

Master Plans for  
Urban Water Infrastructure in  
The City of Vaughan

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**City-Wide Water & Wastewater  
Master Plan Class EA**

**APPENDIX C  
Water Distribution System Pressure  
Monitoring Technical Memorandum**

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JUNE 2014

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for double-sided printing

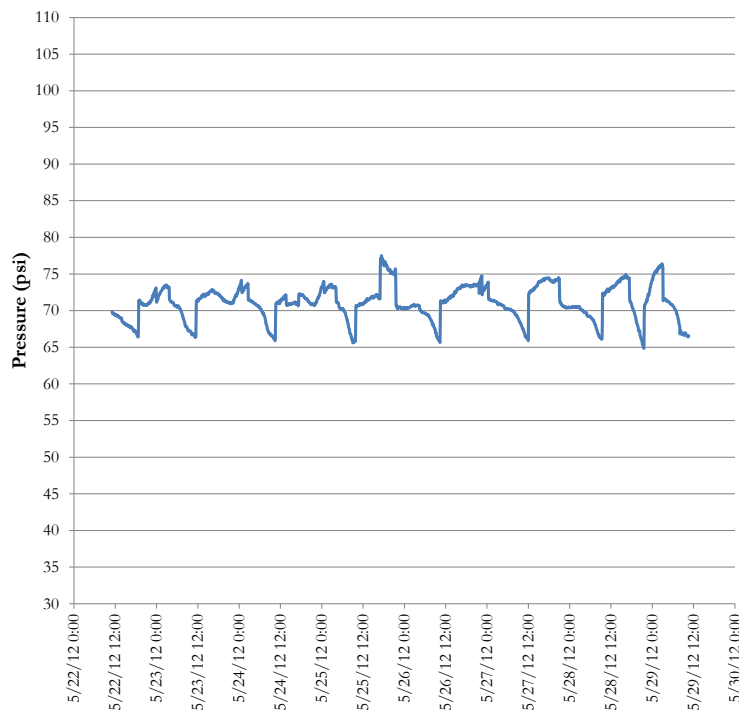
## Technical Memorandum – DRAFT

File: **10010**  
 Date: **12 September 2012**  
 From: **Fabian Papa**, Fabian Papa & Partners Inc.  
**Eric Tuson, Kevin Brown & Matt Fisher**, The Municipal Infrastructure Group Ltd.  
 To: **Michael Frieri, Tony Artuso & Robert Mayer**, City of Vaughan  
 Re: **Water Distribution System Pressure Monitoring**  
**City-Wide Water & Wastewater Master Plan**

This technical memorandum synthesizes field-recorded pressure data across the various pressure districts within the City's distribution system and provides the basis for confirming or establishing appropriate boundary conditions for use in the City-wide hydraulic model developed and employed in this Master Plan project. Where appropriate, additional information with respect to anticipated future boundary conditions has been considered.

### PD4

The following plot describes the pressures at the main source of supply for PD4, being from the City of Toronto at the intersection of Islington Avenue and Steeles Avenue West. In general, the data indicate a variation in pressures experienced at this location and the pressure profile suggests that these pressures are controlled largely by the number of pumps that are on at any given time.



**Location:**

NE Corner of Islington Avenue  
& Steeles Avenue West

**Period:** 22 May to 29 May 2012

**Hydrant GIS ID:** 2971

**Hydrant Field ID:** TBD

**Pressure Recorder ID:** 2785

**Average Pressure:** 71.1 psi or 50.0 m H<sub>2</sub>O

**Standard Deviation:** 2.3 psi or 1.6 m H<sub>2</sub>O

**Coefficient of Variation:** 0.033

**95% Confidence Interval:**

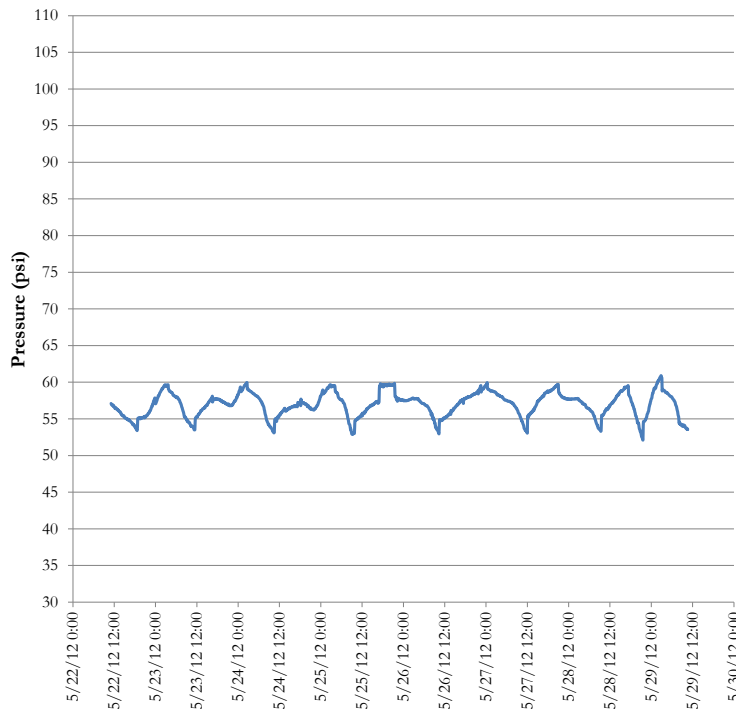
66.4 psi to 75.8 psi or 46.7 m to 53.3 m H<sub>2</sub>O

**Elevation:** 158.416 m (City Survey)

**Average Hydraulic Grade (HGL):** 208.4 m

Other supplies include Pressure Reducing Valves (PRVs) at three locations providing water from the adjacent PD5 system. The boundary conditions for these valves is based on pressure setting information received from the City's Public Works staff during the various working sessions held during this assignment to build and refine the model.

The following pressure recording information is taken from other locations in the PD4 zone:



**Location:**  
 Kipling Avenue & Highway 7  
 (1<sup>st</sup> Hydrant North of Highway 7  
 on East Side of Kipling)

**Period:** 22 May to 29 May 2012

**Pressure Recorder ID:** 2817

**Hydrant GIS ID:** HY00

**Hydrant Field ID:** TBD

**Average Pressure:** 57.0 psi or 40.1 m H<sub>2</sub>O

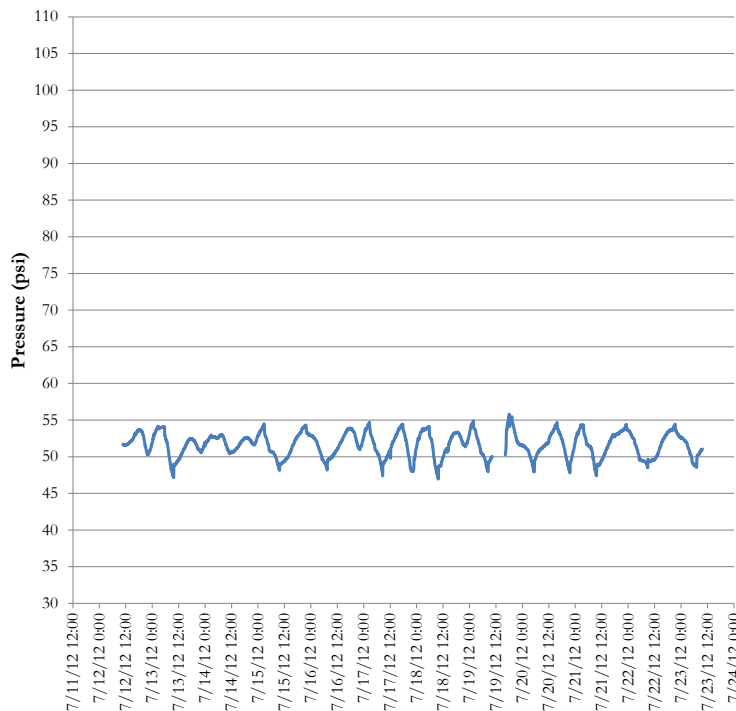
**Standard Deviation:** 1.7 psi or 1.2 m H<sub>2</sub>O

**Coefficient of Variation:** 0.029

**95% Confidence Interval:**  
 53.6 psi to 60.3 psi or 37.7 m to 42.4 m H<sub>2</sub>O

**Elevation:** 167.287 m (City Survey)

**Average Hydraulic Grade (HGL):** 207.4 m



**Location:**  
 139 Claremont Lane

**Period:** 12 July to 23 July 2012  
*(anomalous event on 19 July 2012 removed)*

**Pressure Recorder ID:** 2785

**Hydrant GIS ID:** 3100

**Hydrant Field ID:** TBD

**Average Pressure:** 51.7 psi or 36.3 m H<sub>2</sub>O

**Standard Deviation:** 1.7 psi or 1.2 m H<sub>2</sub>O

**Coefficient of Variation:** 0.032

**95% Confidence Interval:**  
 48.3 psi to 55.0 psi or 34.0 m to 38.7 m H<sub>2</sub>O

**Elevation:** 170.5 m (from model)

**Average Hydraulic Grade (HGL):** 206.8 m

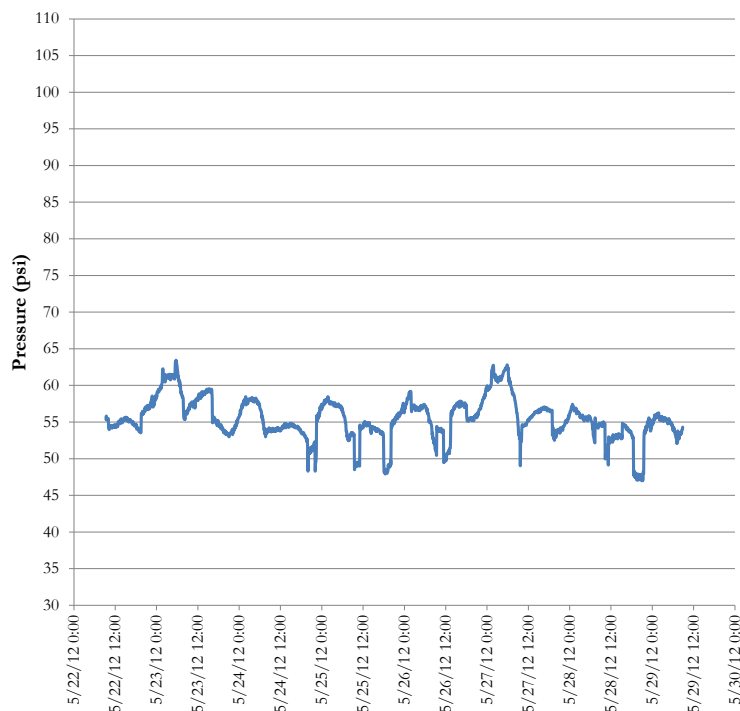
Based on these findings, and compared with the pump curves provided at the Toronto supply (Islington & Steeles) as well as the fixed water surface elevation of the elevated tank (i.e., 206.28 m) as provided in the original model, these boundary conditions continue to be used and are deemed to be somewhat conservative.

## PD5 West

The following series of plots shows the following:

- Measured pressures at 3232 Steeles Avenue West, at its intersection with Adesso Drive and which is indicative of the pressures supplied by the Toronto system to the Region of York's (and City of Vaughan's) PD5 West system. This plot indicates that there are several instances where pressures fall as a result of what appears to be pumps turned off in the supply system from Toronto.
- Measured pressures at 11 Aviva Park Drive, at its intersection with Weston Road and which is located immediately downstream of the East Woodbridge (Weston Road) Booster Pumping Station. This plot somewhat mimics the one for 3232 Steeles Avenue West, as would be expected, however the pressure drops noted above are not apparent. This is likely due to the starting of the pumps in the Weston Road Booster Pumping Station in response to suction side pressures which fall below a specified threshold.
- Superimposed plots of the hydraulic grade elevations of the above two locations, based on the elevations for these locations as represented in the nearest nodes in the City's hydraulic model. This plot indicates that the observed pressures (HGLs) at both locations generally mimic each other, which is to be expected, except in times where the supply pressure from Toronto is low and, at which point, the Region's East Woodbridge Booster Pumping Station apparently starts a pump (or pumps). Interesting to note is that the durations over which these pumps are called into use (i.e., needed) are rather short.

Based on these findings and considering the pump curve information for the Toronto supply that was in the original model supplied by the City, it was determined that the range of operation for the modeled pump curves was similar and appropriate for use for the Toronto supply. With respect to the East Woodbridge Booster Pumping Station on Weston Road, considering that it is expected to be decommissioned by the Region of York, the system was modeled without this station in place. Moreover, future strengthening of the Region's PD5 system has not been taken into account. Accordingly, this approach is deemed to be somewhat conservative.



**Location:**

3232 Steeles Avenue West  
(1<sup>st</sup> Hydrant north of Steeles Avenue  
on Adesso Drive)

**Period:** 22 May to 29 May 2012

**Pressure Recorder ID:** 204226 (PW#1)

**Hydrant GIS ID:** 3358

**Hydrant Field ID:** TBD

**Average Pressure:** 55.5 psi or 39.0 m H<sub>2</sub>O

**Standard Deviation:** 2.8 psi or 2.0 m H<sub>2</sub>O

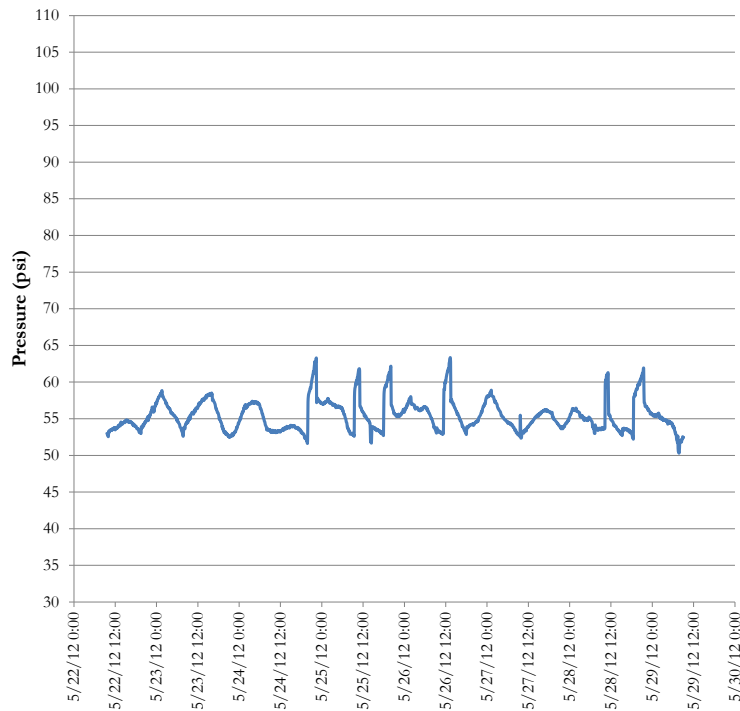
**Coefficient of Variation:** 0.051

**95% Confidence Interval:**

49.8 psi to 61.1 psi or 35.1 m to 43.0 m H<sub>2</sub>O

**Elevation:** 187.789 m (City Survey)

**Average Hydraulic Grade (HGL):** 226.8 m



**Location:**  
 11 Aviva Park Drive  
 (Aviva Park Drive & Weston Road)

**Period:** 22 May to 29 May 2012

**Pressure Recorder ID:** 203878 (PW#2)

**Hydrant GIS ID:** 2656

**Hydrant Field ID:** TBD

**Average Pressure:** 55.4 psi or 38.9 m H<sub>2</sub>O

**Standard Deviation:** 2.1 psi or 1.5 m H<sub>2</sub>O

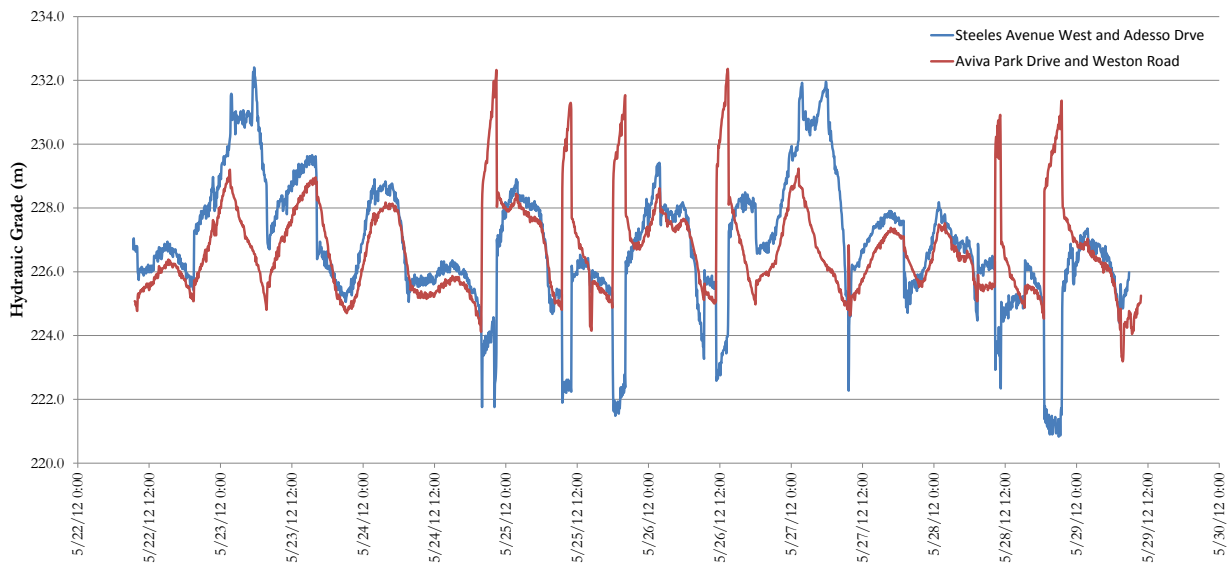
**Coefficient of Variation:** 0.038

**95% Confidence Interval:**  
 51.2 psi to 59.6 psi or 36.0 m to 41.9 m H<sub>2</sub>O

**Elevation:** 187.813 m (City Survey)

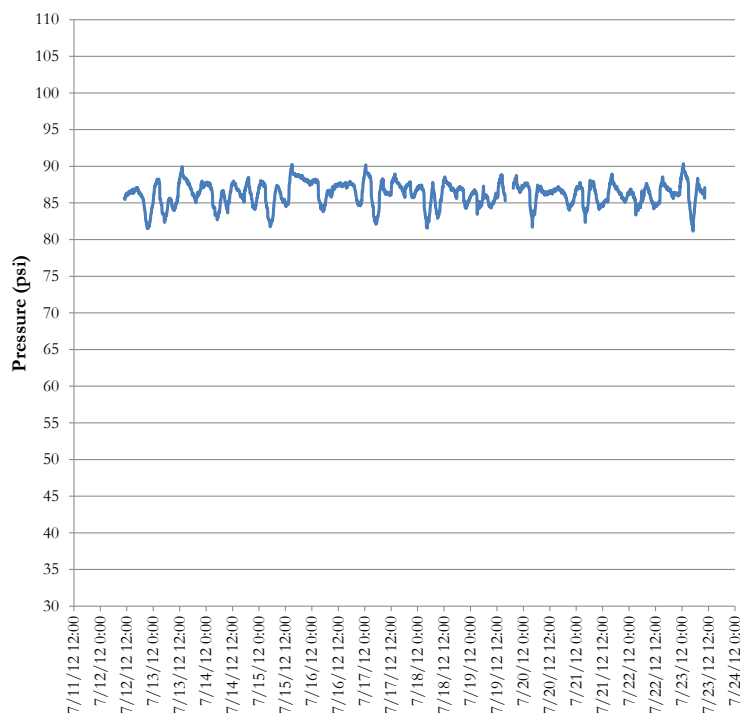
**Average Hydraulic Grade (HGL):** 226.7 m

The following plot shows superimposed hydraulic grades for each of 3232 Steeles Avenue West (at Adesso Drive) and 11 Aviva Park Drive (at Weston Road), pursuant to discussion above:



The PD5 West system is itself composed of essentially two halves, hydraulically speaking, generally located on either side of the PD4 system. There is very little connectivity between these halves and which occurs at two connection points located along Clarence Street at Wycliffe Avenue and Thompson Creek Drive/Woburn Drive.

The following plot is located at this area of interconnection and shows a generally narrower band of pressure ranges, as measured through the coefficient of variation and 95% confidence intervals, than the main supply source for the zone illustrated above. This is to be expected predominantly for two reasons: the buffering impact of the East Woodbridge Elevated Tank as well as the influence of the westerly part of the zone which is supplied from a connection to the PD6 Peel supply on Rutherford Road at Highway 27 via a PRV which releases flow at a set pressure to the PD5 system (see additional discussion below).



**Location:**  
17 Wycliffe Avenue (at Clarence Street)  
*(anomalous event on 19 July 2012 removed)*

**Period:** 12 July to 23 July 2012

**Pressure Recorder ID:** 2817

**Hydrant GIS ID:** 1313

**Hydrant Field ID:** TBD

**Average Pressure:** 86.2 psi or 60.7 m H<sub>2</sub>O

**Standard Deviation:** 1.6 psi or 1.1 m H<sub>2</sub>O

**Coefficient of Variation:** 0.018

**95% Confidence Interval:**  
83.1 psi to 89.4 psi or 58.4 m to 62.9 m H<sub>2</sub>O

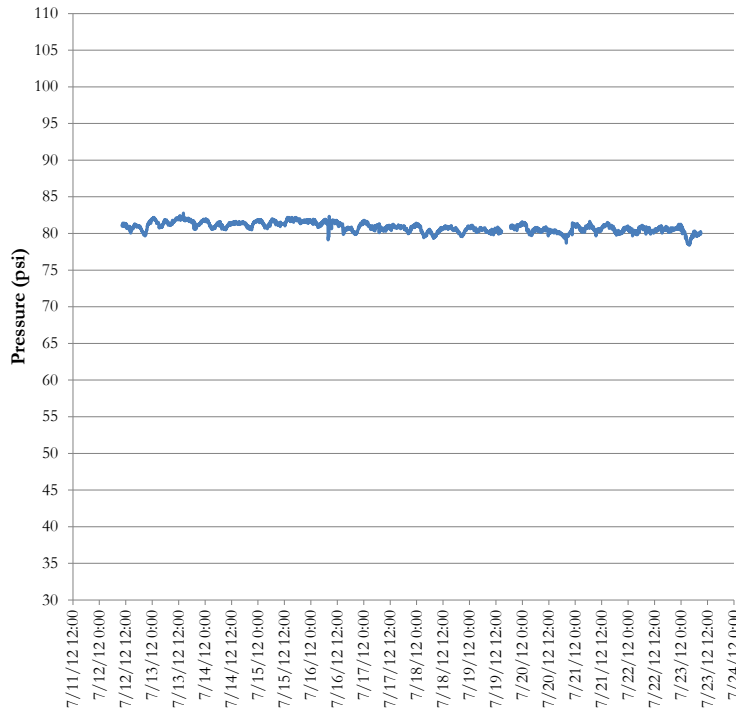
**Elevation:** 168.0 m (from model)

**Average Hydraulic Grade (HGL):** 228.7 m

The following two plots are taken at locations that are well connected to the large Highway 27 watermain which is itself supplied from the PD6 Peel supply on Rutherford Road at Highway 27. As would be expected, there is very narrow variation in the pressures experienced in this part of the system as a result of the relative size of the supply source, the size connectedness of the system's pips, and the relatively modest demands placed on the well-connected system.

It is also noted that the average hydraulic grade line in this part of the PD5 West zone was measured to be approximately 232.5 to 232.9 m, which is somewhat higher than those measured in the easterly part of the zone, being approximately 227.0 m. This would indicate that there would be some transfer of water in an easterly direction across the two connection points along Clarence Street noted above, and this is corroborated by the average hydraulic grade elevation measured at that location of approximately 228.7 m, which lies in between the above values.

For modelling purposes, a boundary condition HGL of 232.5 m is used at the Highway 27 connection point to the Peel supply pipe on Rutherford Road.



**Location:**  
 55 Regal Crest Court, South of  
 Royal Gate Boulevard  
*(anomalous event on 19 July 2012 removed)*

**Period:** 12 July to 23 July 2012

**Pressure Recorder ID:** 204226 (PW#1)

**Hydrant GIS ID:** N04

**Hydrant Field ID:** TBD

**Average Pressure:** 80.8 psi or 56.9 m H<sub>2</sub>O

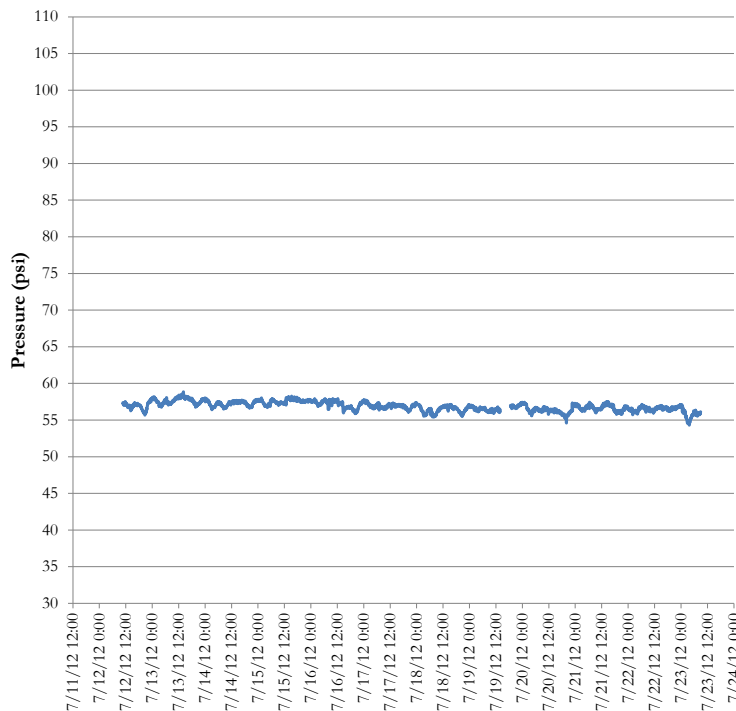
**Standard Deviation:** 0.6 psi or 0.4 m H<sub>2</sub>O

**Coefficient of Variation:** 0.008

**95% Confidence Interval:**  
 79.6 psi to 82.1 psi or 56.0 m to 57.7 m H<sub>2</sub>O

**Elevation:** 176.0 m (from model)

**Average Hydraulic Grade (HGL):** 232.9 m



**Location:**  
 Langstaff Road & Huntington Road  
*(anomalous event on 19 July 2012 removed)*

**Period:** 12 July to 23 July 2012

**Pressure Recorder ID:** 203878 (PW#2)

**Hydrant GIS ID:** N05

**Hydrant Field ID:** TBD

**Average Pressure:** 56.9 psi or 40.0 m H<sub>2</sub>O

**Standard Deviation:** 0.6 psi or 0.4 m H<sub>2</sub>O

**Coefficient of Variation:** 0.011

**95% Confidence Interval:**  
 55.6 psi to 58.1 psi or 39.1 m to 40.9 m H<sub>2</sub>O

**Elevation:** 192.5 m (from model)

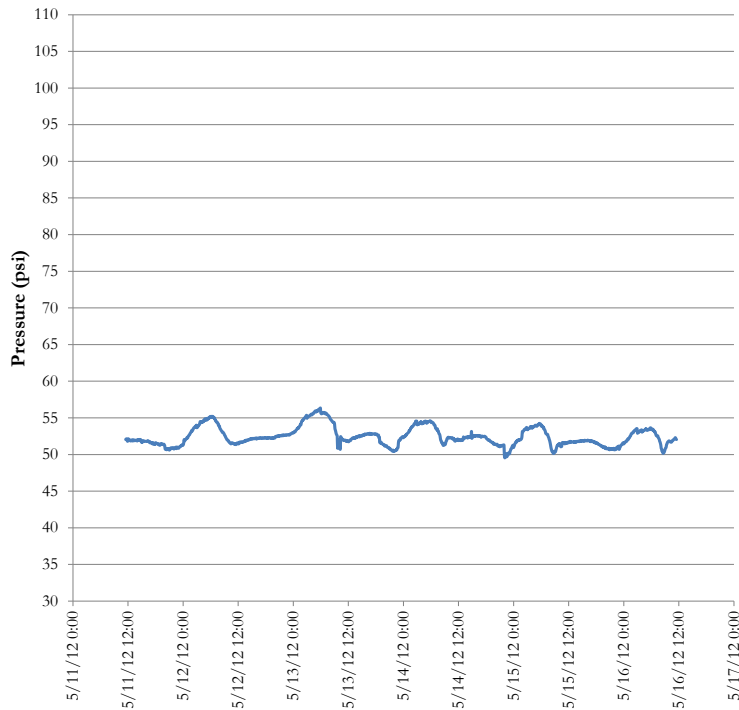
**Average Hydraulic Grade (HGL):** 232.5 m

**Boundary Condition(s) for Modelling:**  
 Average HGL = 232.5 m  
 Used for all demand conditions at  
 Highway 27 connection point.



**PD5 East**

The PD5 East system generally experiences a narrow range of pressures as indicated in the plots below. In some areas, low pressures are experienced, however, this is more due to elevation rather than pressure fluctuations.



**Location:**  
 Northeast Corner of  
 Crestwood Road & Bathurst Street

**Period:** 11 May to 16 May 2012

**Pressure Recorder ID:** 2817

**Hydrant GIS ID:** 3904

**Hydrant Field ID:** 0387

**Average Pressure:** 52.4 psi or 36.9 m H<sub>2</sub>O

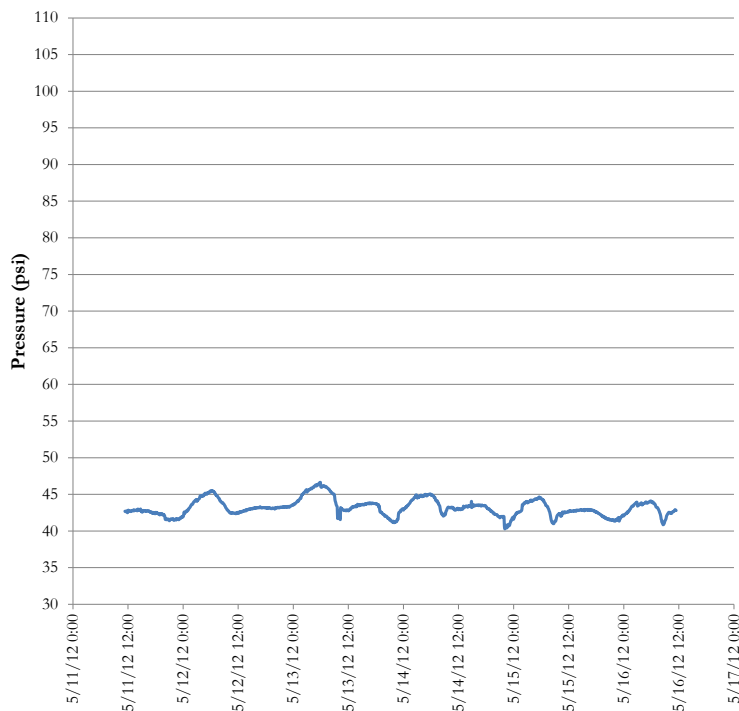
**Standard Deviation:** 1.3 psi or 0.9 m H<sub>2</sub>O

**Coefficient of Variation:** 0.025

**95% Confidence Interval:**  
 49.9 psi to 55.0 psi or 35.1 m to 38.7 m H<sub>2</sub>O

**Elevation:** 191.028 m (City Survey)

**Average Hydraulic Grade (HGL):** 227.9 m



**Location:**  
 Northeast Corner of Bathurst Street  
 & Clark Avenue West

**Period:** 11 May to 16 May 2012

**Pressure Recorder ID:** 2785

**Hydrant GIS ID:** 4351

**Hydrant Field ID:** 0388

**Average Pressure:** 43.2 psi or 30.4 m H<sub>2</sub>O

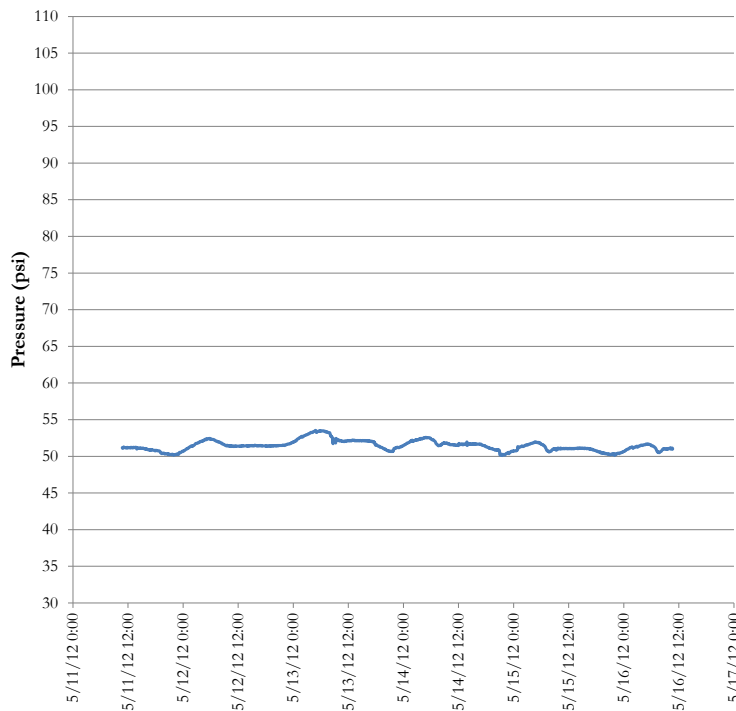
**Standard Deviation:** 1.1 psi or 0.8 m H<sub>2</sub>O

**Coefficient of Variation:** 0.027

**95% Confidence Interval:**  
 40.9 psi to 45.5 psi or 28.8 m to 32.0 m H<sub>2</sub>O

**Elevation:** 197.432 m (City Survey)

**Average Hydraulic Grade (HGL):** 227.8 m



**Location:**  
 Southwest Corner of Dufferin Street  
 & Glen Shields Avenue

**Period:** 11 May to 16 May 2012

**Pressure Recorder ID:** 203878 (PW#2)

**Hydrant GIS ID:** 5309

**Hydrant Field ID:** TBD

**Average Pressure:** 51.5 psi or 36.2 m H<sub>2</sub>O

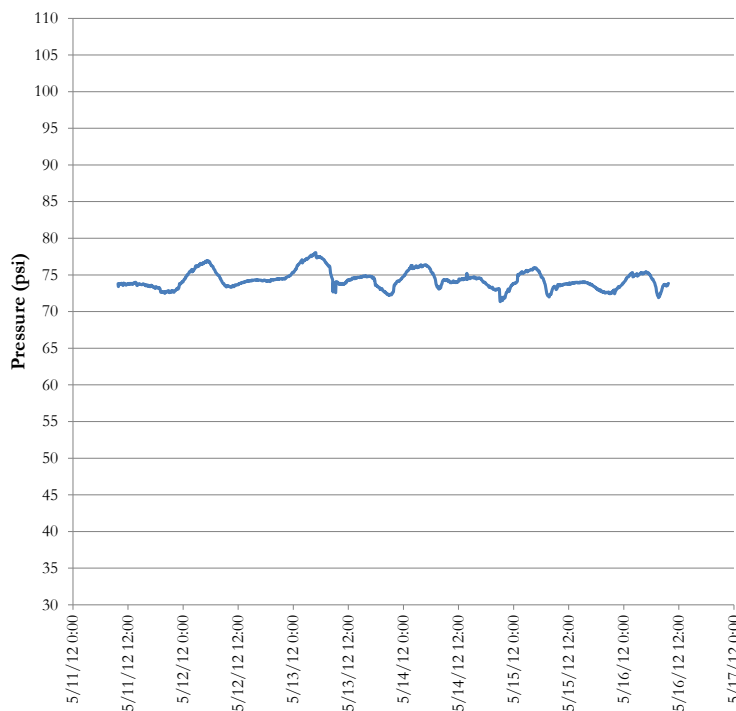
**Standard Deviation:** 0.7 psi or 0.5 m H<sub>2</sub>O

**Coefficient of Variation:** 0.014

**95% Confidence Interval:**  
 50.0 psi to 52.9 psi or 35.2 m to 37.2 m H<sub>2</sub>O

**Elevation:** 191.430 m (City Survey)

**Average Hydraulic Grade (HGL):** 227.6 m



**Location:**  
 Yonge Street & Clark Avenue West

**Period:** 11 May to 16 May 2012

**Pressure Recorder ID:** 204226 (PW#1)

**Hydrant GIS ID:** 4116

**Hydrant Field ID:** TBD

**Average Pressure:** 74.3 psi or 52.3 m H<sub>2</sub>O

**Standard Deviation:** 1.2 psi or 0.9 m H<sub>2</sub>O

**Coefficient of Variation:** 0.017

**95% Confidence Interval:**  
 71.8 psi to 76.8 psi or 50.5 m to 54.0 m H<sub>2</sub>O

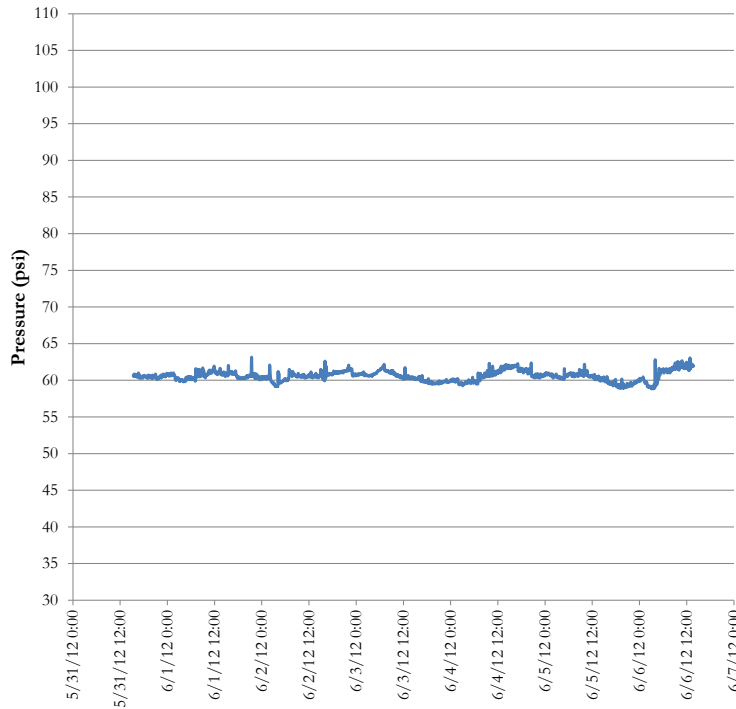
**Elevation:** 175.301 m (City Survey)

**Average Hydraulic Grade (HGL):** 227.6 m

Given the magnitude as well as narrow range of observed pressures which result in average HGL estimates ranging from approximately 227.6 m and 227.9 m, being very close to the original modelling provided by the City using a boundary condition of 228.12 m and which is applied in the modelling work for the Master Plan study for this pressure zone.

**PD6**

The following 2 plots are from locations near to water supply sources to this zone with the former being near to the Maple Reservoir and accordingly shows very little variation in pressures, while the latter is near the source of supply from Toronto and shows higher variability, clearly showing the effect of pumping operations.



**Location:**  
 Rutherford Road & Keele Street

**Period:** 31 May to 07 June 2012

**Pressure Recorder ID:** 204226 (PW#1)

**Hydrant GIS ID:** HY000

**Hydrant Field ID:** 2170

**Average Pressure:** 60.5 psi or 42.6 m H<sub>2</sub>O

**Standard Deviation:** 0.7 psi or 0.5 m H<sub>2</sub>O

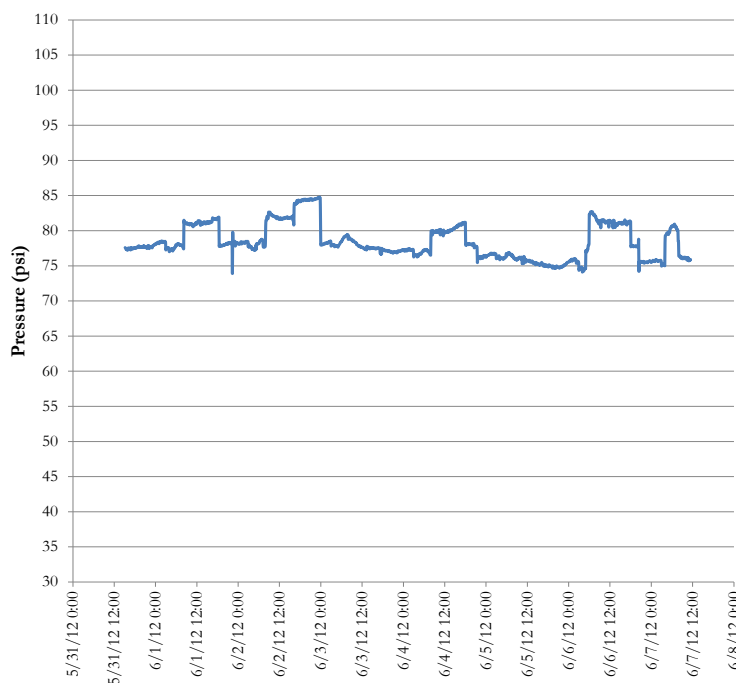
**Coefficient of Variation:** 0.011

**95% Confidence Interval:**  
 59.1 psi to 61.9 psi or 41.6 m to 43.6 m H<sub>2</sub>O

**Elevation:** 220.432 m (City Survey)

**Average Hydraulic Grade (HGL):** 263.0 m

**Boundary Condition(s) for Modelling:**  
 Average HGL = 262.0 m (Vaughan Model)  
 Used for all demand conditions at the Maple Reservoir.



**Location:**  
 Steeles Avenue West & Keele Street

**Period:** 31 May to 07 June 2012

**Pressure Recorder ID:** 2785

**Hydrant GIS ID:** HY000

**Hydrant Field ID:** TBD

**Average Pressure:** 78.4 psi or 55.1 m H<sub>2</sub>O

**Standard Deviation:** 2.5 psi or 1.7 m H<sub>2</sub>O

**Coefficient of Variation:** 0.031

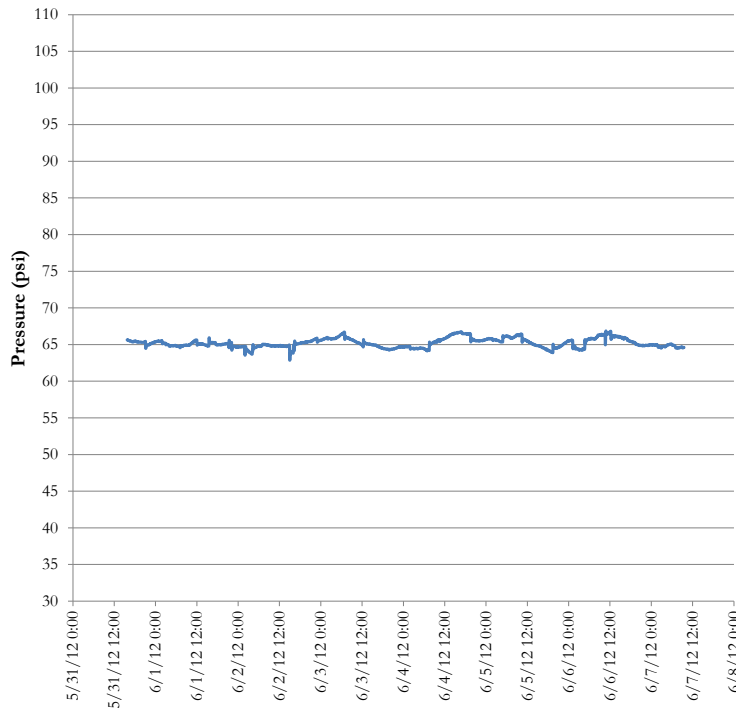
**95% Confidence Interval:**  
 73.5 psi to 83.3 psi or 51.7 m to 58.6 m H<sub>2</sub>O

**Elevation:** 206.0 m (from model)

**Average Hydraulic Grade (HGL):** 261.1 m

**Boundary Condition(s) for Modelling:**  
 Average HGL = 261.1 m  
 Used for all demand conditions at the City of Toronto connection at this location.

The following 2 plots are from locations within the PD6 system which are well connected and, accordingly, show very little variation in observed pressures and which is evident in the calculated coefficients of variation for each.



**Location:**  
 12 Hawkview Boulevard  
 (near Weston & Rutherford Roads)

**Period:** 31 May to 07 June 2012

**Pressure Recorder ID:** 203878 (PW#2)

**Hydrant GIS ID:** 11496

**Hydrant Field ID:** TBD

**Average Pressure:** 65.2 psi or 45.9 m H<sub>2</sub>O

**Standard Deviation:** 0.6 psi or 0.4 m H<sub>2</sub>O

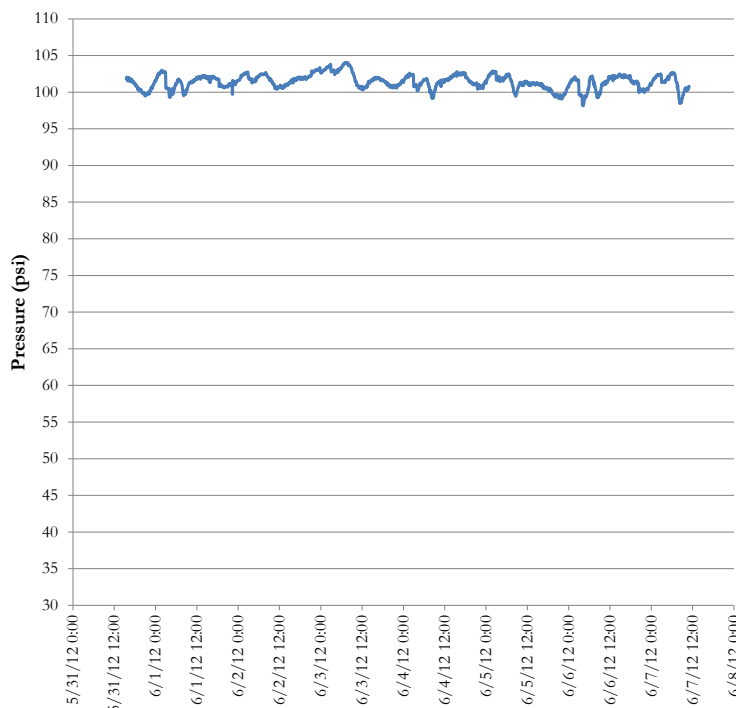
**Coefficient of Variation:** 0.010

**95% Confidence Interval:**  
 64.0 psi to 66.5 psi or 45.0 m to 46.7 m H<sub>2</sub>O

**Elevation:** 216.811 m (City Survey)

**Average Hydraulic Grade (HGL):** 262.7 m

**Boundary Condition(s) for Modelling:**  
 Average HGL = 262.0 m  
 Used for all demand conditions at the Weston & Rutherford connection to Peel supply.



**Location:**  
 Ner Israel Drive & Bathurst Street

**Period:** 31 May to 07 June 2012

**Pressure Recorder ID:** 2817

**Hydrant GIS ID:** unknown

**Hydrant Field ID:** TBD

**Average Pressure:** 101.4 psi or 71.3 m H<sub>2</sub>O

**Standard Deviation:** 1.0 psi or 0.7 m H<sub>2</sub>O

**Coefficient of Variation:** 0.010

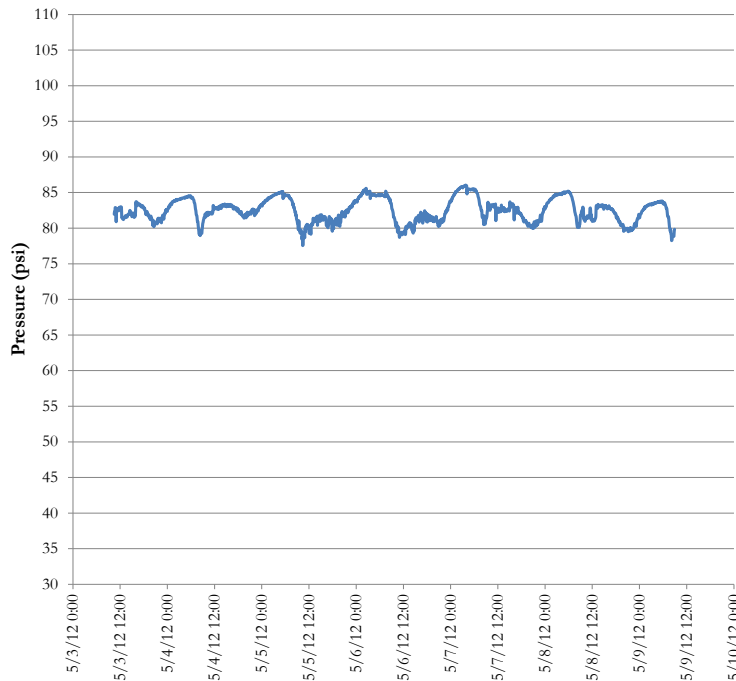
**95% Confidence Interval:**  
 99.4 psi to 103.4 psi or  
 69.9 m to 72.7 m H<sub>2</sub>O

**Elevation:** 189.613 m (City Survey)

**Average Hydraulic Grade (HGL):** 260.9 m

Additional connections to the Region's PD6 infrastructure were similarly set to a boundary condition of 262.0 m.

The following plots are for a location at the northerly limit of the Woodbridge Expansion Area, which is an extremity of the PD6 system and which is not well connected to the remainder of the system. Accordingly, wider variations can be expected. The plots represent “before” and “after” conditions in relation to the realignment of the zone to capture a portion of lands located in the southerly part of Kleinburg. As can be seen, the variation in observed pressures is widened in the “after” condition and the average pressure is somewhat lower.



**Location:**  
 39 Sunset Ridge (@ Islington Avenue)

**Period:** 03 May to 09 May 2012  
 (Before re-alignment of PD6 zone in southerly part of Kleinburg)

**Pressure Recorder ID:** 2785

**Hydrant GIS ID:** 938

**Hydrant Field ID:** TBD

**Average Pressure:** 82.5 psi or 58.0 m H<sub>2</sub>O

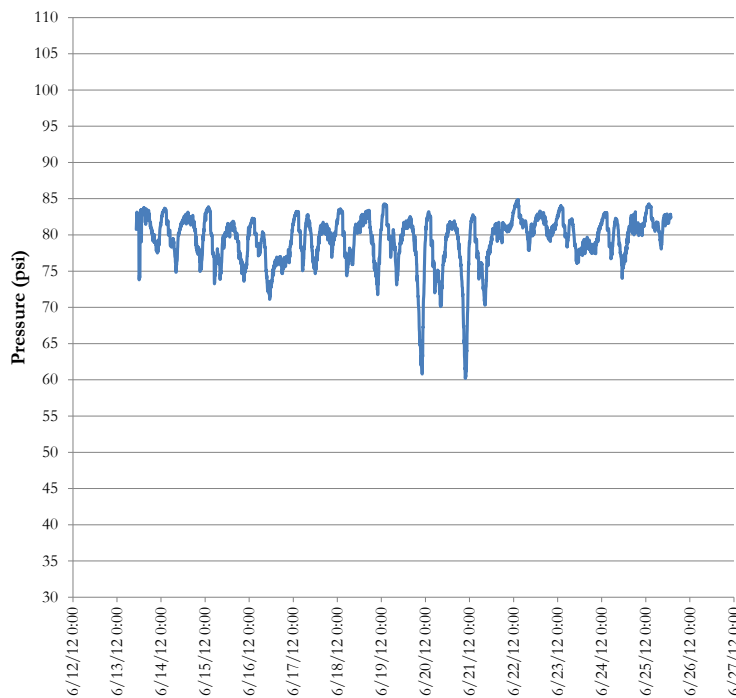
**Standard Deviation:** 1.6 psi or 1.2 m H<sub>2</sub>O

**Coefficient of Variation:** 0.020

**95% Confidence Interval:**  
 79.2 psi to 85.8 psi or 55.7 m to 60.3 m H<sub>2</sub>O

**Elevation:** 203.442 m (City Survey)

**Average Hydraulic Grade (HGL):** 261.4 m



**Location:**  
 39 Sunset Ridge (@ Islington Avenue)

**Period:** 03 May to 09 May 2012  
 (After re-alignment of PD6 zone in southerly part of Kleinburg)

**Pressure Recorder ID:** 2785

**Hydrant GIS ID:** 938

**Hydrant Field ID:** TBD

**Average Pressure:** 79.4 psi or 55.9 m H<sub>2</sub>O

**Standard Deviation:** 3.5 psi or 2.4 m H<sub>2</sub>O

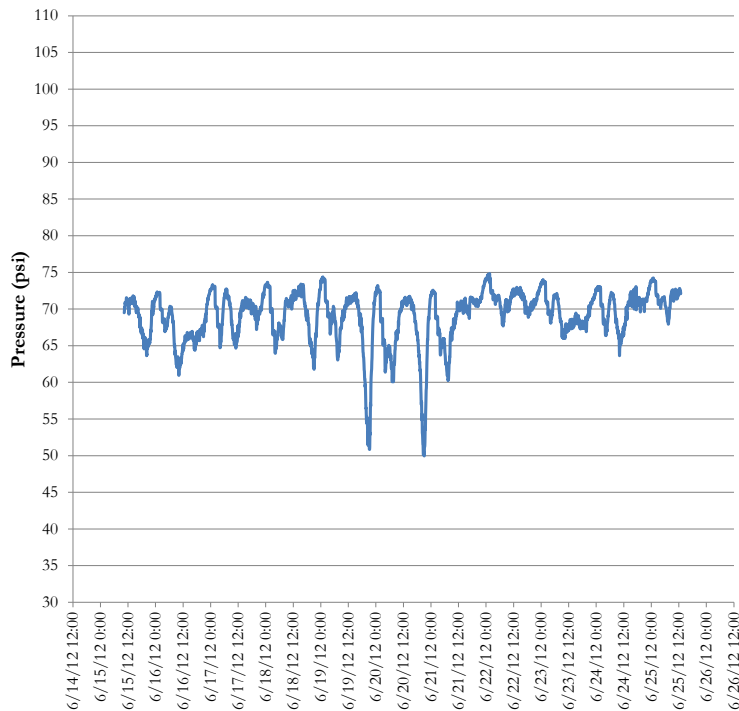
**Coefficient of Variation:** 0.044

**95% Confidence Interval:**  
 72.5 psi to 86.4 psi or 51.0 m to 60.7 m H<sub>2</sub>O

**Elevation:** 203.442 m (City Survey)

**Average Hydraulic Grade (HGL):** 259.3 m

The following plot indicates that, within the realigned portion of the Kleinburg lands, relatively wide fluctuations in pressure are experienced. The lower plot is from a location which derives flow from the PD6 Peel supply on Rutherford Road via a PRV and, accordingly, exhibits a very narrow variation in observed pressures.



**Location:**  
 Pennon Road & Islington Avenue

**Period:** 15 June to 25 June 2012  
 (After re-alignment of PD6 zone in southerly part of Kleinburg)

**Pressure Recorder ID:** 204226 (PW#1)

**Hydrant GIS ID:** unknown

**Hydrant Field ID:** TBD

**Average Pressure:** 69.1 psi or 48.6 m H<sub>2</sub>O

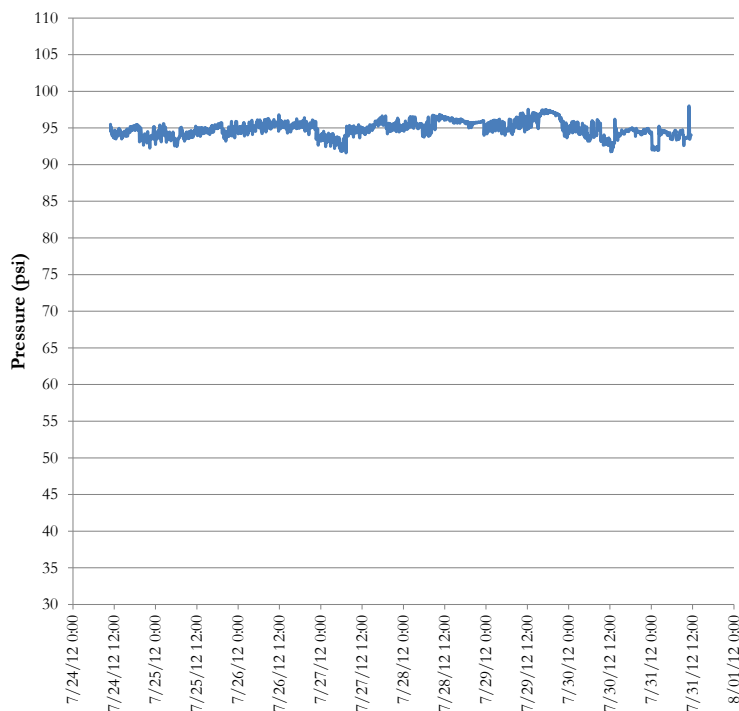
**Standard Deviation:** 3.6 psi or 2.5 m H<sub>2</sub>O

**Coefficient of Variation:** 0.052

**95% Confidence Interval:**  
 61.9 psi to 76.3 psi or 43.5 m to 53.7 m H<sub>2</sub>O

**Elevation:** 210.164 m (City Survey)

**Average Hydraulic Grade (HGL):** 258.8 m



**Location:**  
 Trade Valley Drive & Hunter's Valley Road

**Period:** 24 July to 31 July 2012

**Pressure Recorder ID:** 2785

**Hydrant GIS ID:** N5

**Hydrant Field ID:** TBD

**Average Pressure:** 94.9 psi or 66.7 m H<sub>2</sub>O

**Standard Deviation:** 1.1 psi or 0.8 m H<sub>2</sub>O

**Coefficient of Variation:** 0.011

**95% Confidence Interval:**  
 92.7 psi to 97.0 psi or 65.2 m to 68.2 m H<sub>2</sub>O

**Elevation:** 196.1 m (from plan & profile)

**Average Hydraulic Grade (HGL):** 262.8 m

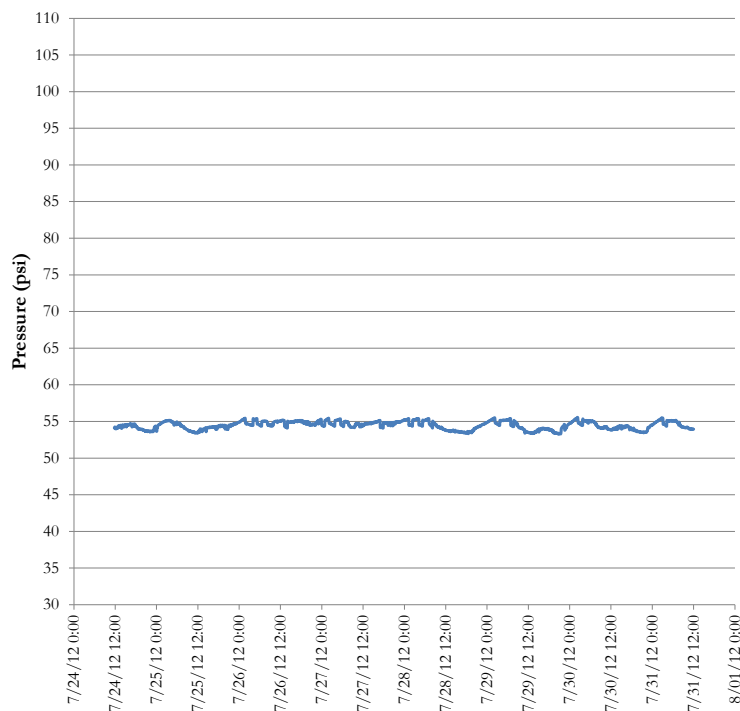
**Boundary Condition(s) for Modelling:**  
 Average HGL = 262.8 m  
 Used for all demand conditions at the connection to Rutherford Road.

## PD7

In general, the observed pressures in the City’s PD7 zone are very stable with very low variation.

The following is a discussion of the each of the plots provided in this section:

- The first plot is from a location very near to the Region of York’s PD7 pumping station which draws water from the Maple Reservoir. Accordingly, the calculated average HGL is used as a boundary condition for modelling purposes.
- The second plot (next page) is near to the Region’s PD7 North Richmond Hill Reservoir. Similarly, the average HGL determined for this location is also used as a boundary condition for modelling purposes.
- The third plot (next page) indicates that, even near the westerly extent of the pressure zone, the observed pressures continue to be rather stable, albeit with a somewhat lower average HGL, which is to be expected.



**Location:**

St. Joan of Arc Avenue & Teston Road

**Period:** 24 July to 31 July 2012

**Pressure Recorder ID:** 2817

**Hydrant GIS ID:** 4748

**Hydrant Field ID:** TBD

**Average Pressure:** 54.5 psi or 38.3 m H<sub>2</sub>O

**Standard Deviation:** 0.5 psi or 0.4 m H<sub>2</sub>O

**Coefficient of Variation:** 0.010

**95% Confidence Interval:**

53.4 psi to 55.5 psi or 37.5 m to 39.1 m H<sub>2</sub>O

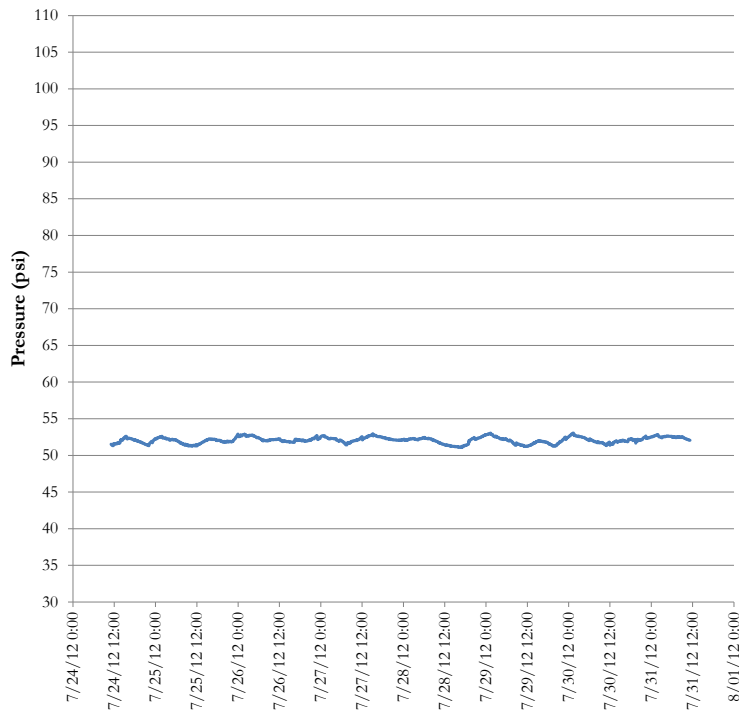
**Elevation:** 254.95 m (from model)

**Average Hydraulic Grade (HGL):** 293.3 m

**Boundary Condition(s) for Modelling:**

Average HGL = 293.0 m (conservative)

Used for all demand conditions at South Maple PD7 Pumping Station at Keele Street & Teston Road.



**Location:**  
62 Torah Gate & Teston Road

**Period:** 24 July to 31 July 2012

**Pressure Recorder ID:** 204226 (PW#1)

**Hydrant GIS ID:** N6

**Hydrant Field ID:** TBD

**Average Pressure:** 52.1 psi or 36.6 m H<sub>2</sub>O

**Standard Deviation:** 0.4 psi or 0.3 m H<sub>2</sub>O

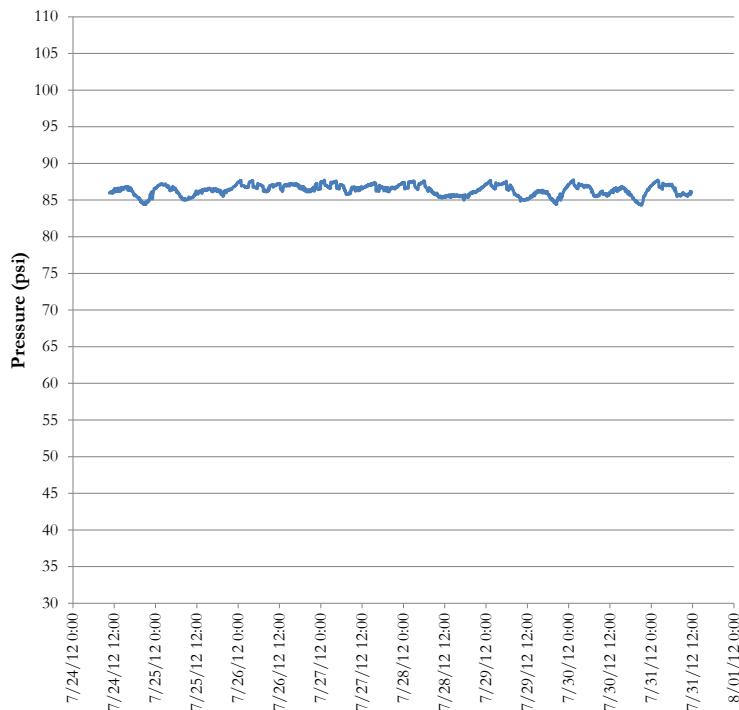
**Coefficient of Variation:** 0.008

**95% Confidence Interval:**  
51.3 psi to 52.9 psi or 36.0 m to 37.2 m H<sub>2</sub>O

**Elevation:** 257.0 m (from Teston Road P&P)

**Average Hydraulic Grade (HGL):** 293.6 m

**Boundary Condition(s) for Modelling:**  
Average HGL = 293.0 m (conservative)  
Used for all demand conditions at the North Richmond Hill PD7 Pumping Station.



**Location:**  
100 Lormel Gate at Vellore Park Avenue  
(Northeast Corner of Intersection)

**Period:** 24 July to 31 July 2012

**Pressure Recorder ID:** 203878 (PW#2)

**Hydrant GIS ID:** N7

**Hydrant Field ID:** TBD

**Average Pressure:** 86.4 psi or 60.7 m H<sub>2</sub>O

**Standard Deviation:** 0.7 psi or 0.5 m H<sub>2</sub>O

**Coefficient of Variation:** 0.008

**95% Confidence Interval:**  
84.9 psi to 87.8 psi or 59.7 m to 61.8 m H<sub>2</sub>O

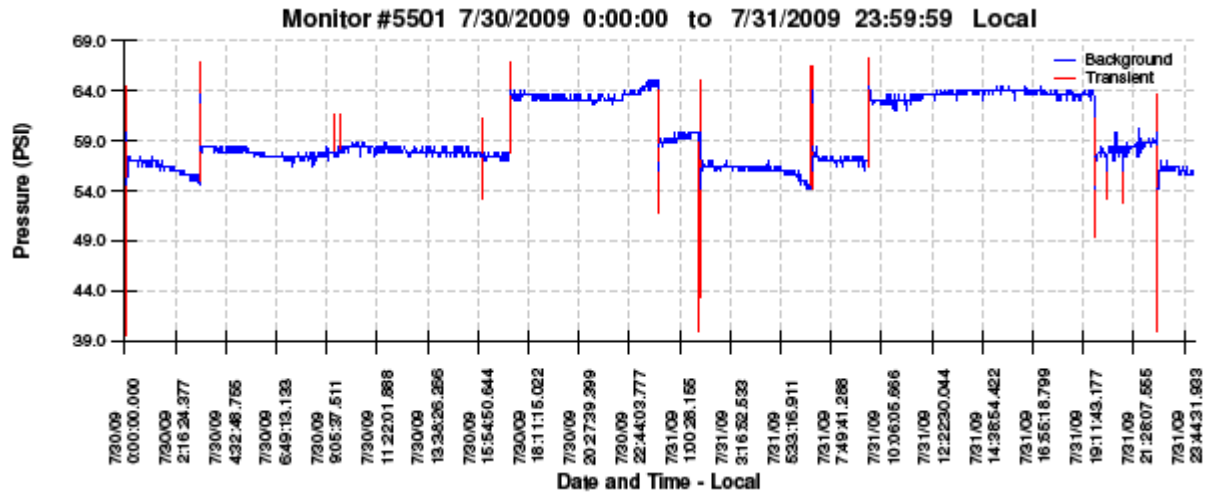
**Elevation:** 230.764 m (from P&P)

**Average Hydraulic Grade (HGL):** 291.5 m



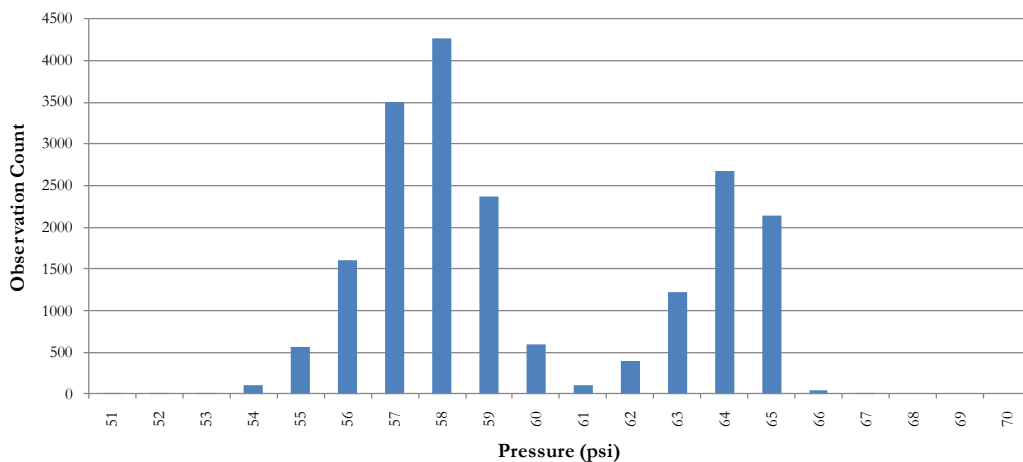
### PD8-East (York Region PD8 Pumping Station)

This pumping station is located on the west side of Bathurst Street, north of Teston Road. High-frequency transient pressure monitoring of this station’s discharge header was undertaken in 2009 by this office in association with HydraTek & Associates. A sample pressure profile for a 48 hour period is provided in the following graphic.



There are generally two output pressures which were observed and depend on the combination of pumps being used in the station at any given time. Given that this station, the reservoir that it draws water from, and the feeder main and reservoir system it feeds into, are owned and operated by the Region, it is deemed to be sufficient for purposes of this project to model this boundary condition as a reservoir of fixed elevation, using the two observed pressure outputs to test the model, depending on which is more critical to the particular analysis at hand.

A statistical analysis of background (blue) pressures for the time period ranging from 12 noon on 23 July 2009 and 12 noon on 19 August 2009 was undertaken and is presented on the following page. This analysis confirms that there are two distinct pressure ranges with the most observed readings being 58 psi and 64 psi (or 40.8 m and 45.0 m of H<sub>2</sub>O, respectively). Using these pressures, in conjunction with the estimated elevation of the discharge header of approximately 285.2 m, the resulting hydraulic grade line elevations to be used in any modelling analysis are accordingly 326.0 m and 330.2 m.

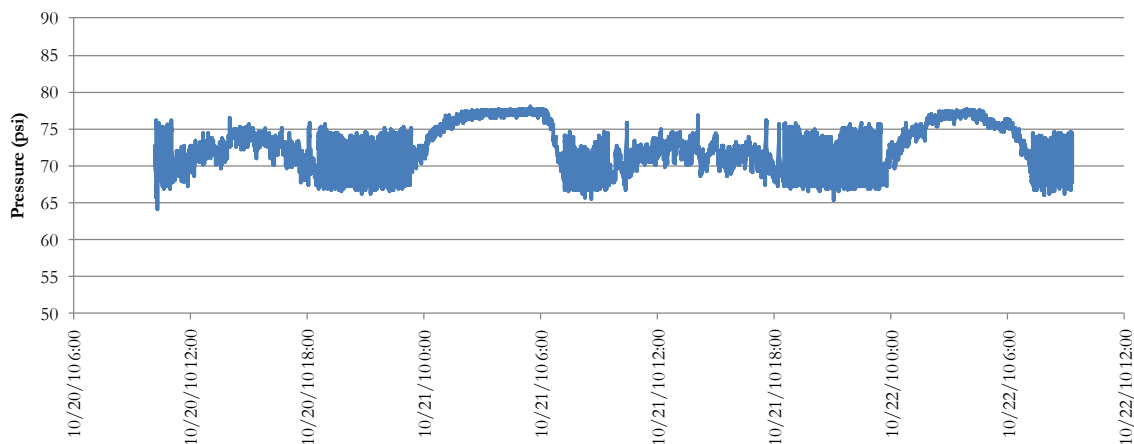


### PD8-West (City of Vaughan PD8-Industrial Booster Pumping Station)

This facility is located at the northeast corner of Keele Street and Teston Road and currently draws water from a 400 mm diameter Region of York PD7 feedermain on the east side of Keele Street and boosts pressures locally for the industrial area generally located on the east side of Keele Street, both north and south of Teston Road. A previously prepared Schedule A+ EA to decommission this facility and connect the distribution network to the 1800 mm diameter Region of York PD8 feedermain located on the west side of Keele Street. The connection point is equipped with PRVs connected in parallel and, at the time of writing, the pressure on the PRVs is planned to be set to deliver a hydraulic grade line (total head) of **320 m**. This boundary condition can be modelled as a reservoir with this value as the fixed water surface elevation for purposes of this project.

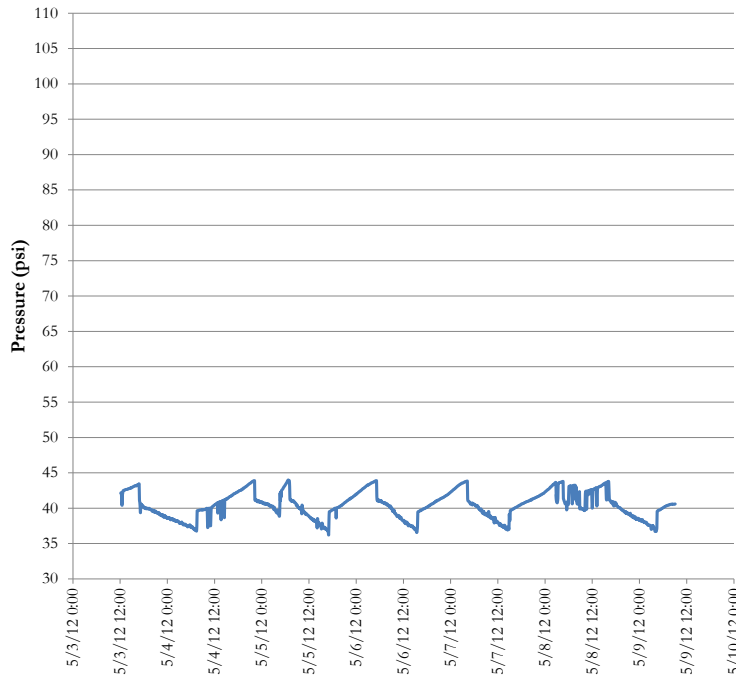
### PD9 (City of Vaughan PD9 Pumping Station)

This pumping station is located on the east side of Keele Street approximately mid-way between Teston and Kirby Roads and on the same lands as the Region of York's North Maple Reservoir Reservoir (PD7). Pressure recordings undertaken by this office in conjunction with HydraTek & Associates for the period spanning from 10 am on 20 October 2010 and 9am on 22 October 2010 are shown on the plot below. The average observed pressure during this period was 72.9 psi (51.2 m H<sub>2</sub>O) with a standard deviation of 2.7 psi (1.9 m H<sub>2</sub>O), noting that higher pressures were observed at night when demand was lowest. It is expected that, for purposes of this project, the average observed pressure would represent an appropriate boundary condition. The elevation of the discharge header where the pressures were observed is estimated at  $\pm 291.8$  m. At the average measured pressure, the resulting hydraulic grade line is therefore **343.0 m** and this boundary condition can also be modeled as a reservoir with this as a fixed value for this project.



**PD-KN**

The following 2 plots are from a hydrant located on Highway 27, near the terminus of Autumn Wind Court. The recordings are taken before and after the re-alignment of the PD6 zone in south Kleinburg which had the effect of reducing the service area supplied by the PD-KN system.



**Location:**  
 Highway 27 at Autumn Wind Court

**Period:** 03 May to 09 May 2012  
*(Before re-alignment of PD6 zone in south Kleinburg)*

**Pressure Recorder ID:** 2817

**Hydrant GIS ID:** 3550

**Hydrant Field ID:** TBD

**Average Pressure:** 40.5 psi or 28.5 m H<sub>2</sub>O

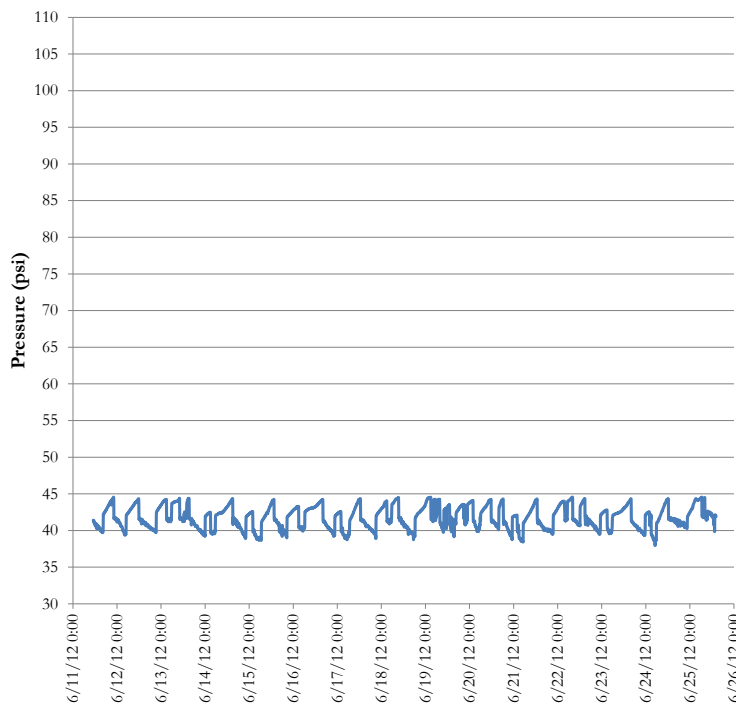
**Standard Deviation:** 1.9 psi or 1.3 m H<sub>2</sub>O

**Coefficient of Variation:** 0.046

**95% Confidence Interval:**  
 36.7 psi to 44.2 psi or 25.8 m to 31.1 m H<sub>2</sub>O

**Elevation:** 239.390 m (City Survey)

**Average Hydraulic Grade (HGL):** 267.9 m



**Location:**  
 Highway 27 at Autumn Wind Court

**Period:** 11 June to 25 June 2012  
*(After re-alignment of PD6 zone in south Kleinburg)*

**Pressure Recorder ID:** 2817

**Hydrant GIS ID:** 3550

**Hydrant Field ID:** TBD

**Average Pressure:** 41.8 psi or 29.4 m H<sub>2</sub>O

**Standard Deviation:** 1.5 psi or 1.1 m H<sub>2</sub>O

**Coefficient of Variation:** 0.036

**95% Confidence Interval:**  
 38.8 psi to 44.9 psi or 27.3 m to 31.5 m H<sub>2</sub>O

**Elevation:** 239.390 m (City Survey)

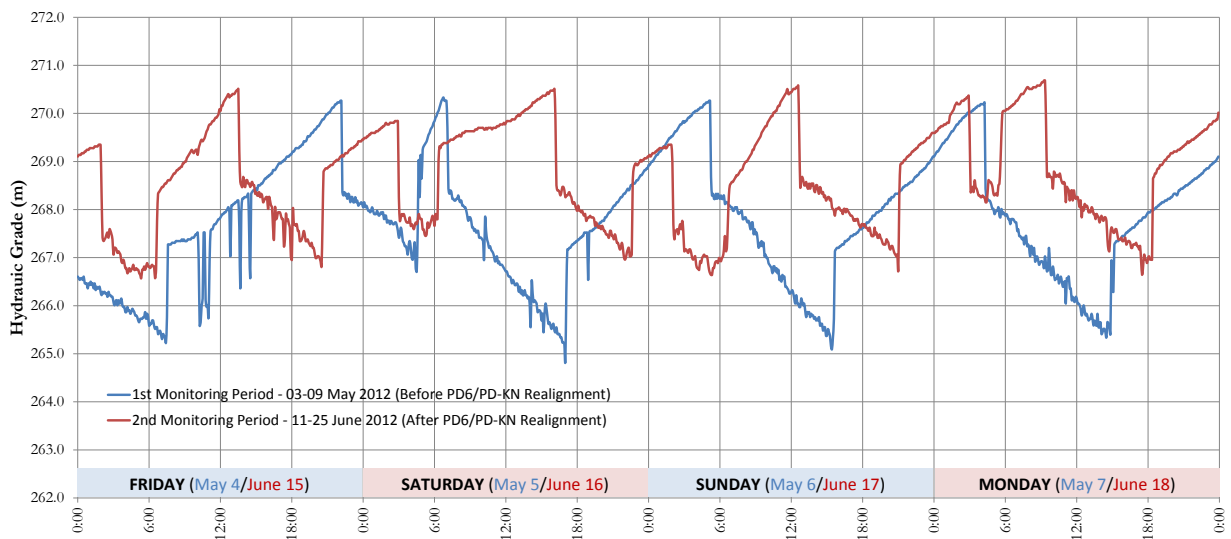
**Average Hydraulic Grade (HGL):** 268.8 m

**Boundary Condition(s) for Modelling:**  
 Average HGL = 268.75 m (Vaughan model)  
 Used for all demand conditions.

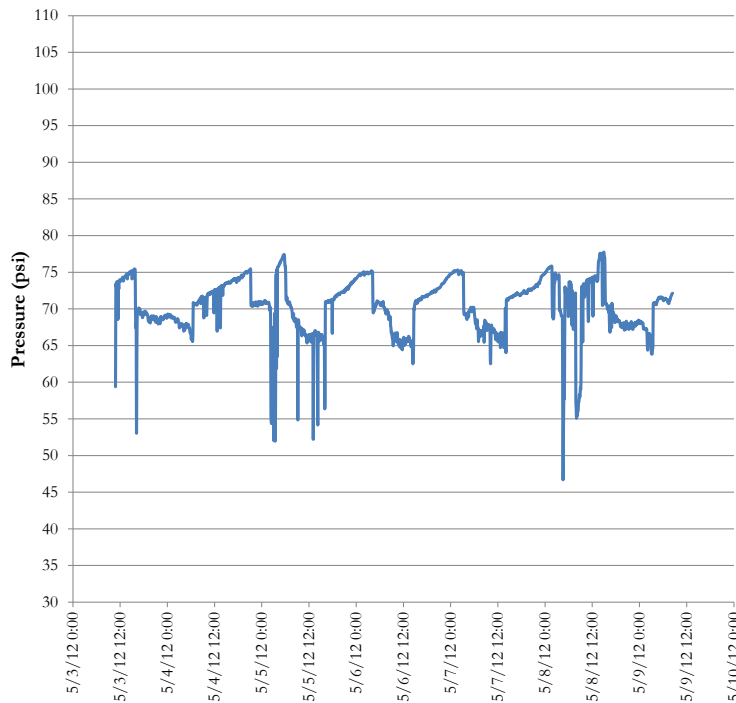
As can be seen from the above plots, this area of the pressure district, characterized by relatively high elevations, experiences relatively low pressures around the lower range of Provincial guidelines. It is noted that the variation in the observed pressures is reduced following the PD6 zone realignment in south Kleinburg, as would be expected.

The hydrant where this monitoring information was collected is located on the north side of the elevated tank and, therefore, the pressures experienced at this point are predominantly due to the tank, rather than the well pumps which feed the tank.

The following plot superimposes the readings at this location (i.e., Highway 27 at Autumn Wind Court) for similar days of the week and which also indicates the narrower operating range. It is noted that this may not be entirely attributable to the zone realignment alone as the pump and tank operation are controlled by the Region. Noting that the pressure levels at which pumps are turned on, being higher in the “after” recording period, may indicate that some changes to the system’s operation may have occurred.



The following set of plots similarly provides a comparison between the “before” and “after” conditions at 376 Stegmans Mill Road. Although there continues to be a reasonably wide fluctuations in recorded pressures after the zone realignment, the variation (as measured through the coefficient of variation and the 95% confidence interval) is reduced from the “before” condition and the average pressure recorded is somewhat higher. Given that the observed pressures at this recording location are influenced by pumping operations at the well locations, there are noticeable drops in pressure observed which are in all likelihood due to pump stops. It is further expected that the instantaneous downsurges are in reality more severe than those represented on the plot due to the recording equipment used.



**Location:**  
 376 Stegmans Mill Road

**Period:** 03 May to 09 May 2012  
*(Before re-alignment of PD6 zone in south Kleinburg)*

**Pressure Recorder ID:** 203878 (PW#2)

**Hydrant GIS ID:** 1151

**Hydrant Field ID:** 6878

**Average Pressure:** 70.4 psi or 49.5 m H<sub>2</sub>O

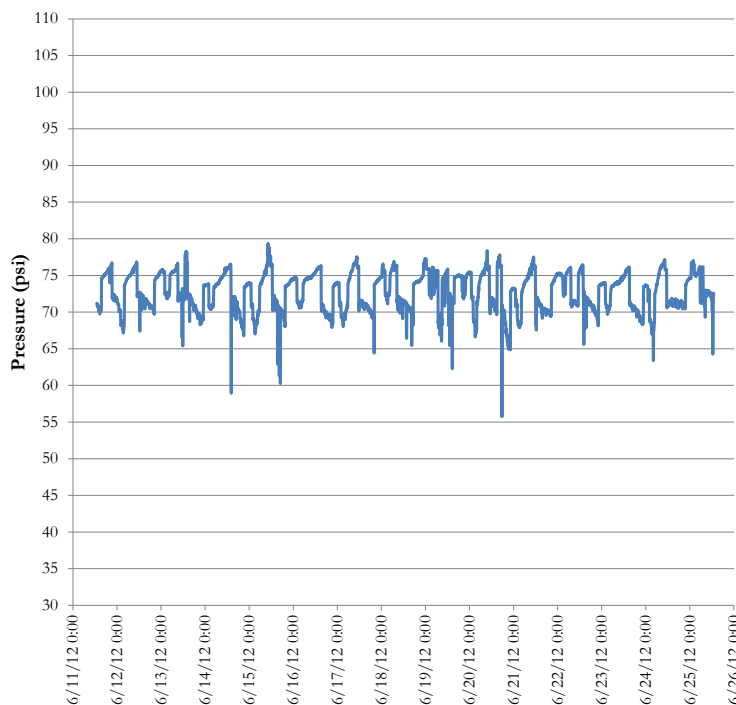
**Standard Deviation:** 3.8 psi or 2.7 m H<sub>2</sub>O

**Coefficient of Variation:** 0.054

**95% Confidence Interval:**  
 62.7 psi to 78.0 psi or 44.1 m to 54.9 m H<sub>2</sub>O

**Elevation:** 217.169 m (City Survey)

**Average Hydraulic Grade (HGL):** 266.7 m



**Location:**  
 376 Stegmans Mill Road

**Period:** 11 June to 25 June 2012  
*(After re-alignment of PD6 zone in south Kleinburg)*

**Pressure Recorder ID:** 203878 (PW#2)

**Hydrant GIS ID:** 1151

**Hydrant Field ID:** 6878

**Average Pressure:** 72.8 psi or 51.2 m H<sub>2</sub>O

**Standard Deviation:** 2.6 psi or 2.9 m H<sub>2</sub>O

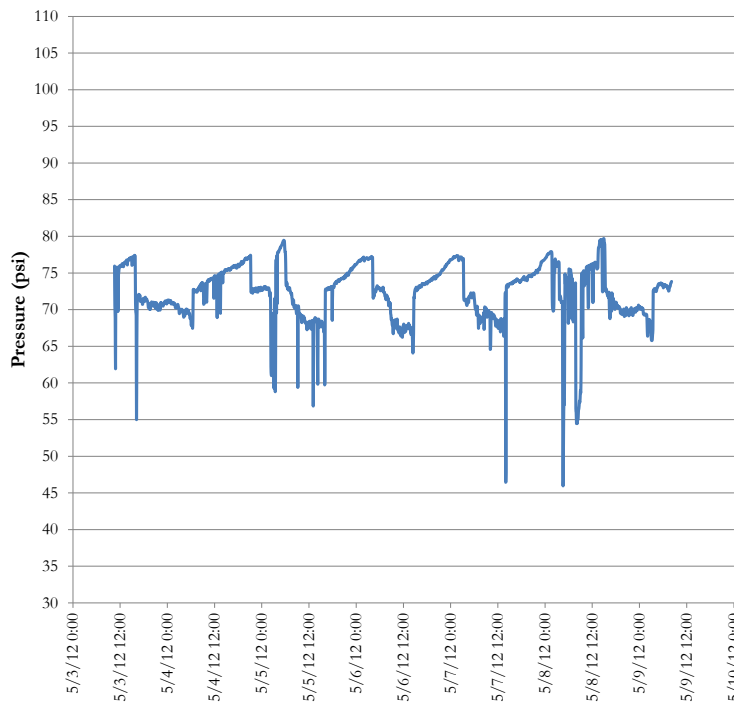
**Coefficient of Variation:** 0.036

**95% Confidence Interval:**  
 67.5 psi to 78.0 psi or 47.5 m to 54.9 m H<sub>2</sub>O

**Elevation:** 217.169 m (City Survey)

**Average Hydraulic Grade (HGL):** 268.4 m

The following plot is for a location located at the southerly extremity of the newly defined PD-KN boundary, after the zone realignment which placed a portion of the lands in south Kleinburg into the PD6 service area. This plot indicates, similar to the above observations, that there is a reasonably wide variation in observed pressures and several sizable downsurges are noted to occur. It is further expected that the instantaneous downsurges are in reality more severe than those represented on the plot due to the recording equipment used.



**Location:**  
 10384 Islington Avenue

**Period:** 03 May to 09 May 2012  
*(Before re-alignment of PD6 zone in south Kleinburg)*

**Pressure Recorder ID:** 204226 (PW#1)

**Hydrant GIS ID:** 3481

**Hydrant Field ID:** 6863

**Average Pressure:** 72.3 psi or 50.8 m H<sub>2</sub>O

**Standard Deviation:** 3.9 psi or 2.8 m H<sub>2</sub>O

**Coefficient of Variation:** 0.055

**95% Confidence Interval:**  
 64.4 psi to 80.2 psi or 45.3 m to 56.4 m H<sub>2</sub>O

**Elevation:** 215.797 m (City Survey)

**Average Hydraulic Grade (HGL):** 266.6 m

For purposes of hydraulic modelling for Master Plan purposes, a boundary condition of 267.0 m is applied at the elevated tank noting that the interim and ultimate conditions in this zone, based on works underway or in progress by the Region, are expected to be an improvement to current conditions.