7. Minimum Residual Water Pressure Maximum Day Flow (for operation of residential fire sprinklers)	350 Kpa (50 psi)

3 PRE-DEVELOPMENT SCENARIO (EXISTING SYSTEM)

Iqaluit's existing water distribution network was analyzed under Peak Hour Demand (PHD) conditions using WaterGEMS. The municipal guidelines require a minimum pressure of 50 psi at junctions during PHD. Several zones within the gravity network failed to meet this requirement, indicating that infrastructure improvements are needed even before incorporating future development demands. Multiple low-pressure junctions were identified, as shown in **Figure 1**.

A third supply line (400mm HDPE, Hazen-Williams C = 120) was proposed from the WTP Reservoir to the Access Vault (AV306) to address these deficiencies. This third supply line significantly improved pressure across the network, making most junctions comply with the 50 psi requirement. **Figure 2**, depicting pressure improvements after the third supply line addition, is provided for reference.

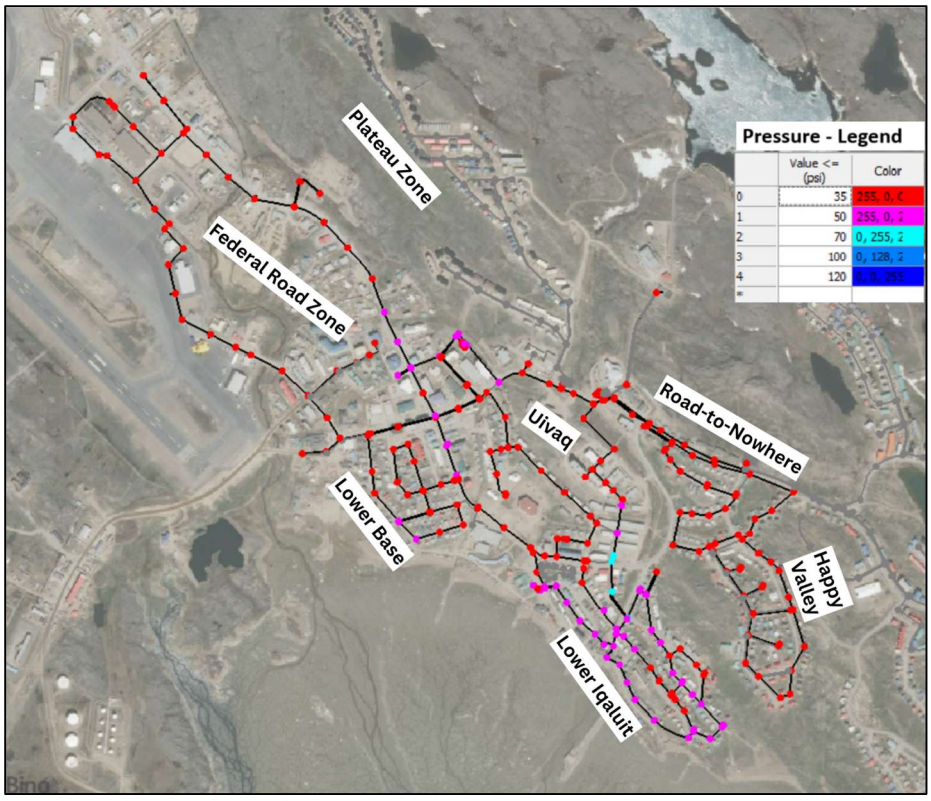

Figure 1: Pre-development Scenario: Low-Pressure Junctions – Gravity System

*** Red dots (junctions) pressures under PHD <= 35 psi**

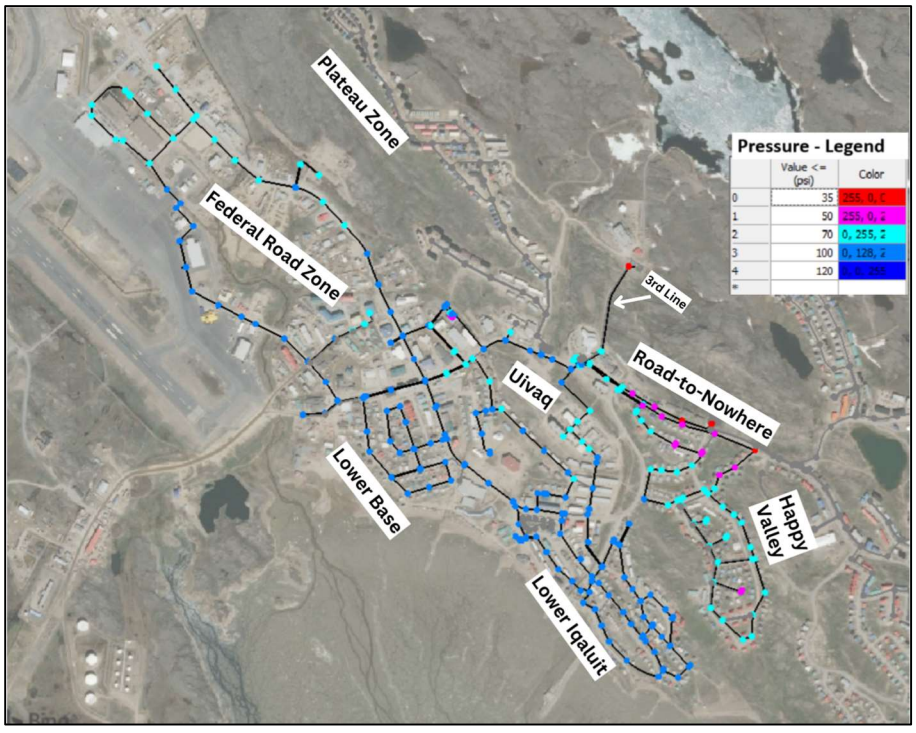

Figure 2: Pre-development Scenario: Improved Pressures Junctions

4 POST-DEVELOPMENT SCENARIO

4.1 FUTURE DEVELOPMENTS & DEMAND ALLOCATION

To model the impact of future developments, water demand calculations were derived from the shapefile, named “Future Growth Plotted,” provided by the Client. This file contained proposed parcels, including their spatial data, with details on their expected status and associated demand. The "Status" column categorized parcels as speculative, planned, confirmed (awaiting application), staff review, approved, under construction, or recently built. Only the parcels classified as "approved," "under construction," and "recent build" were considered for demand allocation in the hydraulic model, ensuring that assumptions reflected actual planned growth. These future development parcels are color-coded in green and shown in **Figure 3**.

Figure 3: Future Development Parcels

The "Demand" column in the shapefile specifies the residential units per building. When a range was given (e.g., 10-20 units), the conservative estimate of the upper limit (20 units) was applied. Using municipal guidelines, demand per unit was calculated based on an occupancy rate of 3.5 persons per residence and a per capita water consumption rate of 400 L/capita/day. This provided the Average Day Demand (ADD). Maximum Day Demand (MDD) was determined to be twice the ADD, while Peak Hour Demand (PHD) was calculated to be four times the ADD. These selected parcels were then georeferenced and assigned demand values in the updated hydraulic model. The calculations are attached along with this memo.

4.2 LIMITATIONS AND ASSUMPTIONS

WSP had requested (in RFI-13) performance data for booster stations 1 and 2, reheat stations, and recirculation pumps. Since the Client provided only limited nameplate data for Booster Station No. 2 and no operational performance curves nor nameplates for others, direct capacity assessments were not possible. Instead, future demands from the Road-to-Nowhere (RTN) and Plateau zones were redistributed into different demand junctions, under the PHD scenario, that are serviced by the three supply lines (two existing and one newly proposed 400mm HDPE line) from the WTP Reservoir. This redistribution ensured that the hydraulic model could capture the additional loads from planned developments without over-reliance on uncertain booster station capacities. However, this approach introduces some uncertainty, as the actual operational constraints of these booster stations remain unknown due to the lack of information related to the pump performance curves and pressure thresholds set in normal operations.

4.3 IMPACT OF FUTURE DEVELOPMENTS ON PHD

The updated model incorporating future subdivision water demands under ADD, MDD, and PHD scenarios indicated significant pressure drops in certain zones, especially during PHD. The model simulations revealed that the Happy Valley zone experienced substantial pressure deficiencies, with multiple junctions registering pressures below 50 psi, as shown in **Figure 4**. This suggests that the newly added 400mm supply line to the existing system alone cannot offset low pressures in Happy Valley. The likely reasons include increased overall system demand, high head loss in existing pipelines, and the limitations of the gravity-fed supply system in maintaining adequate pressure at remote junctions.

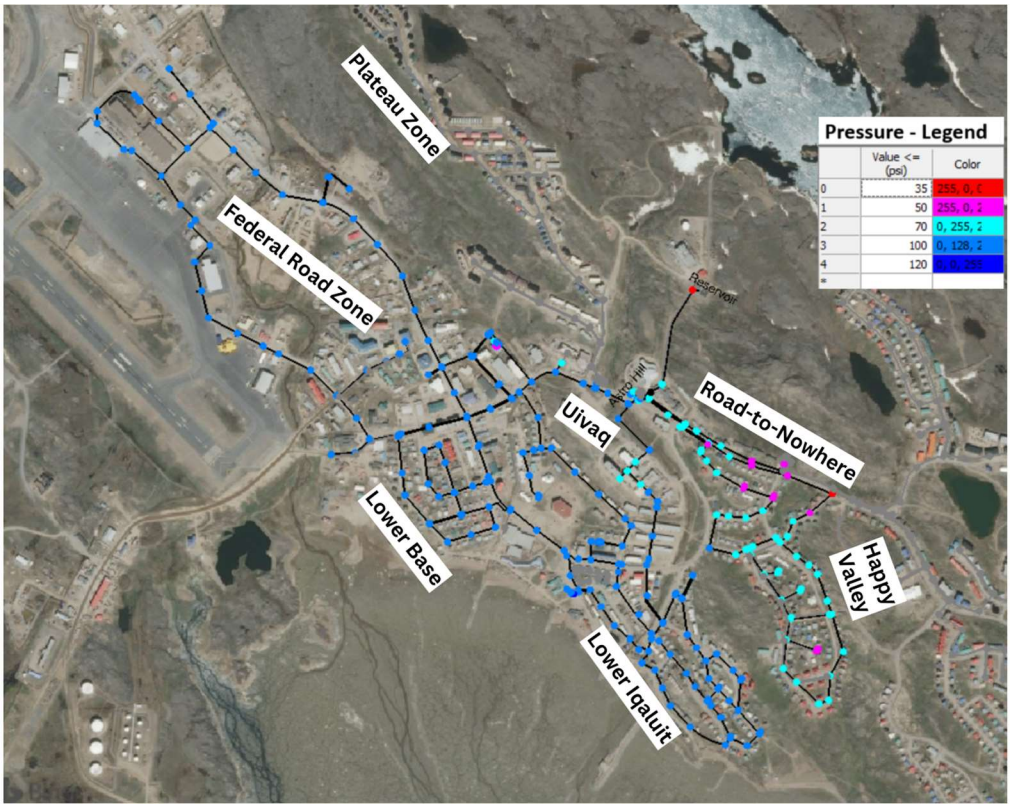

Figure 4: Low-Pressure Junctions in Happy Valley during PHD

To mitigate this issue, a new booster station was proposed near Reheat Station 1, with its supply connection sourced from AV306, as shown in **Figure 5**.

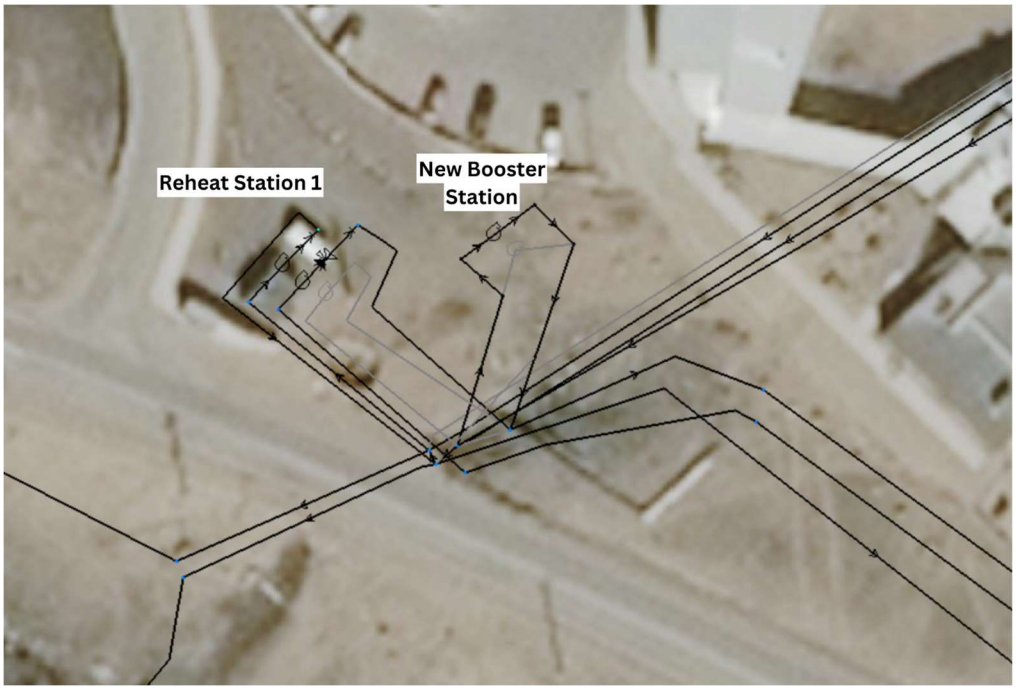

Figure 5: New Booster Station Location

The proposed booster station was preliminary designed with a pump capacity of 25 L/s and a head of 35m. **Figure 6** Illustrates the newly proposed booster station's positive impact on system pressures during PHD. Following its addition, most Happy Valley junctions complied with the 50-psi requirement.

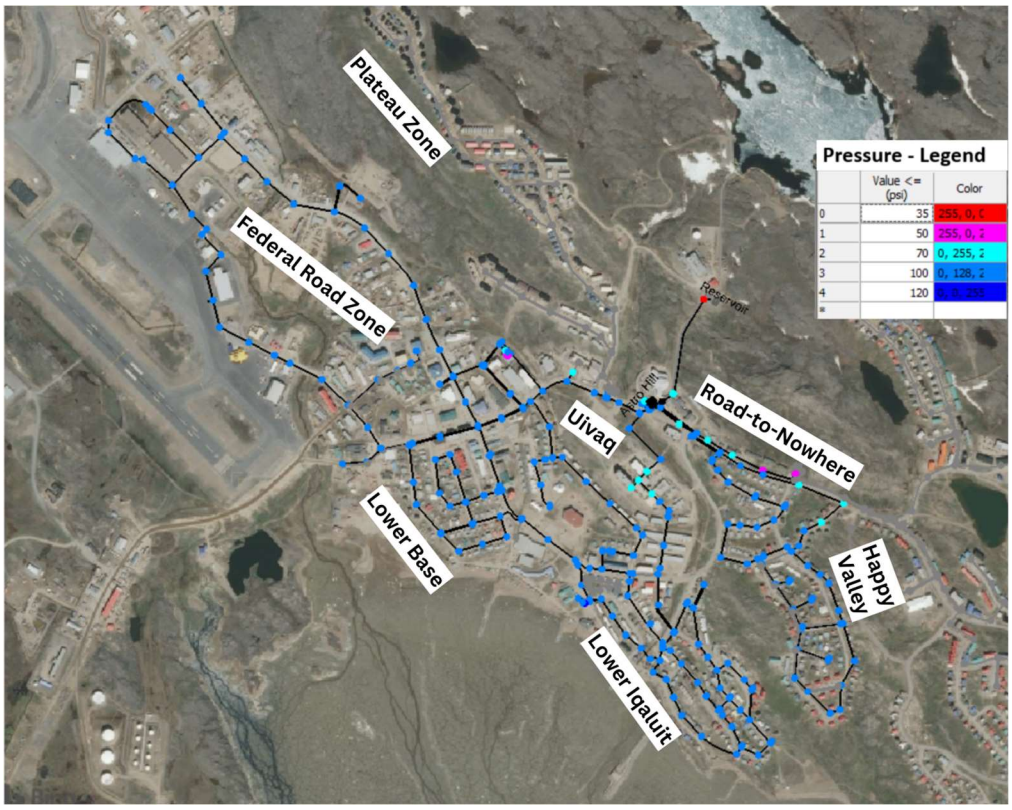

Figure 6: Impact of New Booster Station on Happy Valley (during PHD)

4.4 MAXIMUM DAY DEMAND (MDD) & FIRE FLOW ANALYSIS

The upgraded network, which included the third supply line and the new booster station, was tested under MDD conditions, and the results indicated compliance with pressure requirements, as shown in **Figure 7**.

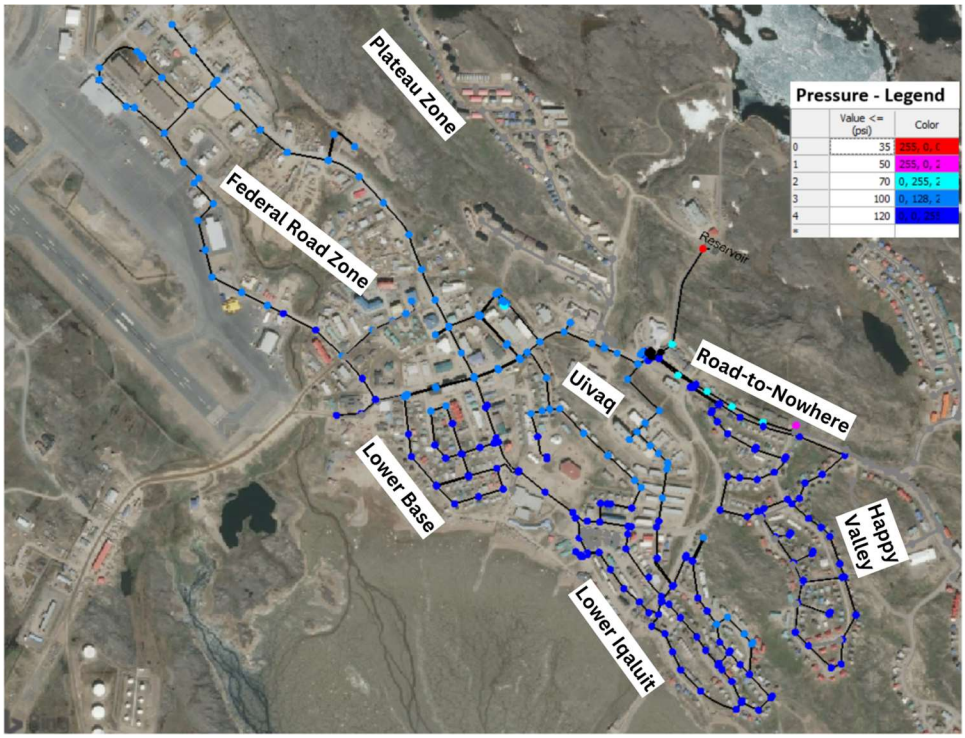

Figure 7: Pressure Junctions (during MDD) comply after Proposed Upgrades

However, under MDD plus fire flow conditions, several Happy Valley and Lower Base zone hydrants failed to meet the required 60 L/s fire flow due to inadequate pipe capacity, as presented in **Figure 8**. Older pipelines, particularly those installed in Happy Valley and Lower Base, experienced high head loss, further contributing to fire flow deficiencies. Some hydrants experienced fire flows below 50 L/s, highlighting the need for immediate intervention.

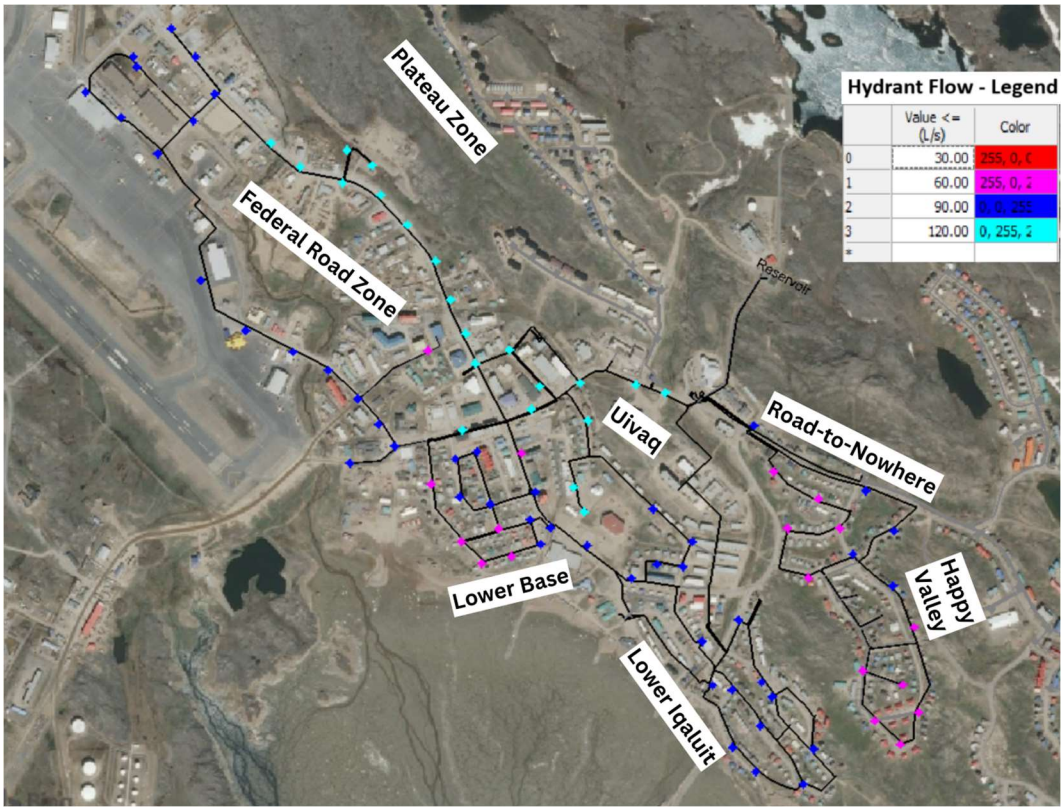

Figure 8: Failed Hydrants (during MDD + Fire flow)

To address this issue, a dedicated fire pump with a capacity of 100 L/s and a head of 75m was proposed at the new booster station. Additionally, water mains in Happy Valley (installed in 1979) and Lower Base (installed in 1990) require replacement to withstand the increased fire pump pressure. **Tables 2** and **3** list the affected pipes, lengths, materials, and proposed diameters for the Lower Base and Happy Valley zones.

Table 2: Lower Base – Pipe Upgrade Summary

Existing Pipes (Before Upgrade)			Proposed Upgrades (After Upgrade)		
Diameter (mm)	Length (m)	Pipe Material	Diameter (mm)	Length (m)	Pipe Material
150	137	Ductile Iron	Replaced by →		
200	1309	HDPE	250	1446	HDPE
∑ Total	**1446**		**∑ Total**	**1446**	

Table 3: Happy Valley – Pipe Upgrade Summary

Existing Pipes (Before Upgrade)			Proposed Upgrades (After Upgrade)		
Diameter (mm)	Length (m)	Pipe Material	Diameter (mm)	Length (m)	Pipe Material
50	152	HDPE	Replaced by →		
150	566	HDPE	125	157	HDPE
200	2149	HDPE	250	2715	HDPE
∑ Total	**2867**		**∑ Total**	**2872**	

In Lower Base, the existing (affected) pipeline network consists of 1,446 meters of water pipes, including 150 mm ductile iron and 200 mm HDPE pipelines. Following the upgrades, the 150 mm ductile iron pipes will be entirely replaced with 250 mm HDPE pipes to improve capacity and longevity. Similarly, the 200 mm HDPE pipes will be upgraded to 250 mm HDPE, ensuring uniformity in pipe sizing for optimized hydraulic performance. The total pipeline replacement length in Lower Base remains 1,446 meters.

In Happy Valley, a total of 2,867 meters of pipelines require replacement. The system consists of 50 mm, 150 mm, and 200 mm pipes made of HDPE and ductile iron. As part of the proposed upgrades, the 50 mm HDPE pipes will be replaced with 100 mm HDPE pipes to enhance system efficiency. The 150 mm and 200 mm HDPE pipes will be upgraded to 250 mm HDPE, increasing the pipeline capacity to accommodate future demand. Following these upgrades, the total pipeline length in Happy Valley will be 2,872 meters, ensuring consistent distribution system improvements. **Figure 9** represents locations of proposed upgrades across both zones.

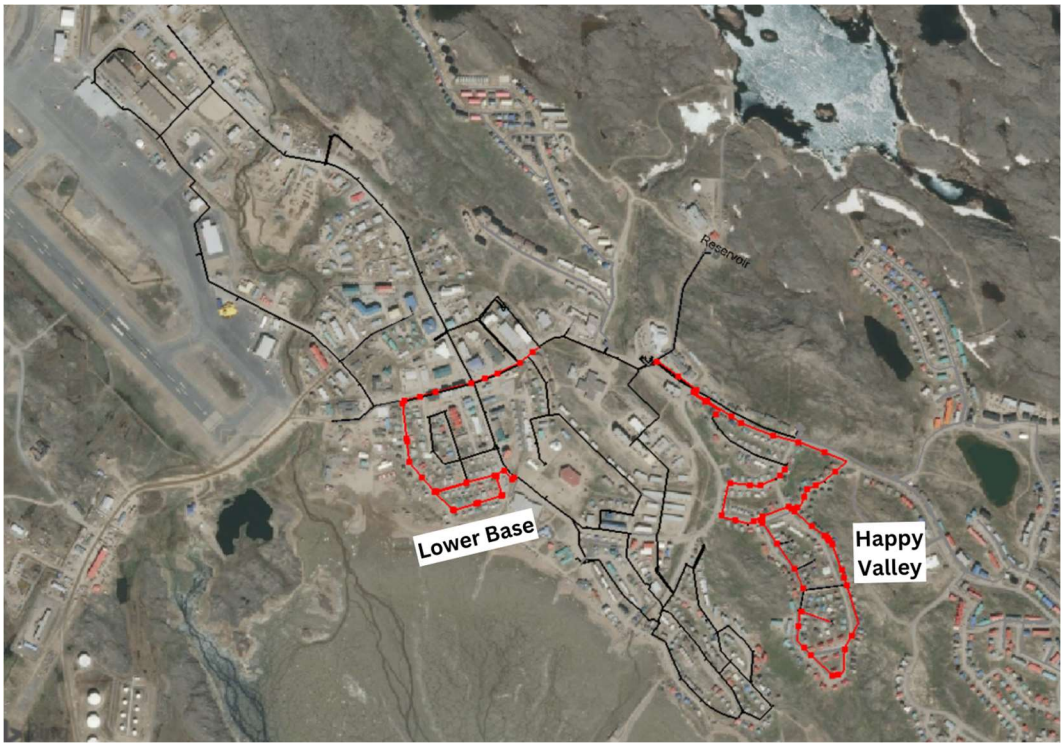

Figure 9: Proposed Pipe Upgrades in Lower Base & Happy Valley (under MDD + Fire flow)

Following the implementation of these upgrades, the model confirmed that fire flow deficiencies were resolved, bringing all hydrants into compliance with municipal requirements. **Figure 10** Depicting the hydrant flow improvements post-upgrades are included for review.

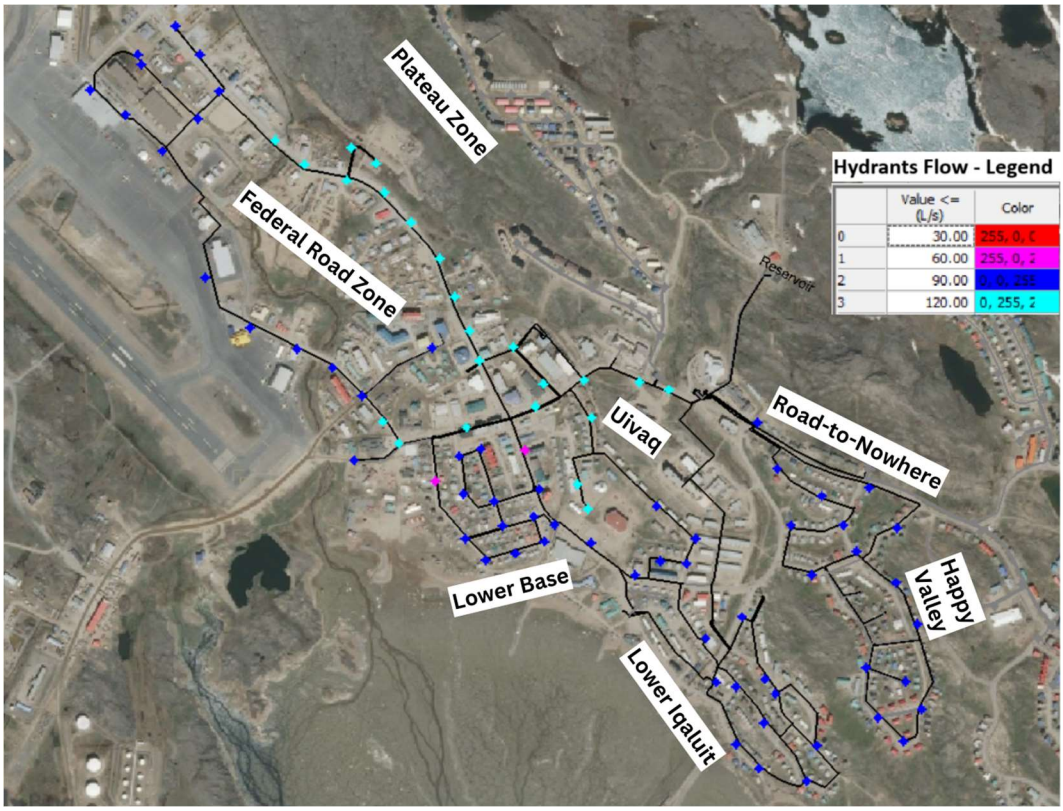

Figure 10: Post-upgrade performance of Failed Hydrants (under MDD + Fire flow)

5 KEY FINDINGS & RECOMMENDATIONS

Based on the hydraulic analysis, the following upgrades are recommended to ensure compliance with Iqaluit's municipal guidelines.

In the immediate term, constructing the third supply line (400mm HDPE) is necessary to resolve existing low-pressure issues. To accommodate future demand, a new booster station should be installed near Reheat Station 1 to support Happy Valley. To ensure compliance with fire flow requirements, a dedicated fire pump (100m head, 75 L/s) should be added at the new booster station. At the same time, aging watermains in Happy Valley and Lower Base should be upgraded to withstand higher pressures.

These upgrades will improve system resiliency, ensuring compliance under existing and future conditions. Additional performance monitoring and further data collection on booster stations are recommended. Please review the findings and let us know if additional refinements are needed.

6 DISCLAIMER

WSP Canada Ltd. completed the preceding analysis with instructions directly from the City of Iqaluit. This review explicitly evaluates Iqaluit's water distribution network and possible solutions for improving it.

The information in this memo is of a planning and conceptual design-related level of detail and cannot be used for infrastructure design without further detailed analyses.

7 CLOSURE

We trust you will find the foregoing report suitable. Should you have any questions, please do not hesitate to contact the undersigned at (204) 781-5002 or via email at Camilo.marquez@wsp.com.

Yours truly,

WSP Canada Inc.

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OBJECTID	fid	Description	Status	Occupancy	Demand	Cons. Demand units	Person/unit	ADD (L/min)	MDD (L/min)	PHD (L/min)	Shape_Length	Shape_Area
1	1	Joamie Ct PH	Recent Build	2024	20-30	30	105	29.167	58.333	116.667	119.0512639	666.3675932
2	2	Astro Hill Gate	Recent Build	2024	30-40	40	140	38.889	77.778	155.556	122.2699441	691.1949179
3	3	Wellness Hub	Recent Build	2024	10-20	20	70	19.444	38.889	77.778	93.00926638	539.5956494
4	4	Nova Office	Construction	2025	10-20	20	70	19.444	38.889	77.778	115.2155177	820.4667011
5	5	NCC LP 1	Recent Build	2024	30-40	40	140	38.889	77.778	155.556	156.123933	994.8406156
6	6	NCC LP 2	Construction	2025	30-40	40	140	38.889	77.778	155.556	149.7632362	925.9979199
7	7	Dentist	Approved	2026	10-20	20	70	19.444	38.889	77.778	78.8021852	338.9469728
8	8	Matt Wilkins	Construction	2025	30-40	40	140	38.889	77.778	155.556	117.1948684	839.0878396
9	9	Milan Behind City Hall	Construction	2025	30-40	40	140	38.889	77.778	155.556	139.7165261	994.9192091
10	10	Fed Temp Staff Housing	Staff Review	2025	10-20	20	70	19.444	38.889	77.778	98.41112932	603.969492
11	11	765 Fred Coman	Approved	2026	10-20	20	70	19.444	38.889	77.778	75.36508009	312.3778734
12	12	Butler Uquutaq	Approved	2027	20-30	30	105	29.167	58.333	116.667	102.0284986	597.8124117
13	13	Youth Hub	Staff Review	2027	10-20	20	70	19.444	38.889	77.778	91.09489594	515.2511385
14	14	Atco Loop TBG	Staff Review	2027	20-30	30	105	29.167	58.333	116.667	158.2739107	1055.212414
15	15	Atco Loop Non Profit	Confirmed, Waiting for Application	2028	20-30	30	105	29.167	58.333	116.667	167.2963751	1139.545998
16	16	Atco Loop NCC	Confirmed, Waiting for Application	2027	30-40	40	140	38.889	77.778	155.556	202.9143801	2442.7603
17	17	Beach Lots	Construction	2025	20-30	30	105	29.167	58.333	116.667	208.0126364	1355.668786
18	18	Shelter Uquutaq	Construction	2026	20-30	30	105	29.167	58.333	116.667	106.8715769	644.0839217
19	19	Milan 36 Unit	Approved	2026	30-40	40	140	38.889	77.778	155.556	112.2033867	661.1494534
20	20	Hunters Market	Staff Review	2026	5-10	10	35	9.722	19.444	38.889	104.1803965	662.5794106
21	21	779/802	Staff Review	2027	20-30	30	105	29.167	58.333	116.667	153.0533641	827.6814755
22	22	1021	Staff Review	2024	0-5	5	17.5	4.861	9.722	19.444	66.09540366	272.4286058
23	23	1023	Construction	2025	0-5	5	17.5	4.861	9.722	19.444	57.60992355	207.3374558
24	24	Marc 5 plex	Staff Review	2028	0-5	5	17.5	4.861	9.722	19.444	43.0031576	108.5659288
25	25	Mark Beh 6 plex	Staff Review	2027	5-10	10	35	9.722	19.444	38.889	103.2152446	617.7221442
26	26	Hospital Hill	Staff Review	2027	30-40	40	140	38.889	77.778	155.556	321.1695731	3759.538883
27	27	Joamie Lot 16	Construction	2025	0-5	5	17.5	4.861	9.722	19.444	57.65668244	203.0050048
28	28	Joamie Lot 15	Construction	2025	0-5	5	17.5	4.861	9.722	19.444	51.65084033	150.6521952
29	29	Joamie Lot 21	Construction	2025	0-5	5	17.5	4.861	9.722	19.444	66.2729844	242.4027595
30	30	Joamie Lot 25	Staff Review	2025	0-5	5	17.5	4.861	9.722	19.444	60.49700757	212.0949699
31	31	Joamie Lot 30	Staff Review	2025	0-5	5	17.5	4.861	9.722	19.444	56.53660192	190.99617
32	32	Joamie Lot 28	Construction	2025	0-5	5	17.5	4.861	9.722	19.444	63.12770057	235.5905491
33	33	NHC Siku	Construction	2024	20-30	30	105	29.167	58.333	116.667	118.973215	579.8802273
34	34	NHC Lower	Confirmed, Waiting for Application	2027	20-30	30	105	29.167	58.333	116.667	198.9102438	2140.125529
35	35	Elders Core Area	Confirmed, Waiting for Application	2028	20-30	30	105	29.167	58.333	116.667	170.5490269	1598.113151
36	36	Astro Hill Lookout	Construction	2026	20-30	30	105	29.167	58.333	116.667	123.7322285	734.1570239
37	37	Astro Biz Hotel	Staff Review	2026	40-50	50	175	48.611	97.222	194.444	136.787868	837.2502693
38	38	PSPC Nikku	Construction	2026	20-30	30	105	29.167	58.333	116.667	96.41600956	574.7803692
39	39	Green Row Redev	Confirmed, Waiting for Application	2028	20-30	30	105	29.167	58.333	116.667	158.3219183	1013.717374
40	40	Astro Hill Future 1	Planned	2029	60-70	70	245	68.056	136.111	272.222	212.7922469	2389.560496
41	41	Astro Hill Future 2	Planned	2028	80-90	90	315	87.500	175.000	350.000	156.8821345	1570.202382
42	42	Astro Hill Future 3	Planned	2029	30-40	40	140	38.889	77.778	155.556	190.0221699	2244.391386
43	43	Astro Hill Future 4	Planned	2027	30-40	40	140	38.889	77.778	155.556	193.7828812	2312.017436
44	44	TBG Phase 1	Staff Review	2026	100-110	110	385	106.944	213.889	427.778	309.7272873	3758.973069
45	45	TBG Phase 2	Planned	2028	100-110	110	385	106.944	213.889	427.778	201.0495333	2447.433851
46	46	TBG Phase 3	Planned	2031	100-110	110	385	106.944	213.889	427.778	202.1380267	2049.64624
47	47	QIA Office	Staff Review	2026	20-30	30	105	29.167	58.333	116.667	219.4073586	2638.270735
48	48	QPI Mixed Use	Staff Review	2026	20-30	30	105	29.167	58.333	116.667	152.4368059	1443.974877
49	49	NCC Redev Capital District	Speculative	2028	50-60	60	210	58.333	116.667	233.333	276.3043157	3832.405392
50	50	C&K 1099	Staff Review	2027	10-20	20	70	19.444	38.889	77.778	116.9779936	785.7062012
51	51	Birchcliff Multi Plex	Speculative	2026	5-10	10	35	9.722	19.444	38.889	66.8527328	265.3703449
52	52	Maker Space	Staff Review	2028	5-10	10	35	9.722	19.444	38.889	149.6079953	1322.621492
53	53	IOL Future Growth	Subdivision	2026	80-90	90	315	87.500	175.000	350.000	943.6682325	38935.85175
54	54	IOL Future Growth	Subdivision	2027	80-90	90	315	87.500	175.000	350.000	635.6152075	21534.00926
55	55	SIDA Future Growth	Subdivision	2030	220-230	230	805	223.611	447.222	894.444	1759.345055	93034.62692
56	56	Recovery Centre	Construction	2025	20-30	30	105	29.167	58.333	116.667	217.0037633	2910.84228
57	57	LTC	Confirmed, Waiting for Application	2029	20-30	30	105	29.167	58.333	116.667	297.1943571	5431.706576
58	58	NIHC	Confirmed, Waiting for Application	2035	5-10	10	35	9.722	19.444	38.889	326.8326739	6616.126548
59	59	Nikku Future	Speculative	2028	20-30	30	105	29.167	58.333	116.667	118.8044785	785.8874333
60	60	Kisaut 2	Confirmed, Waiting for Application	2028	30-40	40	140	38.889	77.778	155.556	178.7741777	1587.372088
61	61	Office Sani	Staff Review	2025	0-5	5	17.5	4.861	9.722	19.444	70.49503249	298.6452259
62	62	NHC Redevelopment	Speculative	2029	20-30	30	105	29.167	58.333	116.667	123.9070036	901.6784074
63	63	NHC / City Res	Speculative	2030	10-20	20	70	19.444	38.889	77.778	173.6237403	1661.788763