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June 1, 2009
File: 1634-00898

City of Ottawa
Planning & Growth Management Department
110 Laurier Avenue West
Ottawa, Ontario
K1P 1J1

Attention: **Charles Warnock**
Program Manager, Development Review Process (Rural West)

Dear Mr. Warnock:

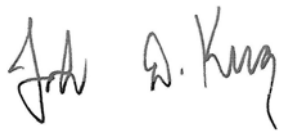
Reference: **Lynwood Mobile Home Park**
Connection to the Carlsbad Springs Trickle Feed System
Feasibility Study

We are pleased to submit herewith our report on the feasibility of connecting the Lynwood Mobile Home Park to the Carlsbad Springs Trickle Feed system. From a hydraulic standpoint, there is adequate capacity in the existing trickle feed system to provide potable water to the Lynwood area using the same flow rates in the current system. This would best be accomplished by constructing a 102mm diameter watermain along Hall Road (from Ninth Line) to the park and adding appropriate storage and pumping on site. It is noted that there are a number of other issues that would need to be resolved prior to approving and making this connection, and these are listed in the report.

We trust the report is complete and meets you current needs. If you require additional information or need anything further, please do not hesitate to contact the undersigned.

Sincerely,

STANTEC CONSULTING LTD.



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Attachment: Report

Lynwood Mobile Home Park Connection to the Carlsbad Springs Trickle Feed System Feasibility Study

June 2009

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1.0 BACKGROUND

1.1 PURPOSE OF THE STUDY

The City of Ottawa is reviewing issues associated with connecting the Lynwood Mobile Home Park to the City's central water supply system through the existing Carlsbad Springs Trickle Feed System, in response to a request from the owners/residents of the Mobile Home Park citing concerns regarding the quality of their groundwater supply. This study has been undertaken to establish the technical feasibility of making such a connection and reviewing some of the key issues associated with its possible implementation.

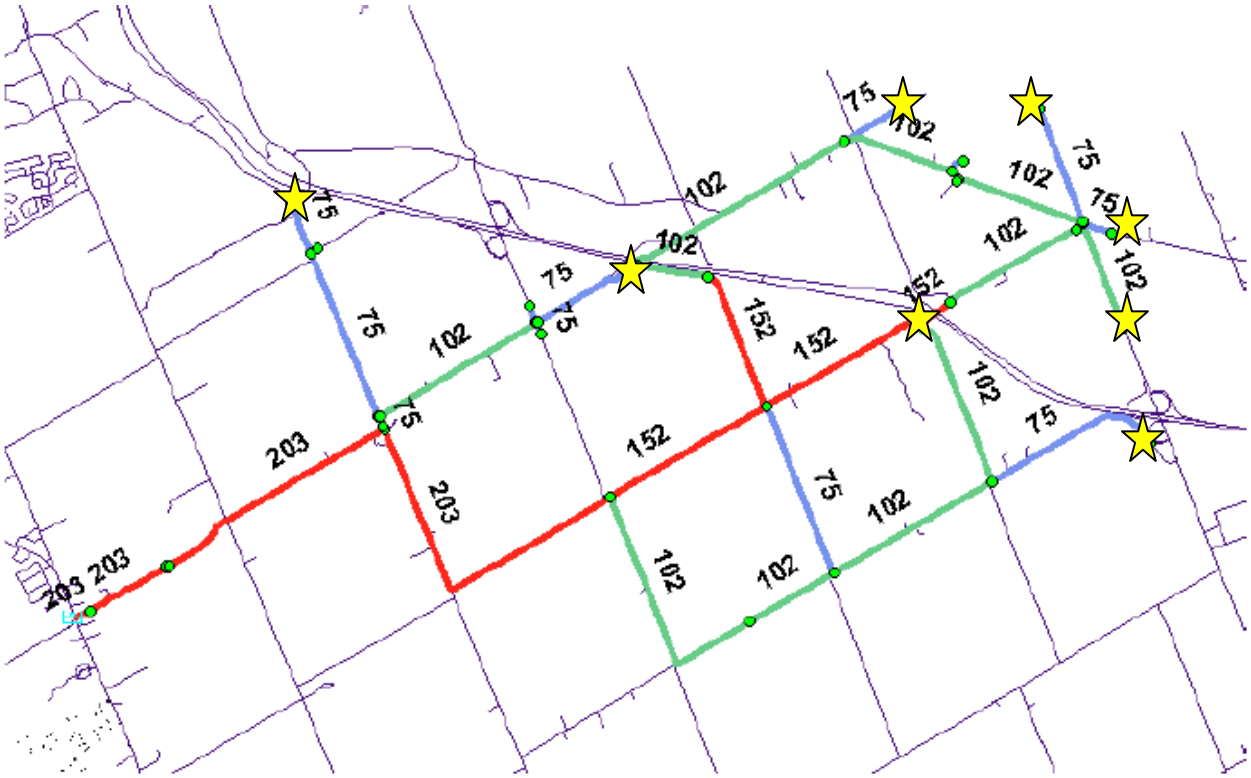
1.2 EXISTING TRICKLE FEED SYSTEM DESIGN

The Carlsbad Springs Trickle Feed Water Systems was designed to provide sufficient water for indoor use only. No allowances were made for outdoor water use (i.e. sprinklers, car washing, etc.) and fire protection is not provided from the system. As such, the system is comprised of small diameter watermains, ranging from 75mm to 200mm in diameter. Because of lower than anticipated water demands and flows in the system, the City has adopted a regular flushing/bleeding program (through "blow-offs") to help ensure turnover of water in the long lengths of pipe and thus maintain adequate chlorine residuals.

The City provided estimates of the flushing based on a water use analysis undertaken in 2003. The total flow rate was estimated at 400L/min from the eight (8) blow-off locations, and it was indicated that this was likely a conservative value. The City also indicated that more recent calculations of the flushing rates, conducted in 2008, suggested flow rates from the blow-offs of 200L/min. These results suggest a typical flow at each blow-off is expected to range from 0.42L/sec to 0.83L/sec. It is understood that these values may change through time and may not be accurate – therefore, flushing rates will not be included in the modeling, however the potential impacts of flushing rates on the results will be presented.

The following **Figure 1-1** provides an overview of the Carlsbad Springs distribution system and indicates the locations where blow-offs are located to encourage water movement through the system.

Figure 1-1: Carlsbad Springs Distribution System (Existing)



Current Blow-Off (flushing) Locations - ★

The Carlsbad Springs Trickle Feed System was initially designed to service up to a maximum of 775 individual connections, which included existing lots and limited infill (primarily severances) homes, businesses and institutional lands. Each connection was allocated a pre-set constant flow rate to their property of 2700L/d – this does not necessarily represent the amount of water consumed in each household each day, but is a flow rate that was determined appropriate to provide sufficient water to meet typical water uses throughout the day to homes in conjunction with in-house water tanks or cisterns. For a very limited number of connections, primarily businesses and institutional users with higher water usage, higher flow rates were allocated, which brought the total system design flow rate to 829 "equivalent units" (where each "equivalent unit" is allocated 2700L/d). With a 10% allowance for leaks and miscellaneous system losses, the total design flow rate for the entire Carlsbad Springs system was 2.46ML/d or 28.5L/s.

It is noted that the Trickle Feed system was designed to solve an existing problem with the groundwater supply in the area, and it was not initially envisioned that extensions to the system would be permitted. It was also clear at the time that the system was not designed to serve new growth, although some limited infilling and severances were considered.

1.3 TRICKLE FEED SYSTEM MONITORING RESULTS

Since its inception as a demonstration / pilot project in 1997, the Region of Ottawa-Carleton and now the City of Ottawa has reviewed the performance of the Carlsbad Springs Trickle Feed system. One of the key design issues assessed was the concept of concurrent usage. The initial design assumed, as a conservative projection, that every connected home would be supplied with water at a flow rate of 2700L/day concurrently at some time during the day. Through their analysis, the City has concluded that not all connections were drawing water concurrently, and as a result, the peak demand in the overall system is less than the design estimate. The following reports were reviewed as part of this study:

- [1]City Memo: Carlsbad Springs – Update on Review of Design Assumptions (2004)
- [2]City Report: Carlsbad Springs Trickle Feed System Performance Evaluation – Final Report
- [3]City Report: Carlsbad Springs Trickle Feed System 2000 Testing and Monitoring Report

The following **Table 1-1** summarizes the results of the City's assessment:

Table 1-1: Actual Concurrent Connection Usage

Year	*1999*	*2000*	*2002*	*2003*
Actual Concurrent Use	43%	39%	40%	45%

The calculations for concurrent usage were based on overall metered flows to the trickle feed system, and thus include any system losses/leakage, flushing flows and flows to customers with a higher flow rate than 2700L/day. Since the concurrent usage used the total system flow divided by the number of connections, the concurrent usage calculation inherently includes appropriate allowances for these factors, and thus no allowance in the flow calculations is required beyond the 2700L/day/connection design parameter.

Based on the assessment of concurrent usage, the City has suggested that a concurrent use of 65% could be applied to further system assessments while remaining adequately conservative.

In 2004, the City conducted a review of the design assumptions used in the Carlsbad Springs system. Further to the concurrent usage assessment, the 2004 review analyzed average consumption usage per connection. These observations suggested that the average domestic demand per connection averaged approximately 450 to 470 L/day (with a range from 100 to 750 L/day). This is approximately half the typical City water demand, and is likely a contributing factor to the lower than expected flows in the system.

In summary, the following flow rates will be used as the design basis for further investigations, including this study:

- 2700 L/day/connection (maximum flow rate per standard individual connection)

(used for setting flow control device)
- o 1755 L/day/connection (65% concurrent usage peak flow rate)
  (used to develop peak flow rates for entire system analyses)
- o 450 L/day/connection (actual average consumption)
  (used to determine average flow rates for entire system analysis)
- o 15.7L/s design flow in existing system (65% concurrent usage peak flow rate)
- o 0.42-0.83L/s per flushing connection (20-40% of actual average consumption)
- o 200L/min flushing flow total is equivalent to approximately 160 connections (65% concurrent usage) or 20% of existing system demand at build-out

In addition to this analysis, the City also undertook a review of the watermain "C" factors associated with the high density polyethylene (HDPE) pipe used throughout the Carlsbad Springs system. The values used in the initial design were derived from the manufacturers' data. **Table 1-2** presents the test results which were undertaken by the City in 1999 and 2000, with the following results:

Table 1-2: Actual Recorded "C" Factors By Pipe Size

Pipe Section	*"C" Value (2000 Test)*	*"C Value (1999 Test)*
200mm Section (185mm ID) on Leitrim	N/A*	144
100mm Section (96mm ID) on Leitrim	127	125
75mm Section on Baseline	118	122

(*) Flows generated during the 2000 test were not sufficiently high to produce a reliable C value estimate.

This suggests that the design "C" value for the larger pipes (200mm) is representative of actual conditions, however, lower "C" values (and thus increased friction) should be used for the smaller diameter mains.

The above modifications to the design values will impact the number of connections allowed and/or the flow rates allowed per connection. The 65% concurrent usage will allow additional connections while the reduced "C" values will reduce the number of connections allowed. The lower than expected average consumption will result in increased travel times in the system, but does not affect the number of connections permitted. The flushing of the system will reduce the number of connections allowed.

2.0 TECHNICAL ASSESSMENT

2.1 HYDRAULIC ANALYSIS AND MODEL SETUP

A hydraulic model with multiple scenarios has been developed based on the model provided by the City of Ottawa to determine the feasibility of connecting the Lynwood Mobile Home Park to the existing Carlsbad Springs Trickle Feed Water System. The impacts on residual pressures, age of water with alternative connecting pipe locations and sizes have been assessed. The setup and the results of these are explained in detail below.

Based on the monitoring results undertaken by the City, the following **Table 2-1** presents the "C" factors that were adopted for use in this study (used throughout the existing system and any new proposed pipes):

Table 2-1: "C" Factors Used in Hydraulic Analysis

C-Factor	*Pipe Sizes*
140	≥ 200mm
125	100mm to 200mm
115	< 100mm

2.2 ALTERNATIVE CONNECTIONS TO LYNWOOD MOBILE HOME PARK

The Lynwood Mobile Home Park has an estimated 120 individual units requiring water. For this analysis, it has been assumed that each unit will require the same amount of water as other connections in Carlsbad Springs (2700L/d) for a total possible flow of 0.32ML/d (3.75L/s) using 100% concurrent usage or 0.21ML/d (2.44L/s) peak demand with 65% concurrent usage.

2.2.1 Route Options to Lynwood Mobile Home Park

For all assessments, full build-out conditions within the existing service area (829 equivalent connections and 10% leakage allowance) has been considered. The following scenarios were assessed:

- **Scenario 1**: The demand in the existing system of 24.2L/s (100% concurrent usage) was distributed over the Carlsbad Springs network per the distribution included in the model provided by the City. The Lynwood Mobile Home Park was not included. For modeling purposes, a fixed head reservoir was placed at the intersection of Bank and Leitrim with a hydraulic grade line (HGL) of 155m to simulate existing boundary conditions. This scenario was used to establish baseline conditions per the original design (with the exception of the revised "C" factors which were used for all

assessments). The performance of the system with a boundary condition HGL at Leitrim and Bank of 145m was also evaluated, as it is understood that the City intends to reduce the HGL in Zone 3C to this level in the near future. Residual pressures and a water age analysis were recorded. It is noted that in some cases, water age analyses were not possible, as some of the shorter dead-ends resulted in extremely long age-of-water results. The purpose of the water age is to compare the existing to future results, and represents the age of water from the Leitrim/Bank intersection only.

- **Scenario 2**: This scenario is identical to Scenario 1 except that a total demand in the existing system of 15.7L/s (65% concurrent usage) was distributed along the existing network and a simulation was run to determine the minimum residual pressure at various points along the system. The Lynwood Mobile Home Park was not included.

- **Scenario 3A**: This scenario is identical to Scenario 2 (with the total demand in the existing system at 15.7L/s or 65% concurrent usage distributed along the existing network). The system was tested to determine the maximum flow (and thus the maximum number of equivalent units) that could be provided with water from the Hall/Ninth Line intersection while maintaining a residual pressure greater than 138kPa in the existing system.

- **Scenario 3B**: The demand in the existing system of 15.7L/s (65% concurrent usage) was initially distributed along the network. The demands throughout the existing system were increased equally (by percentage) to determine the maximum flow (and thus the maximum number of additional equivalent units or maximum increase in flow rate per unit) that could be provided with water throughout the existing system while maintaining a residual pressure greater than 138kPa in the existing system.

- **Scenario 4**: The demand in the existing system of 15.7L/s (65% concurrent usage) was distributed along the network. The 120 unit Lynwood Mobile Home Park demand, with all units drawing at 2700L/d concurrently (total demand of 3.75L/s) was added. The four alternative connection points to the system were evaluated.

- **Scenario 5**: The demand in the existing system of 15.7L/s (65% concurrent usage) was distributed along the network. The 120 unit Lynwood Mobile Home Park demand, with 65% concurrent usage, is 2.44L/s. Simulations were run from each of the four alternative connection points – these are: (a) Ninth Line & Hall Road, (b) Ninth Line & Farmers Way, (c) Boundary Road south of the village with a connection at Ninth Line Road, and (d) Ninth Line near Boundary Road. **Figures 2-1, 2-2, 2-3 and 2-4** present the alternative connection points.

Figure 2-1: Carlsbad Trickle Feed System with Connection at Hall Road

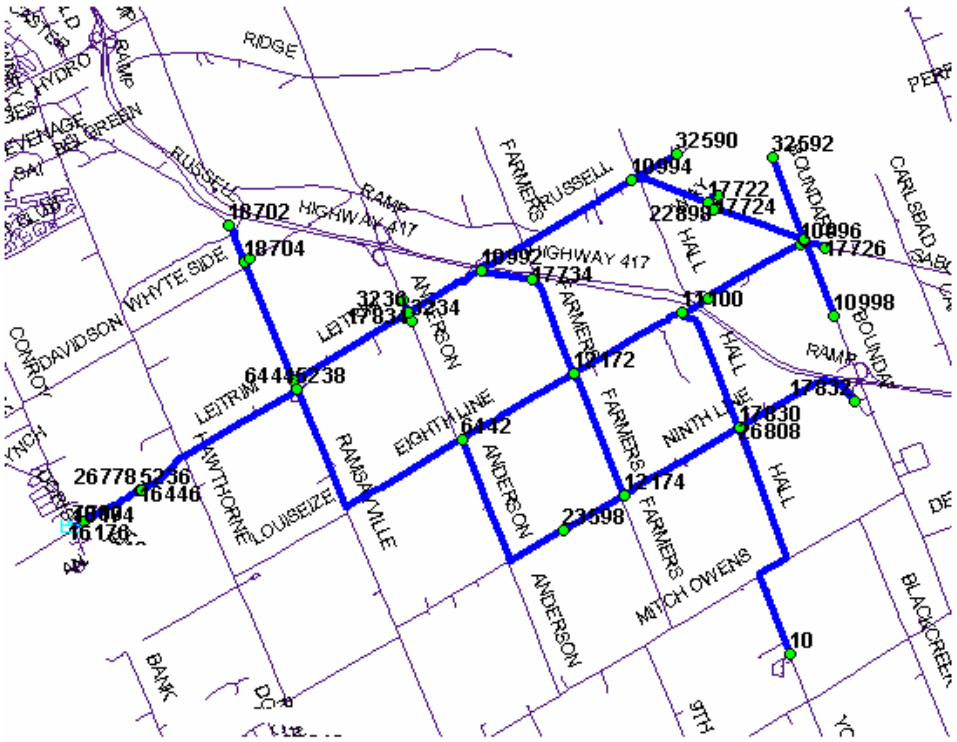


Figure 2-2: Carlsbad Trickle Feed System with Connection at Farmers Way

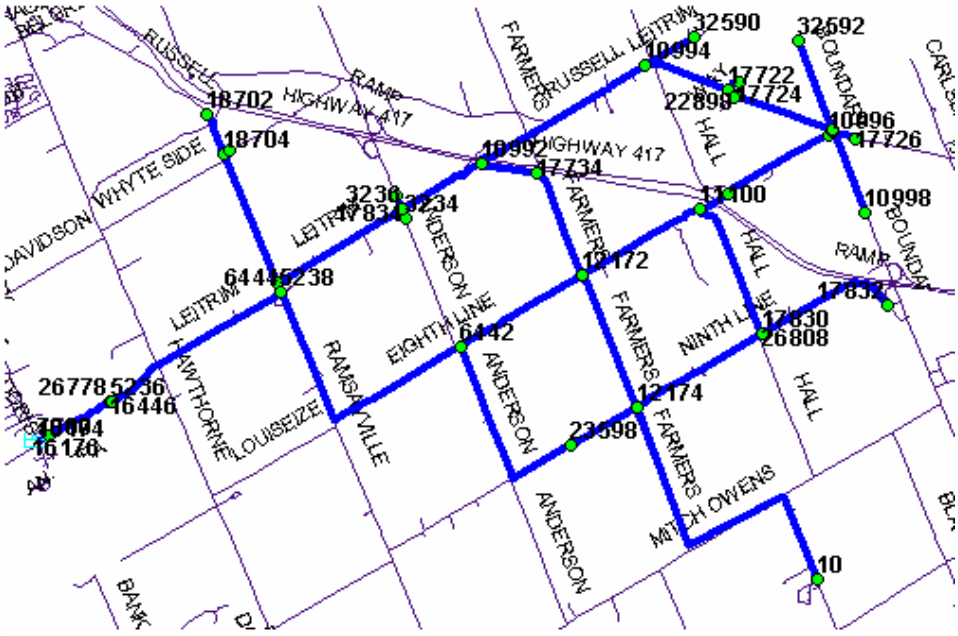


Figure 2-3: Carlsbad Trickle Feed System with Connection at Boundary Road

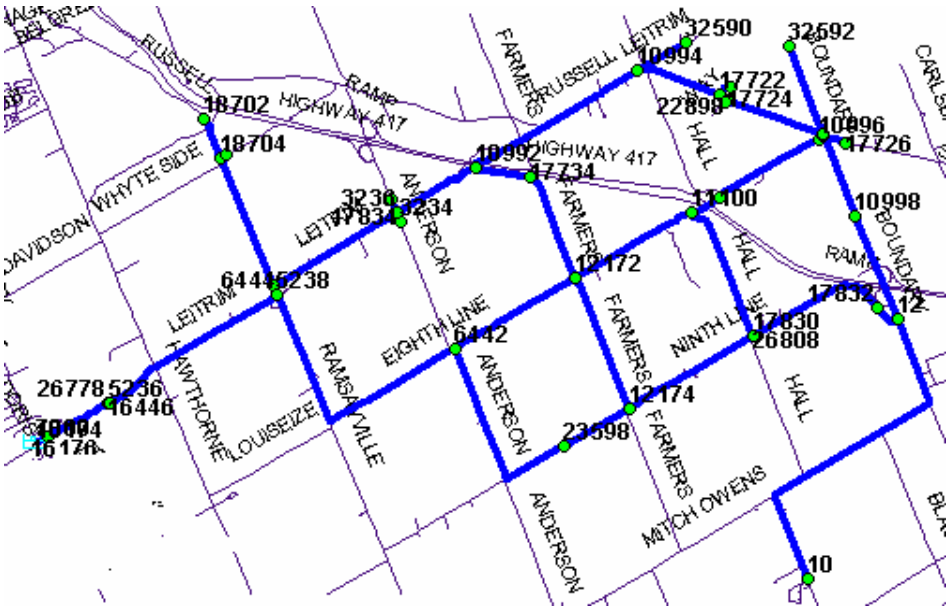
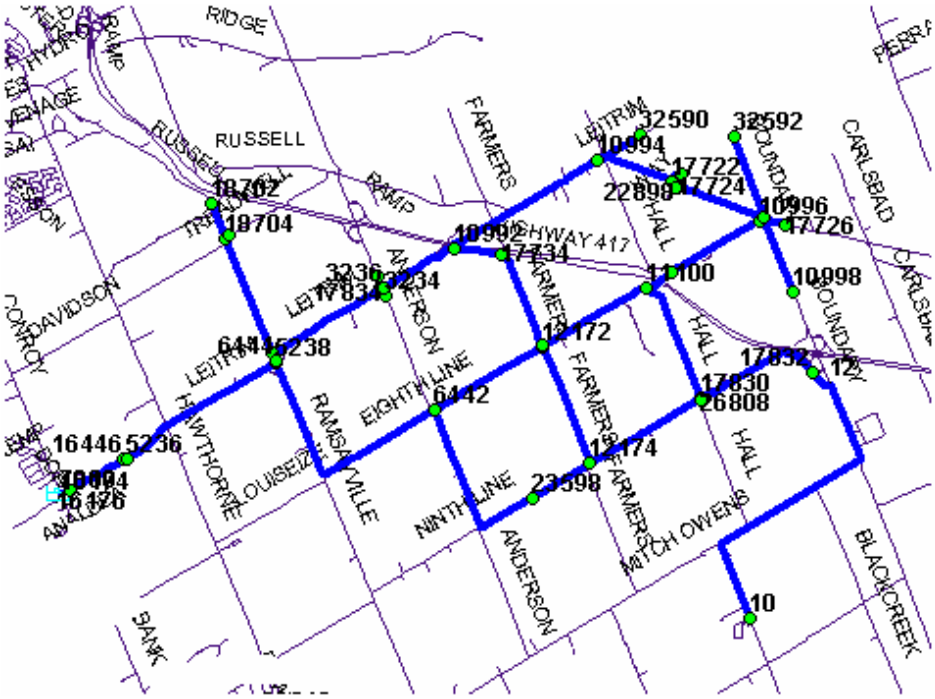


Figure 2-4: Carlsbad Trickle Feed System with Connection at Ninth Line



2.2.2 Fronting Properties

A number of existing properties/residences front along each of the connecting pipe routes from the Carlsbad Springs system to the Lynwood Mobile Home Park. Water servicing of these properties may be required/requested. Although this cannot be confirmed at this time, it will be beneficial in the assessment to consider the potential for servicing these properties and the possible impact on the sizing should this be considered.

A simple count of the existing buildings along each route was conducted, using satellite imagery, without considering the potential for infilling and/or severances of these properties in the future. The following **Table 2-2** presents the approximate maximum number of connections that may be needed for each alternative route.

Table 2-2 Number of Fronting Properties By Alternative Route

Connection Location	*Edwards Only*	*Fronting Pipe Route*	*Total*
Farmers Way	51	31	82
Hall	51	17	68
Boundary	51	29	80
Ninth Line	51	17	68

In reality, different routes would likely front a different number of properties within Edwards itself. For the purposes of this investigation, it has been assumed that an identical number of properties would be considered for servicing should the pipe pass through any part of Edwards.

The following **Figure 2-5** shows the extent of properties in Edwards that have been included in the count:

Figure 2-5: Edwards Community – Potential Lots Serviced

Circle delineates properties included in count of 51 potential connections in Edwards

2.2.3 Private Storage and Pumping

All existing customers serviced by the Carlsbad Spring Trickle Feed System have a cistern (typically 600L-750L in volume), a jet pump, backflow prevention system and water meter installed inside their homes. The total footprint for these components varies, but generally the cistern alone would require at least 1m^2 of floor space and the jet pump another 0.5m^2 for an absolute minimum of say, 1.5m by 1.0m floor space. It is not known the practicality and feasibility of installing individual cisterns and pumps within each trailer, but this must be considered at the next stage in the design of the local system arrangement at the Mobile Home Park. It is suspected that adequate space for a cistern, pump, water meter, flow control device and backflow preventer would not be available inside each mobile home.

Alternatively, the Mobile Home Park could potentially construct a single local storage tank (or multiple tanks) and use a single (or multiple) booster pumps to supply individual units. Essentially, this system would function similarly to a communal well, except that instead of groundwater supply, water is pumped from the local storage tank which is fed from the trickle feed system. Although the sizing for a storage tank could be optimized through a more detailed analysis, it is expected that this would need to be in the order of 40,000-50,000L to adequately service 120 units (say 5m x 6m x 1.5m deep). Booster pumping would be similarly sized to the existing well pumps.

Although beyond the scope of this study, the final setup and arrangement of storage and pumping within the Mobile Home Park would have an impact on the flow rate required. The flow rate to this area could be as high as 2.44ML/d (120 units with 65% concurrent usage and 600-750L cisterns in each unit) and as low as 0.63ML/d (120 units with an average consumption of 450L/day/connection and full balancing storage of approximately 50,000L – calculated as the maximum day divided by four times plus 25% times 1.5 contingency). A higher flow rate could result in a reduced storage volume. For the purpose of this investigation which is to assess the ability of the Carlsbad Springs system to feed the Lynwood Mobile Home Park, the 65% concurrent usage figure will be used.

In addition to the potential for a large storage tank and pumping in the Mobile Home Park, there are several other issues that need to be dealt with should this option proceed. These include ownership, operation and maintenance of the storage of the tank and pumps, standards for construction, ownership and responsibility agreements, individual services to each unit (condition & water quality), water metering, payment, flow controls, backup power requirements, flushing requirements, etc.). As well, since outdoor water use is limited for existing customers in Carlsbad Springs, and many users have kept their private wells available for this use, controls and/or limitations of water usage by individuals may be required within the Park. These issues are not addressed herein, but would need to be addressed prior to finalizing a new supply line to the Lynwood area.

2.3 RESULTS OF ANALYSIS

2.3.1 Residual Pressures

Tables showing the complete results of the analyses of the various alternatives are provided in **Appendix A**. The following **Table 2-3** presents the minimum residual pressures incurred within the existing system (or at the Lynwood Mobile Home Park) under each scenario:

Table 2-3: Minimum Residual Pressures Under Various Scenarios

	Connection to Lynwood Mobile Home Park	*HGL at Leitrim/Bank 155m*	*HGL at Leitrim/Bank 145m*
Scenario 1 Build-Out Carlsbad Springs (100% Concurrent Usage) w/o Lynwood Mobile Home Park	N/A	378 kPa	284 kPa
Scenario 2 Build-Out Carlsbad Springs (65% Concurrent Usage) w/o Lynwood Mobile Home Park	N/A	488 kPa	394 kPa
Scenario 3A Build-Out Carlsbad Springs (65% Concurrent Usage) with max flow from system at Hall	Hall	N/A	138 kPa *(max additional flow = 11.9L/sec = 586 units @ 65%)*
Scenario 3B Max flow to Carlsbad Springs (65% Concurrent Usage) with low residual pressure of 138kPa in existing system w/o Lynwood Mobile Home Park	N/A	N/A	138 kPa *(max additional flow =14.3L/sec = 702 units@ 65% = 90% increase in flow to exist units)*
Scenario 4 Build-Out Carlsbad Springs (65% Concurrent Usage) with Lynwood Mobile Home Park (100% Concurrent Usage or)	Hall	418 kPa (102mm)	324 kPa (102mm)
	Farmers Way	397 kPa (102mm)	305 kPa (102mm)
	Boundary	256 kPa (102mm)	162 kPa (102mm)
	Ninth Line	181 kPa (152mm)	106 kPa (305mm)
Scenario 5 Build-Out Carlsbad Springs (65% Concurrent Usage) with Lynwood Mobile Home Park (65% Concurrent Usage)	Hall	298 kPa (75mm)	203 kPa (75mm)
	Farmers Way	232 kPa (75mm)	139 kPa (75mm)
	Boundary	142 kPa (75mm)	340 kPa (102mm)
	Ninth Line	349 kPa (102mm)	251 kPa (102mm)

Note: Pipe sizes selected to maintain minimum residual pressure of 138kPa (20 psi) where possible. Does not include impact of flushing flows.

Scenarios 1 & 2: With a reduced HGL at Bank & Leitrim and 100% concurrent usage in the existing system, the minimum residual pressure in the system is 284kPa, which increases to 394kPa with only 65% concurrent usage modeled. These are both well above the target minimum of 138kPa and suggest that the system demands could be increased and still function within the City guidelines.

Scenario 3A: With a reduced HGL at Bank & Leitrim and 65% concurrent usage in the existing system, total additional flows from the Hall/Ninth Line intersection ranging up to 11.9L/sec could be achieved while still meeting minimum pressure requirements in the existing system (this would be reduced to approximately 8.6L/sec with flushing at 200L/min). This represents a total additional 586 connections that could be added to the system at this point (at 65% concurrent usage and 2700 L/day each) or 423 new connections with flushing. Under this scenario, the lowest system pressure is realized at the east end of the existing Ninth Line Road pipe.

Scenario 3B: With a reduced HGL at Bank & Leitrim and 65% concurrent usage in the existing system, the total distributed demand in the system could be increased by 14.3L/sec (approximately 30L/sec total demand) while still meeting minimum pressure requirements in the existing system (this would be reduced to approximately 11.0L/sec with flushing at 200L/min). This represents an increase of approximately 702 equivalent units (at 65% concurrent usage and 2700 L/day each) or 540 connections with flushing. Alternatively, this represents a flow rate increase of approximately 90% from 2700L/day to 5145L/day per unit (at 65% concurrent usage) or 4590L/day per unit with flushing at 200L/min. Under this scenario, the lowest system pressure is realized at the south end of the existing Boundary Road pipe.

Scenario 4: With 100% concurrent usage at the Mobile Home Park, with a starting HGL of 145m, all connection points are feasible with the exception of the Ninth Line Road connection (for this location, the residual pressure at the Lynwood Mobile Home Park does not meet the minimum desired pressure of 138kPa even with a 305mm connecting pipe). The new pipe size for a connection at all other points (Boundary Road south of the village, Hall or Farmers Way) would need to be 102mm in diameter.

Scenario 5: With 65% concurrent usage at the Mobile Home Park, with a starting HGL of 145m, all connection points are feasible. The new pipe size for a connection at Ninth Line or Boundary Road (south of the village) would need to be 102mm in diameter instead of 75mm for the Hall or Farmers Way connection points (a combination of 102mm and 75mm for the Boundary Road connection may be considered during final design as the residual pressure with a 102mm pipe is significantly higher than the minimum required). Under these scenarios, the lowest system pressure is realized within the Mobile Home Park.

It is important to consider that the actual flows to the Mobile Home Park may vary depending on how the system is configured. For example, if each individual dwelling unit has its own cistern and pressure pump, it is expected that the peak flow to this entire area would be 65% of the maximum calculated demand (considering non-concurrent usage). However, if the system is configured to supply, say one large storage tank and multiple pressure pumps, then the peak

flow to this area could be 100% of the calculated demand, or it could be designated to be lower to meet system needs.

As well, it may be necessary (or advantageous) to include water servicing or an allowance for water servicing, to existing properties along the selected route to the Mobile Home Park. The ability of the selected route to provide additional flows should thus be considered in the assessment of route and sizing options.

2.3.2 Water Age

Comparative water ages under baseline conditions as well as under each of the four alternative connection points are presented in **Appendix A** for all nodes. The water ages shown are from the intersection of Bank and Leitrim, and thus can be used to determine the relative reduction in travel time associated with including the alternative Lynwood Mobile Home Park connections. Given the nature of this analysis, the results of the water age analysis are best used to determine the relative age of water within the distribution points at various locations. Individual times of travel may vary depending on actual specific local conditions. To facilitate the assessment, the following **Table 2-4** presents the water age for selected nodes only (selected nodes shown in **Figure 2-6**).

Figure 2-6: Selected Nodes for Water Age Assessment

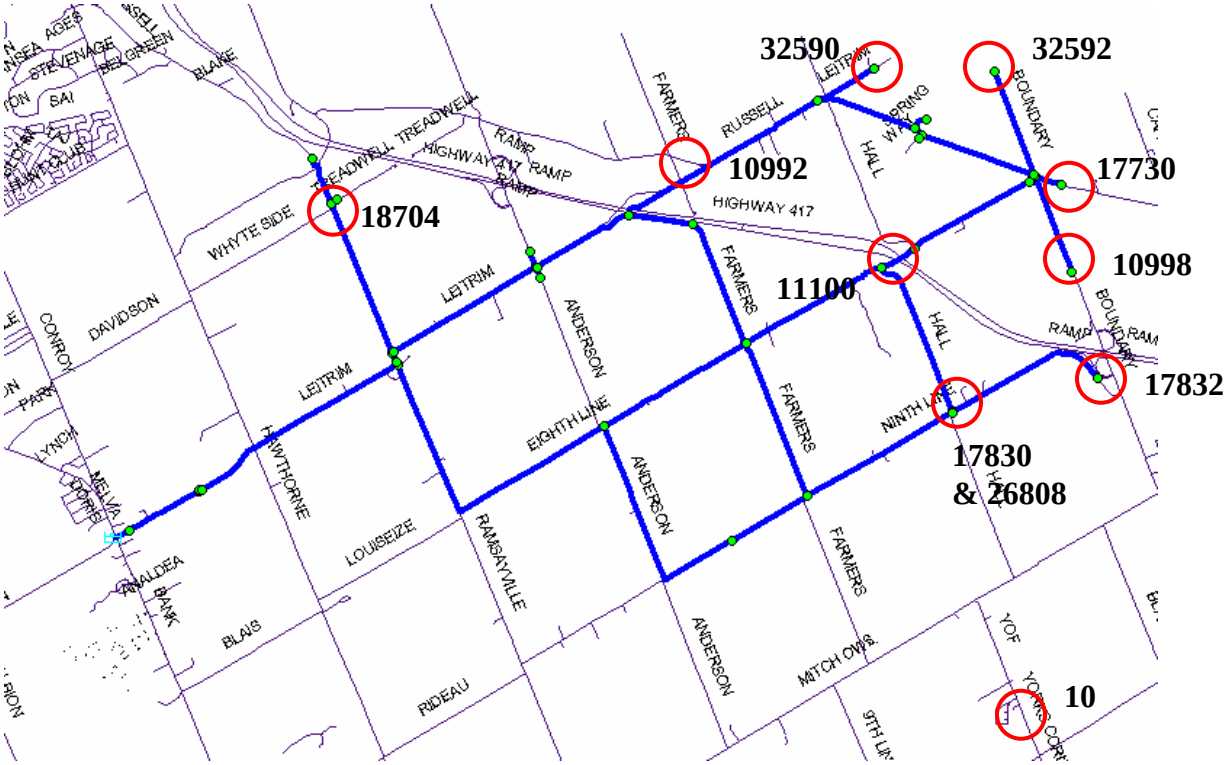


Table 2-4: Water Age at Selected Nodes Under Various Scenarios

Baseline Condition		With Lynwood added			
HGL of 145m @ Leitrim and Bank*		Alternative Connecting Locations			
		Hall	Farmers	Boundary	Ninth Line
Node ID	Water Age (hrs)	Water Age (hrs)	Water Age (hrs)	Water Age (hrs)	Water Age (hrs)
10 (102mm Dia.)	-	55	54	70	64
10 (75mm Dia.)	-	49	47	63	56
10992	**37**	33	33	32	33
10998	**51**	**40**	**41**	**38**	**40**
11100	**40**	**29**	**30**	**29**	**29**
17730	**58**	52	52	52	52
17830	**60**	**42**	**47**	**48**	**42**
17832	**143**	**125**	**130**	**54**	**46**
18704	**25**	24	24	24	24
26808	**59**	**42**	**46**	**48**	**42**
32590	**66**	62	62	60	62
32592	**92**	87	87	87	87
Maximum:	**143 hrs**	125 hrs	130 hrs	87 hrs	87 hrs

** Not accounting for actual water age prior to Leitrim & Bank Intersection*

The two areas in the existing system experiencing the longest travel times are node 17832 (east end of Ninth Line near Boundary Road) and node 32592 (north end of Boundary Road). It is clear that none of the connection options to the Lynwood Mobile Home Park have any significant impact on the time of travel to nodes north of Eighth Line (1-6 hour reductions on parts of Leitrim and Russell), however, the connections do reduce more the travel times more noticeable to some of the areas along Ninth Line Road and on Boundary Road south of the village (typically 11-18 hours).

With a connection at Hall Road, an 18 hour travel time reduction was found along Ninth Line Road, including at the far eastern end of the pipe. As well, an 11 hour reduction in travel time to the south end of Boundary Road was also seen.

Similar results were found with a connection at Farmers Way – although slightly less improvement is seen (typically 13 hour travel time reduction was found along Ninth Line Road).

With a connection to the south end of the Boundary Road pipe (including a connection to Ninth Line), similar reductions are again found on Ninth Line Road and the south end of the Boundary Road pipe (13 hours) except that there is very significant reduction in travel time to the east end of the Ninth Line Road pipe (approximately 90 hour reduction in travel time). It is noted, however, that this reduction still results I travel times to the east of Ninth Line Road of approximately 50 hours, which suggests that flushing would still be required at this location (when compared to travel times to other locations that currently require flushing).

Thus, although all connection points will reduce travel times to the Ninth Line Road area and the south end of Boundary Road somewhat, it does not appear that the reduction would be significant enough to eliminate the need for flushing at the current locations. The only exception is potentially at the east end of Ninth Line Road should this become the supply point for Lynwood Mobile Home Park, where the volume/flow rate could likely be decreased somewhat.

It is noted that, with a connection at Hall Road, the calculated travel time from the connection at Ninth Line Road to the Lynwood Mobile Home Park is in the order of 7 to 13 hours (for 75mm and 100mm connecting pipes respectively). These are, however, based on water use estimates within the Park similar to those being realized throughout the Carlsbad Springs area. Thus, although the calculated travel times are relatively short, there may still be a need for an additional flushing connection at the Mobile Home Park (may only be confirmed after system is in place and actual flows and disinfection residuals can be measured).

2.3.3 Estimated Costs

The alternative sizes, lengths and costs of new pipelines required to make the connections identified above are presented in **Table 2-5**. A high level cost estimate was undertaken for supply and installation of long lengths of HDPE pipe using horizontal directional drilling (HDD). For construction only, it is estimated that 75mm diameter pipe could be installed for approximately $101/m and 102mm diameter pipe would cost approximately $106/m. With an allowance of 50% for contingency and engineering, the total unit cost for HDPE pipe installation is $152/m and $159/m for 75mm and 102mm diameter piping respectively.

Table 2-5: Estimated Costs for Lynwood Park Connecting Pipes

Connection Location	*Diameter*	*Length of Pipeline*	*Opinion of Probable Cost*
Farmers	75mm 102mm	5080m	$ 775,000 $ 810,000
Hall	75mm 102mm	3860m	$ 590,000 $ 615,000
Boundary	75mm 102mm	7140m	$ 1,085,000 $ 1,135,000
Ninth Line	75mm 102mm	5490m	$ 835,000 $ 875,000

It is noted that since approximately 50% of the estimated construction costs is related directly to directional drilling of the pipe (in addition to pipe supply, fusing, chambers, and road restoration costs), there may be alternatives to HDD that could allow for less costly installation. Although not proven in HDPE watermain installations in this area, a tile drain machine, for example, may be feasible and result in some cost reductions (extent of cost savings for this alternative were not able to be confirmed).

All existing customers serviced by the Carlsbad Spring Trickle Feed System have a cistern (typically 600L-750L in volume), a jet pump, backflow prevention system and water meter installed inside their homes. The total footprint for these components varies, but generally the cistern alone would require at least $1m^2$ of floor space and the jet pump another $0.5m^2$ for an absolute minimum of say, 1.5m by 1.0m floor space. It is not known the practicality and feasibility of installing individual cisterns and pumps within each trailer, but this must be considered at the next stage in the design of the local system arrangement at the Mobile Home Park. It is suspected that adequate space for a cistern, pump, water meter, flow control device and backflow prevention device would not be available inside each mobile home.

Alternatively, the Mobile Home Park could potentially construct a single local storage tank (or multiple tanks) and use a single (or multiple) booster pumps to supply individual units. Essentially, this system would function similarly to a communal well, except that instead of groundwater supply, water is pumped from the local storage tank which is fed from the trickle feed system. Although the sizing for a storage tank could be optimized through a more detailed analysis, it is expected that this would need to be in the order of 40,000-50,000L to adequately service 120 units (say 5m x 6m x 1.5m deep). Booster pumping would be similarly sized to the existing well pumps. Control requirements, including metering, backflow prevention, backup power, etc. would need to be confirmed as well to ensure the operation of the system. In addition to the storage and pumping, the condition of the existing service piping to each mobile home would need to be assessed and replaced if necessary. A 50,000L storage tank and associated pump station and controls would be estimated to cost $125,000 or $190,000 including engineering and contingencies.

Although beyond the scope of this study, the final setup and arrangement of storage and pumping within the Mobile Home Park would have an impact on the flow rate required. The flow rate to this area could be as high as 2.44ML/d (120 units with 65% concurrent usage and 600-750L cisterns in each unit) and as low as 0.63ML/d (120 units with an average consumption of 450L/day/connection and full balancing storage of approximately 50,000L – calculated as the maximum day divided by four times plus 25% times 1.5 contingency). A higher flow rate could result in a reduced storage volume.

2.4 EVALUATION OF ALTERNATIVES

The following **Table 2-6** summarizes the number of units/connections associated with each of the alternative connection pipes to the Lynwood Mobile Home Park as well as the estimated capital cost for the connecting pipe to the Carlsbad Springs system and a new 50,000L storage and pumping facility within the Mobile Home Park (does not include service piping within Lynwood):

Table 2-6: Alternative Connections and Costs

Connection Location	*Pipe Size (mm)*	*Number of Connections*		*Max Number of Equivalent Connections Serviceable*			*Capital Cost (Piping, Storage, Pumping) (incl. eng & cont)*
		Lynwood Only	Lynwood + Fronting	Max Flow (L/sec)	At 100% Concurrent	At 65% Concurrent	
Farmers Way	75	120	202	2.72	87	139	$0.97 M
	102	120	202	5.55	178	274	$1.00 M
Hall	75	120	188	2.43	78	120	$0.78 M
	102	120	188	5.16	165	254	$0.81 M
Boundary	75	120	200	2.15	69	106	$1.28 M
	102	120	200	3.93	126	194	$1.33 M
Ninth Line	75	120	188	1.94	62	95	$1.03 M
	102	120	188	2.97	95	146	$1.07 M

Notes: All assessments based on starting HGL of 145m at Bank/Leitrim
All assessments consider 65% concurrent usage in existing Carlsbad system
Lynwood + Fronting include Lynwood, Edwards and fronting properties along the respective route
Does not include impact of flushing flows (potentially 200L/min or 0.42L/sec)

Based on the above, it is evident that neither a 75mm or a 102mm connection at Boundary or Ninth Line Roads has the hydraulic capacity to service the Lynwood Mobile Home Park and the fronting properties along the route (including Edwards). Thus, connections at either of these locations do not provide flexibility in servicing Lynwood. These two route options are also considerably more costly than either the Hall Road or Farmers Way connection.

For both the Farmers Way and Hall Road connections, 75mm piping is sufficient to service the Lynwood Mobile Home Park only, but are not adequate to service all fronting properties along their respective routes (including Edwards). A 102mm connection at Hall Road would provide the required hydraulic capacity to service Lynwood and all fronting properties along the route, and is approximately 20% less costly than the Farmers Way connection.

From the water age assessment, it is not expected that any connection would have a significant impact on the overall flushing requirements, and it is possible that additional flushing would be required in Lynwood under all scenarios.

2.5 CONCLUSIONS

Based on the major issues considered in this study, if servicing to the Lynwood Mobile Home Park from the Carlsbad Springs Trickle Feed system is the preferred option, a 102mm connection at Hall Road and Ninth Line Road is recommended. The estimated cost for the 3860m watermain from Hall and Ninth Line Road to Lynwood is $615,000 and an allowance of $190,000 has been estimated for storage and pumping at the Mobile Home Park. It is expected that regular water flushing will be required at Lynwood to minimize water age in the pipe.

At 65% concurrent usage and a flow rate per connection of 2700L/day, this would be adequate to provide potable water to 120 units in Lynwood Village and the approximately 68 properties fronting the new pipe to Lynwood (including 51 units in Edwards) for a total of 188 connections. If flushing is required at Lynwood, at a flow rate of 0.42L/s (current average), the total number of allowable connections along this route would be reduced from 254 to 234 (a reduction of approximately 20 connections).

With 188 connections in Lynwood Village and along the Hall Road supply route, there would be still be adequate capacity in the existing system to supply an additional 235 units or increase the flow rate per connection to approximately 3500L/day, depending on how the system is configured at the Lynwood Mobile Home Park.

2.6 OTHER ISSUES FOR FURTHER CONSIDERATION

This evaluation is limited to assessing the technical feasibility of connecting the Lynwood Mobile Home Park to the existing Carlsbad Springs Trickle Feed Water System. Other issues that would need to be considered prior to making such a connection include:

- Confirmation that an extension and additional connections represents an acceptable option by the City for utilizing the available excess capacity in the Carlsbad Springs Trickle Feed system.
- Determination of ownership and long term operational issues and costs for a new storage/pumping facility at the Lynwood Mobile Home Park.
- Review and selection of appropriate payment options for the extension and for utilization of the excess capacity.
- Environmental Assessment (EA) requirements, although it appears that this project would be an extension to an existing water supply system located within existing road right-of-ways, etc (no property acquisition required) so it would fall under the Municipal Class EA Schedule “A+” process (pre-approved with public advisory prior to project implementation).
- Review and assessment of alternative design configurations at the Mobile Home Park itself (“workable” solutions for storage/pumping/metering/services and costs) to optimize the system.
- Public education with respect to limits of trickle feed water supply and associated long term maintenance needs.
- Planning issues (such as OPA needs and potential requirement to connect existing properties along the route of any new piping)

- Finalize hydraulic analysis based on final configuration at Lynwood Park and confirm flushing rates to determine actual residual capacity in the system.

APPENDIX A - Hydraulic Modelling – Detailed Results

Scenario 1: Build-out 100% concurrent use w/o Lynwood

HGL		155m	145m	
Node ID	Demand (L/s)	Pressure (kPa)	Pressure (kPa)	Water Age (hrs)
10992	0.8	515	421	11
10994	0.7	555	461	12
10996	1.2	486	392	12
10998	2.6	400	305	13
11098	0.0	596	502	5
11100	0.4	521	427	10
11102	1.0	509	415	11
11104	0.0	596	501	6
12172	0.4	554	460	7
12174	1.7	530	435	10
14038	0.6	554	460	8
16444	2.2	485	391	1
16446	0.0	619	525	1
17722	0.2	553	459	13
17724	0.3	534	440	14
17726	0.5	473	379	13
17728	0.5	489	395	12
17730	2.1	492	398	15
17732	0.1	520	426	16
17734	0.3	525	430	11
17830	0.2	537	442	14
17832	0.2	534	440	31
17834	0.0	602	508	8
18090	0.0	601	507	8
18702	0.0	595	501	-
18704	0.1	595	501	8
22898	0.3	534	440	14
23598	0.8	523	429	9
24356	0.0	614	520	3
24358	0.0	621	526	2
24360	0.0	619	524	2
26778	0.0	618	524	-
26808	0.4	537	442	14
29516	0.0	589	495	-
31628	0.9	378	284	8
3234	0.0	601	507	-
3236	0.1	601	507	9
32590	0.2	491	396	16
32592	0.2	493	399	22
5236	0.9	611	517	3
5238	1.9	609	515	4
6442	2.4	581	487	6
6444	0.0	610	516	5
Min.:	24.2	378	284	1 hr
Max.:	24.2	621	526	31 hrs

Scenario 2: Build-out 65% concurrent use w/o Lynwood

HGL		155m	145m	
Node ID	Demand (L/s)	Pressure (kPa)	Pressure (kPa)	Water Age (hrs)
10992	0.5	635	541	14
10994	0.5	718	624	17
10996	0.8	666	572	16
10998	1.7	590	495	18
11098	0.0	659	565	6
11100	0.3	647	552	14
11102	0.7	638	543	15
11104	0.0	659	564	6
12172	0.3	667	573	10
12174	1.1	650	556	14
14038	0.4	668	574	10
16444	1.4	488	394	1
16446	0.0	634	539	1
17722	0.2	727	632	18
17724	0.2	709	615	19
17726	0.4	655	560	18
17728	0.3	670	576	16
17730	1.4	672	578	21
17732	0.1	694	599	22
17734	0.2	640	546	15
17830	0.1	661	567	20
17832	0.1	659	565	46
17834	0.0	678	584	10
18090	0.0	678	584	10
18702	0.0	670	576	-
18704	0.0	670	576	10
22898	0.2	709	615	19
23598	0.5	637	543	12
24356	0.0	634	540	3
24358	0.0	635	541	2
24360	0.0	635	540	2
26778	0.0	633	539	-
26808	0.3	661	567	20
29516	0.0	666	572	-
31628	0.6	575	480	11
3234	0.0	678	584	-
3236	0.1	679	584	11
32590	0.2	654	560	23
32592	0.2	674	580	31
5236	0.6	633	539	3
5238	1.2	664	569	5
6442	1.5	663	568	8
6444	0.0	664	570	5
Min.:	15.7	488	394	1 hr
Max.:	15.7	727	632	46 hrs

Scenario 3: Build-out 65% concurrent use w/ 100% Lynwood

HGL		155m	145m		155m	145m		155m	145m		155m	145m	
Node ID	Demand (L/s)	Pressure (kPa)	Pressure (kPa)	Water Age (hrs)	Pressure (kPa)	Pressure (kPa)	Water Age (hrs)	Pressure (kPa)	Pressure (kPa)	Water Age (hrs)	Pressure (kPa)	Pressure (kPa)	Water Age (hrs)
10	3.8	418	324	15	397	305	15	256	162	17	181	106	44
10992	0.5	578	484	12	580	486	13	574	479	12	582	484	12
10994	0.5	656	561	15	659	565	15	634	540	14	659	561	15
10996	0.8	600	506	12	604	510	12	565	471	12	604	506	12
10998	1.7	523	429	14	528	433	14	464	370	12	527	429	14
11098	0.0	632	537	5	632	538	5	631	537	5	635	537	5
11100	0.3	576	482	10	581	487	10	575	481	10	580	482	10
11102	0.7	567	473	11	572	478	11	565	471	11	571	473	11
11104	0.0	631	537	6	631	537	6	631	536	6	635	537	6
12172	0.3	608	514	8	610	516	8	607	513	8	612	514	8
12174	1.1	576	482	11	563	469	12	585	491	11	580	482	11
14038	0.4	609	515	9	611	517	9	608	514	9	613	515	9
16444	1.4	487	393	1	487	393	1	487	393	1	491	393	1
16446	0.0	627	533	1	627	533	1	627	533	1	631	533	1
17722	0.2	662	568	16	666	572	16	634	540	15	666	568	16
17724	0.2	644	550	17	648	554	17	615	521	16	648	550	17
17726	0.4	588	494	14	593	498	14	554	460	17	592	494	14
17728	0.3	604	509	12	608	514	13	569	475	15	607	509	12
17730	1.4	606	512	19	610	516	19	572	477	17	610	512	19
17732	0.1	629	535	20	633	539	20	601	507	19	633	535	20
17734	0.2	582	487	15	584	489	15	580	485	13	585	487	15
17830	0.1	569	475	13	583	489	14	586	492	15	573	475	13
17832	0.1	567	473	38	582	487	39	485	390	16	235	137	14
17834	0.0	644	550	8	645	551	8	643	549	8	648	550	8
18090	0.0	644	550	9	644	550	9	642	548	9	648	550	9
18702	0.0	643	549	>300	643	549	>300	642	548	>300	647	549	>300
18704	0.0	643	549	10	643	549	10	642	548	10	647	549	10
22898	0.2	644	550	17	648	554	17	615	521	16	648	550	17
23598	0.5	571	477	9	561	467	9	578	484	10	575	477	9
24356	0.0	625	531	3	625	531	3	625	531	3	629	531	3
24358	0.0	629	535	2	629	535	2	629	535	2	633	535	2
24360	0.0	628	533	2	628	533	2	628	533	2	631	533	2
26778	0.0	627	532	>300	627	532	>300	627	532	>300	630	532	>300
26808	0.3	569	475	13	584	489	13	586	492	15	573	475	13
29516	0.0	632	538	>300	632	538	>300	630	536	>300	636	538	>300
31628	0.6	547	453	10	547	453	10	547	453	10	551	453	10
3234	0.0	643	549	>300	644	550	>300	642	548	>300	647	549	>300
3236	0.1	644	550	9	645	550	9	643	548	9	648	550	9
32590	0.2	591	497	21	595	500	21	569	475	20	595	497	21
32592	0.2	608	514	29	612	518	29	574	479	28	612	514	29
5236	0.6	624	530	3	624	530	3	624	530	3	627	529	3
5238	1.2	639	545	4	639	545	4	639	545	4	643	545	4
6442	1.5	623	529	7	623	529	7	624	529	7	627	529	7
6444	0	640	546	5	640	546	5	640	546	5	644	546	5
Min.:	19.5	418	324	1	397	305	1	256	162	1	181	106	1
Max.:	19.5	662	568	38	666	572	39	643	549	28	666	568	44
			Hall			Farmers			Boundary-1			Boundary-2	
		102mm	102mm		102mm	102mm		102mm	102mm		152mm	304.8mm	

Scenario 4: Build-out 65% concurrent use w/ 65% Lynwood

HGL		155m	145m		155m	145m		155m	145m		155m	145m	
Node ID	Demand (L/s)	Pressure (kPa)	Pressure (kPa)	Water Age (hrs)	Pressure (kPa)	Pressure (kPa)	Water Age (hrs)	Pressure (kPa)	Pressure (kPa)	Water Age (hrs)	Pressure (kPa)	Pressure (kPa)	Water Age (hrs)
10	2.4	298	203	17	232	139	16	142	340	21	349	251	21
10992	0.5	599	505	13	601	506	13	597	503	13	603	505	13
10994	0.5	679	585	15	681	587	15	668	574	15	683	585	15
10996	0.8	624	530	13	627	533	13	608	514	12	628	530	13
10998	1.7	548	454	14	550	456	14	521	427	13	552	454	14
11098	0.0	642	548	6	642	548	6	642	547	6	646	548	6
11100	0.3	602	508	11	605	511	11	602	508	11	606	508	11
11102	0.7	593	499	11	596	502	12	592	498	11	597	499	11
11104	0.0	641	547	6	641	547	6	641	547	6	645	547	6
12172	0.3	630	536	9	631	537	9	630	536	9	634	536	9
12174	1.1	605	511	12	599	504	13	609	515	12	609	511	12
14038	0.4	631	537	9	632	538	9	630	536	9	635	537	9
16444	1.4	487	393	1	487	393	1	487	393	1	491	393	1
16446	0.0	630	535	1	630	535	1	630	535	1	633	535	1
17722	0.2	686	592	17	688	594	17	673	579	16	690	592	17
17724	0.2	668	574	17	670	576	18	654	560	17	672	574	17
17726	0.4	613	519	14	615	521	14	597	503	14	617	519	14
17728	0.3	628	534	13	631	536	13	612	518	13	632	534	13
17730	1.4	631	536	19	633	539	19	614	520	19	634	536	19
17732	0.1	653	559	21	655	561	21	640	546	20	657	559	21
17734	0.2	603	509	15	604	510	15	602	508	14	607	509	15
17830	0.1	607	513	15	614	520	16	614	520	17	611	513	15
17832	0.1	605	511	40	612	518	42	546	452	18	454	356	16
17834	0.0	657	563	9	657	563	9	656	562	9	661	563	9
18090	0.0	657	562	9	657	563	9	656	562	9	660	562	9
18702	0.0	653	559	>300	653	559	>300	653	559	>300	657	559	>300
18704	0.0	653	559	10	653	559	10	653	559	10	657	559	10
22898	0.2	668	574	18	670	576	18	655	560	17	672	574	18
23598	0.5	597	503	10	592	498	10	600	506	10	601	503	10
24356	0.0	629	534	3	629	534	3	629	534	3	632	534	3
24358	0.0	631	537	2	631	537	2	631	537	2	635	537	2
24360	0.0	630	536	2	630	536	2	630	536	2	634	536	2
26778	0.0	629	535	>300	629	535	>300	629	535	>300	633	535	>300
26808	0.3	607	513	14	614	520	16	614	520	16	611	513	14
29516	0.0	645	550	>300	645	551	>300	644	550	>300	648	550	>300
31628	0.6	557	463	10	557	463	10	557	463	10	561	463	10
3234	0.0	656	562	>300	657	562	>300	656	561	>300	660	562	>300
3236	0.1	657	563	10	657	563	10	656	562	10	661	563	10
32590	0.2	614	520	22	616	522	22	604	510	21	618	520	22
32592	0.2	632	538	30	635	541	30	616	522	29	636	538	30
5236	0.6	627	533	3	627	533	3	627	533	3	631	533	3
5238	1.2	648	554	5	648	554	5	648	554	5	652	554	5
6442	1.5	638	544	7	638	544	7	638	544	7	642	544	7
6444	0	649	555	5	649	555	5	649	555	5	653	555	5
Min.:	18.2	298	203	1	232	139	1	142	340	1	349	251	1
Max.:	18.2	686	592	40	688	594	42	673	579	29	690	592	30
			Hall			Farmers			Boundary-1			Boundary-2	
		75mm	75mm		75mm	75mm		75mm	102mm		102mm	102mm	