NIAGARA FEASIBILITY - PHASE 2

ENGINEERING REPORT

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Executive Summary

This Engineering Report has been prepared to generate alternatives for supplying and distributing irrigation water to agricultural lands in the area of Niagara-on-the-Lake (NOTL), Lincoln, and St. Catharines, which account for a total irrigation area of approximately 11,000 ha. Preliminary sizing for the proposed infrastructure has been provided for each alternative along with the opinions of probable costs. For the purpose of this report, the areas have been grouped as follows:

- West District Zone A (Lincoln and St. Catharines)
- East District (NOTL)

Based on the proposal submission, areas above the Escarpment have been excluded for servicing. Various servicing alternatives include either a pipe network or an open channel network or a combination of both as means of supplying irrigation water. The water demands for various crops have been developed based on extensive field investigations by Weather Innovations, which is a sub consultant for this assignment. These crop unit demands have been utilized to generate water demands and size the irrigation infrastructure required for different alternatives. The total water demand for the West District Zone A is 147,354 m^3/d, and for the East District is 141,845 m^3/d.

Unit costs have also been assigned to various capital items. These costs have been assigned using a combination of supplier information, NOTL town staff experience, and Stantec Consulting Ltd.'s knowledge based on previous projects.

Each alternative comprises of one or more intakes for drawing water from the source, and a pipe or an open channel system to convey water. Pipe alternatives also contain one or two booster pumping stations to boost pressures to acceptable levels. A brief description of West District Zone A, and East District Alternatives is presented below:

<u>West District Zone A Alternatives</u>

There are four different alternatives for supply and distribution of irrigation waters for the West District Zone A. There are six numbered intake alternatives for this District listed below:

1. Lake Ontario at Sann Rd.
2. Jordan Harbour at 1st Ave.
3. Lake Ontario at 5th St. Louth
4. 12 Mile Creek at CN crossing

5. 12 Mile Creek at OPG discharge

6. Lake Gibson/Moodie near Decew Rd.

Alternative W1 comprises of an all piped alternative with a single intake. Alternative W2 also comprises of an all piped alternative. However, water for irrigation will be drawn from two sources. Alternative W3 is also an all piped alternative. In this alternative also, water for irrigation will be drawn from two sources. One of the sources will be different from Alternative W2. Alternative W4 comprises of servicing part of the area by an open channel network, and the remaining area by the piped network. The service area east of Sixteen Mile Creek will be serviced by the open channel network. The remaining area will be serviced by the piped network. For this alternative, water sources will be the same as Alternative W3. The following table summarizes each alternative in the West District Zone A.

Table E1: Summary of Alternatives for West District Zone A

Item	Alternative			
	W1	W2	W3	W4
Capital Cost in Million Dollars	75	82	86	71
Annual O & M Cost in Million Dollars	0.32	0.31	0.30	0.38
Total Pipe/Channel Length (km)	140	145.5	151.5	147.5
No. of New Intakes	1	2	2	2
Intake Options	1/2/3	1/2 + 3/4	1/2 + 5/6	1/2 + 5/6
No. of Booster Pumping Stations	2	2	1	1
No. of Major Crossings	2	2	2	2
No. of Minor Crossings	24	24	24	16

East District Alternatives

There are three different alternatives for the East District. There are four major intake alternatives for this District, listed below:

1. Lock 3 Gravity Feed (new)

2. Eastchester Pumping Station (existing capacity 21,800 m^3/d (4,000 USGPM))

3. Queenston Pumping Station (existing capacity 27,255 m^3/d (5,000 USGPM))

4. Ontario Hydro Canal Pumping Station (existing capacity 22,900 m^3/d (4,200 USGPM))

Alternative E1 comprises of an all piped alternative and utilizing three existing intakes for supplying water. Two of the existing intakes will be upgraded to augment capacity to provide the irrigation water needs for the entire East District. Alternative E2 also comprises of an all piped alternative. However, in addition to utilizing the three existing intakes, this alternative proposes a new intake. For this alternative, upgrades have been proposed for one of the three existing intakes. Alternative E3 is an open channel alternative, and proposes to use the existing open channels within the area with major and minor upgrades, and also proposes some new channels. For this alternative also, it is proposed to utilize three existing intakes, and propose one new intake. The following table summarizes the costs for each alternative.

Table E2: Summary of Alternatives for East District

Item	Alternative		
	E1	E2	E3
Capital Cost in Million Dollars	62	66	19
Annual O & M Cost in Million Dollars	0.29	0.29	0.27
Total Pipe/Channel Length (km)	167	167	24
No. of New Intakes	-	1	1
No. of Intake Upgrades	2	1	2
No. of Booster Pumping Stations	1	1	0
No. of Major Crossings	2	2	1
No. of Minor Crossings	0	0	0

Opportunities and Constraints

The level of proposed service would convey water within reach of the individual fields, and it is assumed that the individual farmers would employ their own means to transfer water to their fields. A water utilization protocol would need to be developed in order to manage usage of water by individual farmers. The pipe network system alternatives would provide greater levels of service as compared to the open channel system.

Operating and maintenance costs calculated for the systems proposed above are relatively low when compared to municipally supplied drinking water distribution systems. Costs for these systems tend to be estimated by using 2% of the capital cost of the infrastructure proposed. With irrigation, operation and maintenance costs are relatively lower mainly due to the fact that the system is running for a maximum of four months out of the year. Therefore, using this measurement system, it can be expected that operation and maintenance costs will be in the range of 0.5% to 1% of capital costs.

The designated intake alternatives will have constraints due to permits and water availability. Negotiations with stakeholder interests with the intent of designating agreed upon water takings for each of the intakes proposed will be made prior to the conclusion of this overall Phase 2 study, pursuant to the recommendations made in the *Task 4 – Regulatory Requirements and Related Considerations* technical memorandum prepared by Kinkead Consulting.

As discussed above, more than one intake location has been identified for each intake alternative. Environmental discussion of the intake and distribution alternatives will be prepared as a separate report. At the conclusion of that report, a preferred alternative will be proposed. Selection of the exact intake locations is beyond the scope of this study, and will be dealt with during the Class EA stage of individual intake design.

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1.0 Introduction

Agriculture is one of the most important industries in the Region of Niagara and can benefit by implementing a well designed irrigation scheme. The Northern portion of the Region comprises of five municipalities, namely, Niagara on the Lake, St. Catharines, Lincoln, Grimsby, and Pelham. These areas are very fertile and produce high quality tender fruits, grapes, vegetables, nursery stock and flowers. Together, these areas total to about 23,000 hectares, and generate revenues estimated at 1.8 billion dollars per year. Moreover, with the enhancement of irrigation there is considerable potential for the production of high value crop production in the Region resulting in further increase in revenues. This Engineering Report has been prepared as part of the Niagara Feasibility Phase 2 assignment to evaluate the various alternatives of providing irrigation water to the Region, and also to determine approximate size and probable cost of the infrastructure required. Opinions of probable cost associated with each alternative have also been presented in this report. These alternatives will be further evaluated from the environmental perspective in the subsequent Environmental Impacts Report.

As part of this report, the following areas below the escarpment have been considered for providing pipe or channel irrigation:

- Niagara on the Lake
- Lincoln
- St. Catharines

For the purpose of analysis, these areas have been grouped as follows in this report:

- West District Zone A (Lincoln and St. Catharines)
- East District (Niagara-on-the-Lake)

Based on the terms of the submitted proposal, a pipe or open channel distribution system has not been considered for the Pelham area and other areas above the escarpment. Also, most of the irrigation lands in Grimsby are above the escarpment, and the lands below the escarpment are residential or commercial areas. There is a small portion of irrigation lands below the escarpment, and these are far away from the proposed intakes and it is not practical to supply water to those lands as part of the proposed system. Therefore, Grimsby has been excluded from servicing in this report.

This Engineering Report evaluates different alternatives for providing water for irrigation to the areas below the escarpment. Prior to this report and as part of the Phase 2 feasibility project, extensive field studies were carried out as part of the overall project to collect information pertaining to unit demands for crops. These unit demands have been utilized in this report for the purpose of determining the preliminary sizing of the infrastructure components for different alternatives proposed. Hydraulic models and conveyance capacity calculations were prepared for the pipe and open channel schemes to ascertain the feasibility of these alternatives and also to obtain an opinion of the probable cost associated with each alternative.

1.1 BACKGROUND

Stantec Consulting Ltd. (Stantec) completed Phase 1 of the Feasibility Study in 2005, which provided a range of alternatives for providing raw water for irrigation to the study area. A subsequent Phase 2 Feasibility Study, which was awarded to Stantec in 2006, is currently underway. This Engineering Report forms a part of this study, and will generate various alternatives of providing irrigation water and associated opinions of probable cost.

1.2 SCOPE OF WORK

The scope of work is to generate and provide preliminary design of open channel and pipe conveyance alternatives for areas below the escarpment, and to provide opinions of probable cost associated with each alternative. This report also identifies the opportunities and constraints for each alternative. The intake location for each alternative has been identified from a broad feasibility perspective with the understanding that the exact location will be determined during the subsequent Class EA and detailed design phase for individual projects.

1.3 UNIT DEMANDS

As part of the Phase 2 feasibility study, an extensive field investigation was carried out in order to establish accurate unit demands for each crop. A Water Consumption Report was prepared by Weather Innovations on behalf of Stantec and submitted to the Region of Niagara (Region). Based on the consumption report, the following unit demands have been used for pipeline and open channel systems:

Table 1: Unit Demands for Water Consumption for Various Crops

Crop	Peak Demands (mm/d)	
	Pipeline	Open Channel
Wine Grapes	5.5	7.3
Nurseries	3.0	4.0
Juice Grapes	5.5	7.3
Tender Fruit	6.8	9.1
Greenhouses	7.0	9.3
Pome Fruit	6.8	9.1

Unit demands for Open Channel are greater than pipeline to account for losses at the end of the system, evaporation, and seepage. As part of the overall project, a conveyance efficiency study was performed, which included field measurements. A conveyance efficiency memo was submitted to the Region that discussed water losses in the open channel conveyance system. For details on the conveyance efficiency of the open channel systems, please refer to the channel conveyance efficiency memo.

Detailed water demands based on the above unit consumption rates were calculated for the open channel network and pipeline distribution alternatives for the West District Zone A, and the East District, and are presented in their respective sections. For calculating the water demands at each junction of the model, we have applied the following estimate of service area based on the land use study completed as a part of the overall Phase 2 study:

Estimate of Ultimate Service = Tender Fruit + Nurseries + Greenhouses + Juice Grapes + Pome Fruit + 50% of Wine Grapes

This estimate is based on a conservative evaluation of the probable users of an irrigation system (see Appendix G – Consumption Memo submitted to the Region).

1.4 SERVICE PERIOD

A service period is needed to establish power consumption and total volumetric water takings per season. The following table was taken from the consumption report mentioned above.

Table 2: Seasonal Demands for Peaches and Grapes

Scenario	Irrigation System	Seasonal Demand (mm/year)	
		Peach	Grape
Average Year	Overhead	175	25
	Drip	140	20
Drought Year	Overhead	280	130
	Drip	225	105

In order to arrive at an estimate of service period, the seasonal demand for peaches was divided by the estimated peak demand for tender fruit. The overhead system demand for peaches shown in Table 2 was used since this was deemed as being the most conservative. The service period represents the total time that the system will need to run to produce enough water for both the average and drought years. For the average year, the service period is 25 days or 600 hours. For a drought year, this works out to 40 days or 960 hours.

1.5 UNIT COSTS

Unit costs were prepared for the various components of the pipe and open channel systems, including pumping station costs, pipe costs, creek crossings, etc. to determine opinions of probable cost for the various infrastructure alternatives, which are presented in Sections 2 and 3. Whereas unit costs for the pipes have been prepared based on actual quotes from a manufacturer of PVC pipes, and adding the installation and other expenses to the material costs, costs attributed to pumping stations, and creek crossings etc. have been prepared based on Stantec's extensive experience on previous projects. For deriving the unit costs for the open channel alternatives, experience of staff at the town of Niagara-on-the-Lake (NOTL) was utilized in addition to Stantec's own experience on similar projects.

The tables below provide unit costs for various components of the pipeline and open channel systems. Detailed unit cost table for pipes is presented in Appendix A.

Pipe Cost

The pipe material costs presented are for a PVC pipe, for a pressure rating of 1103 kPa (160 psi) and are suitable for the range of pressures expected for the irrigation system. Clear cover for the pipes has been assumed approximately 1 m, which is typically above the frost depth. We have kept a low cover based on the assumption that the pipe system would be flushed/drained during the winter. The installation allowance includes excavation, bedding, and backfilling. Restoration allowance includes sod and topsoil only. Please refer to Appendix A for details.

Table 3: Unit Costs for Pipes (PVC)

Pipe Size (mm)	Material Unit Cost/m	Installation Allowance/m	Restoration Allowance/m	Appurtenance Allowance/m	Total Cost/m
150	$15	$54	$25	$29	$123
200	$23	$58	$25	$30	$136
250	$32	$62	$25	$31	$150
300	$45	$66	$25	$32	$168
350	$68	$71	$50	$33	$222
400	$86	$76	$50	$35	$247
450	$110	$82	$50	$45	$287
500	$133	$87	$50	$50	$320
600	$220	$118	$50	$60	$448
750	$250	$130	$50	$75	$505
900	$351	$190	$50	$78	$669

Crossing Cost

The unit costs proposed for crossings are over and above the costs related to the pipe, as those are already covered under the pipe unit cost. As presented in Table 4, two types of crossings have been considered for the purpose of this report. Crossings under QEW, and Jordan Harbour have been classified as major, and crossings under other creeks, and railway lines have been classified as minor. It has been assumed that the major crossings will be constructed using trenchless technology, and minor crossings will be constructed using either trenchless technology, or by open cut.

Table 4: Unit Costs for Crossings

Crossing Type	Crossing Unit Cost
Major (QEW, Jordan Harbour)	$175,000
Minor (Railway, creeks)	$75,000

Pumping Station Cost

As mentioned above, pumping station unit costs were arrived at based on Stantec's previous experience. It should be noted that the station unit costs do not include the land costs, as land costs are area dependent, and tend to vary significantly.

Table 5: Unit Costs for Pumping Stations

Station Capacity (L/s)	Pumping Station Unit Cost
<150	$1,000,000 each
150 - 300	$8,000 per L/s
300 – 450	$6,500 per L/s
450 – 600	$5,000 per L/s
600 - 750	$4,500 per L/s
750 – 900	$4,000 per L/s
>900	$3,500 per L/s

Open Channel Cost

For the purposes of design and preparing opinions of probable cost for open channels, the unit costs were divided in to the following three categories:

- Minor work - a channel exists, however some widening and defining may be necessary.
- Major work - a swale or something resembling a channel exists, so defining bottom and banks will be necessary, as well as some rerouting of the existing flow.
- New work - no channel exists, in most cases this new channel would be excavated in an existing right of way or through existing easements.

In general, it has been assumed that the open channels will not be lined, and increased unit crop demands have been utilized for the open channel system to account for seepage and other losses during conveyance. Consequently, the unit costs presented below do not assume lining costs.

Table 6: Unit Costs for Open Channels

Channel Works	Channel Construction Unit Cost/m
Minor Work	$7
Major Work	$20
New Work	$25

2.0 West District Zone A

The West District includes all rural areas inside the municipal boundaries of Lincoln and St. Catharines. Zone A is the area that is considered below the escarpment. For the purpose of this analysis, we have considered the area north of Regional Road 81 to be below the escarpment, with the exception of the area east of the Sixteen Mile Creek, which extends this southern boundary to Pelham Rd. Figure 1 presents the study area boundary, land use, and the municipal boundaries.

2.1 TOPOGRAPHY AND GENERAL LAND FEATURES

The entire area slopes towards Lake Ontario from the escarpment, with the slope gradually reducing towards the lake. The area immediately north of the study area boundary has steeper slopes and is sometimes referred to as the “Escarpment Bench.” The ground elevations vary from a maximum of 120 m above mean sea level to a minimum of 80 m above mean sea level. The West District area contains Jordan Harbour (Twenty Mile Creek), Sixteen Mile Creek, and Fifteen Mile Creek as major waterways. The total area in West District Zone A is approximately 70,000,000 m^2 (7,000 ha). Area considered for irrigation in the West District Zone A is 48,938,000 m^2 (4,894 ha).

2.2 WATER DEMANDS

Water demands were calculated based on the requirement of each crop and the area for each crop derived from the land use map produced for the West District Zone A (Figure 1). A summary of these demands is presented in Table 7. For the purpose of preliminarily sizing of the pipeline distribution system, assumptions have been made as described in Section 1.3. Because of the assumptions made in Section 1.3, cash crops, idle land, pasture, and other fruit have not been assigned a demand. It is possible that these lands could be converted in the future to tender fruit or wine grape production, however, this expectation of future land use change is expected to be covered by the ultimate demand service as calculated in Section 1.3. Area factors have been applied as described in the Detailed Land Use Report as a part of this study. Detailed tables for water demand calculations for modeling purposes are presented in Appendix B.

Table 7: Water Demand Summary for Different Crops in West District Zone A

Category	Map Colour	Gross Area (m^2)	Area Factor	Peak Demand (mm/d)	Peak Demand (m^3/d)
Grapes - Wine	Green	18,865,000	85	5.5	44,097
Tender Fruit	Orange	15,929,000	85	6.8	92,070
Nurseries	Pink	3,478,000	85	3.0	8,869
Greenhouse	Blue	2,650,000	30	7.0	5,565
Grapes - Juice	Purple	4,961,000	85	5.5	23,193
Pome Fruit	Red	3,055,000	85	6.8	17,658
Idle Land	Maroon	15,222,000	85	0	0
Cash Crops	Dark Yellow	2,596,000	85	0	0
Pasture Cattle	Light Yellow	927,000	85	0	0
Other Fruit	Brown	566,000	85	0	0
Other	White	1,118,000	85	0	0
Total		*69,367,000*			*191,452*

In order to calculate the water demands for irrigation, unit demands were developed as part of this Phase 2 Study. Extensive field studies were undertaken to develop unit consumption demands for different crops, which are presented in the Water Consumption Report submitted separately to the Region. The unit demands developed are presented in Table 1.

In order to provide an estimate of maximum peak demand, the assumption was made that peak demands for each crop would not coincide (see Appendix G – Consumption Memo). In other words, the entire District would not be requesting water simultaneously. Two demand totals were developed based on this assumption. The two demands are estimated by eliminating one of either tender fruit or wine grapes from the demand calculation. Demand 1 eliminates wine grapes, and Demand 2 eliminates tender fruit. The maximum of Demand 1 and 2 was used for the purposes of this project. Table 8 shows the demand totals for West District Zone A using this assumption.

Table 8: Total Demand for West District Zone A

	Peak Demand (m^3/d)	
	Pipe Network	**Open Channel Network**
Demand 1	147,354	196,472
Demand 2	99,381	132,508
Max. 1 and 2	147,354	196,472

For the open channel alternatives an irrigation loss factor of 0.75 was applied to the demands. This increased the demands for the open channel calculations by 1.33 as shown in Table 8 above.

2.3 POTENTIAL INTAKE LOCATIONS

The following intake alternatives have been considered for the West District Zone A. These have been identified as general locations for the purpose of identifying sources of water for irrigation, to include them for modeling, and preparing opinions of probable cost. Figures presenting the servicing alternatives show locations for the potential intake locations identified below. A subsequent environmental study will evaluate these alternatives from the environmental standpoint. Finding the exact intake locations is beyond the scope of this report and should be investigated and finalized at the time of the individual Class EA and detailed design.

1. Lake Ontario at Sann Rd.
2. Jordan Harbour at 1st Ave.
3. Lake Ontario at 5th St. Louth.
4. 12 Mile Creek at CN crossing.
5. 12 Mile Creek at OPG discharge.
6. Lake Gibson/Moodie near Decew Rd.

The above designated intake alternatives will potentially have constraints due to permits and water availability. Negotiation with stakeholders on the location of the above intakes will need to be completed, as well as the associated permitting. This is discussed further in Section 4.3.

2.4 WEST DISTRICT ZONE A – DISTRIBUTION ALTERNATIVES

For the purpose of this study, a distribution system is defined as the infrastructure used to convey irrigation water from source to farm gate. This infrastructure will include the intakes for drawing water from the source, pipes or open channels to convey water to the farm gate along with all the necessary appurtenances, and any booster pumping stations required to boost the pressures to acceptable levels. We have considered two main distribution alternatives for the purpose of this study:

1. Pipeline Distribution
2. Open Channel Distribution

Pipeline Distribution

A pipeline distribution system will comprise of buried pipelines from the source to the consumers. This system will be pressurized enough to ensure that consumers can readily receive water at the outlet locations. Outlet locations will be provided at a specified spacing throughout the distribution system. It will be up to the user to convey water from these pre-selected locations to their own onsite storage, or directly onto their lands. This utilization by individual farmers should be based on a water utilization protocol, which will need to be developed by the Region. Water provided to the growers will generally have "residual pressure". In lower lands and at points closer to the supply source and booster pumping stations, this pressure may be sufficient to operate low pressure irrigation systems such as drippers, sprayers, and low to medium range sprinklers. The conceptual design, however, is not based on providing a minimum pressure for the user, and it is assumed that the growers will provide the on-farm pressure requirement of the supplied raw water. The system, however, could be designed to provide a minimum pressure to the users at a later stage with minimal modifications, if the cost of the additional system pressurizing justifies the savings of on-farm pumping.

Open Channel Distribution

An open channel distribution system, for the purpose of this study, would be an irrigation distribution network using portions of natural watercourses and man-made open drainage systems to convey irrigation water to the user. This type of distribution system is currently being used in parts of Niagara-on-the-Lake. The designation of Open Channel Distribution does not preclude the use of some pipeline in the system, as irrigation water from some sources will need to be transmitted to the heads of the irrigation channels using pipelines. However, minimizing the use of pipes will result in significant savings in the initial capital cost of the systems.

Similar to the piped system, it is the responsibility of the growers to convey water from the channel to their field. This can be accomplished by building a dam structure or digging a pool in a convenient location and pumping water from that location to the grower's property. Similar to the pipe system, a water utilization protocol will need to be developed by the Region.

An open channel distribution system requires a fairly flat irrigation area preferably with a uniform gentle slope. The lands below the Escarpment mostly have these characteristics. This distribution alternative was considered for West District Zone A in the Phase 1 portion of this study. After a detailed review of the contour maps, existing channels, and intake alternatives for the West District, it was decided that the area east of 16 Mile creek was the only location where open channel distribution was feasible.

A description of the various servicing alternatives is presented below:

2.4.1 Alternative W1

Alternative W1 comprises of an all piped alternatives with a single intake. For this alternative, the following intake alternatives could be considered:

Intake 1: Lake Ontario at Sann Road, or Intake 2: Jordan Harbour at 1st Avenue, or Intake 3: Lake Ontario at 5th St. Louth

For the purpose of modeling and capacity estimation, Intake 1 has been utilized. The required capacity for the intake will be 147,354 m^3/d respectively. Comparative evaluation between the three intakes is beyond the scope of this report. However, the Environmental Impacts Report will discuss these alternative locations from the environmental standpoint. Detailed investigation and finalization should be in the scope of the Class EA, and detailed design.

In addition to a single intake, this alternative will require two booster pumping stations to ensure that the residual pressures are within acceptable limits. The booster pumping stations are proposed at the following locations:

Booster Pumping Station No.1 Capacity = 8,073 m^3/d (1480 USGPM) at Third St. Louth near Regional Rd. 81

Booster Pumping Station No.2 Capacity = 96,285 m^3/d (17,663 USGPM) at John St. and Victoria Rd., in Vineland

This alternative is presented in Figure 2.

2.4.2 Alternative W2

Alternative W2 also comprises of an all piped alternative. However, water for irrigation will be drawn from two sources. The following intake alternatives have been considered for this alternative:

Intake 1: Lake Ontario at Sann Road, or Intake 2: Jordan Harbour at 1st Avenue, and

Intake 3: Lake Ontario at 5th St. Louth, or Intake 4: 12 Mile Creek at CN Crossing

For the purpose of modeling and capacity estimation, Intakes 1 and 3 have been utilized. The required capacity for the two intakes will be 104,120 m^3/d, and 43,234 m^3/d respectively. The Environmental Impacts Report being prepared as part of this project will address the comparative evaluation between different locations from the environmental standpoint.

This alternative will require two booster pumping stations to ensure that the residual pressures are within acceptable limits. The booster pumping stations are the same as Alternative W1.

This alternative is presented in Figure 3.

2.4.3 Alternative W3

Alternative W3 is also an all piped alternative. In this alternative, water for irrigation will be drawn from two sources. One of the sources will be different from Alternative W2. The following intake alternatives have been considered for this alternative:

Intake 1: Lake Ontario at Sann Road, or Intake 2: Jordan Harbour at 1st Avenue, and

Intake 5: 12 Mile Creek at OPG discharge, or Intake 6: Lake Gibson/Moodie near Decew Rd

For the purpose of modeling and capacity estimation, Intakes 1 and 5 have been utilized. The required capacity for the two intakes will be 116,793 m^3/d, and 30,562 m^3/d respectively. The Environmental Impacts Report being prepared as part of this project will address the comparative evaluation between different locations from the environmental standpoint.

This alternative will require one booster pumping station to ensure that the residual pressures are within acceptable limits. The booster pumping station is proposed at the following location:

Booster Pumping Station No.2 Capacity = 96,285 m^3/d (17,663 USGPM) at John St. and Victoria Rd., in Vineland

This alternative is presented in Figure 4.

2.4.4 Alternative W4

Alternative W4 comprises of servicing part of the area by an open channel network, and the remaining area by the piped network. The service area east of Sixteen Mile Creek will be serviced by the open channel network. The remaining area will be serviced by the piped network. For this alternative, water sources will be the same as Alternative W3.

For the purpose of modeling and capacity estimation, Intakes 1 and 5 have been utilized. The required capacity for the two intakes will be 111,503 m^3/d, and 47,800 m^3/d respectively. The Environmental Impacts Report being prepared as part of this project will address the comparative evaluation between different locations from the environmental standpoint.

This alternative will require one booster pumping station to ensure that the residual pressures are within acceptable limits. The booster pumping station is proposed at the following location:

Booster Pumping Station No.2 Capacity = 60,434 m^3/d (11,087 USGPM) at John St. and Victoria Rd., in Vineland

This alternative is presented in Figures 5 and 6. Figure 5 presents the pipe network and Figure 6 presents the open channel network.

2.5 PIPE NETWORK AND HYDRAULIC MODELING

A pipeline distribution system in the West District will be composed of a grid of distribution piping, with a number of creek and highway crossings. The pipelines will generally be constructed within the road or railroad right-of-way.

A hydraulic model was created in WaterCAD modeling software to simulate the pipe distribution network using the water demands to estimate the pipe sizes, and to arrive at an opinion of probable cost for supplying irrigation water to the West District Zone A using a pipe distribution network. Different pipe distribution alternatives were established as different scenarios in the model to have them as separate entities.

In general, the pipe infrastructure has been sized to keep the residual pressures above 207 kPa (30 psi), and below 690 kPa (100 psi), and the velocities between 0.8 m/s, and 2.5 m/s. The estimated pipe sizes ranged from a minimum of 150 mm to a maximum of 900 mm. Also, in order to keep the residual pressures within acceptable limits, one or two booster pumping stations have been proposed depending on the alternative.

The sizes of the intakes, and the transmission mains from the intakes to the distribution network were based on the demand calculations for each alternative using the assumptions stated in Sections 1.3 and 2.2 to prevent over-sizing of these components. These assumptions are based on the general premise that it is improbable for the entire West District Zone A to require water simultaneously.

Figures 2, 3, and 4 show the pipe sizes and pumping station sizes required for Alternatives W1, W2, and W3, whereas Alternative W4 is presented in Figures 5 and 6, with Figure 5 showing the pipe network, and Figure 6 showing the open channel network.

2.6 CHANNEL DISTRIBUTION AND HYDRAULIC CALCULATIONS

An open channel distribution system allows the use of the existing waterways and ditches for the distribution of irrigation water from the source to the consumers. Some pipeline transmission and distribution to the heads of the open channels along the Escarpment will be necessary. Water supplied to the open channels near the escarpment will flow northward throughout the irrigation areas following the natural slope of the area toward Lake Ontario.

The area east of 16 Mile Creek was considered as an alternative for open channel distribution for the West District Zone A. Existing mapping was provided by the Region and NPCA in order to identify existing drainage channels. A field survey was conducted by Stantec staff, and photos and measurements were taken of the existing drainage network in the area. From this information an extensive table of the drain capacities was created and compared with the demand required for irrigation. The type of work needed to upgrade the channels in order to meet the demand was split into three categories: minor, major and new:

- Minor work - a channel exists, however some widening and defining may be necessary.
- Major work - a swale or some form of a channel exists, so defining bottom and banks will be necessary, as well as some rerouting of the existing flow.
- New work - no channel exists, in most cases this new channel would be dug in existing right of way or through existing easements.

A linear cost was applied to each type of work needed, and the totals were added to the table in Section 2.7 below. Valves and control structures will also need to be constructed in order to route flows in the appropriate directions at a couple of locations.

Figure 6 shows the open channel distribution system as proposed, and outlines the areas needing work as defined above. In addition, upgrades to existing culverts were needed in several areas. These are noted on the figure and associated costs have been added to the totals in Table 15. Appendix C summarizes the calculations used to indicate the type of work needed, or the size of culvert required. Appendix D is a CD of pictures used in assessing the conveyance capacity and overall status of the existing drainage channels. Appendix E contains a figure showing photo locations and field notes.

2.7 OPINION OF PROBABLE COSTS

This section presents opinions of probable cost on various alternatives for providing irrigation to the West District Zone A using pipeline and a combination of open channel and pipeline distribution networks. Preliminary determination of the pipe sizes was carried out using the hydraulic model, and sizes of open channels were determined from first principles using hand calculations. Unit costs for pipes, crossings and pumping stations were developed and are described in Section 1.4.

Table 9 through Table 16 present the opinions of capital and O&M cost for the four alternatives for the West District Zone A considered above. Recognizing that the probable costs at this stage are preliminary, and these could vary by as much as 20% to 30% from the actual project cost at the detailed design stage, the opinions of costs have been rounded to the nearest hundred dollars. The capital costs are based on the unit rates presented in Section 1.0 of this report. The operating costs are based on average pump run times based on historical information in NOTL, and the water demands for West District Zone A. Ontario Ministry of Energy rates have been utilized for the energy requirements for operating costs. The general operating and maintenance costs are based on existing budget for the Town of NOTLs 2006 figures, and are pro-rated for the size of each alternative. The general O&M costs do not include an allowance for infrastructure replacement. It is anticipated that this cost will be minimal during the initial years of installing the new infrastructure and will increase as the infrastructure ages.

Table 9: Opinion of Probable Capital Cost for Irrigation Infrastructure – Alternative W1

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost	Cost
Pipe	150	18,149	m	$123	$2,227,060
	200	0	m	$136	$ -
	250	815	m	$150	$22,400
	300	27,969	m	$169	$4,716,410
	350	32,111	m	$222	$7,142,450
	400	7,599	m	$247	$1,879,920
	450	5,285	m	$287	$1,515,050
	500	6,788	m	$320	$2,169,110
	600	11,702	m	$448	$5,241,210
	750	16,154	m	$505	$8,159,390
	900	13,625	m	$669	$9,116,900
Pipe Subtotal					**$42,289,900**
Minor Crossing (Small creek, railway)	*150	1	lump sum	$75,000	$75,000
	*300	6	lump sum	$75,000	$450,000
	*350	7	lump sum	$75,000	$525,000
	*400	1	lump sum	$75,000	$75,000
	*450	1	lump sum	$75,000	$75,000
	*600	1	lump sum	$75,000	$75,000
	*900	4	lump sum	$75,000	$300,000
	^400	1	lump sum	$75,000	$75,000
	^750	2	lump sum	$75,000	$150,000
Minor Crossing Subtotal					**$1,800,000**
Major Crossing (QEW, Jordon Harbour)	**450**	1	lump sum	$175,000	$175,000
	900	1	lump sum	$175,000	$175,000
Major Crossing Subtotal					**$350,000**
Pumping Station	Intake 1	1705	L/s	$3,500	$5,969,220
	Booster 1	93	L/s	-	$1,000,000
	Booster 2	1114	L/s	$3,500	$3,900,400
Pumping Station Subtotal					**$10,869,620**
Subtotal					$55,309,520
Allowance for contingencies, permits, approvals & engineering, etc. (35%)					$19,358,330
Total Cost (excluding GST)					**$74,667,900**

^ denotes a creek crossing

* denotes a railway crossing

bold denotes a QEW crossing

Note: Pumping station costs do not take into account the land costs.

Table 10: Opinion of Probable Operating and Maintenance Cost for Irrigation Infrastructure – Alternative W1

Item	Hours of Operation per year (hrs)	Consumption (kwh)	Unit Cost ($)/kwh	Cost ($)
Booster Pump 1	600	23,570	0.102	$ 2,400
Booster Pump 2	600	562,235	0.102	$ 57,350
Intake Pump 1	600	1,369,537	0.102	$139,690
Other O&M*				$117,680
Total Cost				**$317,100**

*Based on 2006 operating costs for existing NOTL irrigation system

Table 11: Opinion of Probable Capital Cost for Irrigation Infrastructure – Alternative W2

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost	Cost
Pipe	150	10,365	m	$123	$1,271,890
	200	0	m	$136	$ -
	250	5,360	m	$150	$805,020
	300	22,243	m	$169	$3,750,840
	350	15,587	m	$222	$3,467,020
	400	15,124	m	$247	$3,741,530
	450	20,567	m	$287	$5,895,940
	500	9,650	m	$320	$3,083,660
	600	1,683	m	$448	$753,800
	750	37,951	m	$505	$19,169,050
	900	7,043	m	$669	$4,712,680
Pipe Subtotal					**$46,651,430**
Minor Crossing (Small creek, railway)	*150	1	lump sum	$75,000	$75,000
	*300	6	lump sum	$75,000	$450,000
	*350	7	lump sum	$75,000	$525,000
	*400	1	lump sum	$75,000	$75,000
	*450	1	lump sum	$75,000	$75,000
	*600	1	lump sum	$75,000	$75,000
	*900	4	lump sum	$75,000	$300,000
	^400	1	lump sum	$75,000	$75,000
	^750	2	lump sum	$75,000	$150,000
Minor Crossing Subtotal					**$1,800,000**
Major Crossing (QEW, Jordan Harbour)	**450**	1	lump sum	$175,000	$175,000
	900	1	lump sum	$175,000	$175,000
Major Crossing Subtotal					**$350,000**
Pumping Station	Intake 1	1,205	L/s	$3,500	$4,217,850
	Intake 3	500	L/s	$5,000	$2,501,950
	Booster 1	93	L/s	-	$1,000,000
	Booster 2	1,114	L/s	$3,500	$3,900,440
Pumping Station Subtotal					**$11,620,240**
Subtotal					$60,421,670
Allowance for contingencies, permits, approvals & engineering etc. (35%)					$21,147,580
Total Cost (excluding GST)					**$81,569,300**

^ denotes a creek crossing
* denotes a railway crossing
bold denotes a QEW crossing
Note: Pumping Station costs do not take into account the land costs.

Table 12: Opinion of Probable Operating and Maintenance Cost for Irrigation Infrastructure – Alternative W2

Item	Hours of Operation per year (hrs)	Consumption (kwh)	Unit Cost ($)/kwh	Cost ($)
Intake Pump 1	600	967,712	0.102	$98,710
Intake Pump 3	600	380,787	0.102	$38,840
Booster Pump 1	600	23,570	0.102	$2,410
Booster Pump 2	600	468,530	0.102	$ 47,790
Other O&M*				$125,040
Total Cost				**$312,800**

*Based on 2006 operating costs for existing NOTL irrigation system

Table 13: Opinion of Probable Capital Cost for Irrigation Infrastructure – Alternative W3

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost	Cost
Pipe	150	13,461	m	$123	$1,651,800
	200	0	m	$136	$ -
	250	2,168	m	$150	$325,610
	300	24,597	m	$169	$4,147,790
	350	15,328	m	$222	$3,409,410
	400	8,917	m	$247	$2,205,980
	450	0	m	$287	$ -
	500	29,277	m	$320	$9,355,470
	600	15,107	m	$448	$6,766,270
	750	33,930	m	$505	$17,138,040
	900	8,727	m	$669	$5,839,500
Pipe Subtotal					**$50,839,870**
Minor Crossing (Small creek, railway)	*150	1	lump sum	$75,000	$75,000
	*300	6	lump sum	$75,000	$450,000
	*350	7	lump sum	$75,000	$525,000
	*400	1	lump sum	$75,000	$75,000
	*450	1	lump sum	$75,000	$75,000
	*600	1	lump sum	$75,000	$75,000
	*900	4	lump sum	$75,000	$300,000
	^400	1	lump sum	$75,000	$75,000
	^750	2	lump sum	$75,000	$150,000
Minor Crossing Subtotal					**$1,800,000**
Major Crossing (QEW, Jordan Harbour)	**450**	1	lump sum	$175,000	$175,000
	900	1	lump sum	$175,000	$175,000
Major Crossing Subtotal					**$350,000**
Pumping Station	Intake 1	1352	L/s	$3,500	$4,731,200
	Intake 5	354	L/s	$6,500	$2,299,180
	Booster 2	1114	L/s	$3,500	$3,900,440
Pumping Station Subtotal					**$10,930,820**
Subtotal					$63,920,690
Allowance for contingencies, permits, approvals & engineering etc. (35%)					$22,372,240
Total Cost (excluding GST)					**$86,292,900**

^ denotes a creek crossing
* denotes a railway crossing
bold denotes a QEW crossing
Note: Pumping Station costs do not take into account the land costs.

Table 14: Opinion of Probable Operating and Maintenance Cost for Irrigation Infrastructure – Alternative W3

Item	Hours of Operation per year (hrs)	Consumption (kwh)	Unit Cost ($)/kwh	Cost ($)
Intake Pump 1	600	1,085,497	0.102	$110,720
Intake Pump 5	600	202,255	0.102	$20,630
Booster Pump 2	600	515,383	0.102	$52,570
Other O&M*				$117,680
Total Cost				**$301,600**

*Based on 2006 operating costs for existing NOTL irrigation system

Table 15: Opinion of Probable Capital Cost for Irrigation Infrastructure – Alternative W4

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost	Cost
Pipe	150	13,144	m	$123	$1,612,900
	200	1,359	m	$136	$184,860
	250	10,588	m	$150	$1,590,210
	300	9,731	m	$169	$1,640,940
	350	23,775	m	$222	$5,288,270
	400	0	m	$247	$ -
	450	0	m	$287	$ -
	500	0	m	$320	$ -
	600	5,285	m	$448	$2,367,100
	750	25,666	m	$505	$12,963,900
	900	7,043	m	$669	$4,712,680
Pipe Subtotal					**$30,360,860**
Minor Crossing (small creek, railway)	*150	2	lump sum	$75,000	$150,000
	*250	2	lump sum	$75,000	$150,000
	*350	6	lump sum	$75,000	$450,000
	*600	1	lump sum	$75,000	$75,000
	*750	3	lump sum	$75,000	$225,000
	*900	2	lump sum	$75,000	$150,000
Minor Crossing Subtotal					**$1,200,000**
Major Crossing (QEW, Jordan Harbour)	**450**	1	lump sum	$175,000	$175,000
	900	1	lump sum	$175,000	$175,000
Major Crossing Subtotal					**$350,000**
Pumping Station	Intake 1	1,152	L/s	$3,500	$4,032,880
	Booster 2	699	L/s	$4,500	$3,147,620
Pumping Station Subtotal					**$7,180,500**
Major Work	n/a	20,057	m	$20	$401,140
Minor Work	n/a	12,854	m	$7	$89,980
New Work	n/a	3,259	m	$25	$81,490
Channel Subtotal					**$572,610**
Supply Pipe	900	11,546	m	$669	$7,725,710
Transfer Pipe	300	3,275	m	$169	$552,280
Pipe Subtotal					**$8,277,990**
Transfer Pumping Station	Seventh Street #1	162	L/s	$8,000	$1,294,480
	Seventh Street #2	123	lump sum	$1,000,000	$1,000,000
	Eleventh Street	63	lump sum	$1,000,000	$1,000,000
	Lakeshore	59	lump sum	$1,000,000	$1,000,000
Transfer Pumping Station Subtotal					**$4,294,480**
Culverts	n/a	27	each	$5,000	$135,000

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost	Cost
Subtotal					$52,371,440
Allowance for contingencies, permits, approvals & engineering etc. (35%)					$18,330,000
Total Cost (excluding GST)					**$70,701,400**

^ denotes a creek crossing
* denotes a railway crossing
bold denotes a QEW crossing
Note: Pumping Station costs do not take into account the land costs.

Table 16: Opinion of Probable Operating and Maintenance Cost for Irrigation Infrastructure – Alternative W4

Item	Hours of Operation per year (hrs)	Consumption (kwh)	Unit Cost ($)/kwh	Cost ($)
Booster Pump 2	600	441,114	0.102	$44,990
Intake Pump 1	600	1,199,105	0.102	$122,310
Intake Pump 5	600	409,373	0.102	$41,760
Seventh Street #1	600	13,606	0.102	$1,390
Seventh Street #2	600	10,318	0.102	$1,050
Eleventh Street	600	5,335	0.102	$540
Lakeshore	600	14,806	0.102	$1,510
Other O&M				$161,810
Total Cost				**$375,400**

*Based on 2006 operating costs for existing NOTL irrigation system

3.0 East District

The East District includes all rural areas inside the municipal boundaries of the Town of Niagara on the Lake (NOTL). For the purpose of this analysis, we have considered the area north of Queenston Rd to be considered below the Escarpment, and therefore feasible for open channel irrigation. Figure 7 presents the study area boundary, the land use, and the municipal boundaries.

3.1 TOPOGRAPHY AND GENERAL LAND FEATURES

The East District is bounded by the escarpment on the south, Lake Ontario on the north, the Welland Canal on the west, and the Niagara River on the east. The land slopes gradually from the escarpment down to the lake. The ground elevations vary from a maximum of 125 m above mean sea level to a minimum of 80 m above mean sea level. The District contains the Four Mile Creek as a major watershed. The total area in East District is approximately 90,000,000 m^2 (9,000 ha). Area considered for irrigation in the East District is 63,780,000 m^2 (6,378 ha). There is an existing irrigation system which is discussed in more detail in Section 3.6.1.

3.2 WATER DEMANDS

Water demands were calculated based on the requirement of each crop and the area for each crop. Figure 7 shows the land use map produced for the East District. A summary of these demands is presented in Table 17. For the purpose of preliminarily sizing of the pipeline distribution system, assumptions have been made as described in Section 1.3. Detailed tables for water demand calculations for modeling purposes for the East District are presented in Appendix B.

Table 17: Water Demand Summary for Different Crops in East District

Category	Map Colour	Gross Area (m^2)	Area Factor	Peak Demand (mm/d)	Peak Demand (m^3/d)
Grapes - Wine	Green	36,425,000	85	5.5	85,143
Tender Fruit	Orange	20,553,000	85	6.8	118,796
Nurseries	Pink	1,959,000	85	3.0	4,995
Greenhouse	Blue	2,130,000	30	7.0	4,473
Grapes - Juice	Purple	1,901,000	85	5.5	8,887
Pome Fruit	Red	812,000	85	6.8	4,693
Idle Land	Maroon	16,282,000	85	0	0
Cash Crops	Dark Yellow	4,272,000	85	0	0
Pasture Cattle	Light Yellow	893,000	85	0	0
Other Fruit	Brown	84,000	85	0	0
Other	White	2,041,000	85	0	0
Total		**87,352,000**			**226,989**

In order to provide an estimate of maximum peak demand, the assumption was made that peak demands for each crop would not coincide (see Appendix G – Consumption Memo). In other words, the entire District would not be requesting water simultaneously. Two demand totals were developed based on this assumption. The two demands are estimated by eliminating one of either tender fruit or wine grapes from the demand calculation. Demand 1 eliminates wine grapes, and Demand 2 eliminates tender fruit. The maximum of Demand 1 and 2 was used for the purposes of this project. Table 19 shows the demand totals for the East District using this assumption.

Table 18: Total Demand for East District

	Peak Demand (m^3/d)	
	Pipe Network	**Open Channel Network**
Demand 1	141,845	189,127
Demand 2	108,192	144,256
Max. 1 and 2	141,845	189,127

For the open channel alternatives an irrigation loss factor of 0.75 was applied to the demands. This increased the demands for the open channel calculations by 1.33, as shown in Table 18. This is further discussed in Section 3.6.

Appendix H shows the historical water taking estimates for the existing NOTL Irrigation System, provided by the Town staff. Using the service period calculated in Section 1.4, the total demand for the existing system was estimated at 126,467 m^3/d, which is comparable to the 189,127 m^3/d estimated for the ultimate peak demand for the expanded East District.

3.3 POTENTIAL INTAKE LOCATIONS

Since the East District has existing intake locations, it was decided that these locations could be used for any of the distribution alternatives. These have been identified as general locations for the purpose of identifying sources of water for irrigation, to include them for modeling, and preparing opinions of probable cost. Figures presenting the servicing alternatives show alternative locations for the potential intakes identified below. A subsequent environmental study will evaluate these alternatives from the environmental standpoint. Finding the exact intake locations is beyond the scope of this report and should be investigated and finalized at the time of the individual Class EA and detailed design. The following intake alternatives have been considered for the East District:

1. Lock 3 Gravity Feed (new).
2. Eastchester Pumping Station (existing capacity 21,800 m^3/d (4,000 USGPM)).

3. Queenston Pumping Station (existing capacity 27,255 m^3/d (5,000 USGPM)).

4. Ontario Hydro Canal Pumping Station (existing capacity 22,900 m^3/d (4,200 USGPM)).

The above capacities are based on the existing PTTWs. Negotiation with stakeholders on the location and expansion of the above intakes will need to be completed, as well as the associated permitting. This is discussed further in Section 4.3.

3.4 EAST DISTRICT – DISTRIBUTION ALTERNATIVES

For the purpose of this study, distribution system is defined as the infrastructure used to convey irrigation water from source to farm gate. This infrastructure will include the intakes for drawing water from the source, pipes or open channels to convey water to the farm gate along with all the necessary appurtenances, and any booster pumping stations required to boost the pressures to acceptable levels. As with West District Zone A, we have considered two main distribution alternatives for the purpose of this study:

1. Pipeline Distribution

2. Open Channel Distribution

See Section 2.4 for a definition of these services.

An open channel distribution system requires a fairly flat irrigation area preferably with a uniform gentle slope. The lands below the Escarpment mostly have these characteristics. This distribution alternative is already being used in a large portion of the East District. When considering alternatives for open channel distribution, the existing system was used as a basis for expansion.

Since intake locations are already established, each alternative makes use of the existing locations as intake alternatives. There will be upgrades associated with the piped alternatives to satisfy pressure requirements, however existing maximum flow will be used.

The following alternatives have been considered for distribution of irrigation waters:

3.4.1 Alternative E1

Alternative E1 comprises of an all piped alternative and utilizing three existing intakes for supplying water. Two of the existing three intakes will be upgraded to augment capacity to provide the irrigation water needs for the entire East District. For this alternative the intake capacities will be as follows:

Intake 2: Eastchester Pumping Station (Upgraded Capacity 43,600 m3/d (8,000 USGPM))

Intake 3: Queenston Pumping Station (Upgraded Capacity 75,345 m3/d (13,800 USGPM))

Intake 4: Ontario Hydro Canal Pumping Station (No Upgrades, Existing Capacity 22,900 m3/d (4,200 USGPM))

In addition to the intake upgrades, one new booster pumping station will be required for this alternative to ensure that the pressures are within acceptable limits. The booster pumping station is proposed at the following location:

Booster Pumping Station (Capacity = 9020 m^3/d (1655 USGPM) at Concession 5 and Line 8

This alternative is presented in Figure 8.

3.4.2 Alternative E2

Alternative E2 also comprises of an all piped alternative. However, in addition to utilizing the three existing intakes, this alternative proposes a new intake. For this alternative, upgrades have been proposed for one of the three existing intakes. For this alternative, intake capacities will be as follows:

Intake 1: Lock 3 Pumping Station (New, Proposed Capacity 42,500 m^3/d (7800 USGPM))

Intake 2: Eastchester Pumping Station (No Upgrades, Existing Capacity 21,800 m^3/d (4,000 USGPM))

Intake 3: Queenston Pumping Station (Upgraded Capacity 54,510 m^3/d (10,000 USGPM))

Intake 4: Ontario Hydro Canal Pumping Station (No Upgrades, Existing Capacity 22,900 m^3/d (4,200 USGPM))

In addition to the intake upgrades, one booster pumping station will be required for this alternative to ensure that the pressures are within acceptable limits. The booster pumping station is the same as Alternative E1

This alternative is presented in Figure 9.

3.4.3 Alternative E3

Alternative E3 is an open channel alternative, and proposes to use the existing open channels within the area with major and minor upgrades, and also proposes some new channels. For this alternative also, it is proposed to utilize three existing major intakes, two existing minor intakes (siphons) and propose one new intake. For this alternative, the intake capacities will be as follows:

Intake 1: Lock 3 Gravity Feed (New, Proposed Capacity 53,965 m^3/d (9,900 USGPM))

Intake 2: Eastchester Pumping Station (No Upgrades, Existing Capacity 21,800 m^3/d (4,000 USGPM))

Intake 3: Queenston Pumping Station (Upgraded Capacity 81,765 m^3/d (15,000 USGPM))

Intake 4: Ontario Hydro Canal Pumping Station (Upgraded Capacity 33,000 m^3/d (6,050 USGPM))

For this alternative, Intake 2 is proposed to be relocated upstream on the Welland Canal.

A detailed description of flow rate calculations and system upgrades are discussed in Section 3.6. This alternative is presented in Figure 10.

3.5 PIPE NETWORK AND HYDRAULIC MODELING

A pipeline distribution system in the East District will be composed of a grid of distribution piping, with a number creek and regional road crossings. The pipelines will generally be constructed within the existing road or railroad right-of-way.

A hydraulic model was created in WaterCAD modeling software to simulate the pipe distribution network using the water demands to estimate the pipe sizes, and to arrive at an opinion of probable cost for supplying irrigation water to the East District using a pipe distribution network. Different pipe distribution alternatives were created as different scenarios in the model, to have them as separate entities.

In general, the pipe infrastructure has been sized to keep the residual pressures above 207 kPa (30 psi), and below 690 kPa (100 psi), and the velocities between 0.8 m/s, and 2.5 m/s. The estimated pipe sizes ranged from a minimum of 150 mm to a maximum of 900 mm. Also, in order to keep the residual pressures within acceptable limits, one booster pumping station has been proposed for each of the alternatives E1 and E2.

The sizes of the intakes, and the transmissions main from the intakes to the distribution network were based on the demand calculations for each alternative using the assumptions stated in Sections 1.3 and 2.2 to prevent over-sizing of these components. These assumptions are based on the premise that it is improbable for the entire East District to require water simultaneously.

Figures 8 and 9 show the pipe sizes and pumping station sizes required for Alternatives E1 and E2. Existing pumping stations were considered requiring upgrades to process piping and pumps as currently they are not capable of providing the lift and the flow needed for the piped system. The capacity used for these existing sources was limited only by the existing Permit to Take Water. Any upgrades necessary beyond the existing Permit to take Water would need approval by the MOE.

3.6 CHANNEL DISTRIBUTION AND HYDRAULIC CALCULATIONS

Alternative E3 uses an open channel distribution system to convey the water from the sources to the growers. This system is different than the proposed open channel system in the West

District Zone A because it mostly includes an existing irrigation network. This alternative looks at upgrading this existing system to meet ultimate demands as calculated in this report, and to provide a greater level of service, both in terms of the service area coverage, and density of service. Existing system flows and infrastructure components, and proposed upgrades mentioned in this section are based partly on previous reports and existing level of service in addition to consultation with Town staff.

3.6.1 Existing Irrigation Infrastructure

The NOTL Municipal Irrigation System operates from mid-May until mid-September, providing irrigation water through municipal drains to approximately 3235 ha (8,000 acres) of irrigated land. In addition to irrigation for plant water demand, the system provides water for frost protection during May for a number of berry growers. The current maximum system capacity is 15,000 USGPM (82,000 m^3/day or 800 acre-inches/day), using the Welland Canal, Niagara River and OPG facilities as sources.

The distribution system is composed of a number of drains conveying irrigation water generally from south to north. In the past, the system has occasionally failed to satisfy demand. An additional supply capacity would be desirable on the west side of the system to eliminate occasional water shortages. There is also an area in the south west portion of the District that currently has no distribution system.

For a detailed description of the existing irrigation infrastructure see the Engineers Reports by Wiebe Engineering on each of the following systems:

- Harrison Municipal Irrigation System A (April 30, 1999)
- Harrison Municipal Irrigation System B (April 30, 1999)
- Harrison Routh Irrigation System Niagara River Supply (July 9, 2003, revised February 2, 2007)
- Four Mile Creek Municipal Irrigation System (May 9, 1997)
- Airport Bright and Lavigne Municipal Irrigation System (May 10, 2000)
- Airport (Carlton Siphon) No. 1 Municipal Irrigation System (August 28, 1998)

3.6.2 Proposed Upgrades

The existing system currently does not provide water to all growers in the East District. Expansion of the system is needed in the south west part of the Town, where a large area of growers do not have access to irrigation water. This area is currently being considered for expansion by the Town of NOTL. K-Smart Associates produced a Feasibility Study Report on the Airport, Bright and Lavigne (ABL) Irrigation System, for which the Town is currently considering the preferred alternative for construction in phases in the near future. For the purpose of this report, it is assumed that the preferred alternative from the K-Smart report is not part of the existing irrigation infrastructure. We will, however, assume that this alternative will be constructed as a part of Alternative E3 and the estimated costs associated with the upgrades will be attached. Figure 10 includes the existing system and upgrades associated with the ABL system as proposed by K-Smart.

Growers in other areas are not able access water because of their distance from existing irrigation channels. This includes growers situated in two areas:

1. North of Line 4 on Concession 1 Road, and
2. North of Church Road west of Stewart Road.

There are other areas where the density of service is not complete, but it is the best that can be expected using the existing drainage infrastructure. Figure 10 shows the proposed upgrades to these areas. This includes expansion of the Routh Drain to include the Vandalaar and Epp Drains, as well as an additional transfer station at Church St. to expand the Airport 1 Drain to cover more area in the northwest portion of the District.

3.6.3 Estimation of Required Demand

The above Engineers Reports provide recommendations for further upgrades to the existing system in order to satisfy grower demand. These and other previous studies have used a fixed rate of 25 mm/week over the entire service area to calculate the ultimate flow requirements for design of the supply and distribution systems. Currently none of the systems meet this demand figure. By using the demand numbers generated in Section 1.3 and the land use map completed as a part of the larger study, more accurate demand numbers for each system were generated.

Each of the municipal drains used for irrigation are assigned a service area. Table 19 summarizes the demands for the areas associated with each drain.

Table 19: Service Areas and Demands for Each Drain Used for Irrigation in NOTL

Drain	Factored Area (m^2)	Demand 1 (m^3/d)	Demand 2 (m^3/d)	MAX 1 and 2
Airport 1	7,359,850	30,661	17,162	30,661
Airport 3	5,795,450	11,756	19,552	19,552
Lavigne	4,621,000	5,915	19,100	19,100
Bright	3,594,650	6,458	10,569	10,569
Carlton	218,450	959	498	959
Cole	2,351,000	3,006	8,916	8,916
Four Mile Creek	6,512,900	31,687	15,772	31,687
Three Mile Creek	2,428,900	12,736	5,179	12,736
Harrison 1	6,315,900	26,350	17,192	26,350
Harrison 2	225,250	1,327	395	1,327
Harrison 4	655,350	3,875	1,110	3,875
Harrison 6	5,931,100	28,576	11,942	28,576
Routh	4,529,650	20,171	9,317	20,171
Epp	1,231,650	4,801	2,574	4,801
Excluded	**1,270,400**	**848**	**4,978**	**4,978**

Each drain is a part of a larger system serviced by one or two supply sources, summarized below:

1. ABL System – Airport 1, Airport 3, Lavigne, Bright, Carlton, Cole
2. Four Mile Creek System – Four Mile Creek
3. Harrison System – Three Mile Creek, Harrison 1, Harrison 2, Harrison 4, Harrison 6, Routh, Epp

The excluded areas mentioned in Table 19 were considered for irrigation by the piped system, but could not be serviced by the open channel system. This is discussed further in Section 4.2.

In order to estimate the ultimate flows needed to supply each system, the demands for each system were totalized. The maximum between Demand 1 and 2 as described in Section 3.2 was used for estimating the flows needed for each intake. Table 20 summarizes the areas and the demands for each system.

Table 20: Total Service Areas and Demands for Each System in NOTL

By System	Factored Area (m^2)	Demand 1 (m^3/d)	Demand 2 (m^3/d)	MAX 1 and 2
ABL	23,940,400	58,756	75,797	75,797
Four Mile Creek	6,738,150	33,015	16,1617	33,015
Harrison	21,092,550	96,509	47,315	96,509

The system demands were then divided among the existing and proposed intakes to arrive at proposed flow rates for each intake. These rates are summarized in Figure 10.

3.7 OPINION OF PROBABLE COST

Tables 21 through 26 present opinions of probable capital and O&M costs for the three alternatives considered for the East District. Estimation of pipe sizes and unit costs is as described in Section 2.7 for the West District Zone A alternatives.

Table 21: Opinion of Probable Capital Cost for Irrigation Infrastructure – Alternative E1

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost ($)	Cost ($)
Pipe	150	24,749	m	$123	$3,036,950
	200	2,460	m	$136	$334,630
	250	8,537	m	$150	$1,282,170
	300	64,851	m	$169	$10,935,820
	350	21,384	m	$222	$4,756,440
	400	15,597	m	$247	$3,858,540
	450	3,740	m	$287	$1,072,150
	500	6,802	m	$320	$2,173,580
	600	13,202	m	$448	$5,913,040
	750	3,146	m	$505	$1,589,040
	900	2,516	m	$669	$1,683,530
Pipe Subtotal					**$36,635,890**
Major Crossing (QEW, Hwy 405)	**300**	1	lump sum	$175,000	$175,000
	400	1	lump sum	$175,000	$175,000
Major Crossing Subtotal					**$350,000**
Pumping Station	Intake 2	505	L/s	$5,000	$2,523,150
	Intake 3	872	L/s	$4,000	$3,488,200
	Intake 4	265	L/s	$8,000	$2,120,400
	Booster 1	104	L/s	-	$1,000,000
Pumping Station Subtotal					**$9,131,750**
Subtotal					$6,117,640
Allowance for contingencies, permits, approvals & engineering etc. (35%)					$16,141,170
Total Cost (excluding GST)					**$62,258,800**

^ denotes a creek crossing
* denotes a railway crossing
bold denotes a QEW or Hwy 405 crossing

Table 22: Opinion of Probable Operating and Maintenance Cost for Irrigation Infrastructure – Alternative E1

Item	Hours of Operation per year (hrs)	Consumption (kwh)	Unit Cost ($)/kwh	Cost ($)
Booster Pumping Station 1	600	17,557	0.102	$1,790
Intake Pump 2	600	135,783	0.102	$13,850
Intake Pump 3	600	813,928	0.102	$83,020
Intake Pump 4	600	122,576	0.102	$12,500
Other O&M*				$181,330
Total Cost				**$292,500**

*Based on 2006 operating costs for existing NOTL irrigation system

Table 23: Opinion of Probable Capital Cost for Irrigation Infrastructure – Alternative E2

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost ($)	Cost ($)
Pipe	150	18224	m	123	$2,236,270
	200	0	m	136	$ -
	250	2082	m	150	$312,700
	300	78219	m	169	$13,190,070
	350	8244	m	222	$1,833,710
	400	8326	m	247	$2,059,770
	450	19399	m	287	$5,561,110
	500	16985	m	320	$5,427,560
	600	6288	m	448	$2,816,330
	750	9217	m	505	$4,655,510
	900	0	m	669	$ -
Pipe Subtotal					**$38,093,030**
Major Crossing (QEW, Hwy 405)	**300**	1	lump sum	$175,000	$175,000
	500	1	lump sum	$175,000	$175,000
Major Crossing Subtotal					**$350,000**
Pumping Station	Intake 1	492	L/s	$5,000	$2,459,950
	Intake 2	252	L/s	$8,000	$2,018,480
	Intake 3	631	L/s	$4,500	$2,839,050
	Intake 4	265	L/s	$8,000	$2,120,400
	Booster 1	104	L/s	-	$1,000,000
Pumping Station Subtotal					**$10,437,880**
Subtotal					$48,880,910
Allowance for contingencies, permits, approvals & engineering etc. (35%)					$17,108,320
Total Cost (excluding GST)					**$65,989,200**

^ denotes a creek crossing

* denotes a railway crossing

bold denotes a QEW or Hwy 405 crossing

Table 24: Opinion of Probable Operating and Maintenance Cost for Irrigation Infrastructure – Alternative E2

Item	Hours of Operation per year (hrs)	Consumption (kwh)	Unit Cost ($)/kwh	Cost ($)
Booster Pumping Station 1	600	17,557	0.102	$1,790
Intake Pump 1	600	273,038	0.102	$27,850
Intake Pump 2	600	78,500	0.102	$8,010
Intake Pump 3	600	456,230	0.102	$46,540
Intake Pump 4	600	122,576	0.102	$12,500
Other O&M*				$192,000
Total Cost				**$288,700**

*Based on 2006 operating costs for existing NOTL irrigation system

Table 25: Opinion of Probable Capital Cost for Irrigation Infrastructure – Alternative E3

Item	Diameter (mm)	Unit Amount	Unit	Unit Cost ($)	Cost ($)
Proposed Irrigation Channel	n/a	18198	m	$20	$363,950
Proposed Supply and Transfer Pipeline	750	5903	m	$510	$3,010,580
Major Crossing (QEW, Hwy 405)	**750**	1	lump sum	$175,000	$175,000
Pumping Station	Hydro	382	L/s	$6,500	$2,482,610
	Queenston	946	L/s	$3,500	$3,312,230
	ABL	252	L/s	$8,000	$2,018,480
Pumping Station Subtotal					**$7,813,320**
Transfer Pumping Station	TMC	147	lump sum	-	$1,000,000
	Church St	147	lump sum	-	$1,000,000
Transfer Pumping Station Subtotal					**$2,000,000**
Gravity Intake			lump sum		$1,000,000
Subtotal					$14,362,850
Allowance for contingencies, permits, approvals & engineering etc. (35%)					$5,027,000
Total Cost (excluding GST)					**$19,389,900**

Table 26: Opinion of Probable Operating and Maintenance Cost for Irrigation Infrastructure – Alternative E3

Item	Hours of Operation per year (hrs)	Consumption (kwh)	Unit Cost ($)/kwh	Cost ($)
Transfer Pump 1	600	123,60	0.102	$1,260
Transfer Pump 2	600	123,60	0.102	$1,260
Intake Pump 2	600	63,648	0.102	$6,490
Intake Pump 3	600	437,662	0.102	$44,640
Intake Pump 4	600	32,116	0.102	$3,280
Other O&M*^				$213,330
Total Cost				**$270,300**

^adjusted to include capital works already installed

*Based on 2006 operating costs for existing NOTL irrigation system

4.0 Opportunities and Constraints

4.1 SERVICE LEVELS

The level of proposed service would convey water within reach of the individual fields, and it is assumed that the individual farmers would employ their own means to transfer water to their fields. A water utilization protocol would need to be developed in order to manage usage of water by individual farmers. The pipe network system alternatives would provide greater levels of service as compared to the open channel system, as pipes could essentially be installed along the road Right of Way or through any easement without considering the lay of the land, as opposed to the channels, where topography has to be considered. There are operational issues with providing an intensified channel network in that all the channels need to be flowing with water thereby increasing the losses and consequently the water requirements. For the open channel system, it may not be possible to provide each landowner with water on or next to their property.

4.2 ESCARPMENT BENCH

As noted in Section 2.1, the West District area slopes from south to north with the steep slope close to the escarpment, and gradual slope away from the escarpment towards the lake. Due to sharp elevation increases in the southern portion of the District, some areas were not considered for service by any of the West District Alternatives. This excluded area is the Escarpment Bench. There are several grape growers south of Regional Road 81 that reside in this elevated area and will not be serviced by this irrigation system. The extra head needed to lift irrigation waters to these agricultural lands was weighed against the small size of the additional area serviced and it was decided that it was not practical. In the East District, this Escarpment Bench was less of an issue for the piped alternatives, however it did contribute in the design of the open channel system, as the area south of York Road was not considered for irrigation by Alternative E3 (see Figure 7).

4.3 WATER AVAILABILITY AND PERMIT REQUIREMENTS

The designated intake alternatives will have constraints due to permits and water availability. Each intake has been allocated an estimated ultimate flow rate based on demand figures as detailed in Sections 2.4.1 through 2.4.4. Negotiations with stakeholder interests with the intent of designating agreed upon water takings for each of the intakes proposed will be made prior to the conclusion of this overall Phase 2 study, pursuant to the recommendations made in the *Task 4 – Regulatory Requirements and Related Considerations* technical memorandum prepared by Kinkead Consulting.

4.4 INTAKE LOCATIONS

As discussed in Sections 2.3, 2.4, 3.3 and 3.4, more than one intake location has been identified for each intake alternatives. Environmental discussion of the intake and distribution alternatives will be prepared as a separate report. At the conclusion of that report, a preferred alternative will be proposed. Selection of the exact intake locations is beyond the scope of this study, and will be dealt with during the Class EA stage of individual intake design.

4.5 PIPE NETWORK VERSUS OPEN CHANNEL NETWORK

In general, the pipe network system will provide a greater level of service as described in the general discussion about the service levels above. This is due to the area topography and availability of existing drainage channels. The area along Fifth Street Louth north of Third Avenue and the area north of the QEW are examples of reduced level of service in the West District. In the East District, the area between Three and Four Mile Creek is an example of reduced level of service. A pipe network system will also have lower losses as compared to an open channel system primarily because it is a closed system, and water cannot be lost at the end of the system, infiltrate in the ground, or evaporate in to the atmosphere. This difference has been accounted for in the development of the unit demands for crops. As is evident in Table 1, we have assumed unit demands for open channel system to be higher than that for the pipe system. A pipe network also allows better control of water distribution as water can quickly reach where required. Travel times for irrigation waters in the existing NOTL open channel system are in the order of 3 hrs/km. While comparing the probable cost opinions for the capital cost between the open channel and pipe network schemes, these differences should be kept in mind.

5.0 Summary and Next Steps

5.1 GENERAL

This section summarizes the servicing alternatives prepared and presented for the West District Zone A and the East District, and also provides an outline of the next steps required to take the overall project to conclusion. It is worth noting that the purpose of this Engineering Report was to prepare alternatives for providing irrigation water to the areas below the Escarpment, and prepare opinions of probable cost associated with each alternative. Selection of preferred alternatives is beyond the scope of this Engineering Report, and prior to selecting the preferred alternative, an Environmental Impacts Report will be prepared that will evaluate alternative solutions for their environmental impact. Preferred servicing alternatives will then be prepared for both the districts. Subsequently, a Public Information Centre will be scheduled for obtaining public input. Section 5.3 outlines the next steps that will be carried out to take this study to conclusion.

5.2 SUMMARY OF THE ALTERNATIVES

A summary of the alternatives prepared in this report are presented below. In general, the probable cost opinions for different alternatives are within reasonable range of each other, except for Alternative E3, which is an open channel alternative. However, the opinions of costs associated with each alternative are preliminary and could vary as much as 20% to 30% from the actual project cost. Therefore, it is recommended that cost should not be the guiding criteria for the selection of a preferred alternative.

5.2.1 West District Zone A

Four alternatives were prepared for the West District Zone A. Alternatives W1 through W3 includes all-pipe servicing solutions with different intake arrangements. Alternative W4 proposes a combination of pipe and gravity channel solution, with gravity servicing proposed for the area east of Sixteen Mile Creek, and pipe servicing proposed for the remaining area. Table 27 presents a summary of the servicing alternatives for the West District Zone A.

Table 27: Summary of Alternatives for West District Zone A

Item	Alternative			
	W1	W2	W3	W4
Capital Cost in Million Dollars	75	82	86	71
Annual O & M Cost in Million Dollars	0.32	0.31	0.30	0.38
Total Pipe/Channel Length (km)	140	145.5	151.5	147.5
No. of New Intakes	1	2	2	2
Intake Options	1/2/3	1/2 + 3/4	1/2 + 5/6	1/2 + 5/6
No. of Booster Pumping Stations	2	2	1	1
No. of Major Crossings	2	2	2	2
No. of Minor Crossings	24	24	24	16

The probable costs for the alternatives range from a minimum of 71 million dollars for alternative W4, which is a combination of gravity and pipe servicing to a maximum of 86 Million dollars for alternative W3. Alternative W1 proposes to utilize a single intake to draw water as opposed to all the other alternatives which utilize two intakes. For that reason, Alternative W1 is the least expensive solution between the all-pipe alternatives W1, W2, and W3. However, W1 provides lesser redundancy in the overall system due to a single intake. The annual O&M costs are also comparable for the four alternatives. Appendix A presents detailed probable opinions for the pipe costs, and the O&M costs. The total length of pipes/channels is similar in all the alternatives, and therefore, the level of servicing is comparable between alternatives.

5.2.2 East District

Three alternatives were proposed for the East District. Alternatives E1 and E2 includes all-pipe servicing solutions, and alternative E3 proposes to use the existing open channels within the area with major and minor upgrades, and also proposes some new channels. Table 28 presents a summary of the servicing alternatives proposed for the East District.

Table 28: Summary of Alternatives for East District

Item	Alternative		
	E1	E2	E3
Capital Cost in Million Dollars	62	66	19
Annual O & M Cost in Million Dollars	0.29	0.29	0.27
Total Pipe/Channel Length (km)	167	167	24
No. of New Intakes	-	1	1
No. of Intake Upgrades	2	1	2
No. of Booster Pumping Stations	1	1	0
No. of Major Crossings	2	2	1
No. of Minor Crossings	0	0	0

The Probable costs for the alternatives range from a minimum of 19 Million dollars for alternative E3, which is a gravity servicing solution to a maximum of 66 Million dollars for alternative E2. This huge difference in the probable costs between pipe and channel is attributed to the difference in the unit costs for open channels and pipes, and also to the level of service. As is evident from the above table, the length of Pipes/Channels for alternative E3 is of the order of 24 kilometers, as opposed to 167 kilometers for the pipe alternatives E1 and E2.Therefore, when comparing the gravity and pipe servicing alternatives, the large difference in the levels of servicing should be kept in mind. Alternative E1 proposes to upgrade the existing intakes and does not propose construction of a new intake, whereas the other two alternatives, E2 and E3 propose one new intake in addition to upgrading some of the existing intakes. The annual O&M costs are comparable for the four alternatives. Appendix A presents detailed probable cost opinions for the pipe costs, and the O&M costs.

5.3 NEXT STEPS

A brief discussion on the next steps required to take this project to conclusion is presented here. The servicing alternatives established in this report will be further evaluated from the environmental perspective in the subsequent Environmental Impacts Report. At the completion of the Environmental Impacts Report, a PIC will be scheduled. Upon conclusion of the Public Information Centre, a Project Report will be prepared, which will include the public comments, and all the tech memos and reports previously completed as part of this project. This Project Report will be placed on Public record for the stipulated period, subsequent to which, Notice of Completion will be issued. Other deliverables that will be prepared as part of this project are:

- Management Tech Memo, which will detail the management of the proposed infrastructure, and will be prepared based on consultations with the growers
- Phasing Report, which will discuss the timing issues related to providing irrigation servicing to different areas within the overall study area.
- These deliverables will be included as Appendices to the Project Report prepared previously.

--- STANTEC CONSULTING LTD. ---

APPENDIX A

Detailed Unit Cost Tables for Infrastructure Components

Region of Niagara

11-Jun-07

Cost of Excavation	**10**	**$/m^3**
Installation Cost (upto 825 mm)	**10**	**% of Pipe Cost**
Installation Cost (> 825 mm)	**15**	**% of Pipe Cost**
Cost of Backfill	**5**	**$/m^3**
Cost of Granular Bedding	**25**	**$/m^3**
Restoration Cost	**5**	**$/m^2**
Hydrant Cost	**0**	**$/No.**
Liner Plate Allowance	**0**	**% of Total Cost**
EA Cost	**0**	**% of Total Cost**
Design Cost	**5**	**% of Total Cost**
Contract Administration Cost	**0**	**% of Total Cost**
Contingencies	**10**	**% of Total Cost**
GST	**6**	**% of Total Cost**

WATER SERVICING INFRASTRUCTURE AVERAGE UNIT PRICES

Nom. Pipe	Outer	Depth to	Minimum	Excavation		Bedding		Pipe		Backfill		Restoration Allowance		Watermain Appurtenance	Dewatering	Subtotal	Liner Plate	Subtotal	EA	Design	Contract Admin	Contingencies	TOTAL	GST	TOTAL
Size	Diameter	Invert	Trench Width	Vol.	Cost	Vol.	Cost	Cost	Installation Allowance	Vol.	Cost	Area	Cost	Allowance	Allowance	Unit Cost	Allowance	Unit Cost	Cost	Cost	Cost		(Excluding GST)		(Including GST)
(mm)	(m)	(m)	(m)	(m^3)	($/m)	(m^3)	($/m)	($/m)	($/m)	(m^3)	($/m)	m^2	($/m)	($/m)	($/m)	($/m)	($/m)	($/m)	($/m)	($/m)	($/m)	($/m)	($/m)	($/m)	($/m)
150	0.15	1.2	1.35	2.2	22.05	1.0	24.87	14.39	1.44	1.2	5.96	5	25	29.00	0	122.71	0.00	122.71	0.00	6.14	0.00	12.27	141.12	8.47	149.59
200	0.2	1.2	1.4	2.3	22.80	1.1	27.21	22.92	2.29	1.2	5.80	5	25	30.00	0	136.03	0.00	136.03	0.00	6.80	0.00	13.60	156.43	9.39	165.82
250	0.25	1.2	1.45	2.4	23.55	1.2	29.59	32.22	3.22	1.1	5.61	5	25	31.00	0	150.19	0.00	150.19	0.00	7.51	0.00	15.02	172.72	10.36	183.08
300	0.3	1.2	1.5	2.4	24.30	1.3	31.98	45.41	4.54	1.1	5.40	5	25	32.00	0	168.63	0.00	168.63	0.00	8.43	0.00	16.86	193.93	11.64	205.56
350	0.35	1.2	1.55	2.5	25.05	1.4	34.41	68.01	6.80	1.0	5.16	10	50	33.00	0	222.43	0.00	222.43	0.00	11.12	0.00	22.24	255.80	15.35	271.14
400	0.4	1.2	1.6	2.6	25.80	1.5	36.86	86.21	8.62	1.0	4.90	10	50	35.00	0	247.39	0.00	247.39	0.00	12.37	0.00	24.74	284.50	17.07	301.57
450	0.45	1.2	1.65	2.7	26.55	1.6	39.34	110.16	11.02	0.9	4.61	10	50	45.00	0	286.67	0.00	286.67	0.00	14.33	0.00	28.67	329.68	19.78	349.46
500	0.5	1.2	1.7	2.7	27.30	1.7	41.84	132.83	13.28	0.9	4.30	10	50	50.00	0	319.55	0.00	319.55	0.00	15.98	0.00	31.96	367.49	22.05	389.54
600	0.6	1.5	1.8	4.0	39.60	1.9	46.93	220.33	22.03	1.8	9.00	10	50	60.00	0	447.89	0.00	447.89	0.00	22.39	0.00	44.79	515.08	30.90	545.98
750	0.75	1.5	1.95	4.2	42.30	2.2	54.77	250.04	25.00	1.6	7.99	10	50	75.00	0	505.10	0.00	505.10	0.00	25.25	0.00	50.51	580.86	34.85	615.72
900	0.9	1.8	2.1	6.0	60.30	2.5	62.85	350.94	52.64	2.9	14.40	10	50	78.00	0	669.13	0.00	669.13	0.00	33.46	0.00	66.91	769.50	46.17	815.67
1000	1	2.1	2.2	8.2	81.60	2.7	68.37	314.57	47.18	4.6	23.20	10	50	80.00	0	664.92	0.00	664.92	13.30	33.25	33.25	66.49	811.20	48.67	859.87
1050	1.05	2.1	2.25	8.3	82.80	2.8	71.16	354.76	53.21	4.6	22.84	10	50	80.00	0	714.77	0.00	714.77	14.30	35.74	35.74	71.48	872.02	52.32	924.34
1200	1.2	2.1	2.4	8.6	86.40	3.2	79.73	446.29	66.94	4.3	21.60	10	50	83.00	0	833.96	0.00	833.96	16.68	41.70	41.70	83.40	1017.43	61.05	1078.48
1350	1.35	2.5	2.55	12.3	122.60	3.5	88.53	577.49	86.62	7.3	36.44	10	50	86.00	0	1,047.68	0.00	1,047.68	20.95	52.38	52.38	104.77	1278.17	76.69	1354.86
1600	1.6	2.5	2.8	13.0	129.60	4.1	103.73	825.23	123.78	6.8	34.00	15	75	86.00	0	1,377.35	0.00	1,377.35	27.55	68.87	68.87	137.73	1680.36	100.82	1781.18

Notes

1) Pipe Cost has been taken from pipe suppliers (up to 900mm PVC, up to 1600 mm HDPE)
2) Restoration cost is for topsoil and sod only
3) AssumedValve Chamber Spacing 100 m
4) Assumed restoration area 5 m^2 up to 600 mm dia. pipe
   Assumed restoration area 10 m^2 up to 1350 mm dia. pipe
   Assumed restoration area 15 m^2 up to 3000 mm dia. pipe
5) Dewatering Allowance : Assumed that dewatering will not be required
6) Total unit price includes GST (6%)

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Detailed Operating Costs for East and West District

District	Alternative	Booster Pump	Transfer Pump	Intake Pump	Flow (m^3/day)	Flow (m^3/s)	Gravity (m/s^2)	Elevation of 'reservoir' (m)	Elevation of intake (m)	Head (m)	Efficiency	Time (hrs)	Power (kW)	Energy (kWh)	Cost ($)
West Zone A	W1	1			8,073	0.09	9.81	117		30	0.7	600	39.28	23570.28	$ 2,400
	W1	2			96,285	1.11	9.81	94		60	0.7	600	937.06	562235.63	$ 57,350
	W1			1	147,354	1.71	9.81	170	74.5	95.5	0.7	600	2282.56	1369537.02	$ 139,690
	W2			1	104,120	1.21	9.81	170	74.5	95.5	0.7	600	1612.85	967711.73	$ 98,710
	W2			3	43,234	0.50	9.81	165	74.5	90.5	0.7	600	634.65	380787.32	$ 38,840
	W2	1			8,073	0.09	9.81	117		30	0.7	600	39.28	23570.28	$ 2,400
	W2	2			96,285	1.11	9.81	94		50	0.7	600	780.88	468529.69	$ 47,790
	W3			1	116,793	1.35	9.81	170	74.5	95.5	0.7	600	1809.16	1085497.08	$ 110,720
	W3			5	30,562	0.35	9.81	150	82	68	0.7	600	337.09	202254.95	$ 20,630
	W3	2			96,285	1.11	9.81	94		55	0.7	600	858.97	515382.66	$ 52,570
	W4	2			60,434	0.70	9.81	94		75	0.7	600	735.19	441114.24	$ 44,990
	W4			1	111,503	1.29	9.81	185	74.5	110.5	0.7	600	1998.51	1199105.25	$ 122,310
	W4			5	47,800	0.55	9.81	170	82	88	0.7	600	682.29	409372.86	$ 41,760
	W4		1		13,980	0.16	9.81			10	0.7	600	22.68	13605.54	$ 1,390
	W4		2		10,602	0.12	9.81			10	0.7	600	17.20	10318.02	$ 1,050
	W4		3		5,482	0.06	9.81			10	0.7	600	8.89	5335.16	$ 540
	W4		4		5,071	0.06	9.81			30	0.7	600	24.68	14805.51	$ 1,510
East	E1			2	43,600	0.50	9.81	135	103	32	0.7	600	226.30	135782.86	$ 13,850
	E1			3	75,345	0.87	9.81	190	79	111	0.7	600	1356.55	813927.82	$ 83,020
	E1			4	22,900	0.27	9.81	230	175	55	0.7	600	204.29	122576.34	$ 12,500
	E1	1			9,020	0.10	9.81	100		20	0.7	600	29.26	17556.79	$ 1,790
	E2	1			9,020	0.10	9.81	100		20	0.7	600	29.26	17556.79	$ 1,790
	E2			1	42,508	0.49	9.81	180	114	66	0.7	600	455.06	273037.99	$ 27,850
	E2			2	21,800	0.25	9.81	140	103	37	0.7	600	130.83	78499.46	$ 8,010
	E2			3	54,510	0.63	9.81	165	79	86	0.7	600	760.38	456229.23	$ 46,540
	E2			4	22,900	0.27	9.81	230	175	55	0.7	600	204.29	122576.34	$ 12,500
	E3		1		12,700	0.15	9.81			10	0.7	600	20.60	12359.82	$ 1,260
	E3		2		12,700	0.15	9.81			10	0.7	600	20.60	12359.82	$ 1,260
	E3			2	21,800	0.25	9.81			30	0.7	600	106.08	63648.21	$ 6,490
	E3			3	81,765	0.95	9.81			55	0.7	600	729.44	437661.76	$ 44,640
	E3			4	33,000	0.38	9.81			10	0.7	600	53.53	32116.07	$ 3,280

APPENDIX B

Detailed Water Demands

Land Use	Grapes - Wine	Tender Fruit	Nurseries	Greenhouse	Grapes - Juice	Pome Fruit	Idle Land	Cash Crops	Pasture Cattle	Other Fruit	Other		Wine Grape Usage Factor		
Colour	Green	Orange	Pink	Blue	Purple	Red	Maroon	Dark yellow	Light yellow	Brown	White		0.5		
Water Demand	0.0073	0.0091	0.0040	0.0093	0.0073	0.0091	0	0	0	0	0		Irrigation loss Factor		
Area Factor	0.85	0.85	0.85	0.3	0.85	0.85							0.75		
Node	**Area of Land Use (in 1000m²)**											**Total Area (m^2)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
1	753	0	0	0	81	0	222	0	33	0	0	**708,900**	**505**	**2,852**	**2,852**
2	235	128	0	0	0	197	390	0	0	37	0	**476,000**	**2,505**	**2,251**	**2,505**
3	0	69	0	0	0	0	0	0	0	0	0	**58,650**	**532**	**0**	**532**
4	0	149	0	67	0	0	25	0	0	0	0	**146,750**	**1,336**	**188**	**1,336**
5	0	0	40	0	0	0	0	0	0	0	0	**34,000**	**136**	**136**	**136**
6	0	230	0	0	0	20	0	0	0	0	0	**212,500**	**1,927**	**154**	**1,927**
7	0	209	0	0	0	0	0	0	0	0	0	**177,650**	**1,611**	**0**	**1,611**
8	62	84	0	0	0	169	230	0	0	0	0	**267,750**	**1,950**	**1,496**	**1,950**
9	0	314	0	19	0	0	0	0	0	0	0	**272,600**	**2,473**	**53**	**2,473**
10	100	12	0	0	0	0	0	0	0	0	0	**95,200**	**92**	**312**	**312**
10A	0	244	0	39	0	53	87	0	0	0	0	**264,150**	**2,398**	**518**	**2,398**
11	0	238	0	0	0	0	0	0	0	0	0	**202,300**	**1,834**	**0**	**1,834**
12	60	65	14	0	0	0	30	0	0	0	0	**118,150**	**549**	**235**	**549**
13	118	148	0	0	0	0	65	0	0	0	0	**226,100**	**1,141**	**368**	**1,141**
14	0	154	0	107	0	0	0	0	0	0	0	**163,000**	**1,486**	**300**	**1,486**
15	35	64	0	42	0	0	0	0	0	0	0	**96,750**	**611**	**227**	**611**
16	90	138	0	0	0	0	0	0	0	0	0	**193,800**	**1,064**	**281**	**1,064**
17	76	51	0	39	0	0	0	0	0	0	0	**119,650**	**502**	**346**	**502**
18	81	64	0	141	0	0	0	0	0	0	0	**165,550**	**888**	**647**	**888**
19	105	0	0	0	67	0	0	0	0	0	0	**146,200**	**418**	**745**	**745**
20	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	**0**
21	11	221	0	0	0	0	0	0	0	0	0	**197,200**	**1,703**	**34**	**1,703**
22	16	33	0	0	12	0	0	0	0	0	0	**51,850**	**329**	**125**	**329**
23	71	112	0	0	0	45	352	0	0	0	0	**193,800**	**1,210**	**568**	**1,210**
24	0	61	0	0	0	0	53	0	0	0	0	**51,850**	**470**	**0**	**470**
25	0	0	0	0	0	52	283	0	0	0	0	**44,200**	**401**	**401**	**401**
26	349	0	0	0	0	0	105	0	0	0	0	**296,650**	**0**	**1,088**	**1,088**
27	198	0	0	26	0	0	335	0	0	0	0	**176,100**	**73**	**690**	**690**
28	191	41	0	0	44	0	21	0	0	0	0	**234,600**	**590**	**870**	**870**
29	134	86	0	0	0	0	45	0	0	0	0	**187,000**	**663**	**418**	**663**
30	79	0	0	0	0	63	0	210	0	0	0	**120,700**	**486**	**732**	**732**
31	191	216	0	0	0	0	0	0	0	125	0	**345,950**	**1,665**	**595**	**1,665**
32	78	0	0	0	0	115	104	0	0	0	0	**164,050**	**886**	**1,129**	**1,129**
33	0	0	0	103	77	0	0	0	0	0	0	**96,350**	**768**	**768**	**768**
34	0	0	0	40	0	0	40	0	0	0	0	**12,000**	**112**	**112**	**112**
35	55	0	0	0	0	0	252	0	0	0	0	**46,750**	**0**	**171**	**171**
36	204	0	0	17	0	60	567	0	0	0	0	**229,500**	**510**	**1,146**	**1,146**
37	0	37	0	0	0	36	53	0	0	0	0	**62,050**	**563**	**277**	**563**
38	0	0	0	0	0	0	129	0	0	0	0	**0**	**0**	**0**	**0**
39	163	0	0	0	0	0	119	0	0	0	0	**138,550**	**0**	**508**	**508**
40	700	70	116	10	0	0	224	0	0	0	0	**756,100**	**962**	**2,604**	**2,604**
41	176	106	0	0	81	118	325	0	0	0	132	**408,850**	**2,231**	**1,963**	**2,231**
42	165	20	0	15	0	0	30	0	0	0	0	**161,750**	**196**	**556**	**556**
44	220	50	0	0	18	74	187	55	0	0	0	**307,700**	**1,068**	**1,368**	**1,368**
45	821	159	0	0	0	0	425	0	49	0	0	**833,000**	**1,225**	**2,559**	**2,559**
46	144	52	0	0	180	25	169	0	61	0	0	**340,850**	**1,715**	**1,763**	**1,763**
47	181	117	0	0	0	39	131	0	0	0	0	**286,450**	**1,202**	**865**	**1,202**

Land Use	Grapes - Wine	Tender Fruit	Nurseries	Greenhouse	Grapes - Juice	Pome Fruit	Idle Land	Cash Crops	Pasture Cattle	Other Fruit	Other		Wine Grape Usage Factor		
Colour	Green	Orange	Pink	Blue	Purple	Red	Maroon	Dark yellow	Light yellow	Brown	White		0.5		
Water Demand	0.0073	0.0091	0.0040	0.0093	0.0073	0.0091	0	0	0	0	0		Irrigation loss Factor		
Area Factor	0.85	0.85	0.85	0.3	0.85	0.85							0.75		
Node	**Area of Land Use (in 1000m^2)**											**Total Area (m^2)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
48	175	0	0	0	119	24	223	158	0	0	0	**270,300**	**927**	**1,472**	**1,472**
49	83	0	0	0	117	0	233	0	0	0	653	**170,000**	**729**	**988**	**988**
50	0	0	0	0	0	0	50	0	0	0	0	**0**	**0**	**0**	**0**
51	304	197	0	12	66	0	142	57	0	0	0	**485,550**	**1,963**	**1,392**	**1,963**
52	0	402	0	0	0	467	78	0	0	0	0	**738,650**	**6,697**	**3,599**	**6,697**
53	420	64	0	0	208	169	193	0	0	0	0	**731,850**	**3,092**	**3,908**	**3,908**
54	405	0	0	41	238	0	46	0	0	0	0	**558,850**	**1,598**	**2,861**	**2,861**
55	581	0	0	112	0	0	202	0	0	0	0	**527,450**	**314**	**2,124**	**2,124**
56	121	221	0	0	0	0	99	267	0	0	0	**290,700**	**1,703**	**377**	**1,703**
57	47	346	0	0	0	184	91	0	0	0	0	**490,450**	**4,085**	**1,565**	**4,085**
58	81	519	0	0	0	0	0	24	0	0	0	**510,000**	**4,000**	**252**	**4,000**
59	0	140	0	0	0	0	85	0	0	0	0	**119,000**	**1,079**	**0**	**1,079**
60	0	340	0	0	0	0	0	0	0	0	0	**289,000**	**2,620**	**0**	**2,620**
61	0	445	89	0	0	0	0	0	0	0	0	**453,900**	**3,732**	**303**	**3,732**
62	35	742	0	0	20	35	182	0	0	0	0	**707,200**	**6,113**	**503**	**6,113**
63	0	370	0	0	0	0	0	0	0	0	0	**314,500**	**2,851**	**0**	**2,851**
64	0	302	61	47	0	0	0	0	0	0	0	**322,650**	**2,666**	**339**	**2,666**
65	0	162	463	0	0	0	9	0	0	47	0	**531,250**	**2,823**	**1,574**	**2,823**
66	0	555	0	0	0	0	69	0	0	62	0	**471,750**	**4,277**	**0**	**4,277**
67	68	489	166	0	0	0	0	0	0	0	0	**614,550**	**4,333**	**776**	**4,333**
68	0	186	0	27	0	15	156	0	0	40	0	**178,950**	**1,625**	**191**	**1,625**
69	0	0	0	0	0	0	334	0	0	0	0	**0**	**0**	**0**	**0**
70	61	123	0	0	0	0	42	0	0	0	0	**156,400**	**948**	**190**	**948**
71	54	26	0	0	0	27	75	0	0	0	226	**90,950**	**408**	**376**	**408**
72	0	40	0	71	0	0	91	0	0	0	0	**55,300**	**507**	**199**	**507**
73	0	132	51	70	0	0	0	0	0	0	0	**176,550**	**1,387**	**369**	**1,387**
74	0	397	0	0	0	10	0	0	0	0	0	**345,950**	**3,137**	**77**	**3,137**
75	0	1036	12	11	0	39	0	0	0	0	0	**927,250**	**8,356**	**372**	**8,356**
76	156	399	0	37	0	0	111	0	0	0	0	**482,850**	**3,179**	**590**	**3,179**
77	28	0	124	0	0	20	13	0	0	0	0	**146,200**	**576**	**663**	**663**
78	0	968	127	0	0	0	0	0	0	61	0	**930,750**	**7,892**	**432**	**7,892**
79	46	0	0	0	129	0	49	0	0	0	107	**148,750**	**804**	**947**	**947**
80	171	511	138	49	199	32	71	0	0	0	0	**908,050**	**6,032**	**2,626**	**6,032**
81	0	295	0	158	200	69	352	0	87	0	0	**526,800**	**4,494**	**2,221**	**4,494**
82	269	92	132	385	0	93	94	0	63	0	0	**613,600**	**2,953**	**3,082**	**3,082**
83	637	0	0	96	197	0	0	99	0	0	0	**737,700**	**1,497**	**3,482**	**3,482**
85	373	0	0	0	313	0	0	0	0	0	0	**583,100**	**1,951**	**3,114**	**3,114**
86	315	0	0	0	21	314	0	0	0	0	0	**552,500**	**2,551**	**3,533**	**3,533**
87	193	0	0	0	198	72	379	0	0	0	0	**393,550**	**1,789**	**2,391**	**2,391**
88	624	97	20	0	0	0	0	0	0	0	0	**629,850**	**816**	**2,013**	**2,013**
89	324	0	165	0	104	0	72	0	0	0	0	**504,050**	**1,209**	**2,219**	**2,219**
90	191	0	0	0	428	0	179	0	0	0	0	**526,150**	**2,668**	**3,263**	**3,263**
91	98	0	0	0	0	0	294	0	0	0	0	**83,300**	**0**	**305**	**305**
92	712	0	0	0	544	0	0	403	0	0	0	**1,067,600**	**3,391**	**5,610**	**5,610**
93	405	0	0	0	0	0	217	0	0	0	0	**344,250**	**0**	**1,262**	**1,262**
94	151	0	0	0	0	0	0	0	0	0	0	**128,350**	**0**	**471**	**471**
95	0	0	315	83	0	0	84	0	31	0	0	**292,650**	**1,303**	**1,303**	**1,303**
96	146	109	163	32	0	0	167	0	0	0	0	**364,900**	**1,484**	**1,099**	**1,484**

Land Use	Grapes - Wine	Tender Fruit	Nurseries	Greenhouse	Grapes - Juice	Pome Fruit	Idle Land	Cash Crops	Pasture Cattle	Other Fruit	Other		Wine Grape Usage Factor		
Colour	Green	Orange	Pink	Blue	Purple	Red	Maroon	Dark yellow	Light yellow	Brown	White		0.5		
Water Demand	0.0073	0.0091	0.0040	0.0093	0.0073	0.0091	0	0	0	0	0		Irrigation loss Factor		
Area Factor	0.85	0.85	0.85	0.3	0.85	0.85							0.75		
Node	**Area of Land Use (in 1000m^2)**											**Total Area (m^2)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
97	0	180	250	149	0	0	112	0	0	0	0	**410,200**	**2,654**	**1,267**	**2,654**
98	137	60	0	0	0	0	88	0	0	0	0	**167,450**	**462**	**427**	**462**
99	0	47	0	0	0	12	57	0	0	0	0	**50,150**	**455**	**92**	**455**
100	0	271	338	0	0	24	28	0	0	0	0	**538,050**	**3,423**	**1,334**	**3,423**
101	0	165	69	0	0	0	157	0	0	0	0	**198,900**	**1,506**	**235**	**1,506**
102	0	238	0	0	0	0	0	0	0	0	0	**202,300**	**1,834**	**0**	**1,834**
103	0	105	0	43	0	90	0	22	0	0	0	**178,650**	**1,623**	**814**	**1,623**
104	0	207	98	12	0	0	27	0	0	0	0	**262,850**	**1,962**	**367**	**1,962**
105	539	0	0	0	0	21	136	111	0	0	0	**476,000**	**162**	**1,842**	**1,842**
106	227	128	0	144	0	0	69	78	0	0	0	**344,950**	**1,390**	**1,111**	**1,390**
107	296	262	0	0	0	0	130	0	0	38	0	**474,300**	**2,019**	**923**	**2,019**
108	0	189	0	37	0	0	17	0	0	0	0	**171,750**	**1,560**	**104**	**1,560**
109	21	352	76	29	0	15	41	0	0	0	0	**403,100**	**3,168**	**521**	**3,168**
110	154	154	0	157	0	0	154	0	0	41	0	**308,900**	**1,626**	**920**	**1,626**
111	337	0	0	97	69	0	56	0	0	0	0	**374,200**	**702**	**1,752**	**1,752**
112	81	0	0	0	38	0	72	0	0	0	0	**101,150**	**237**	**489**	**489**
113	0	124	335	0	0	41	0	0	0	115	0	**425,000**	**2,411**	**1,455**	**2,411**
114	99	0	0	0	77	0	270	153	0	0	0	**149,600**	**480**	**789**	**789**
115	0	0	0	0	201	0	436	0	0	0	0	**170,850**	**1,253**	**1,253**	**1,253**
116	175	0	53	86	321	0	169	0	0	0	0	**492,450**	**2,422**	**2,967**	**2,967**
117	195	0	0	0	525	0	869	95	61	0	0	**612,000**	**3,273**	**3,880**	**3,880**
118	193	0	0	0	69	109	553	175	100	0	0	**315,350**	**1,270**	**1,872**	**1,872**
119	86	0	63	0	0	0	416	133	304	0	0	**126,650**	**214**	**482**	**482**
120	620	0	0	0	0	107	1098	131	116	0	0	**617,950**	**825**	**2,757**	**2,757**
121	174	0	0	0	0	0	0	425	0	0	0	**147,900**	**0**	**542**	**542**
122	634	0	0	0	0	0	266	0	22	0	0	**538,900**	**0**	**1,976**	**1,976**
123	369	0	0	0	0	0	0	0	0	0	0	**313,650**	**0**	**1,150**	**1,150**
124	1076	0	0	0	0	0	213	0	0	0	0	**914,600**	**0**	**3,354**	**3,354**
125	316	0	0	0	0	0	308	0	0	0	0	**268,600**	**0**	**985**	**985**
Total Area	**18,865,000**	**15,929,000**	**3,478,000**	**2,650,000**	**4,961,000**	**3,055,000**	**#######**	**2,596,000**	**927,000**	**566,000**	**1,118,000**				
Total Demand (unfactored)	**58,796**	**122,759**	**11,825**	**7,420**	**30,924**	**23,544**	**0**	**0**	**0**	**0**	**0**	**40,139,800**	**196,472**	**132,509**	**238,935**
									For St. Catharines Open Channel Totals				**47,801**	**53,203**	**70,114**

Land Use	Grapes - Wine	Tender Fruit	Nurseries	Greenhouse	Grapes - Juice	Pome Fruit	Idle Land	Cash Crops	Pasture Cattle	Other Fruit	Other		Wine Grape Usage Factor		
Colour	Green	Orange	Pink	Blue	Purple	Red	Maroon	Dark yellow	Light yellow	Brown	White		0.5		
Water Demand	0.0073	0.0091	0.0040	0.0093	0.0073	0.0091	0	0	0	0	0		Irrigation loss Factor		
Area Factor	0.85	0.85	0.85	0.3	0.85	0.85							0.75		
Node	**Area of Land Use (in 1000m^2)**											**Factored Area (m^2)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
1	0	141	0	0	0	0	0	0	0	0	0	**119,850**	**1,087**	**0**	**1,087**
2	0	362	0	0	0	0	0	0	0	0	0	**307,700**	**2,790**	**0**	**2,790**
3	0	324	0	23	144	0	0	0	0	42	0	**404,700**	**3,459**	**962**	**3,459**
4	0	25	0	26	0	0	0	0	0	0	0	**29,050**	**265**	**73**	**265**
5	413	0	0	106	0	0	0	0	0	0	0	**382,850**	**297**	**1,584**	**1,584**
6	0	102	20	0	0	0	83	0	0	42	0	**103,700**	**854**	**68**	**854**
7	104	0	31	0	0	0	0	580	0	0	0	**114,750**	**105**	**430**	**430**
8	1171	521	0	0	0	0	30	40	0	0	0	**1,438,200**	**4,015**	**3,650**	**4,015**
9	1759	0	0	0	0	0	233	0	0	0	0	**1,495,150**	**0**	**5,482**	**5,482**
10	0	400	63	0	0	0	0	20	0	0	0	**393,550**	**3,297**	**214**	**3,297**
11	0	604	24	0	0	0	0	0	0	0	0	**533,800**	**4,736**	**82**	**4,736**
12	260	256	0	0	171	0	40	0	0	0	0	**583,950**	**3,039**	**1,876**	**3,039**
13	596	314	0	0	0	0	0	0	0	0	0	**773,500**	**2,420**	**1,858**	**2,420**
14	60	398	0	0	0	0	103	0	0	0	0	**389,300**	**3,067**	**187**	**3,067**
15	0	75	0	0	0	23	20	0	0	0	0	**83,300**	**755**	**177**	**755**
16	0	88	0	0	0	0	24	0	0	0	0	**74,800**	**678**	**0**	**678**
17	0	291	0	200	0	0	24	0	0	0	0	**307,350**	**2,803**	**560**	**2,803**
18	0	118	0	40	0	0	41	0	0	0	0	**112,300**	**1,021**	**112**	**1,021**
18A	290	393	0	0	0	95	0	0	0	0	0	**661,300**	**3,761**	**1,636**	**3,761**
20	459	0	0	0	0	0	0	0	0	0	0	**390,150**	**0**	**1,431**	**1,431**
21	724	38	0	0	0	59	251	0	0	0	0	**697,850**	**748**	**2,711**	**2,711**
22	314	0	0	0	0	0	1270	0	74	0	1142	**266,900**	**0**	**979**	**979**
23	1340	0	0	0	77	0	0	190	0	0	0	**1,204,450**	**480**	**4,656**	**4,656**
24	243	0	0	0	287	0	49	0	49	0	0	**450,500**	**1,789**	**2,546**	**2,546**
25	1682	0	0	0	0	0	143	0	0	0	0	**1,429,700**	**0**	**5,242**	**5,242**
26	579	0	0	432	0	0	85	597	0	0	224	**621,750**	**1,210**	**3,014**	**3,014**
27	0	0	0	0	0	0	673	404	385	0	125	**0**	**0**	**0**	**0**
28	67	0	0	0	0	0	143	0	0	0	0	**56,950**	**0**	**209**	**209**
29	41	0	0	0	0	0	406	0	0	0	0	**34,850**	**0**	**128**	**128**
30	199	0	0	0	105	0	505	198	0	0	0	**258,400**	**655**	**1,275**	**1,275**
31	566	0	0	0	0	0	0	0	0	0	0	**481,100**	**0**	**1,764**	**1,764**
32	379	0	0	0	0	0	203	0	0	0	0	**322,150**	**0**	**1,181**	**1,181**
33	502	0	0	79	0	0	595	376	52	0	0	**450,400**	**221**	**1,786**	**1,786**
34	0	0	0	20	0	0	248	0	0	0	0	**6,000**	**56**	**56**	**56**
35	205	0	0	0	0	0	686	205	59	0	0	**174,250**	**0**	**639**	**639**
36	360	0	0	0	50	0	437	205	0	0	0	**348,500**	**312**	**1,434**	**1,434**
37	403	214	0	0	0	0	287	327	0	0	0	**524,450**	**1,649**	**1,256**	**1,649**
38	656	0	0	0	81	0	479	0	135	0	0	**626,450**	**505**	**2,549**	**2,549**
39	1005	0	0	0	0	0	76	0	0	0	0	**854,250**	**0**	**3,132**	**3,132**
40	773	462	0	0	0	0	0	0	0	0	0	**1,049,750**	**3,560**	**2,409**	**3,560**
41	155	80	0	0	0	0	74	0	0	0	0	**199,750**	**617**	**483**	**617**
42	651	0	0	0	207	0	52	0	0	0	0	**729,300**	**1,290**	**3,319**	**3,319**
43	0	82	0	0	0	0	0	0	0	0	0	**69,700**	**632**	**0**	**632**
44	979	0	0	0	0	0	104	0	0	0	0	**832,150**	**0**	**3,051**	**3,051**
45	469	394	0	98	0	0	115	0	0	0	0	**762,950**	**3,311**	**1,736**	**3,311**
46	516	0	0	0	0	0	0	110	0	0	0	**438,600**	**0**	**1,608**	**1,608**
47	494	0	0	0	0	0	0	0	0	0	0	**419,900**	**0**	**1,540**	**1,540**

Land Use	Grapes - Wine	Tender Fruit	Nurseries	Greenhouse	Grapes - Juice	Pome Fruit	Idle Land	Cash Crops	Pasture Cattle	Other Fruit	Other		Wine Grape Usage Factor		
Colour	Green	Orange	Pink	Blue	Purple	Red	Maroon	Dark yellow	Light yellow	Brown	White		0.5		
Water Demand	0.0073	0.0091	0.0040	0.0093	0.0073	0.0091	0	0	0	0	0		Irrigation loss Factor		
Area Factor	0.85	0.85	0.85	0.3	0.85	0.85							0.75		
Node	**Area of Land Use (in 1000m^2)**											**Factored Area (m^2)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
48	988	0	0	0	0	0	122	0	0	0	0	**839,800**	**0**	**3,079**	**3,079**
49	204	487	0	0	0	0	25	0	0	0	0	**587,350**	**3,753**	**636**	**3,753**
50	846	356	0	0	0	0	0	0	0	0	0	**1,021,700**	**2,744**	**2,637**	**2,744**
51	0	73	0	0	0	0	0	0	0	0	0	**62,050**	**563**	**0**	**563**
52	0	72	0	0	0	0	0	0	0	0	0	**61,200**	**555**	**0**	**555**
53	186	141	0	0	0	70	0	0	0	0	0	**337,450**	**1,626**	**1,119**	**1,626**
54	104	793	48	12	0	0	80	0	56	0	0	**806,850**	**6,308**	**521**	**6,308**
55	14	124	0	12	0	0	0	0	0	0	0	**120,900**	**989**	**77**	**989**
56	28	805	0	5	0	40	0	0	0	0	0	**743,550**	**6,526**	**410**	**6,526**
57	0	0	0	0	0	0	86	0	0	0	0	**0**	**0**	**0**	**0**
59	35	19	0	0	0	0	19	0	0	0	0	**45,900**	**146**	**109**	**146**
60	92	206	0	0	0	0	0	0	0	0	0	**253,300**	**1,588**	**287**	**1,588**
61	0	90	0	0	0	0	0	0	0	0	0	**76,500**	**694**	**0**	**694**
62	61	201	0	0	0	36	0	0	0	0	0	**253,300**	**1,826**	**468**	**1,826**
63	43	140	0	0	0	0	19	0	0	0	0	**155,550**	**1,079**	**134**	**1,079**
64	98	79	0	0	0	33	0	0	0	0	0	**178,500**	**863**	**560**	**863**
65	284	0	0	0	0	0	0	0	0	0	0	**241,400**	**0**	**885**	**885**
66	473	224	0	112	0	63	204	0	0	0	0	**679,600**	**2,525**	**2,273**	**2,525**
67	0	92	144	157	0	0	80	0	0	0	0	**247,700**	**1,638**	**929**	**1,638**
68	83	85	91	0	0	0	0	0	0	0	0	**220,150**	**964**	**568**	**964**
69	412	623	0	68	0	0	20	0	0	0	120	**900,150**	**4,992**	**1,474**	**4,992**
70	133	122	0	0	0	0	18	0	0	0	0	**216,750**	**940**	**415**	**940**
71	0	76	0	0	0	0	192	0	0	0	0	**64,600**	**586**	**0**	**586**
72	557	426	0	0	0	0	0	0	0	0	0	**835,550**	**3,283**	**1,736**	**3,283**
73	236	324	0	0	0	0	37	0	0	0	0	**476,000**	**2,497**	**736**	**2,497**
74	188	63	0	0	0	0	0	0	0	0	0	**213,350**	**486**	**586**	**586**
75	265	94	0	0	0	0	0	0	0	0	0	**305,150**	**724**	**826**	**826**
76	98	794	0	0	0	0	61	0	0	0	0	**758,200**	**6,119**	**305**	**6,119**
77	211	635	0	0	0	0	0	0	0	0	0	**719,100**	**4,894**	**658**	**4,894**
78	137	142	0	0	0	0	54	0	0	0	0	**237,150**	**1,094**	**427**	**1,094**
79	193	0	0	0	0	0	0	0	0	0	0	**164,050**	**0**	**602**	**602**
80	300	106	0	0	0	0	39	0	0	0	0	**345,100**	**817**	**935**	**935**
81	642	0	0	0	0	0	186	0	0	0	0	**545,700**	**0**	**2,001**	**2,001**
82	729	0	0	0	40	0	59	0	0	0	0	**653,650**	**249**	**2,521**	**2,521**
83	756	24	0	0	0	0	60	0	0	0	0	**663,000**	**185**	**2,356**	**2,356**
84	423	0	0	0	0	0	0	0	0	0	0	**359,550**	**0**	**1,318**	**1,318**
85	278	82	0	0	0	0	31	0	0	0	0	**306,000**	**632**	**866**	**866**
86	450	0	0	0	0	0	298	0	0	0	0	**382,500**	**0**	**1,403**	**1,403**
87	625	122	0	0	0	0	59	0	0	0	0	**634,950**	**940**	**1,948**	**1,948**
88	197	36	0	0	0	0	0	0	0	0	0	**198,050**	**277**	**614**	**614**
89	1055	0	0	0	0	0	69	0	0	0	0	**896,750**	**0**	**3,288**	**3,288**
90	299	0	0	0	40	0	116	0	0	0	0	**288,150**	**249**	**1,181**	**1,181**
91	286	110	0	0	0	0	0	0	0	0	0	**336,600**	**848**	**891**	**891**
92	528	0	0	0	0	0	321	0	0	0	0	**448,800**	**0**	**1,646**	**1,646**
93	0	156	0	0	0	0	156	146	0	0	241	**132,600**	**1,202**	**0**	**1,202**
94	168	25	0	0	0	0	541	595	0	0	0	**164,050**	**193**	**524**	**524**
95	154	0	0	0	0	42	402	0	0	0	0	**166,600**	**324**	**804**	**804**
96	237	0	0	0	410	0	624	0	0	0	0	**549,950**	**2,556**	**3,294**	**3,294**

Land Use	Grapes - Wine	Tender Fruit	Nurseries	Greenhouse	Grapes - Juice	Pome Fruit	Idle Land	Cash Crops	Pasture Cattle	Other Fruit	Other		Wine Grape Usage Factor		
Colour	Green	Orange	Pink	Blue	Purple	Red	Maroon	Dark yellow	Light yellow	Brown	White		0.5		
Water Demand	0.0073	0.0091	0.0040	0.0093	0.0073	0.0091	0	0	0	0	0		Irrigation loss Factor		
Area Factor	0.85	0.85	0.85	0.3	0.85	0.85							0.75		
Node	**Area of Land Use (in 1000m^2)**											**Factored Area (m^2)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
97	375	0	0	188	0	0	211	0	0	0	0	**375,150**	**526**	**1,695**	**1,695**
98	0	0	0	0	0	0	187	0	0	0	0	**0**	**0**	**0**	**0**
99	0	0	0	0	0	0	694	0	0	0	0	**0**	**0**	**0**	**0**
100	0	0	0	0	66	0	276	0	0	0	0	**56,100**	**411**	**411**	**411**
101	50	177	0	0	0	0	227	0	0	0	0	**192,950**	**1,364**	**156**	**1,364**
102	412	89	0	0	47	0	222	0	0	0	0	**465,800**	**979**	**1,577**	**1,577**
103	184	191	219	0	0	0	37	41	0	0	0	**504,900**	**2,217**	**1,318**	**2,217**
104	625	95	0	121	0	0	0	0	0	0	0	**648,300**	**1,071**	**2,287**	**2,287**
105	638	75	0	42	0	0	0	0	0	0	0	**618,650**	**696**	**2,106**	**2,106**
106	473	136	0	0	0	0	33	0	0	0	0	**517,650**	**1,048**	**1,474**	**1,474**
107	472	0	0	0	0	0	0	0	0	0	0	**401,200**	**0**	**1,471**	**1,471**
108	176	100	0	46	0	0	19	0	0	0	0	**248,400**	**899**	**677**	**899**
109	0	502	81	0	0	0	107	0	0	0	0	**495,550**	**4,144**	**275**	**4,144**
110	80	126	0	0	0	0	58	0	0	0	0	**175,100**	**971**	**249**	**971**
111	32	1205	0	0	0	0	0	0	0	0	0	**1,051,450**	**9,287**	**100**	**9,287**
112	10	452	270	0	0	0	44	0	0	0	0	**622,200**	**4,401**	**949**	**4,401**
113	80	129	0	0	0	0	0	0	0	0	0	**177,650**	**994**	**249**	**994**
114	118	419	20	129	0	0	45	0	0	0	0	**512,150**	**3,658**	**797**	**3,658**
115	0	405	91	53	38	36	98	0	0	0	0	**500,400**	**4,093**	**972**	**4,093**
116	0	221	54	0	0	0	0	0	0	0	0	**233,750**	**1,887**	**184**	**1,887**
117	0	237	129	0	0	0	48	0	0	0	0	**311,100**	**2,265**	**439**	**2,265**
118	379	169	0	0	0	0	107	0	0	0	0	**465,800**	**1,302**	**1,181**	**1,302**
119	0	402	0	0	0	6	0	0	0	0	0	**346,800**	**3,144**	**46**	**3,144**
120	0	88	252	0	0	0	0	0	0	0	0	**289,000**	**1,535**	**857**	**1,535**
121	71	469	193	0	101	99	105	0	0	0	0	**793,050**	**5,663**	**2,270**	**5,663**
122	303	152	0	80	0	81	400	0	83	0	0	**479,600**	**2,020**	**1,793**	**2,020**
123	70	0	0	0	37	107	256	138	0	0	0	**181,900**	**1,055**	**1,273**	**1,273**
124	0	0	0	0	0	0	73	100	0	0	0	**0**	**0**	**0**	**0**
125	134	511	0	81	0	22	326	0	0	0	0	**591,250**	**4,334**	**814**	**4,334**
126	57	144	64	0	0	0	77	0	0	0	0	**225,250**	**1,327**	**395**	**1,327**
127	0	47	0	0	0	0	181	0	0	0	189	**39,950**	**362**	**0**	**362**
128	176	339	165	0	0	0	527	0	0	0	0	**578,000**	**3,174**	**1,110**	**3,174**
129	0	44	0	0	0	0	467	0	0	0	0	**37,400**	**339**	**0**	**339**
Total Area	**36,425,000**	**20,553,000**	**1,959,000**	**2,130,000**	**1,901,000**	**812,000**	**16,282,000**	**4,272,000**	**893,000**	**84,000**	**2,041,000**				
Total Demand (unfactored)	**113,525**	**158,395**	**6,661**	**5,964**	**11,850**	**6,258**	**0**	**0**	**0**	**0**	**0**	**53,041,500**	**189,127**	**144,257**	**262,803**
											new drain	**2,189,700**	**12,794**	**4,696**	**12,794**

Areas for Separate NOTL Systems

By Drain	**Factored Area (m^2)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
Airport 1	7,359,850	30,661	17,162	30,661
Airport 3	5,795,450	11,756	19,552	19,552
Lavigne	4,621,000	5,915	19,100	19,100
Bright	3,594,650	6,458	10,569	10,569
Carlton	218,450	959	498	959
Cole	2,351,000	3,006	8,916	8,916
Four Mile Creek	6,512,900	31,687	15,772	31,687
Three Mile Creek	2,428,900	12,736	5,179	12,736
Harrison 1	6,315,900	26,350	17,192	26,350
Harrison 2	225,250	1,327	395	1,327
Harrison 4	655,350	3,875	1,110	3,875
Harrison 6	5,931,100	28,576	11,942	28,576
Routh	4,529,650	20,171	9,317	20,171
Epp	1,231,650	4,801	2,574	4,801
Excluded	*1,270,400*	*848*	*4,978*	4,978

25 mm/week full areas	**By System**	**Factored Area (m^2)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
100589.916	ABL	23,940,400	58,756	75,797	75,797
28311.55462	Four Mile Creek	6,738,150	33,015	16,167	33,015
88624.15966	Harrison	21,092,550	96,509	47,315	96,509

Land Use	Grapes - Wine	Tender Fruit	Nurseries	Greenhouse	Grapes - Juice	Pome Fruit	Idle Land	Cash Crops	Pasture Cattle	Other Fruit	Other		Wine Grape Usage Factor		
Colour	Green	Orange	Pink	Blue	Purple	Red	Maroon	Dark yellow	Light yellow	Brown	White		0.5		
Water Demand	0.0055	0.0068	0.0030	0.0070	0.0055	0.0068	0	0	0	0	0		Irrigation loss Factor		
Area Factor	0.85	0.85	0.85	0.3	0.85	0.85							1		
Node	**Area of Land Use (in 1000m^2)**											**Total Area (m^2)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
1	0	141	0	0	0	0	0	0	0	0	0	**119,850**	**815**	**0**	**815**
2	0	362	0	0	0	0	0	0	0	0	0	**307,700**	**2,092**	**0**	**2,092**
3	0	324	0	23	144	0	0	0	0	42	0	**404,700**	**2,594**	**722**	**2,594**
4	0	25	0	26	0	0	0	0	0	0	0	**29,050**	**199**	**55**	**199**
5	413	0	0	106	0	0	0	0	0	0	0	**382,850**	**223**	**1,188**	**1,188**
6	0	102	20	0	0	0	83	0	0	42	0	**103,700**	**641**	**51**	**641**
7	104	0	31	0	0	0	0	580	0	0	0	**114,750**	**79**	**322**	**322**
8	1171	521	0	0	0	0	30	40	0	0	0	**1,438,200**	**3,011**	**2,737**	**3,011**
9	1759	0	0	0	0	0	233	0	0	0	0	**1,495,150**	**0**	**4,112**	**4,112**
10	0	400	63	0	0	0	0	20	0	0	0	**393,550**	**2,473**	**161**	**2,473**
11	0	604	24	0	0	0	0	0	0	0	0	**533,800**	**3,552**	**61**	**3,552**
12	260	256	0	0	171	0	40	0	0	0	0	**583,950**	**2,279**	**1,407**	**2,279**
13	596	314	0	0	0	0	0	0	0	0	0	**773,500**	**1,815**	**1,393**	**1,815**
14	60	398	0	0	0	0	103	0	0	0	0	**389,300**	**2,300**	**140**	**2,300**
15	0	75	0	0	0	23	20	0	0	0	0	**83,300**	**566**	**133**	**566**
16	0	88	0	0	0	0	24	0	0	0	0	**74,800**	**509**	**0**	**509**
17	0	291	0	200	0	0	24	0	0	0	0	**307,350**	**2,102**	**420**	**2,102**
18	0	118	0	40	0	0	41	0	0	0	0	**112,300**	**766**	**84**	**766**
18A	290	393	0	0	0	95	0	0	0	0	0	**661,300**	**2,821**	**1,227**	**2,821**
20	459	0	0	0	0	0	0	0	0	0	0	**390,150**	**0**	**1,073**	**1,073**
21	724	38	0	0	0	59	251	0	0	0	0	**697,850**	**561**	**2,033**	**2,033**
22	314	0	0	0	0	0	1270	0	74	0	1142	**266,900**	**0**	**734**	**734**
23	1340	0	0	0	77	0	0	190	0	0	0	**1,204,450**	**360**	**3,492**	**3,492**
24	243	0	0	0	287	0	49	0	49	0	0	**450,500**	**1,342**	**1,910**	**1,910**
25	1682	0	0	0	0	0	143	0	0	0	0	**1,429,700**	**0**	**3,932**	**3,932**
26	579	0	0	432	0	0	85	597	0	0	224	**621,750**	**907**	**2,261**	**2,261**
27	0	0	0	0	0	0	673	404	385	0	125	**0**	**0**	**0**	**0**
28	67	0	0	0	0	0	143	0	0	0	0	**56,950**	**0**	**157**	**157**
29	41	0	0	0	0	0	406	0	0	0	0	**34,850**	**0**	**96**	**96**
30	199	0	0	0	105	0	505	198	0	0	0	**258,400**	**491**	**956**	**956**
31	566	0	0	0	0	0	0	0	0	0	0	**481,100**	**0**	**1,323**	**1,323**
32	379	0	0	0	0	0	203	0	0	0	0	**322,150**	**0**	**886**	**886**
33	502	0	0	79	0	0	595	376	52	0	0	**450,400**	**166**	**1,339**	**1,339**
34	0	0	0	20	0	0	248	0	0	0	0	**6,000**	**42**	**42**	**42**
35	205	0	0	0	0	0	686	205	59	0	0	**174,250**	**0**	**479**	**479**
36	360	0	0	0	50	0	437	205	0	0	0	**348,500**	**234**	**1,075**	**1,075**
37	403	214	0	0	0	0	287	327	0	0	0	**524,450**	**1,237**	**942**	**1,237**
38	656	0	0	0	81	0	479	0	135	0	0	**626,450**	**379**	**1,912**	**1,912**
39	1005	0	0	0	0	0	76	0	0	0	0	**854,250**	**0**	**2,349**	**2,349**
40	773	462	0	0	0	0	0	0	0	0	0	**1,049,750**	**2,670**	**1,807**	**2,670**
41	155	80	0	0	0	0	74	0	0	0	0	**199,750**	**462**	**362**	**462**
42	651	0	0	0	207	0	52	0	0	0	0	**729,300**	**968**	**2,489**	**2,489**
43	0	82	0	0	0	0	0	0	0	0	0	**69,700**	**474**	**0**	**474**
44	979	0	0	0	0	0	104	0	0	0	0	**832,150**	**0**	**2,288**	**2,288**
45	469	394	0	98	0	0	115	0	0	0	0	**762,950**	**2,483**	**1,302**	**2,483**
46	516	0	0	0	0	0	0	110	0	0	0	**438,600**	**0**	**1,206**	**1,206**
47	494	0	0	0	0	0	0	0	0	0	0	**419,900**	**0**	**1,155**	**1,155**

Land Use	Grapes - Wine	Tender Fruit	Nurseries	Greenhouse	Grapes - Juice	Pome Fruit	Idle Land	Cash Crops	Pasture Cattle	Other Fruit	Other		Wine Grape Usage Factor		
Colour	Green	Orange	Pink	Blue	Purple	Red	Maroon	Dark yellow	Light yellow	Brown	White		0.5		
Water Demand	0.0055	0.0068	0.0030	0.0070	0.0055	0.0068	0	0	0	0	0		Irrigation loss Factor		
Area Factor	0.85	0.85	0.85	0.3	0.85	0.85							1		
Node	**Area of Land Use (in 1000m^2)**											**Total Area (m^2)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
48	988	0	0	0	0	0	122	0	0	0	0	**839,800**	**0**	**2,309**	**2,309**
49	204	487	0	0	0	0	25	0	0	0	0	**587,350**	**2,815**	**477**	**2,815**
50	846	356	0	0	0	0	0	0	0	0	0	**1,021,700**	**2,058**	**1,978**	**2,058**
51	0	73	0	0	0	0	0	0	0	0	0	**62,050**	**422**	**0**	**422**
52	0	72	0	0	0	0	0	0	0	0	0	**61,200**	**416**	**0**	**416**
53	186	141	0	0	0	70	0	0	0	0	0	**337,450**	**1,220**	**839**	**1,220**
54	104	793	48	12	0	0	80	0	56	0	0	**806,850**	**4,731**	**391**	**4,731**
55	14	124	0	12	0	0	0	0	0	0	0	**120,900**	**742**	**58**	**742**
56	28	805	0	5	0	40	0	0	0	0	0	**743,550**	**4,895**	**307**	**4,895**
57	0	0	0	0	0	0	86	0	0	0	0	**0**	**0**	**0**	**0**
59	35	19	0	0	0	0	19	0	0	0	0	**45,900**	**110**	**82**	**110**
60	92	206	0	0	0	0	0	0	0	0	0	**253,300**	**1,191**	**215**	**1,191**
61	0	90	0	0	0	0	0	0	0	0	0	**76,500**	**520**	**0**	**520**
62	61	201	0	0	0	36	0	0	0	0	0	**253,300**	**1,370**	**351**	**1,370**
63	43	140	0	0	0	0	19	0	0	0	0	**155,550**	**809**	**101**	**809**
64	98	79	0	0	0	33	0	0	0	0	0	**178,500**	**647**	**420**	**647**
65	284	0	0	0	0	0	0	0	0	0	0	**241,400**	**0**	**664**	**664**
66	473	224	0	112	0	63	204	0	0	0	0	**679,600**	**1,894**	**1,705**	**1,894**
67	0	92	144	157	0	0	80	0	0	0	0	**247,700**	**1,229**	**697**	**1,229**
68	83	85	91	0	0	0	0	0	0	0	0	**220,150**	**723**	**426**	**723**
69	412	623	0	68	0	0	20	0	0	0	120	**900,150**	**3,744**	**1,106**	**3,744**
70	133	122	0	0	0	0	18	0	0	0	0	**216,750**	**705**	**311**	**705**
71	0	76	0	0	0	0	192	0	0	0	0	**64,600**	**439**	**0**	**439**
72	557	426	0	0	0	0	0	0	0	0	0	**835,550**	**2,462**	**1,302**	**2,462**
73	236	324	0	0	0	0	37	0	0	0	0	**476,000**	**1,873**	**552**	**1,873**
74	188	63	0	0	0	0	0	0	0	0	0	**213,350**	**364**	**439**	**439**
75	265	94	0	0	0	0	0	0	0	0	0	**305,150**	**543**	**619**	**619**
76	98	794	0	0	0	0	61	0	0	0	0	**758,200**	**4,589**	**229**	**4,589**
77	211	635	0	0	0	0	0	0	0	0	0	**719,100**	**3,670**	**493**	**3,670**
78	137	142	0	0	0	0	54	0	0	0	0	**237,150**	**821**	**320**	**821**
79	193	0	0	0	0	0	0	0	0	0	0	**164,050**	**0**	**451**	**451**
80	300	106	0	0	0	0	39	0	0	0	0	**345,100**	**613**	**701**	**701**
81	642	0	0	0	0	0	186	0	0	0	0	**545,700**	**0**	**1,501**	**1,501**
82	729	0	0	0	40	0	59	0	0	0	0	**653,650**	**187**	**1,891**	**1,891**
83	756	24	0	0	0	0	60	0	0	0	0	**663,000**	**139**	**1,767**	**1,767**
84	423	0	0	0	0	0	0	0	0	0	0	**359,550**	**0**	**989**	**989**
85	278	82	0	0	0	0	31	0	0	0	0	**306,000**	**474**	**650**	**650**
86	450	0	0	0	0	0	298	0	0	0	0	**382,500**	**0**	**1,052**	**1,052**
87	625	122	0	0	0	0	59	0	0	0	0	**634,950**	**705**	**1,461**	**1,461**
88	197	36	0	0	0	0	0	0	0	0	0	**198,050**	**208**	**460**	**460**
89	1055	0	0	0	0	0	69	0	0	0	0	**896,750**	**0**	**2,466**	**2,466**
90	299	0	0	0	40	0	116	0	0	0	0	**288,150**	**187**	**886**	**886**
91	286	110	0	0	0	0	0	0	0	0	0	**336,600**	**636**	**669**	**669**
92	528	0	0	0	0	0	321	0	0	0	0	**448,800**	**0**	**1,234**	**1,234**
93	0	156	0	0	0	0	156	146	0	0	241	**132,600**	**902**	**0**	**902**
94	168	25	0	0	0	0	541	595	0	0	0	**164,050**	**145**	**393**	**393**
95	154	0	0	0	0	42	402	0	0	0	0	**166,600**	**243**	**603**	**603**
96	237	0	0	0	410	0	624	0	0	0	0	**549,950**	**1,917**	**2,471**	**2,471**

Land Use	Grapes - Wine	Tender Fruit	Nurseries	Greenhouse	Grapes - Juice	Pome Fruit	Idle Land	Cash Crops	Pasture Cattle	Other Fruit	Other				
Colour	Green	Orange	Pink	Blue	Purple	Red	Maroon	Dark yellow	Light yellow	Brown	White				
Water Demand	0.0055	0.0068	0.0030	0.0070	0.0055	0.0068	0	0	0	0	0				
Area Factor	0.85	0.85	0.85	0.3	0.85	0.85									
Node	**Area of Land Use (in 1000m^2)**											**Total Area (m^2)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
97	375	0	0	188	0	0	211	0	0	0	0	**375,150**	**395**	**1,271**	**1,271**
98	0	0	0	0	0	0	187	0	0	0	0	**0**	**0**	**0**	**0**
99	0	0	0	0	0	0	694	0	0	0	0	**0**	**0**	**0**	**0**
100	0	0	0	0	66	0	276	0	0	0	0	**56,100**	**309**	**309**	**309**
101	50	177	0	0	0	0	227	0	0	0	0	**192,950**	**1,023**	**117**	**1,023**
102	412	89	0	0	47	0	222	0	0	0	0	**465,800**	**734**	**1,183**	**1,183**
103	184	191	219	0	0	0	37	41	0	0	0	**504,900**	**1,662**	**989**	**1,662**
104	625	95	0	121	0	0	0	0	0	0	0	**648,300**	**803**	**1,715**	**1,715**
105	638	75	0	42	0	0	0	0	0	0	0	**618,650**	**522**	**1,580**	**1,580**
106	473	136	0	0	0	0	33	0	0	0	0	**517,650**	**786**	**1,106**	**1,106**
107	472	0	0	0	0	0	0	0	0	0	0	**401,200**	**0**	**1,103**	**1,103**
108	176	100	0	46	0	0	19	0	0	0	0	**248,400**	**675**	**508**	**675**
109	0	502	81	0	0	0	107	0	0	0	0	**495,550**	**3,108**	**207**	**3,108**
110	80	126	0	0	0	0	58	0	0	0	0	**175,100**	**728**	**187**	**728**
111	32	1205	0	0	0	0	0	0	0	0	0	**1,051,450**	**6,965**	**75**	**6,965**
112	10	452	270	0	0	0	44	0	0	0	0	**622,200**	**3,301**	**712**	**3,301**
113	80	129	0	0	0	0	0	0	0	0	0	**177,650**	**746**	**187**	**746**
114	118	419	20	129	0	0	45	0	0	0	0	**512,150**	**2,744**	**598**	**2,744**
115	0	405	91	53	38	36	98	0	0	0	0	**500,400**	**3,070**	**729**	**3,070**
116	0	221	54	0	0	0	0	0	0	0	0	**233,750**	**1,415**	**138**	**1,415**
117	0	237	129	0	0	0	48	0	0	0	0	**311,100**	**1,699**	**329**	**1,699**
118	379	169	0	0	0	0	107	0	0	0	0	**465,800**	**977**	**886**	**977**
119	0	402	0	0	0	6	0	0	0	0	0	**346,800**	**2,358**	**35**	**2,358**
120	0	88	252	0	0	0	0	0	0	0	0	**289,000**	**1,151**	**643**	**1,151**
121	71	469	193	0	101	99	105	0	0	0	0	**793,050**	**4,247**	**1,703**	**4,247**
122	303	152	0	80	0	81	400	0	83	0	0	**479,600**	**1,515**	**1,344**	**1,515**
123	70	0	0	0	37	107	256	138	0	0	0	**181,900**	**791**	**955**	**955**
124	0	0	0	0	0	0	73	100	0	0	0	**0**	**0**	**0**	**0**
125	134	511	0	81	0	22	326	0	0	0	0	**591,250**	**3,251**	**610**	**3,251**
126	57	144	64	0	0	0	77	0	0	0	0	**225,250**	**996**	**296**	**996**
127	0	47	0	0	0	0	181	0	0	0	189	**39,950**	**272**	**0**	**272**
128	176	339	165	0	0	0	527	0	0	0	0	**578,000**	**2,380**	**832**	**2,380**
129	0	44	0	0	0	0	467	0	0	0	0	**37,400**	**254**	**0**	**254**
Total Area	**36,425,000**	**20,553,000**	**1,959,000**	**2,130,000**	**1,901,000**	**812,000**	**16,282,000**	**4,272,000**	**893,000**	**84,000**	**2,041,000**	**53,041,500**	**141,845**	**108,192**	**197,102**
Total Demand (unfactored)	**85,143**	**118,796**	**4,995**	**4,473**	**8,887**	**4,693**	**0**	**0**	**0**	**0**	**0**				

Wine Grape Usage Factor: 0.5
Irrigation loss Factor: 1

By Area	Factored Area (m^2)	Demand 1 (m3/d)	Demand 2 (m3/d)	MAX 1 and 2
E-1,2 Booster 1	2,709,200	3,010	9,020	9,020

Land Use	Grapes - Wine	Tender Fruit	Nurseries	Greenhouse	Grapes - Juice	Pome Fruit	Idle Land	Cash Crops	Pasture Cattle	Other Fruit	Other		Wine Grape Usage Factor		
Colour	Green	Orange	Pink	Blue	Purple	Red	Maroon	Dark yellow	Light yellow	Brown	White		0.5		
Water Demand	0.0055	0.0068	0.0030	0.0070	0.0055	0.0068	0	0	0	0	0		Irrigation loss Factor		
Area Factor	0.85	0.85	0.85	0.3	0.85	0.85							1		
Node	**Area of Land Use (in 1000m²)**											**Total Area (m²)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
1	753	0	0	0	81	0	222	0	33	0	0	**708,900**	**379**	**2,139**	**2,139**
2	235	128	0	0	0	197	390	0	0	37	0	**476,000**	**1,879**	**1,688**	**1,879**
3	0	69	0	0	0	0	0	0	0	0	0	**58,650**	**399**	**0**	**399**
4	0	149	0	67	0	0	25	0	0	0	0	**146,750**	**1,002**	**141**	**1,002**
5	0	0	40	0	0	0	0	0	0	0	0	**34,000**	**102**	**102**	**102**
6	0	230	0	0	0	20	0	0	0	0	0	**212,500**	**1,445**	**116**	**1,445**
7	0	209	0	0	0	0	0	0	0	0	0	**177,650**	**1,208**	**0**	**1,208**
8	62	84	0	0	0	169	230	0	0	0	0	**267,750**	**1,462**	**1,122**	**1,462**
9	0	314	0	19	0	0	0	0	0	0	0	**272,600**	**1,855**	**40**	**1,855**
10	100	12	0	0	0	0	0	0	0	0	0	**95,200**	**69**	**234**	**234**
10A	0	244	0	39	0	53	87	0	0	0	0	**264,150**	**1,799**	**388**	**1,799**
11	0	238	0	0	0	0	0	0	0	0	0	**202,300**	**1,376**	**0**	**1,376**
12	60	65	14	0	0	0	30	0	0	0	0	**118,150**	**411**	**176**	**411**
13	118	148	0	0	0	0	65	0	0	0	0	**226,100**	**855**	**276**	**855**
14	0	154	0	107	0	0	0	0	0	0	0	**163,000**	**1,115**	**225**	**1,115**
15	35	64	0	42	0	0	0	0	0	0	0	**96,750**	**458**	**170**	**458**
16	90	138	0	0	0	0	0	0	0	0	0	**193,800**	**798**	**210**	**798**
17	76	51	0	39	0	0	0	0	0	0	0	**119,650**	**377**	**260**	**377**
18	81	64	0	141	0	0	0	0	0	0	0	**165,550**	**666**	**485**	**666**
19	105	0	0	0	67	0	0	0	0	0	0	**146,200**	**313**	**559**	**559**
20	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	**0**
21	11	221	0	0	0	0	0	0	0	0	0	**197,200**	**1,277**	**26**	**1,277**
22	16	33	0	0	12	0	0	0	0	0	0	**51,850**	**247**	**94**	**247**
23	71	112	0	0	0	45	352	0	0	0	0	**193,800**	**907**	**426**	**907**
24	0	61	0	0	0	0	53	0	0	0	0	**51,850**	**353**	**0**	**353**
25	0	0	0	0	0	52	283	0	0	0	0	**44,200**	**301**	**301**	**301**
26	349	0	0	0	0	0	105	0	0	0	0	**296,650**	**0**	**816**	**816**
27	198	0	0	26	0	0	335	0	0	0	0	**176,100**	**55**	**517**	**517**
28	191	41	0	0	44	0	21	0	0	0	0	**234,600**	**443**	**652**	**652**
29	134	86	0	0	0	0	45	0	0	0	0	**187,000**	**497**	**313**	**497**
30	79	0	0	0	0	63	0	210	0	0	0	**120,700**	**364**	**549**	**549**
31	191	216	0	0	0	0	0	0	0	125	0	**345,950**	**1,248**	**446**	**1,248**
32	78	0	0	0	0	115	104	0	0	0	0	**164,050**	**665**	**847**	**847**
33	0	0	0	103	77	0	0	0	0	0	0	**96,350**	**576**	**576**	**576**
34	0	0	0	40	0	0	40	0	0	0	0	**12,000**	**84**	**84**	**84**
35	55	0	0	0	0	0	252	0	0	0	0	**46,750**	**0**	**129**	**129**
36	204	0	0	17	0	60	567	0	0	0	0	**229,500**	**383**	**859**	**859**
37	0	37	0	0	0	36	53	0	0	0	0	**62,050**	**422**	**208**	**422**
38	0	0	0	0	0	0	129	0	0	0	0	**0**	**0**	**0**	**0**
39	163	0	0	0	0	0	119	0	0	0	0	**138,550**	**0**	**381**	**381**
40	700	70	116	10	0	0	224	0	0	0	0	**756,100**	**721**	**1,953**	**1,953**
41	176	106	0	0	81	118	325	0	0	0	132	**408,850**	**1,673**	**1,472**	**1,673**
42	165	20	0	15	0	0	30	0	0	0	0	**161,750**	**147**	**417**	**417**
44	220	50	0	0	18	74	187	55	0	0	0	**307,700**	**801**	**1,026**	**1,026**
45	821	159	0	0	0	0	425	0	49	0	0	**833,000**	**919**	**1,919**	**1,919**
46	144	52	0	0	180	25	169	0	61	0	0	**340,850**	**1,287**	**1,323**	**1,323**
47	181	117	0	0	0	39	131	0	0	0	0	**286,450**	**902**	**649**	**902**

Land Use	Grapes - Wine	Tender Fruit	Nurseries	Greenhouse	Grapes - Juice	Pome Fruit	Idle Land	Cash Crops	Pasture Cattle	Other Fruit	Other		Wine Grape Usage Factor		
Colour	Green	Orange	Pink	Blue	Purple	Red	Maroon	Dark yellow	Light yellow	Brown	White		0.5		
Water Demand	0.0055	0.0068	0.0030	0.0070	0.0055	0.0068	0	0	0	0	0		Irrigation loss Factor		
Area Factor	0.85	0.85	0.85	0.3	0.85	0.85							1		
Node	**Area of Land Use (in 1000m^2)**											**Total Area (m^2)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
48	175	0	0	0	119	24	223	158	0	0	0	**270,300**	**695**	**1,104**	**1,104**
49	83	0	0	0	117	0	233	0	0	0	653	**170,000**	**547**	**741**	**741**
50	0	0	0	0	0	0	50	0	0	0	0	**0**	**0**	**0**	**0**
51	304	197	0	12	66	0	142	57	0	0	0	**485,550**	**1,472**	**1,044**	**1,472**
52	0	402	0	0	0	467	78	0	0	0	0	**738,650**	**5,023**	**2,699**	**5,023**
53	420	64	0	0	208	169	193	0	0	0	0	**731,850**	**2,319**	**2,931**	**2,931**
54	405	0	0	41	238	0	46	0	0	0	0	**558,850**	**1,199**	**2,145**	**2,145**
55	581	0	0	112	0	0	202	0	0	0	0	**527,450**	**235**	**1,593**	**1,593**
56	121	221	0	0	0	0	99	267	0	0	0	**290,700**	**1,277**	**283**	**1,277**
57	47	346	0	0	0	184	91	0	0	0	0	**490,450**	**3,063**	**1,173**	**3,063**
58	81	519	0	0	0	0	0	24	0	0	0	**510,000**	**3,000**	**189**	**3,000**
59	0	140	0	0	0	0	85	0	0	0	0	**119,000**	**809**	**0**	**809**
60	0	340	0	0	0	0	0	0	0	0	0	**289,000**	**1,965**	**0**	**1,965**
61	0	445	89	0	0	0	0	0	0	0	0	**453,900**	**2,799**	**227**	**2,799**
62	35	742	0	0	20	35	182	0	0	0	0	**707,200**	**4,585**	**378**	**4,585**
63	0	370	0	0	0	0	0	0	0	0	0	**314,500**	**2,139**	**0**	**2,139**
64	0	302	61	47	0	0	0	0	0	0	0	**322,650**	**2,000**	**254**	**2,000**
65	0	162	463	0	0	0	9	0	0	47	0	**531,250**	**2,117**	**1,181**	**2,117**
66	0	555	0	0	0	0	69	0	0	62	0	**471,750**	**3,208**	**0**	**3,208**
67	68	489	166	0	0	0	0	0	0	0	0	**614,550**	**3,250**	**582**	**3,250**
68	0	186	0	27	0	15	156	0	0	40	0	**178,950**	**1,218**	**143**	**1,218**
69	0	0	0	0	0	0	334	0	0	0	0	**0**	**0**	**0**	**0**
70	61	123	0	0	0	0	42	0	0	0	0	**156,400**	**711**	**143**	**711**
71	54	26	0	0	0	27	75	0	0	0	226	**90,950**	**306**	**282**	**306**
72	0	40	0	71	0	0	91	0	0	0	0	**55,300**	**380**	**149**	**380**
73	0	132	51	70	0	0	0	0	0	0	0	**176,550**	**1,040**	**277**	**1,040**
74	0	397	0	0	0	10	0	0	0	0	0	**345,950**	**2,352**	**58**	**2,352**
75	0	1036	12	11	0	39	0	0	0	0	0	**927,250**	**6,267**	**279**	**6,267**
76	156	399	0	37	0	0	111	0	0	0	0	**482,850**	**2,384**	**442**	**2,384**
77	28	0	124	0	0	20	13	0	0	0	0	**146,200**	**432**	**497**	**497**
78	0	968	127	0	0	0	0	0	0	61	0	**930,750**	**5,919**	**324**	**5,919**
79	46	0	0	0	129	0	49	0	0	0	107	**148,750**	**603**	**711**	**711**
80	171	511	138	49	199	32	71	0	0	0	0	**908,050**	**4,524**	**1,970**	**4,524**
81	0	295	0	158	200	69	352	0	87	0	0	**526,800**	**3,371**	**1,666**	**3,371**
82	269	92	132	385	0	93	94	0	63	0	0	**613,600**	**2,214**	**2,311**	**2,311**
83	637	0	0	96	197	0	0	99	0	0	0	**737,700**	**1,123**	**2,612**	**2,612**
85	373	0	0	0	313	0	0	0	0	0	0	**583,100**	**1,463**	**2,335**	**2,335**
86	315	0	0	0	21	314	0	0	0	0	0	**552,500**	**1,913**	**2,649**	**2,649**
87	193	0	0	0	198	72	379	0	0	0	0	**393,550**	**1,342**	**1,793**	**1,793**
88	624	97	20	0	0	0	0	0	0	0	0	**629,850**	**612**	**1,510**	**1,510**
89	324	0	165	0	104	0	72	0	0	0	0	**504,050**	**907**	**1,664**	**1,664**
90	191	0	0	0	428	0	179	0	0	0	0	**526,150**	**2,001**	**2,447**	**2,447**
91	98	0	0	0	0	0	294	0	0	0	0	**83,300**	**0**	**229**	**229**
92	712	0	0	0	544	0	0	403	0	0	0	**1,067,600**	**2,543**	**4,208**	**4,208**
93	405	0	0	0	0	0	217	0	0	0	0	**344,250**	**0**	**947**	**947**
94	151	0	0	0	0	0	0	0	0	0	0	**128,350**	**0**	**353**	**353**
95	0	0	315	83	0	0	84	0	31	0	0	**292,650**	**978**	**978**	**978**
96	146	109	163	32	0	0	167	0	0	0	0	**364,900**	**1,113**	**824**	**1,113**

Land Use	Grapes - Wine	Tender Fruit	Nurseries	Greenhouse	Grapes - Juice	Pome Fruit	Idle Land	Cash Crops	Pasture Cattle	Other Fruit	Other		Wine Grape Usage Factor		
Colour	Green	Orange	Pink	Blue	Purple	Red	Maroon	Dark yellow	Light yellow	Brown	White		0.5		
Water Demand	0.0055	0.0068	0.0030	0.0070	0.0055	0.0068	0	0	0	0	0		Irrigation loss Factor		
Area Factor	0.85	0.85	0.85	0.3	0.85	0.85							1		
Node	**Area of Land Use (in 1000m²)**											**Total Area (m²)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
97	0	180	250	149	0	0	112	0	0	0	0	**410,200**	**1,991**	**950**	**1,991**
98	137	60	0	0	0	0	88	0	0	0	0	**167,450**	**347**	**320**	**347**
99	0	47	0	0	0	12	57	0	0	0	0	**50,150**	**341**	**69**	**341**
100	0	271	338	0	0	24	28	0	0	0	0	**538,050**	**2,567**	**1,001**	**2,567**
101	0	165	69	0	0	0	157	0	0	0	0	**198,900**	**1,130**	**176**	**1,130**
102	0	238	0	0	0	0	0	0	0	0	0	**202,300**	**1,376**	**0**	**1,376**
103	0	105	0	43	0	90	0	22	0	0	0	**178,650**	**1,217**	**611**	**1,217**
104	0	207	98	12	0	0	27	0	0	0	0	**262,850**	**1,472**	**275**	**1,472**
105	539	0	0	0	0	21	136	111	0	0	0	**476,000**	**121**	**1,381**	**1,381**
106	227	128	0	144	0	0	69	78	0	0	0	**344,950**	**1,042**	**833**	**1,042**
107	296	262	0	0	0	0	130	0	0	38	0	**474,300**	**1,514**	**692**	**1,514**
108	0	189	0	37	0	0	17	0	0	0	0	**171,750**	**1,170**	**78**	**1,170**
109	21	352	76	29	0	15	41	0	0	0	0	**403,100**	**2,376**	**390**	**2,376**
110	154	154	0	157	0	0	154	0	0	41	0	**308,900**	**1,220**	**690**	**1,220**
111	337	0	0	97	69	0	56	0	0	0	0	**374,200**	**526**	**1,314**	**1,314**
112	81	0	0	0	38	0	72	0	0	0	0	**101,150**	**178**	**367**	**367**
113	0	124	335	0	0	41	0	0	0	115	0	**425,000**	**1,808**	**1,091**	**1,808**
114	99	0	0	0	77	0	270	153	0	0	0	**149,600**	**360**	**591**	**591**
115	0	0	0	0	201	0	436	0	0	0	0	**170,850**	**940**	**940**	**940**
116	175	0	53	86	321	0	169	0	0	0	0	**492,450**	**1,816**	**2,225**	**2,225**
117	195	0	0	0	525	0	869	95	61	0	0	**612,000**	**2,454**	**2,910**	**2,910**
118	193	0	0	0	69	109	553	175	100	0	0	**315,350**	**953**	**1,404**	**1,404**
119	86	0	63	0	0	0	416	133	304	0	0	**126,650**	**161**	**362**	**362**
120	620	0	0	0	0	107	1098	131	116	0	0	**617,950**	**618**	**2,068**	**2,068**
121	174	0	0	0	0	0	0	425	0	0	0	**147,900**	**0**	**407**	**407**
122	634	0	0	0	0	0	266	0	22	0	0	**538,900**	**0**	**1,482**	**1,482**
123	369	0	0	0	0	0	0	0	0	0	0	**313,650**	**0**	**863**	**863**
124	1076	0	0	0	0	0	213	0	0	0	0	**914,600**	**0**	**2,515**	**2,515**
125	316	0	0	0	0	0	308	0	0	0	0	**268,600**	**0**	**739**	**739**
Total Area	**18,865,000**	**15,929,000**	**3,478,000**	**2,650,000**	**4,961,000**	**3,055,000**	**15,222,000**	**2,596,000**	**927,000**	**566,000**	**1,118,000**	**40,139,800**	**147,354**	**99,381**	**179,201**
Total Demand (unfactored)	**44,097**	**92,070**	**8,869**	**5,565**	**23,193**	**17,658**	**0**	**0**	**0**	**0**	**0**				

By Area	**Factored Area (m²)**	**Demand 1 (m3/d)**	**Demand 2 (m3/d)**	**MAX 1 and 2**
W-2 West	18,822,450	75,870	41,124	87,164
W-2 East	21,317,350	71,484	58,258	92,037
W-4 West	26,442,300	111,503	59,479	126,616
W-1,2,3 Booster 2	25,476,500	96,285	61,166	116,838
W-4 Booster 2	11,779,000	60,434	21,263	64,252
W-1,2 Booster 1	2,801,600	618	8,073	8,073

APPENDIX C

Open Channel Capacity Survey Calculations

NIAGARA IRRIGATION STUDY - 1611-10576
Ditch Capacity Calculations

INPUT								CALCULATED VALUES				
ID #	Manning's 'n'	Channel Slope	Left Side Slope m/m	Right Side Slope m/m	Bottom Width m	Flow Depth m	lhs-rhs = Calculations are correct when lhs-rhs = 0	Velocity m/s	Area m^2	Wetted Perimeter m	Hydraulic Radius '(r) m	Flow m^3/s
			[3 means 3:1]									
249	0.035	0.3%	2	2	0.3	0.350	0	0.55	0.350	1.865	0.188	0.191
250	0.035	0.3%	4	4	1	0.200	0	0.44	0.360	2.649	0.136	0.159
252	0.035	0.3%	2	2	1	0.450	0	0.72	0.855	3.012	0.284	0.615
253	0.035	0.3%	4	4	0.5	0.250	0	0.46	0.375	2.562	0.146	0.174
255	0.035	0.3%	4	4	1	0.250	0	0.50	0.500	3.062	0.163	0.249
256	0.035	0.3%	2	2	0.5	0.250	0	0.48	0.250	1.618	0.155	0.120
257	0.035	0.3%	3	3	0.5	0.350	0	0.57	0.543	2.714	0.200	0.309
258	0.035	0.3%	3	3	0.65	0.400	0	0.63	0.740	3.180	0.233	0.466
259	0.035	0.3%	3	3	0.5	0.300	0	0.52	0.420	2.397	0.175	0.219
260	0.035	0.3%	2	2	0.5	0.350	0	0.58	0.420	2.065	0.203	0.242
261	0.035	0.3%	2	2	0.75	0.350	0	0.61	0.508	2.315	0.219	0.307
262	0.035	0.3%	2	2	0.6	0.550	0	0.76	0.935	3.060	0.306	0.707
264	0.035	0.3%	2	2	0.3	0.300	0	0.50	0.270	1.642	0.164	0.135
265	0.03	0.3%	2	2	0.3	0.350	0	0.64	0.350	1.865	0.188	0.223
269	0.035	0.3%	2	2	0.3	0.250	0	0.45	0.200	1.418	0.141	0.090
270	0.035	0.3%	2	3	0.6	0.250	0	0.49	0.306	1.950	0.157	0.149
274	0.035	0.5%	2	2	1	0.450	0	0.87	0.855	3.012	0.284	0.746
280	0.035	0.5%	2	2	1	0.300	0	0.70	0.480	2.342	0.205	0.337
290	0.035	0.5%	2	2	1.5	0.500	0	0.97	1.250	3.736	0.335	1.217
295	0.035	1.1%	2	2	0	0.300	0	0.79	0.180	1.342	0.134	0.141
296	0.035	1.1%	2	2	0.2	0.450	0	1.10	0.495	2.212	0.224	0.547
300	0.035	0.5%	2	1	1	0.300	0	0.71	0.435	2.095	0.208	0.308
306	0.035	0.5%	1	5	2.5	0.200	0	0.60	0.620	3.803	0.163	0.374
310	0.03	0.3%	3	3	0.2	0.300	0	0.54	0.330	2.097	0.157	0.179
312	0.03	0.5%	4	4	0.3	0.450	0	0.90	0.945	4.011	0.236	0.850
313	0.03	0.5%	2	3	0.6	0.300	0	0.76	0.405	2.220	0.182	0.307
313	0.03	0.3%	3	3	0.3	0.300	0	0.57	0.360	2.197	0.164	0.206
314	0.03	0.3%	5	5	0.2	0.200	0	0.43	0.240	2.240	0.107	0.104
328	0.035	0.5%	2	2	2	1.300	0	1.69	5.980	7.814	0.765	10.108
336	0.035	0.3%	3	3	1.7	0.500	0	0.78	1.600	4.862	0.329	1.252
342	0.035	0.5%	4	4	1	0.200	0	0.53	0.360	2.649	0.136	0.192
349	0.035	0.3%	3	3	0.5	0.300	0	0.51	0.420	2.397	0.175	0.216
352	0.035	0.5%	3	2	0.75	0.300	0	0.67	0.450	2.370	0.190	0.300
355	0.035	0.5%	3	3	1.5	0.300	0	0.72	0.720	3.397	0.212	0.517
358	0.035	0.5%	4	4	0.5	0.450	0	0.79	1.035	4.211	0.246	0.820
367	0.035	0.5%	5	4	0.2	0.200	0	0.46	0.220	2.044	0.108	0.101
375	0.035	0.5%	3	3	0.2	0.300	0	0.59	0.330	2.097	0.157	0.194
378	0.035	0.5%	3	3	0.2	0.450	0	0.76	0.698	3.046	0.229	0.527
380	0.03	0.3%	4	4	1	0.300	0	0.61	0.660	3.474	0.190	0.405
380	0.035	0.5%	3	3	1.5	0.300	0	0.72	0.720	3.397	0.212	0.517
385	0.03	0.5%	2	2	0.3	0.500	0	0.95	0.650	2.536	0.256	0.618
407	0.035	0.2%	2	2	0.2	0.300	0	0.37	0.240	1.542	0.156	0.089

NIAGARA IRRIGATION STUDY - 1611-10576
Culvert Capacity Calculations

INPUT								CALCULATED VALUES				
ID #	Manning's 'n'	Channel Slope	Diameter m	Theta	Alpha	Flow Depth m	lhs-rhs = Calculations are correct when lhs-rhs = 0	Velocity m/s	Area m^2	Wetted Perimeter m	Hydraulic Radius '(r) m	Flow m^3/s
355	0.024	0.5%	0.9	0.00222	3.14604	0.449	0	1.09	0.317	1.411717	0.225	0.345
299	0.024	0.5%	1.2	0.16745	3.47649	0.500	0	1.22	0.446	1.684018	0.265	0.542
274	0.024	0.5%	1.8	0.5236	4.18879	0.450	0	1.21	0.497	1.884956	0.264	0.603
358	0.024	0.5%	2.1	0.60825	4.35808	0.450	0	1.23	0.544	2.021357	0.269	0.669
384	0.024	0.5%	1.5	0.41152	3.96463	0.450	0	1.19	0.446	1.738919	0.256	0.530
302	0.024	0.5%	0.9	0.00222	3.14604	0.449	0	1.09	0.317	1.411717	0.225	0.345
362	0.024	0.5%	0.75	-0.3398	2.46192	0.500	0	1.07	0.313	1.432975	0.218	0.334
363	0.024	0.5%	1.2	0.16745	3.47649	0.500	0	1.22	0.446	1.684018	0.265	0.542
329	0.024	0.5%	1.5	0.06672	3.27502	0.700	0	1.49	0.809	2.25612	0.358	1.202
352	0.024	0.5%	0.6	-0.7297	1.68214	0.500	0	0.95	0.252	1.380314	0.182	0.239
357	0.024	0.5%	0.6	-0.7297	1.68214	0.500	0	0.95	0.252	1.380314	0.182	0.239
316	0.013	0.5%	0.9	0.11134	3.36427	0.400	0	1.91	0.273	1.31351	0.208	0.522

NIAGARA IRRIGATION STUDY - 1611-10576
Culvert Capacity Calculations

ID #	Qty.	Shape	Material	Size		Length	Slope	Conveyance capacity
				Depth	Width			
				mm	mm	m	%	m^3/s
Typical D/W Culv	1	Circular	CSP		300	5.5	0.5	0.049
Typical D/W Culv	1	Circular	CSP		350	5.5	0.5	0.072
Typical D/W Culv	1	Circular	CSP		400	5.5	0.5	0.101
270	2	Circular	CSP		400	11	0.5	0.190
278	1	Box	Conc	1300	1800	10	0.5	3.320
355	1	Circular	CSP		900	10	0.5	0.798
299	1	Circular	CSP		1200	19	0.5	1.554
274	1	Circular	CSP		1800	10	0.5	4.556
350	1	Box	Conc	500	500	15	0.5	0.213
365	1	Circular	CSP		1500	10	0.5	2.890
362	2	Circular	CSP		700	6	0.5	0.420
305	1	Box	Conc	1830	2440	10	0.5	7.513
352	1	Circular	CSP		750	6	0.5	0.508
379	1	Circular	CSP		500	100	0.5	0.152
379	1	Circular	CSP		500	100	0.3	0.128
379	1	Circular	CSP		500	100	0.2	0.114

Note: Lengths are assumed to be a typical rural road unless otherwise noted
All slopes assumed to be 0.5%

Existing Drains					
ID #	Type	Flow m^3/d	Demand m^3/d	% of Capacity m/m	Type of work needed none, minor, major, new
249	chan	16512	5226	32%	minor
250	chan	13696	5226	38%	minor
252	chan	53151	5226	10%	minor
253	chan	14993	5226	35%	minor
255	chan	21503	5226	24%	minor
256	chan	10362	5226	50%	minor
257	chan	26699	5226	20%	minor
258	chan	40300	5226	13%	minor
259	chan	18928	5226	28%	minor
260	chan	20907	5226	25%	minor
261	chan	26557	5226	20%	minor
262	chan	61060	5226	9%	minor
264	chan	11666	5226	45%	minor
265	chan	19264	5226	27%	minor
269	chan	7800	5226	67%	minor
270	chan	12834	5226	41%	minor
274	chan	64455	2720	4%	none
280	chan	29129	22347	77%	major
290	chan	105157	19255	18%	none
295	chan	12213	20394	167%	none
296	chan	47232	20394	43%	none
300	chan	26624	20394	77%	minor
306	chan	32299	20394	63%	none
310	chan	15422	13980	91%	major
312	chan	73414	0	0%	none
313	chan	26534	13980	53%	major
313	chan	17833	13980	78%	major
314	chan	8958	13981	156%	major
328	chan	873357	7946	1%	none
336	chan	108146	5226	5%	none
342	chan	16609	5226	31%	none
349	chan	18648	5226	28%	minor
352	chan	25953	22347	86%	major
355	chan	44674	19255	43%	none
358	chan	70891	22347	32%	none
367	chan	8688	5482	63%	minor
374	chan	-	10602	-	new
375	chan	16788	10602	63%	major
378	chan	45570	10602	23%	none
380	chan	34976	10602	30%	none
380	chan	44674	10602	24%	none
385	chan	53410	10603	20%	none
407	chan	7668	5071	66%	major
408	chan	-	5071	-	new

Existing Culverts Flowing Partial (no flooding)					
ID #	Type	Flow m^3/d	Demand m^3/d	% of Capacity m/m	Type of work needed none, minor, major, new
355	culv	29841	19255	65%	none
299	culv	46830	20394	44%	none
274	culv	52107	2720	5%	none
358	culv	57760	22347	39%	none
384	culv	45810	10602	23%	none
302	culv	29841	20394	68%	none
362	culv	28879	5482	19%	none
363	culv	46830	5482	12%	none
329	culv	103863	7946	8%	none
352	culv	20613	22347	108%	upsize to 1200
357	culv	20613	22347	108%	upsize to 1200
316	culv	45066	13980	31%	none
270	culv	16416	5226	32%	none
350	box	18403	5226	28%	none
379	culv	13133	10602	81%	none

Existing Culverts Flowing Full					
ID #	Type	Flow m^3/d	Demand m^3/d	% of Capacity m/m	Type of work needed none, minor, major, new
253	culv	4234	5226	123%	upsize to 400
255	culv	4234	5226	123%	upsize to 400
258	culv	6221	5226	84%	upsize to 400
262	culv	13133	5226	40%	none
264	culv	6221	5226	84%	upsize to 400
265	culv	6221	5226	84%	upsize to 400
310	culv	4234	13980	330%	upsize to 750
313	culv	6221	13980	225%	upsize to 750
313	culv	6221	13980	225%	upsize to 750
313	culv	6221	13980	225%	upsize to 750
313	culv	6221	13980	225%	upsize to 750
313	culv	6221	13980	225%	upsize to 750
313	culv	6221	13980	225%	upsize to 750
313	culv	6221	13980	225%	upsize to 750
321	box	4000	13980	350%	replace box
375	culv	4234	10602	250%	upsize to 600
377	culv	6221	10603	170%	upsize to 600
377	culv	6221	10604	170%	upsize to 600
377	culv	6221	10605	170%	upsize to 600

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APPENDIX D

CD of Survey Pictures

If you wish to view the pictures contained in this report, please contact the Regional Municipality of Niagara or Stantec Consulting Ltd.

APPENDIX E

Open Channel Survey Expanded Drawing – Picture Locations and Notes

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APPENDIX F

Model Output Tables for Piped Network Alternatives

APPENDIX F

Alternative W1

Scenario: Scenerio 1
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-2	965.00	300.0	PVC	140.0	1,401	141.94	141.76	0.19	0.19	0.23
P-3	661.00	300.0	PVC	140.0	399	141.76	141.74	0.01	0.02	0.07
P-4	400.00	150.0	PVC	140.0	102	136.32	136.30	0.02	0.04	0.07
P-5	661.00	150.0	PVC	140.0	452	136.32	135.86	0.46	0.69	0.30
P-6	845.00	300.0	PVC	140.0	-5,419	141.94	143.94	2.00	2.36	0.89
P-7	969.00	450.0	PVC	140.0	-11,650	143.94	145.25	1.31	1.35	0.85
P-8	733.00	300.0	PVC	140.0	-1,855	142.15	142.39	0.24	0.32	0.30
P-9	829.00	300.0	PVC	140.0	-4,769	142.39	143.94	1.54	1.86	0.78
P-10	937.00	300.0	PVC	140.0	1,115	142.39	142.27	0.12	0.13	0.18
P-12	662.00	150.0	PVC	140.0	-2,132	137.31	145.44	8.13	12.28	1.40
P-13	964.00	450.0	PVC	140.0	-17,047	145.44	148.07	2.64	2.74	1.24
P-14	805.00	150.0	PVC	140.0	-756	135.86	137.31	1.45	1.80	0.50
P-15	502.00	450.0	PVC	140.0	-11,795	148.07	148.77	0.69	1.38	0.86
P-16	839.00	450.0	PVC	140.0	-12,253	148.77	150.01	1.25	1.48	0.89
P-17	510.00	350.0	PVC	140.0	6,427	150.01	149.23	0.78	1.53	0.77
P-18	849.00	350.0	PVC	140.0	6,050	149.23	148.07	1.16	1.37	0.73
P-19	818.00	450.0	PVC	140.0	-19,346	150.01	152.84	2.83	3.46	1.41
P-20	229.00	450.0	PVC	140.0	-19,905	152.84	153.68	0.84	3.65	1.45
P-21	841.00	450.0	PVC	140.0	-21,182	153.68	157.12	3.44	4.09	1.54
P-22	877.00	900.0	PVC	140.0	-177,318	157.12	163.39	6.27	7.15	3.23
P-24	847.00	300.0	PVC	140.0	6,356	157.12	154.43	2.69	3.17	1.04
P-25	175.00	300.0	PVC	140.0	6,055	154.43	153.93	0.51	2.90	0.99
P-26	852.00	350.0	PVC	140.0	353	153.93	153.92	0.01	0.01	0.04
P-27	833.00	300.0	PVC	140.0	5,702	153.93	151.76	2.16	2.59	0.93
P-28	956.00	350.0	PVC	140.0	517	151.76	151.75	0.01	0.01	0.06
P-29	1,007.00	150.0	PVC	140.0	-1,089	148.82	152.38	3.56	3.54	0.71
P-30	473.00	150.0	PVC	140.0	84	152.38	152.37	0.01	0.03	0.06
P-31	822.00	300.0	PVC	140.0	-1,302	152.38	152.52	0.14	0.17	0.21
P-32	722.00	900.0	PVC	140.0	-148,451	152.52	156.24	3.72	5.15	2.70
P-34	789.00	150.0	PVC	140.0	230	148.82	148.67	0.16	0.20	0.15
P-35	1,383.00	350.0	PVC	140.0	7,489	148.67	145.86	2.81	2.03	0.90
P-36	839.00	350.0	PVC	140.0	5,536	145.86	144.89	0.97	1.16	0.67
P-37	1,568.00	350.0	PVC	140.0	-4,290	144.89	146.02	1.13	0.72	0.52
P-38	1,025.00	350.0	PVC	140.0	-13,508	146.02	152.22	6.20	6.05	1.62
P-39	657.00	150.0	PVC	140.0	263	152.22	152.05	0.17	0.26	0.17

Scenario: Scenerio 1
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-40	811.00	900.0	PVC	140.0	116,021	148.67	146.02	2.64	3.26	2.11
P-41	842.00	750.0	PVC	140.0	21,815	152.52	152.22	0.30	0.36	0.57
P-42	813.00	350.0	PVC	140.0	7,906	144.89	143.06	1.82	2.24	0.95
P-43	1,447.00	350.0	PVC	140.0	552	143.06	143.04	0.02	0.02	0.07
P-44	809.00	900.0	PVC	140.0	-123,917	143.04	146.02	2.98	3.68	2.25
P-45	826.00	750.0	PVC	140.0	7,018	152.22	152.18	0.04	0.04	0.18
P-46	1,061.00	350.0	PVC	140.0	16,354	152.18	143.04	9.14	8.62	1.97
P-47	1,681.00	150.0	PVC	140.0	-154	152.05	152.21	0.16	0.09	0.10
P-48	527.00	150.0	PVC	140.0	-154	152.21	152.26	0.05	0.09	0.10
P-49	879.00	350.0	PVC	140.0	4,424	143.06	142.39	0.67	0.77	0.53
P-50	1,777.00	350.0	PVC	140.0	-5,616	142.39	144.51	2.12	1.19	0.68
P-51	1,032.00	300.0	PVC	140.0	-7,209	144.51	148.64	4.13	4.01	1.18
P-52	815.00	250.0	PVC	140.0	0	148.64	134.99	0.00	0.00	0.00
P-53	1,042.00	350.0	PVC	140.0	-1,277	134.99	135.07	0.08	0.08	0.15
P-54	784.00	900.0	PVC	140.0	-142,589	135.07	138.82	3.75	4.78	2.59
P-55	1,598.00	350.0	PVC	140.0	-7,894	138.82	142.39	3.57	2.24	0.95
P-56	1,030.00	350.0	PVC	140.0	-23,427	135.07	152.34	17.27	16.77	2.82
P-57	805.00	750.0	PVC	140.0	11,132	152.34	152.26	0.08	0.10	0.29
P-58	918.00	900.0	PVC	140.0	-139,718	138.82	143.04	4.22	4.60	2.54
P-59	869.00	750.0	PVC	140.0	10,238	152.26	152.18	0.08	0.09	0.27
P-60	875.00	300.0	PVC	140.0	-10,209	148.64	155.32	6.68	7.63	1.67
P-61	1,663.00	750.0	PVC	140.0	-36,032	152.34	153.86	1.51	0.91	0.94
P-62	432.00	750.0	PVC	140.0	-36,841	153.86	154.27	0.41	0.95	0.97
P-63	605.00	150.0	PVC	140.0	0	154.27	165.68	0.00	0.00	0.00
P-68	939.00	600.0	PVC	140.0	33,966	158.56	156.29	2.27	2.42	1.39
P-70	584.00	150.0	PVC	140.0	-497	148.75	149.23	0.48	0.83	0.33
P-71	853.00	300.0	PVC	140.0	6,357	149.23	146.52	2.71	3.17	1.04
P-72	864.00	300.0	PVC	140.0	4,843	146.52	144.87	1.66	1.92	0.79
P-73	626.00	300.0	PVC	140.0	3,392	144.87	144.25	0.62	0.99	0.56
P-74	779.00	150.0	PVC	140.0	-306	148.97	149.23	0.26	0.34	0.20
P-75	805.00	150.0	PVC	140.0	-380	146.12	146.52	0.41	0.50	0.25
P-77	2,042.00	300.0	PVC	140.0	-4,786	146.52	150.35	3.83	1.88	0.78
P-79	2,037.00	300.0	PVC	140.0	-4,816	144.87	148.73	3.87	1.90	0.79
P-80	759.00	400.0	PVC	140.0	-711	152.62	152.63	0.01	0.01	0.07
P-81	837.00	750.0	PVC	140.0	65,111	152.63	150.35	2.28	2.72	1.71

Scenario: Scenerio 1
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-82	869.00	750.0	PVC	140.0	53,144	150.35	148.73	1.62	1.87	1.39
P-84	1,026.00	600.0	PVC	140.0	8,184	147.28	147.10	0.18	0.17	0.34
P-85	1,015.00	600.0	PVC	140.0	5,737	147.10	147.01	0.09	0.09	0.23
P-87	1,383.00	400.0	PVC	140.0	2,649	150.44	150.23	0.21	0.15	0.24
P-88	1,001.00	400.0	PVC	140.0	3,810	150.35	150.05	0.30	0.30	0.35
P-90	867.00	400.0	PVC	140.0	6,959	150.05	149.25	0.80	0.92	0.64
P-91	973.00	400.0	PVC	140.0	5,166	149.25	148.73	0.52	0.53	0.48
P-92	1,031.00	600.0	PVC	140.0	-7,952	147.11	147.28	0.17	0.16	0.33
P-93	795.00	150.0	PVC	140.0	-1,040	141.66	144.25	2.58	3.25	0.68
P-94	1,039.00	600.0	PVC	140.0	5,508	147.01	146.93	0.09	0.08	0.23
P-95	536.00	600.0	PVC	140.0	4,208	146.93	146.90	0.03	0.05	0.17
P-96	678.00	600.0	PVC	140.0	353	146.93	146.93	0.00	0.00	0.01
P-97	970.00	350.0	PVC	140.0	848	143.89	143.85	0.03	0.04	0.10
P-99	1,110.00	350.0	PVC	140.0	-130	143.85	143.85	0.00	0.00	0.02
P-100	908.00	350.0	PVC	140.0	-2,121	143.85	144.03	0.18	0.20	0.26
P-101	853.00	350.0	PVC	140.0	1,961	144.03	143.89	0.14	0.17	0.24
P-102	1,439.00	350.0	PVC	140.0	341	144.03	144.02	0.01	0.01	0.04
P-103	347.00	300.0	PVC	140.0	-1,376	144.59	144.65	0.06	0.19	0.23
P-104	807.00	350.0	PVC	140.0	503	144.65	144.64	0.01	0.01	0.06
P-105	695.00	350.0	PVC	140.0	4,770	144.64	144.03	0.61	0.88	0.57
P-106	915.00	350.0	PVC	140.0	-2,457	144.64	144.88	0.24	0.26	0.30
P-107	1,035.00	350.0	PVC	140.0	-3,587	144.88	145.42	0.54	0.52	0.43
P-108	889.00	350.0	PVC	140.0	-510	145.42	145.43	0.01	0.01	0.06
P-109	807.00	350.0	PVC	140.0	-2,926	145.43	145.72	0.29	0.36	0.35
P-110	425.00	400.0	PVC	140.0	-5,418	145.72	145.96	0.25	0.58	0.50
P-111	395.00	400.0	PVC	140.0	-7,805	145.96	146.41	0.45	1.14	0.72
P-112	873.00	400.0	PVC	140.0	-6,442	146.41	147.11	0.70	0.80	0.59
P-113	1,020.00	350.0	PVC	140.0	-3,669	145.42	145.97	0.55	0.54	0.44
P-114	836.00	750.0	PVC	140.0	-7,335	145.97	146.01	0.04	0.05	0.19
P-115	854.00	750.0	PVC	140.0	-13,328	146.01	146.13	0.12	0.14	0.35
P-116	815.00	750.0	PVC	140.0	-28,084	146.13	146.60	0.47	0.57	0.74
P-117	868.00	750.0	PVC	140.0	-33,384	146.60	147.28	0.68	0.79	0.87
P-118	1,020.00	400.0	PVC	140.0	-2,877	146.41	146.60	0.18	0.18	0.26
P-119	968.00	350.0	PVC	140.0	-3,236	145.72	146.13	0.42	0.43	0.39
P-120	1,019.00	350.0	PVC	140.0	-3,768	145.43	146.01	0.58	0.57	0.45

Scenario: Scenerio 1
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-122	1,031.00	750.0	PVC	140.0	10,300	146.13	146.04	0.09	0.09	0.27
P-123	1,047.00	400.0	PVC	140.0	1,381	146.60	146.55	0.05	0.05	0.13
P-124	631.00	750.0	PVC	140.0	367	146.04	146.04	0.00	0.00	0.01
P-125	823.00	750.0	PVC	140.0	8,619	146.04	145.99	0.05	0.06	0.23
P-129	862.00	500.0	PVC	140.0	-739	175.44	175.44	0.00	0.00	0.04
P-130	836.00	500.0	PVC	140.0	3,957	175.44	175.35	0.09	0.11	0.23
P-131	813.00	500.0	PVC	140.0	407	175.35	175.35	0.00	0.00	0.02
P-132	1,031.00	500.0	PVC	140.0	1,482	175.35	175.33	0.02	0.02	0.09
P-133	759.00	500.0	PVC	140.0	863	175.44	175.44	0.00	0.01	0.05
P-135	3,067.00	500.0	PVC	140.0	0	145.99	175.35	0.00	0.00	0.00
P-136	784.00	600.0	PVC	140.0	30,758	156.29	154.72	1.58	2.01	1.26
P-137	433.00	750.0	PVC	140.0	38,806	154.72	154.27	0.45	1.04	1.02
P-138	917.00	300.0	PVC	140.0	10,187	161.69	154.72	6.97	7.60	1.67
P-139	1,075.00	300.0	PVC	140.0	6,196	161.69	158.43	3.25	3.03	1.01
P-140	826.00	300.0	PVC	140.0	3,368	158.43	157.62	0.81	0.98	0.55
P-142	826.00	900.0	PVC	140.0	-125,701	158.56	161.69	3.12	3.78	2.29
P-145	493.00	300.0	PVC	140.0	2,150	157.62	157.41	0.21	0.43	0.35
P-146	581.00	900.0	PVC	140.0	-88,485	157.41	158.56	1.15	1.97	1.61
P-147	813.00	300.0	PVC	140.0	-9,544	149.23	154.71	5.48	6.74	1.56
P-148	1,236.00	900.0	PVC	140.0	81,091	154.71	152.63	2.08	1.68	1.48
P-151	580.00	150.0	PVC	140.0	0	156.29	200.00	0.00	0.00	0.00
P-152	1,082.00	150.0	PVC	140.0	0	200.00	143.89	0.00	0.00	0.00
P-153	857.00	750.0	PVC	140.0	5,709	145.99	145.96	0.03	0.03	0.15
P-154	858.00	600.0	PVC	140.0	362	145.96	145.96	0.00	0.00	0.01
P-156	479.00	750.0	PVC	140.0	2,727	145.97	145.96	0.00	0.01	0.07
P-157	552.00	750.0	PVC	140.0	2,727	145.96	145.96	0.00	0.01	0.07
P-161	891.00	300.0	PVC	140.0	4,369	151.76	150.35	1.41	1.58	0.72
P-162	837.00	150.0	PVC	140.0	2,113	150.35	140.24	10.11	12.08	1.38
P-163	836.00	150.0	PVC	140.0	576	140.24	139.33	0.91	1.09	0.38
P-164	852.00	150.0	PVC	140.0	1,107	143.00	139.90	3.11	3.65	0.72
P-165	836.00	150.0	PVC	140.0	847	139.90	138.04	1.86	2.22	0.55
P-166	1,014.00	150.0	PVC	140.0	-1,604	143.00	150.35	7.35	7.25	1.05
P-167	1,127.00	150.0	PVC	140.0	-289	139.90	140.24	0.34	0.30	0.19
P-168	123.00	450.0	PVC	140.0	12,505	145.44	145.25	0.19	1.54	0.91
P-169	170.00	900.0	PVC	140.0	148,873	157.12	156.24	0.88	5.18	2.71

Scenario: Scenerio 1
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-170	1,067.00	300.0	PVC	140.0	-547	158.40	158.43	0.04	0.03	0.09
P-171	1,789.00	300.0	PVC	140.0	-1,058	145.76	145.96	0.21	0.11	0.17
P-173	1,002.00	400.0	PVC	140.0	10,745	152.63	150.56	2.07	2.07	0.99
P-174	210.00	400.0	PVC	140.0	5,261	150.56	150.44	0.12	0.55	0.48
P-175	856.00	400.0	PVC	140.0	5,484	150.56	150.05	0.51	0.59	0.51
P-176	837.00	150.0	PVC	140.0	-1,999	136.32	145.44	9.12	10.90	1.31
P-177	1,031.00	900.0	PVC	140.0	124,953	152.52	148.67	3.86	3.74	2.27
P-178	1,047.00	350.0	PVC	140.0	-4,376	144.64	145.43	0.79	0.75	0.53
P-179	921.00	900.0	PVC	140.0	177,565	170.00	163.39	6.61	7.17	3.23
P-180	1,095.00	300.0	PVC	140.0	-3,351	144.65	145.72	1.06	0.97	0.55
P-185	832.00	750.0	PVC	140.0	51,184	148.73	147.28	1.45	1.74	1.34
P-186	437.00	900.0	PVC	140.0	-144,084	161.69	163.82	2.13	4.87	2.62
P-187	711.00	300.0	PVC	140.0	13,008	163.82	155.32	8.50	11.95	2.13
P-188	327.00	900.0	PVC	140.0	157,092	165.68	163.82	1.87	5.72	2.86
P-189	765.00	600.0	PVC	140.0	8,074	145.96	145.83	0.13	0.17	0.33
P-190	2,296.00	600.0	PVC	140.0	8,074	175.83	175.44	0.39	0.17	0.33
P-191	1,491.00	900.0	PVC	150.0	90,635	157.41	154.71	2.71	1.82	1.65
P-192	1,300.00	900.0	PVC	140.0	161,677	135.07	127.23	7.84	6.03	2.94
P-193	384.00	900.0	PVC	140.0	161,677	168.00	165.68	2.32	6.03	2.94
P-194	1,969.00	300.0	PVC	150.0	2,139	141.94	141.21	0.73	0.37	0.35
P-195	2,643.00	600.0	PVC	150.0	0	200.00	172.98	0.00	0.00	0.00
P-196	686.00	600.0	PVC	150.0	0	172.98	145.96	0.00	0.00	0.00
P-197	456.00	150.0	PVC	150.0	0	200.00	193.86	0.00	0.00	0.00
P-198	268.00	150.0	PVC	150.0	0	193.86	187.72	0.00	0.00	0.00
P-199	509.00	150.0	PVC	150.0	0	187.72	181.58	0.00	0.00	0.00
P-200	196.00	150.0	PVC	150.0	0	181.58	175.44	0.00	0.00	0.00
P-201	349.00	150.0	PVC	150.0	0	200.00	193.86	0.00	0.00	0.00
P-202	494.00	150.0	PVC	150.0	0	193.86	187.72	0.00	0.00	0.00
P-203	508.00	150.0	PVC	150.0	0	187.72	181.58	0.00	0.00	0.00
P-204	992.00	150.0	PVC	150.0	0	181.58	175.44	0.00	0.00	0.00

Scenario: Scenerio 1
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m³/day)	Calculated Hydraulic Grade (m)	Pressure (psi)
J-1	110.00	2,139	141.11	44.160
J-2	113.00	1,879	141.94	41.081
J-3	92.00	399	141.74	70.608
J-4	91.00	1,002	141.76	72.045
J-5	90.00	102	136.30	65.719
J-6	89.00	1,445	136.32	67.163
J-7	81.00	1,208	135.86	77.868
J-8	95.00	1,462	143.94	69.464
J-9	98.00	1,855	142.15	62.675
J-10A	93.00	1,799	142.39	70.110
J-11	79.00	1,376	137.31	82.765
J-12	89.00	411	145.44	80.110
J-13	87.00	855	145.25	82.679
J-14	84.00	1,115	142.27	82.717
J-15	83.00	458	148.77	93.357
J-16	80.00	798	148.07	96.629
J-17	79.00	377	149.23	99.696
J-18	83.00	666	150.01	95.125
J-19	82.00	559	152.84	100.560
J-21	83.00	1,277	153.68	100.326
J-22	80.00	247	163.39	118.375
J-23	83.00	907	157.12	105.210
J-24	80.00	353	153.92	104.925
J-25	83.00	301	154.43	101.396
J-25A	80.00	0	153.93	104.934
J-26	83.00	816	151.76	97.608
J-27	78.00	517	151.75	104.685
J-28	83.00	652	150.35	95.604
J-29	78.00	497	143.00	92.271
J-30	77.00	549	139.90	89.282
J-31	83.00	1,248	140.24	81.251
J-32	78.00	847	138.04	85.226
J-33	81.00	576	139.33	82.799
J-34	87.00	84	152.37	92.791
J-35	90.00	129	152.38	88.553
J-36	96.00	859	148.82	74.979
J-37	83.00	422	156.24	103.962
J-39	88.00	381	152.52	91.588
J-40	110.00	1,953	145.86	50.902
J-41	96.00	1,673	148.67	74.757
J-42	85.00	417	152.05	95.180
J-44	85.00	1,026	152.22	95.418
J-45	110.00	1,919	144.89	49.521
J-46	91.00	1,323	146.02	78.100
J-47	84.00	902	152.18	96.786
J-48	86.00	1,104	143.04	80.967
J-49	85.00	741	152.26	95.475
J-50	84.00	0	152.21	96.824
J-51	83.00	1,472	152.34	98.432
J-52	90.50	5,023	138.82	68.583
J-53	110.00	2,931	143.06	46.933
J-54	111.00	2,145	142.39	44.559

Scenario: Scenerio 1
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m^3/day)	Calculated Hydraulic Grade (m)	Pressure (psi)
J-55	110.00	1,593	144.51	48.981
J-56	98.00	1,277	134.99	52.507
J-57	90.00	3,063	135.07	63.976
J-58	95.00	3,000	148.64	76.141
J-59	85.00	809	153.86	97.739
J-60	86.00	1,965	154.27	96.900
J-61	96.00	2,799	155.32	84.199
J-62	94.00	4,585	165.68	101.754
J-63	90.00	2,139	154.72	91.863
J-64	95.00	2,000	161.69	94.659
J-65	96.00	2,117	158.43	88.622
J-66	84.00	3,208	156.29	102.618
J-67	95.00	3,250	158.56	90.224
J-68	96.00	1,218	157.62	87.474
J-70	101.00	711	158.40	81.473
J-71	86.00	306	148.60	88.856
J-72	85.50	380	145.75	85.521
J-73	86.00	1,040	141.29	78.486
J-74	87.00	2,352	143.88	80.734
J-75	87.00	6,267	144.50	81.615
J-76	88.00	2,384	148.86	86.390
J-77	91.00	497	148.38	81.445
J-78	88.00	5,919	146.15	82.547
J-79	100.00	711	152.25	74.167
J-80	100.00	4,524	152.26	74.182
J-81	101.00	3,371	149.98	69.531
J-82	92.00	2,311	148.36	80.004
J-83	102.00	2,612	150.07	68.240
J-85	100.00	2,335	149.68	70.521
J-86	103.00	2,649	149.86	66.517
J-87	101.00	1,793	148.88	67.964
J-88	86.00	1,510	146.74	86.224
J-89	90.00	1,664	146.91	80.786
J-90	98.00	2,447	146.74	69.178
J-91	101.00	229	146.64	64.791
J-92	120.00	4,208	146.53	37.660
J-93	118.00	947	146.56	40.537
J-94	125.00	353	146.56	30.601
J-95	88.00	978	143.48	78.755
J-96	88.00	1,113	143.52	78.805
J-97	87.00	1,991	143.48	80.177
J-98	85.00	347	143.66	83.268
J-99	89.00	341	143.65	77.577
J-100	90.00	2,567	144.27	77.039
J-101	90.00	1,130	144.51	77.374
J-102	91.00	1,376	144.22	75.544
J-103	90.50	1,217	145.39	77.912
J-104	90.00	1,472	144.28	77.055
J-105	95.00	1,381	146.18	72.648
J-106	92.00	1,042	146.23	76.975
J-107	91.00	1,514	146.04	78.134
J-108	91.00	1,170	145.59	77.493

Scenario: Scenerio 1
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m^3/day)	Calculated Hydraulic Grade (m)	Pressure (psi)
J-109	90.00	2,376	145.35	78.562
J-110	94.00	1,220	145.76	73.473
J-111	107.00	1,314	145.67	54.889
J-112	109.00	367	145.67	52.050
J-113	91.00	1,808	145.06	76.735
J-114	90.00	591	145.05	78.136
J-115	100.00	940	145.60	64.725
J-116	97.00	2,225	145.64	69.040
J-117	99.00	2,910	145.62	66.170
J-118	105.00	0	145.59	57.617
J-119	107.00	362	145.59	54.777
J-120	120.00	2,068	174.98	78.045
J-121	117.00	407	174.98	82.302
J-122	128.00	1,482	174.96	66.663
J-123	130.00	863	175.07	63.973
J-124	123.00	2,515	175.07	73.917
J-125	113.00	739	175.07	88.105
J-126	100.00	0	145.59	64.720
J-129	95.00	0	157.41	88.595
J-130	90.00	0	154.34	91.324
J-136	95.00	0	163.82	97.681
J-137	105.00	0	172.80	96.233
J-138	98.00	0	150.19	74.082
J-139	108.00	0	193.77	121.744
J-140	110.00	0	187.53	110.058
J-141	113.00	0	181.30	96.952
J-142	115.00	0	193.77	111.807
J-143	117.00	0	187.53	100.121
J-144	117.00	0	181.30	91.274

Stantec

APPENDIX F

Alternative W2

Scenario: Scenario 2
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-2	965.00	750.0	PVC	140.0	1,401	128.76	128.76	0.00	0.00	0.04
P-3	661.00	750.0	PVC	140.0	399	128.76	128.76	0.00	0.00	0.01
P-4	400.00	400.0	PVC	140.0	102	128.83	128.83	0.00	0.00	0.01
P-5	661.00	400.0	PVC	140.0	452	128.83	128.83	0.00	0.01	0.04
P-6	845.00	750.0	PVC	140.0	-5,419	128.76	128.78	0.02	0.03	0.14
P-7	969.00	750.0	PVC	140.0	-11,650	128.78	128.89	0.11	0.11	0.31
P-8	733.00	750.0	PVC	140.0	-1,855	128.76	128.76	0.00	0.00	0.05
P-9	829.00	750.0	PVC	140.0	-4,769	128.76	128.78	0.02	0.02	0.12
P-10	937.00	750.0	PVC	140.0	1,115	128.76	128.76	0.00	0.00	0.03
P-12	662.00	400.0	PVC	140.0	-2,132	128.84	128.91	0.07	0.10	0.20
P-13	964.00	400.0	PVC	140.0	-17,047	128.91	133.59	4.68	4.86	1.57
P-14	805.00	400.0	PVC	140.0	-756	128.83	128.84	0.01	0.02	0.07
P-15	502.00	400.0	PVC	140.0	-8,882	133.59	134.32	0.73	1.45	0.82
P-16	839.00	400.0	PVC	140.0	-9,340	134.32	135.66	1.34	1.59	0.86
P-17	510.00	400.0	PVC	140.0	9,340	135.66	134.84	0.81	1.59	0.86
P-18	849.00	400.0	PVC	140.0	8,963	134.84	133.59	1.25	1.48	0.83
P-19	818.00	400.0	PVC	140.0	-19,346	135.66	140.68	5.02	6.14	1.78
P-20	229.00	400.0	PVC	140.0	-19,905	140.68	142.16	1.48	6.47	1.83
P-21	841.00	400.0	PVC	140.0	-21,182	142.16	148.27	6.11	7.26	1.95
P-22	877.00	900.0	PVC	140.0	-124,893	148.27	151.54	3.28	3.74	2.27
P-24	847.00	300.0	PVC	140.0	6,356	148.27	145.58	2.69	3.17	1.04
P-25	175.00	300.0	PVC	140.0	6,055	145.58	145.07	0.51	2.90	0.99
P-26	852.00	150.0	PVC	140.0	353	145.07	144.70	0.37	0.44	0.23
P-27	833.00	250.0	PVC	140.0	5,702	145.07	139.82	5.25	6.31	1.34
P-28	956.00	150.0	PVC	140.0	517	139.82	138.97	0.85	0.89	0.34
P-29	1,007.00	150.0	PVC	140.0	-434	144.46	145.10	0.65	0.64	0.28
P-30	473.00	150.0	PVC	140.0	84	145.10	145.09	0.01	0.03	0.06
P-31	822.00	150.0	PVC	140.0	-647	145.10	146.21	1.11	1.35	0.42
P-32	722.00	900.0	PVC	140.0	-96,026	146.21	147.87	1.66	2.30	1.75
P-34	789.00	150.0	PVC	140.0	-425	144.46	144.94	0.49	0.62	0.28
P-35	1,383.00	450.0	PVC	140.0	7,636	144.94	144.09	0.86	0.62	0.56
P-36	839.00	450.0	PVC	140.0	5,683	144.09	143.79	0.30	0.36	0.41
P-37	1,568.00	450.0	PVC	140.0	-4,759	143.79	144.19	0.40	0.26	0.35
P-38	1,025.00	500.0	PVC	140.0	-16,548	144.19	145.78	1.59	1.55	0.98
P-39	657.00	150.0	PVC	140.0	255	145.78	145.62	0.16	0.24	0.17

Scenario: Scenario 2
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-40	811.00	900.0	PVC	140.0	58,819	144.94	144.19	0.75	0.93	1.07
P-41	842.00	750.0	PVC	140.0	26,445	146.21	145.78	0.43	0.51	0.69
P-42	813.00	450.0	PVC	140.0	8,523	143.79	143.17	0.62	0.76	0.62
P-43	1,447.00	450.0	PVC	140.0	-443	143.17	143.18	0.00	0.00	0.03
P-44	809.00	900.0	PVC	140.0	-69,285	143.18	144.19	1.02	1.26	1.26
P-45	826.00	750.0	PVC	140.0	8,616	145.78	145.73	0.05	0.06	0.23
P-46	1,061.00	500.0	PVC	140.0	20,975	145.73	143.18	2.55	2.40	1.24
P-47	1,681.00	150.0	PVC	140.0	-162	145.62	145.80	0.17	0.10	0.11
P-48	527.00	150.0	PVC	140.0	-162	145.80	145.85	0.05	0.10	0.11
P-49	879.00	450.0	PVC	140.0	6,035	143.17	142.82	0.35	0.40	0.44
P-50	1,777.00	450.0	PVC	140.0	-5,556	142.82	143.43	0.61	0.34	0.40
P-51	1,032.00	450.0	PVC	140.0	-7,149	143.43	144.00	0.56	0.55	0.52
P-52	815.00	350.0	PVC	140.0	8,781	144.00	141.78	2.22	2.72	1.06
P-53	1,042.00	350.0	PVC	140.0	7,504	141.78	139.65	2.12	2.04	0.90
P-54	784.00	900.0	PVC	140.0	-93,137	139.65	141.36	1.70	2.17	1.69
P-55	1,598.00	450.0	PVC	140.0	-9,446	141.36	142.82	1.47	0.92	0.69
P-56	1,030.00	500.0	PVC	140.0	-34,808	139.65	145.98	6.33	6.14	2.05
P-57	805.00	750.0	PVC	140.0	14,164	145.98	145.85	0.13	0.16	0.37
P-58	918.00	900.0	PVC	140.0	-88,714	141.36	143.18	1.82	1.98	1.61
P-59	869.00	750.0	PVC	140.0	13,261	145.85	145.73	0.12	0.14	0.35
P-60	875.00	350.0	PVC	140.0	-18,930	144.00	153.88	9.89	11.30	2.28
P-61	1,663.00	750.0	PVC	140.0	-50,444	145.98	148.80	2.82	1.69	1.32
P-62	432.00	750.0	PVC	140.0	-51,253	148.80	149.56	0.75	1.75	1.34
P-63	605.00	450.0	PVC	140.0	0	149.56	167.36	0.00	0.00	0.00
P-68	939.00	500.0	PVC	140.0	22,793	159.69	157.06	2.63	2.81	1.34
P-70	584.00	300.0	PVC	140.0	-497	153.89	153.90	0.02	0.03	0.08
P-71	853.00	300.0	PVC	140.0	4,790	153.90	152.30	1.60	1.88	0.78
P-72	864.00	300.0	PVC	140.0	3,769	152.30	151.26	1.04	1.21	0.62
P-73	626.00	300.0	PVC	140.0	3,392	151.26	150.64	0.62	0.99	0.56
P-74	779.00	300.0	PVC	140.0	-306	153.89	153.90	0.01	0.01	0.05
P-75	805.00	300.0	PVC	140.0	-380	152.29	152.30	0.01	0.02	0.06
P-77	2,042.00	300.0	PVC	140.0	-5,277	152.30	156.89	4.59	2.25	0.86
P-79	2,037.00	300.0	PVC	140.0	-5,890	151.26	156.87	5.61	2.76	0.96
P-80	759.00	300.0	PVC	140.0	-711	156.98	157.02	0.04	0.05	0.12
P-81	837.00	750.0	PVC	140.0	13,824	157.02	156.89	0.13	0.15	0.36

Scenario: Scenario 2
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-82	869.00	750.0	PVC	140.0	4,890	156.89	156.87	0.02	0.02	0.13
P-84	1,026.00	750.0	PVC	140.0	8,184	156.87	156.81	0.06	0.06	0.21
P-85	1,015.00	750.0	PVC	140.0	5,737	156.81	156.78	0.03	0.03	0.15
P-87	1,383.00	750.0	PVC	140.0	2,649	156.91	156.90	0.01	0.01	0.07
P-88	1,001.00	400.0	PVC	140.0	285	156.89	156.89	0.00	0.00	0.03
P-90	867.00	750.0	PVC	140.0	3,863	156.89	156.88	0.01	0.01	0.10
P-91	973.00	750.0	PVC	140.0	2,070	156.88	156.87	0.00	0.00	0.05
P-92	1,031.00	300.0	PVC	140.0	301	156.88	156.87	0.01	0.01	0.05
P-93	795.00	300.0	PVC	140.0	-1,040	150.55	150.64	0.09	0.11	0.17
P-94	1,039.00	750.0	PVC	140.0	5,508	156.78	156.75	0.03	0.03	0.14
P-95	536.00	750.0	PVC	140.0	4,208	156.75	156.74	0.01	0.02	0.11
P-96	678.00	750.0	PVC	140.0	353	156.75	156.75	0.00	0.00	0.01
P-97	970.00	450.0	PVC	140.0	7,031	163.03	162.52	0.51	0.53	0.51
P-99	1,110.00	450.0	PVC	140.0	6,053	162.52	162.07	0.45	0.40	0.44
P-100	908.00	450.0	PVC	140.0	4,062	162.07	161.89	0.17	0.19	0.30
P-101	853.00	750.0	PVC	140.0	-44,280	161.89	163.03	1.14	1.33	1.16
P-102	1,439.00	450.0	PVC	140.0	341	161.89	161.89	0.00	0.00	0.02
P-103	347.00	450.0	PVC	140.0	-1,376	159.78	159.79	0.01	0.03	0.10
P-104	807.00	450.0	PVC	140.0	-11,401	159.79	160.83	1.05	1.30	0.83
P-105	695.00	750.0	PVC	140.0	-47,655	160.83	161.89	1.06	1.53	1.25
P-106	915.00	450.0	PVC	140.0	5,734	160.83	160.50	0.33	0.36	0.42
P-107	1,035.00	450.0	PVC	140.0	4,604	160.50	160.25	0.25	0.24	0.34
P-108	889.00	300.0	PVC	140.0	318	160.25	160.24	0.01	0.01	0.05
P-109	807.00	300.0	PVC	140.0	4,388	160.24	158.95	1.29	1.60	0.72
P-110	425.00	300.0	PVC	140.0	6,234	158.95	157.65	1.30	3.06	1.02
P-111	395.00	300.0	PVC	140.0	3,847	157.65	157.16	0.49	1.25	0.63
P-112	873.00	300.0	PVC	140.0	1,811	157.16	156.88	0.27	0.31	0.30
P-113	1,020.00	300.0	PVC	140.0	3,695	160.25	159.07	1.19	1.16	0.61
P-114	836.00	400.0	PVC	140.0	-7,093	159.07	159.87	0.80	0.96	0.65
P-115	854.00	400.0	PVC	140.0	12,757	159.87	157.44	2.42	2.84	1.17
P-116	815.00	600.0	PVC	140.0	12,688	157.44	157.12	0.32	0.39	0.52
P-117	868.00	600.0	PVC	140.0	10,788	157.12	156.87	0.25	0.29	0.44
P-118	1,020.00	300.0	PVC	140.0	522	157.16	157.12	0.03	0.03	0.09
P-119	968.00	300.0	PVC	140.0	4,331	158.95	157.44	1.51	1.56	0.71
P-120	1,019.00	750.0	PVC	140.0	22,074	160.24	159.87	0.37	0.37	0.58

Scenario: Scenario 2
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-122	1,031.00	400.0	PVC	140.0	3,179	157.44	157.22	0.22	0.22	0.29
P-123	1,047.00	300.0	PVC	140.0	1,381	157.12	156.93	0.20	0.19	0.23
P-124	631.00	400.0	PVC	140.0	367	157.22	157.22	0.00	0.00	0.03
P-125	823.00	400.0	PVC	140.0	1,498	157.22	157.17	0.04	0.05	0.14
P-129	862.00	350.0	PVC	140.0	-739	180.09	180.11	0.02	0.03	0.09
P-130	836.00	350.0	PVC	140.0	3,957	180.11	179.59	0.52	0.62	0.48
P-131	813.00	350.0	PVC	140.0	407	179.59	179.59	0.01	0.01	0.05
P-132	1,031.00	350.0	PVC	140.0	1,482	179.59	179.49	0.10	0.10	0.18
P-133	759.00	350.0	PVC	140.0	863	180.11	180.09	0.03	0.04	0.10
P-135	3,067.00	350.0	PVC	140.0	0	157.17	179.59	0.00	0.00	0.00
P-136	784.00	500.0	PVC	140.0	19,585	157.06	155.40	1.66	2.12	1.15
P-137	433.00	500.0	PVC	140.0	53,218	155.40	149.56	5.84	13.49	3.14
P-138	917.00	500.0	PVC	140.0	35,772	161.32	155.40	5.93	6.46	2.11
P-139	1,075.00	500.0	PVC	140.0	13,493	161.32	160.18	1.14	1.06	0.80
P-140	826.00	500.0	PVC	140.0	10,665	160.18	159.61	0.57	0.69	0.63
P-142	826.00	750.0	PVC	140.0	-54,806	159.69	161.32	1.63	1.98	1.44
P-145	493.00	500.0	PVC	140.0	9,447	159.61	159.34	0.27	0.55	0.56
P-146	581.00	750.0	PVC	140.0	-28,763	159.34	159.69	0.35	0.60	0.75
P-147	813.00	300.0	PVC	140.0	-7,977	153.90	157.83	3.93	4.83	1.31
P-148	1,236.00	750.0	PVC	140.0	30,233	157.83	157.02	0.81	0.66	0.79
P-151	580.00	500.0	PVC	140.0	0	157.06	150.00	0.00	0.00	0.00
P-152	1,082.00	750.0	PVC	140.0	52,425	165.00	163.03	1.97	1.82	1.37
P-153	857.00	350.0	PVC	140.0	-1,412	157.17	157.25	0.08	0.09	0.17
P-154	858.00	350.0	PVC	140.0	362	157.25	157.25	0.01	0.01	0.04
P-156	479.00	400.0	PVC	140.0	9,848	159.07	158.22	0.84	1.76	0.91
P-157	552.00	400.0	PVC	140.0	9,848	158.22	157.25	0.97	1.76	0.91
P-161	891.00	250.0	PVC	140.0	4,369	139.82	136.39	3.43	3.85	1.03
P-162	837.00	250.0	PVC	140.0	2,976	136.39	134.80	1.58	1.89	0.70
P-163	836.00	250.0	PVC	140.0	576	134.80	134.73	0.08	0.09	0.14
P-164	852.00	150.0	PVC	140.0	244	134.63	134.44	0.19	0.22	0.16
P-165	836.00	250.0	PVC	140.0	847	134.44	134.28	0.15	0.18	0.20
P-166	1,014.00	150.0	PVC	140.0	-741	134.63	136.39	1.76	1.74	0.49
P-167	1,127.00	250.0	PVC	140.0	-1,152	134.44	134.80	0.37	0.33	0.27
P-168	123.00	750.0	PVC	140.0	12,505	128.91	128.89	0.02	0.13	0.33
P-169	170.00	900.0	PVC	140.0	96,448	148.27	147.87	0.39	2.32	1.75

Scenario: Scenario 2
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-170	1,067.00	500.0	PVC	140.0	-636	160.18	160.18	0.00	0.00	0.04
P-171	1,789.00	300.0	PVC	140.0	-1,058	157.44	157.65	0.21	0.11	0.17
P-173	1,002.00	750.0	PVC	140.0	11,174	157.02	156.92	0.10	0.10	0.29
P-174	210.00	750.0	PVC	140.0	5,261	156.92	156.91	0.01	0.03	0.14
P-175	856.00	750.0	PVC	140.0	5,913	156.92	156.89	0.03	0.03	0.15
P-176	837.00	400.0	PVC	140.0	-1,999	128.83	128.91	0.08	0.09	0.18
P-177	1,031.00	900.0	PVC	140.0	68,553	146.21	144.94	1.27	1.23	1.25
P-178	1,047.00	750.0	PVC	140.0	27,952	160.83	160.24	0.59	0.57	0.73
P-179	921.00	900.0	PVC	140.0	125,140	155.00	151.54	3.46	3.75	2.28
P-180	1,095.00	450.0	PVC	140.0	8,553	159.79	158.95	0.84	0.76	0.62
P-185	832.00	750.0	PVC	140.0	-1,241	156.87	156.87	0.00	0.00	0.03
P-186	437.00	750.0	PVC	140.0	-106,071	161.32	164.26	2.93	6.71	2.78
P-187	711.00	350.0	PVC	140.0	21,729	164.26	153.88	10.37	14.59	2.61
P-188	327.00	750.0	PVC	140.0	127,800	167.36	164.26	3.10	9.48	3.35
P-189	765.00	350.0	PVC	140.0	8,074	157.25	155.47	1.78	2.33	0.97
P-190	2,296.00	350.0	PVC	140.0	8,074	185.47	180.11	5.35	2.33	0.97
P-191	1,491.00	750.0	PVC	140.0	38,210	159.34	157.83	1.51	1.01	1.00
P-192	1,300.00	750.0	PVC	140.0	132,385	139.65	126.50	13.16	10.12	3.47
P-193	384.00	750.0	PVC	140.0	132,385	171.24	167.36	3.89	10.12	3.47
P-194	1,969.00	750.0	PVC	140.0	2,139	128.76	128.75	0.01	0.00	0.06
P-195	2,643.00	150.0	PVC	140.0	0	150.00	153.62	0.00	0.00	0.00
P-196	686.00	150.0	PVC	140.0	0	153.62	157.25	0.00	0.00	0.00
P-197	456.00	150.0	PVC	140.0	0	150.00	157.52	0.00	0.00	0.00
P-198	268.00	150.0	PVC	140.0	0	157.52	165.05	0.00	0.00	0.00
P-199	509.00	150.0	PVC	140.0	0	165.05	172.57	0.00	0.00	0.00
P-200	196.00	150.0	PVC	140.0	0	172.57	180.09	0.00	0.00	0.00
P-201	349.00	150.0	PVC	140.0	0	150.00	157.52	0.00	0.00	0.00
P-202	494.00	150.0	PVC	140.0	0	157.52	165.05	0.00	0.00	0.00
P-203	508.00	150.0	PVC	140.0	0	165.05	172.57	0.00	0.00	0.00
P-204	992.00	150.0	PVC	140.0	0	172.57	180.09	0.00	0.00	0.00

Scenario: Scenario 2
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m^3/day)	Calculated Hydraulic Grade (m)	Pressure (psi)
J-1	110.00	2,139	128.75	26.614
J-2	113.00	1,879	128.76	22.370
J-3	92.00	399	128.76	52.175
J-4	91.00	1,002	128.76	53.595
J-5	90.00	102	128.83	55.117
J-6	89.00	1,445	128.83	56.537
J-7	81.00	1,208	128.83	67.887
J-8	95.00	1,462	128.78	47.953
J-9	98.00	1,855	128.76	43.665
J-10A	93.00	1,799	128.76	50.766
J-11	79.00	1,376	128.84	70.744
J-12	89.00	411	128.91	56.646
J-13	87.00	855	128.89	59.463
J-14	84.00	1,115	128.76	63.539
J-15	83.00	458	134.32	72.844
J-16	80.00	798	133.59	76.067
J-17	79.00	377	134.84	79.266
J-18	83.00	666	135.66	74.742
J-19	82.00	559	140.68	83.290
J-21	83.00	1,277	142.16	83.974
J-22	80.00	247	151.54	101.555
J-23	83.00	907	148.27	92.643
J-24	80.00	353	144.70	91.835
J-25	83.00	301	145.58	88.829
J-25A	80.00	0	145.07	92.367
J-26	83.00	816	139.82	80.651
J-27	78.00	517	138.97	86.540
J-28	83.00	652	136.39	75.781
J-29	78.00	497	134.63	80.379
J-30	77.00	549	134.44	81.529
J-31	83.00	1,248	134.80	73.534
J-32	78.00	847	134.28	79.891
J-33	81.00	576	134.73	76.266
J-34	87.00	84	145.09	82.457
J-35	90.00	129	145.10	78.219
J-36	96.00	859	144.46	68.782
J-37	83.00	422	147.87	92.084
J-39	88.00	381	146.21	82.632
J-40	110.00	1,953	144.09	48.389
J-41	96.00	1,673	144.94	69.475
J-42	85.00	417	145.62	86.054
J-44	85.00	1,026	145.78	86.278
J-45	110.00	1,919	143.79	47.962
J-46	91.00	1,323	144.19	75.505
J-47	84.00	902	145.73	87.622
J-48	86.00	1,104	143.18	81.161
J-49	85.00	741	145.85	86.379
J-50	84.00	0	145.80	87.721
J-51	83.00	1,472	145.98	89.402
J-52	90.50	5,023	141.36	72.188
J-53	110.00	2,931	143.17	47.088
J-54	111.00	2,145	142.82	45.169

Scenario: Scenario 2
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m^3/day)	Calculated Hydraulic Grade (m)	Pressure (psi)
J-55	110.00	1,593	143.43	47.454
J-56	98.00	1,277	141.78	62.138
J-57	90.00	3,063	139.65	70.482
J-58	95.00	3,000	144.00	69.548
J-59	85.00	809	148.80	90.564
J-60	86.00	1,965	149.56	90.215
J-61	96.00	2,799	153.88	82.165
J-62	94.00	4,585	167.36	104.128
J-63	90.00	2,139	155.40	92.827
J-64	95.00	2,000	161.32	94.143
J-65	96.00	2,117	160.18	91.103
J-66	84.00	3,208	157.06	103.701
J-67	95.00	3,250	159.69	91.826
J-68	96.00	1,218	159.61	90.297
J-70	101.00	711	160.18	84.000
J-71	86.00	306	153.89	96.373
J-72	85.50	380	152.29	94.800
J-73	86.00	1,040	150.55	91.626
J-74	87.00	2,352	150.64	90.332
J-75	87.00	6,267	151.26	91.213
J-76	88.00	2,384	153.90	93.547
J-77	91.00	497	153.89	89.265
J-78	88.00	5,919	152.30	91.271
J-79	100.00	711	156.98	80.879
J-80	100.00	4,524	157.02	80.938
J-81	101.00	3,371	156.89	79.335
J-82	92.00	2,311	156.87	92.083
J-83	102.00	2,612	156.91	77.943
J-85	100.00	2,335	156.89	80.751
J-86	103.00	2,649	156.90	76.510
J-87	101.00	1,793	156.88	79.314
J-88	86.00	1,510	156.88	100.618
J-89	90.00	1,664	156.87	94.924
J-90	98.00	2,447	156.81	83.483
J-91	101.00	229	156.78	79.181
J-92	120.00	4,208	156.74	52.157
J-93	118.00	947	156.75	55.009
J-94	127.00	353	156.75	42.233
J-95	88.00	978	162.52	105.772
J-96	88.00	1,113	163.03	106.503
J-97	87.00	1,991	162.07	106.558
J-98	85.00	347	161.89	109.149
J-99	89.00	341	161.89	103.467
J-100	90.00	2,567	160.83	100.547
J-101	90.00	1,130	160.50	100.074
J-102	91.00	1,376	159.78	97.627
J-103	90.50	1,217	157.44	95.026
J-104	90.00	1,472	159.79	99.059
J-105	95.00	1,381	156.93	87.903
J-106	92.00	1,042	157.12	92.441
J-107	91.00	1,514	157.16	93.905
J-108	91.00	1,170	157.65	94.607

Scenario: Scenario 2
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m³/day)	Calculated Hydraulic Grade (m)	Pressure (psi)
J-109	90.00	2,376	158.95	97.873
J-110	94.00	1,220	157.44	90.053
J-111	107.00	1,314	157.22	71.283
J-112	109.00	367	157.22	68.440
J-113	91.00	1,808	160.24	98.283
J-114	90.00	591	160.25	99.718
J-115	100.00	940	159.07	83.842
J-116	97.00	2,225	159.87	89.236
J-117	99.00	2,910	157.17	82.576
J-118	105.00	0	157.25	74.171
J-119	107.00	362	157.25	71.323
J-120	120.00	2,068	179.59	84.592
J-121	117.00	407	179.59	88.839
J-122	128.00	1,482	179.49	73.088
J-123	130.00	863	180.09	71.096
J-124	123.00	2,515	180.11	81.072
J-125	113.00	739	180.09	95.232
J-126	100.00	0	158.22	82.646
J-129	95.00	0	159.34	91.332
J-130	90.00	0	157.83	96.285
J-136	95.00	0	164.26	98.308
J-137	105.00	0	153.62	69.019
J-138	98.00	0	156.92	83.629
J-139	108.00	0	157.52	70.296
J-140	110.00	0	165.05	78.135
J-141	113.00	0	172.57	84.554
J-142	115.00	0	157.52	60.359
J-143	117.00	0	165.05	68.198
J-144	117.00	0	172.57	78.877

Stantec

APPENDIX F

Alternative W3

Scenario: Scenario 3
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-2	965.00	750.0	PVC	140.0	1,401	132.88	132.88	0.00	0.00	0.04
P-3	661.00	750.0	PVC	140.0	399	132.88	132.88	0.00	0.00	0.01
P-4	400.00	400.0	PVC	140.0	102	132.95	132.95	0.00	0.00	0.01
P-5	661.00	400.0	PVC	140.0	452	132.95	132.95	0.00	0.01	0.04
P-6	845.00	750.0	PVC	140.0	-5,419	132.88	132.90	0.02	0.03	0.14
P-7	969.00	750.0	PVC	140.0	-11,650	132.90	133.01	0.11	0.11	0.31
P-8	733.00	750.0	PVC	140.0	-1,855	132.88	132.88	0.00	0.00	0.05
P-9	829.00	750.0	PVC	140.0	-4,769	132.88	132.90	0.02	0.02	0.12
P-10	937.00	750.0	PVC	140.0	1,115	132.88	132.88	0.00	0.00	0.03
P-12	662.00	400.0	PVC	140.0	-2,132	132.96	133.03	0.07	0.10	0.20
P-13	964.00	400.0	PVC	140.0	-17,047	133.03	137.71	4.68	4.86	1.57
P-14	805.00	400.0	PVC	140.0	-756	132.95	132.96	0.01	0.02	0.07
P-15	502.00	400.0	PVC	140.0	-8,882	137.71	138.44	0.73	1.45	0.82
P-16	839.00	400.0	PVC	140.0	-9,340	138.44	139.78	1.34	1.59	0.86
P-17	510.00	400.0	PVC	140.0	9,340	139.78	138.96	0.81	1.59	0.86
P-18	849.00	400.0	PVC	140.0	8,963	138.96	137.71	1.25	1.48	0.83
P-19	818.00	400.0	PVC	140.0	-19,346	139.78	144.80	5.02	6.14	1.78
P-20	229.00	400.0	PVC	140.0	-19,905	144.80	146.28	1.48	6.47	1.83
P-21	841.00	400.0	PVC	140.0	-21,182	146.28	152.39	6.11	7.26	1.95
P-22	877.00	900.0	PVC	140.0	-133,464	152.39	156.09	3.71	4.23	2.43
P-24	847.00	300.0	PVC	140.0	6,356	152.39	149.70	2.69	3.17	1.04
P-25	175.00	300.0	PVC	140.0	6,055	149.70	149.19	0.51	2.90	0.99
P-26	852.00	150.0	PVC	140.0	353	149.19	148.82	0.37	0.44	0.23
P-27	833.00	300.0	PVC	140.0	5,702	149.19	147.03	2.16	2.59	0.93
P-28	956.00	150.0	PVC	140.0	517	147.03	146.18	0.85	0.89	0.34
P-29	1,007.00	300.0	PVC	140.0	-2,880	148.56	149.29	0.74	0.73	0.47
P-30	473.00	150.0	PVC	140.0	84	149.29	149.28	0.01	0.03	0.06
P-31	822.00	300.0	PVC	140.0	-3,093	149.29	149.98	0.69	0.84	0.51
P-32	722.00	900.0	PVC	140.0	-104,597	149.98	151.93	1.94	2.69	1.90
P-34	789.00	300.0	PVC	140.0	2,021	148.56	148.26	0.30	0.38	0.33
P-35	1,383.00	750.0	PVC	140.0	23,225	148.26	147.70	0.56	0.40	0.61
P-36	839.00	750.0	PVC	140.0	21,272	147.70	147.41	0.29	0.34	0.56
P-37	1,568.00	750.0	PVC	140.0	-9,112	147.41	147.52	0.11	0.07	0.24
P-38	1,025.00	500.0	PVC	140.0	-9,471	147.52	148.09	0.57	0.55	0.56
P-39	657.00	150.0	PVC	140.0	411	148.09	147.71	0.38	0.58	0.27

Scenario: Scenario 3
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-40	811.00	900.0	PVC	140.0	58,025	148.26	147.52	0.73	0.90	1.06
P-41	842.00	500.0	PVC	140.0	20,221	149.98	148.09	1.89	2.25	1.19
P-42	813.00	750.0	PVC	140.0	28,465	147.41	146.94	0.48	0.59	0.75
P-43	1,447.00	750.0	PVC	140.0	9,870	146.94	146.82	0.12	0.08	0.26
P-44	809.00	900.0	PVC	140.0	-57,061	146.82	147.52	0.71	0.88	1.04
P-45	826.00	500.0	PVC	140.0	9,312	148.09	147.65	0.44	0.53	0.55
P-46	1,061.00	500.0	PVC	140.0	11,457	147.65	146.82	0.83	0.78	0.68
P-47	1,681.00	150.0	PVC	140.0	-6	147.71	147.71	0.00	0.00	0.00
P-48	527.00	150.0	PVC	140.0	-6	147.71	147.71	0.00	0.00	0.00
P-49	879.00	750.0	PVC	140.0	15,664	146.94	146.76	0.17	0.19	0.41
P-50	1,777.00	600.0	PVC	140.0	-21,248	146.76	148.57	1.80	1.01	0.87
P-51	1,032.00	750.0	PVC	140.0	-22,841	148.57	148.97	0.40	0.39	0.60
P-52	815.00	500.0	PVC	140.0	24,787	148.97	146.30	2.67	3.28	1.46
P-53	1,042.00	500.0	PVC	140.0	23,510	146.30	143.20	3.10	2.97	1.39
P-54	784.00	900.0	PVC	140.0	-107,028	143.20	145.40	2.20	2.81	1.95
P-55	1,598.00	750.0	PVC	140.0	-34,767	145.40	146.76	1.36	0.85	0.91
P-56	1,030.00	500.0	PVC	140.0	-29,250	143.20	147.79	4.59	4.45	1.72
P-57	805.00	500.0	PVC	140.0	3,794	147.79	147.71	0.08	0.10	0.22
P-58	918.00	900.0	PVC	140.0	-77,284	145.40	146.82	1.41	1.54	1.41
P-59	869.00	500.0	PVC	140.0	3,047	147.71	147.65	0.06	0.07	0.18
P-60	875.00	500.0	PVC	140.0	-50,628	148.97	159.73	10.76	12.30	2.98
P-61	1,663.00	500.0	PVC	140.0	-34,515	147.79	157.85	10.06	6.05	2.03
P-62	432.00	500.0	PVC	140.0	-35,324	157.85	160.58	2.73	6.31	2.08
P-63	605.00	750.0	PVC	140.0	0	160.58	173.16	0.00	0.00	0.00
P-68	939.00	750.0	PVC	140.0	16,895	164.66	164.45	0.21	0.22	0.44
P-70	584.00	250.0	PVC	140.0	-497	160.36	160.40	0.04	0.07	0.12
P-71	853.00	500.0	PVC	140.0	15,506	160.40	159.23	1.17	1.37	0.91
P-72	864.00	500.0	PVC	140.0	8,468	159.23	158.84	0.39	0.45	0.50
P-73	626.00	500.0	PVC	140.0	3,392	158.84	158.79	0.05	0.08	0.20
P-74	779.00	250.0	PVC	140.0	-306	160.38	160.40	0.02	0.03	0.07
P-75	805.00	250.0	PVC	140.0	-380	159.19	159.23	0.03	0.04	0.09
P-77	2,042.00	500.0	PVC	140.0	739	159.23	159.22	0.01	0.00	0.04
P-79	2,037.00	500.0	PVC	140.0	-1,191	158.84	158.86	0.02	0.01	0.07
P-80	759.00	500.0	PVC	140.0	-711	159.88	159.88	0.00	0.00	0.04
P-81	837.00	600.0	PVC	140.0	18,578	159.88	159.22	0.66	0.79	0.76

Scenario: Scenario 3
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-82	869.00	600.0	PVC	140.0	12,973	159.22	158.86	0.35	0.41	0.53
P-84	1,026.00	600.0	PVC	140.0	8,184	158.76	158.58	0.18	0.17	0.34
P-85	1,015.00	600.0	PVC	140.0	5,737	158.58	158.49	0.09	0.09	0.23
P-87	1,383.00	300.0	PVC	140.0	2,649	157.88	157.02	0.87	0.63	0.43
P-88	1,001.00	300.0	PVC	140.0	2,973	159.22	158.44	0.78	0.78	0.49
P-90	867.00	300.0	PVC	140.0	-348	158.44	158.45	0.01	0.01	0.06
P-91	973.00	300.0	PVC	140.0	-2,141	158.45	158.86	0.41	0.42	0.35
P-92	1,031.00	350.0	PVC	140.0	-3,252	158.31	158.76	0.45	0.43	0.39
P-93	795.00	500.0	PVC	140.0	-1,040	158.78	158.79	0.01	0.01	0.06
P-94	1,039.00	600.0	PVC	140.0	5,508	158.49	158.41	0.09	0.08	0.23
P-95	536.00	600.0	PVC	140.0	4,208	158.41	158.38	0.03	0.05	0.17
P-96	678.00	600.0	PVC	140.0	353	158.41	158.41	0.00	0.00	0.01
P-97	970.00	300.0	PVC	140.0	848	155.14	155.06	0.07	0.08	0.14
P-99	1,110.00	300.0	PVC	140.0	-130	155.06	155.07	0.00	0.00	0.02
P-100	908.00	300.0	PVC	140.0	-2,121	155.07	155.44	0.38	0.42	0.35
P-101	853.00	300.0	PVC	140.0	1,961	155.44	155.14	0.31	0.36	0.32
P-102	1,439.00	350.0	PVC	140.0	341	155.44	155.43	0.01	0.01	0.04
P-103	347.00	350.0	PVC	140.0	-1,376	156.85	156.88	0.03	0.09	0.17
P-104	807.00	350.0	PVC	140.0	1,966	156.88	156.74	0.14	0.17	0.24
P-105	695.00	300.0	PVC	140.0	4,770	156.74	155.44	1.30	1.86	0.78
P-106	915.00	300.0	PVC	140.0	-1,892	156.74	157.05	0.31	0.34	0.31
P-107	1,035.00	300.0	PVC	140.0	-3,022	157.05	157.88	0.83	0.80	0.49
P-108	889.00	300.0	PVC	140.0	713	157.88	157.83	0.05	0.06	0.12
P-109	807.00	300.0	PVC	140.0	-575	157.83	157.86	0.03	0.04	0.09
P-110	425.00	350.0	PVC	140.0	-1,827	157.86	157.92	0.06	0.15	0.22
P-111	395.00	350.0	PVC	140.0	-4,214	157.92	158.20	0.28	0.70	0.51
P-112	873.00	350.0	PVC	140.0	-1,742	158.20	158.31	0.12	0.14	0.21
P-113	1,020.00	300.0	PVC	140.0	-4,326	157.88	159.46	1.59	1.56	0.71
P-114	836.00	600.0	PVC	140.0	11,360	159.46	159.20	0.27	0.32	0.47
P-115	854.00	600.0	PVC	140.0	5,137	159.20	159.13	0.06	0.07	0.21
P-116	815.00	600.0	PVC	140.0	12,179	159.13	158.84	0.29	0.36	0.50
P-117	868.00	600.0	PVC	140.0	5,770	158.84	158.76	0.08	0.09	0.24
P-118	1,020.00	350.0	PVC	140.0	-3,986	158.20	158.84	0.64	0.63	0.48
P-119	968.00	350.0	PVC	140.0	-5,938	157.86	159.13	1.28	1.32	0.71
P-120	1,019.00	300.0	PVC	140.0	-3,999	157.83	159.20	1.37	1.34	0.65

Scenario: Scenario 3
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-122	1,031.00	500.0	PVC	140.0	-14,201	159.13	160.34	1.20	1.17	0.84
P-123	1,047.00	350.0	PVC	140.0	1,381	158.84	158.75	0.09	0.09	0.17
P-124	631.00	350.0	PVC	140.0	367	160.34	160.33	0.00	0.01	0.04
P-125	823.00	500.0	PVC	140.0	-15,882	160.34	161.52	1.18	1.44	0.94
P-129	862.00	750.0	PVC	140.0	43,115	183.36	182.26	1.09	1.27	1.13
P-130	836.00	750.0	PVC	140.0	39,737	182.26	181.35	0.91	1.09	1.04
P-131	813.00	750.0	PVC	140.0	407	181.35	181.35	0.00	0.00	0.01
P-132	1,031.00	750.0	PVC	140.0	1,482	181.35	181.35	0.00	0.00	0.04
P-133	759.00	750.0	PVC	140.0	863	182.26	182.26	0.00	0.00	0.02
P-135	3,067.00	500.0	PVC	140.0	-35,780	161.52	181.35	19.83	6.47	2.11
P-136	784.00	500.0	PVC	140.0	13,687	164.45	163.60	0.86	1.09	0.81
P-137	433.00	500.0	PVC	140.0	37,289	163.60	160.58	3.02	6.98	2.20
P-138	917.00	500.0	PVC	140.0	25,741	166.82	163.60	3.22	3.51	1.52
P-139	1,075.00	350.0	PVC	140.0	7,266	166.82	164.76	2.06	1.92	0.87
P-140	826.00	350.0	PVC	140.0	4,438	164.76	164.12	0.64	0.77	0.53
P-142	826.00	750.0	PVC	140.0	-63,706	164.66	166.82	2.16	2.61	1.67
P-145	493.00	350.0	PVC	140.0	3,220	164.12	163.91	0.21	0.42	0.39
P-146	581.00	750.0	PVC	140.0	-43,561	163.91	164.66	0.75	1.29	1.14
P-147	813.00	500.0	PVC	140.0	-18,693	160.40	161.98	1.58	1.94	1.10
P-148	1,236.00	600.0	PVC	140.0	28,088	161.98	159.88	2.10	1.70	1.15
P-151	580.00	500.0	PVC	140.0	0	164.45	150.00	0.00	0.00	0.00
P-152	1,082.00	150.0	PVC	140.0	0	150.00	155.14	0.00	0.00	0.00
P-153	857.00	500.0	PVC	140.0	16,988	161.52	160.13	1.39	1.63	1.00
P-154	858.00	600.0	PVC	140.0	362	160.13	160.13	0.00	0.00	0.01
P-156	479.00	600.0	PVC	140.0	-16,626	159.46	159.77	0.31	0.64	0.68
P-157	552.00	600.0	PVC	140.0	-16,626	159.77	160.13	0.36	0.64	0.68
P-161	891.00	300.0	PVC	140.0	4,369	147.03	145.62	1.41	1.58	0.72
P-162	837.00	300.0	PVC	140.0	2,750	145.62	145.06	0.56	0.67	0.45
P-163	836.00	300.0	PVC	140.0	576	145.06	145.02	0.03	0.04	0.09
P-164	852.00	150.0	PVC	140.0	470	142.74	142.10	0.64	0.75	0.31
P-165	836.00	150.0	PVC	140.0	847	142.10	140.25	1.86	2.22	0.55
P-166	1,014.00	150.0	PVC	140.0	-967	142.74	145.62	2.88	2.84	0.63
P-167	1,127.00	150.0	PVC	140.0	-926	142.10	145.06	2.95	2.62	0.61
P-168	123.00	750.0	PVC	140.0	12,505	133.03	133.01	0.02	0.13	0.33
P-169	170.00	900.0	PVC	140.0	105,019	152.39	151.93	0.46	2.71	1.91

Scenario: Scenario 3
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-170	1,067.00	350.0	PVC	140.0	-592	164.74	164.76	0.02	0.02	0.07
P-171	1,789.00	350.0	PVC	140.0	-1,106	157.81	157.92	0.11	0.06	0.13
P-173	1,002.00	300.0	PVC	140.0	4,275	159.88	158.35	1.53	1.52	0.70
P-174	210.00	300.0	PVC	140.0	5,261	158.35	157.88	0.47	2.24	0.86
P-175	856.00	300.0	PVC	140.0	-986	158.35	158.44	0.09	0.10	0.16
P-176	837.00	400.0	PVC	140.0	-1,999	132.95	133.03	0.08	0.09	0.18
P-177	1,031.00	900.0	PVC	140.0	80,902	149.98	148.26	1.72	1.67	1.47
P-178	1,047.00	300.0	PVC	140.0	-3,478	156.74	157.83	1.09	1.04	0.57
P-179	921.00	900.0	PVC	140.0	133,711	160.00	156.09	3.91	4.24	2.43
P-180	1,095.00	350.0	PVC	140.0	-4,814	156.88	157.86	0.98	0.90	0.58
P-185	832.00	600.0	PVC	140.0	7,330	158.86	158.76	0.10	0.12	0.30
P-186	437.00	750.0	PVC	140.0	-98,713	166.82	169.39	2.57	5.88	2.59
P-187	711.00	500.0	PVC	140.0	53,427	169.39	159.73	9.66	13.59	3.15
P-188	327.00	750.0	PVC	140.0	152,140	173.16	169.39	3.77	11.52	3.99
P-189	765.00	750.0	PVC	140.0	0	160.13	160.13	0.00	0.00	0.00
P-190	2,296.00	750.0	PVC	140.0	0	182.26	182.26	0.00	0.00	0.00
P-191	1,491.00	750.0	PVC	140.0	46,781	163.91	161.98	1.93	1.30	1.23
P-192	1,300.00	900.0	PVC	140.0	156,725	143.20	135.80	7.40	5.69	2.85
P-193	384.00	900.0	PVC	140.0	156,725	175.34	173.16	2.19	5.69	2.85
P-194	1,969.00	750.0	PVC	140.0	2,139	132.88	132.87	0.01	0.00	0.06
P-195	2,643.00	150.0	PVC	140.0	0	150.00	155.06	0.00	0.00	0.00
P-196	686.00	150.0	PVC	140.0	0	155.06	160.13	0.00	0.00	0.00
P-197	456.00	750.0	PVC	140.0	43,854	185.00	184.48	0.52	1.15	1.15
P-198	268.00	750.0	PVC	140.0	43,854	184.48	184.17	0.31	1.15	1.15
P-199	509.00	750.0	PVC	140.0	43,854	184.17	183.58	0.59	1.15	1.15
P-200	196.00	750.0	PVC	140.0	43,854	183.58	183.36	0.23	1.15	1.15
P-201	349.00	750.0	PVC	140.0	0	150.00	158.34	0.00	0.00	0.00
P-202	494.00	750.0	PVC	140.0	0	158.34	166.68	0.00	0.00	0.00
P-203	508.00	750.0	PVC	140.0	0	166.68	175.02	0.00	0.00	0.00
P-204	992.00	750.0	PVC	140.0	0	175.02	183.36	0.00	0.00	0.00

Scenario: Scenario 3
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m³/day)	Calculated Hydraulic Grade (m)	Pressure (psi)
J-1	110.00	2,139	132.88	32.480
J-2	113.00	1,879	132.89	28.235
J-3	92.00	399	132.89	58.041
J-4	91.00	1,002	132.89	59.460
J-5	90.00	102	132.96	60.983
J-6	89.00	1,445	132.96	62.403
J-7	81.00	1,208	132.96	73.753
J-8	95.00	1,462	132.91	53.818
J-9	98.00	1,855	132.89	49.530
J-10A	93.00	1,799	132.90	56.632
J-11	79.00	1,376	132.97	76.609
J-12	89.00	411	133.04	62.512
J-13	87.00	855	133.02	65.328
J-14	84.00	1,115	132.90	69.405
J-15	83.00	458	138.45	78.709
J-16	80.00	798	137.72	81.933
J-17	79.00	377	138.97	85.132
J-18	83.00	666	139.79	80.608
J-19	82.00	559	144.81	89.155
J-21	83.00	1,277	146.29	89.840
J-22	80.00	247	156.10	108.021
J-23	83.00	907	152.40	98.508
J-24	80.00	353	148.83	97.701
J-25	83.00	301	149.71	94.694
J-25A	80.00	0	149.20	98.232
J-26	83.00	816	147.04	90.906
J-27	78.00	517	146.19	96.795
J-28	83.00	652	145.63	88.902
J-29	78.00	497	142.75	91.911
J-30	77.00	549	142.11	92.428
J-31	83.00	1,248	145.07	88.103
J-32	78.00	847	140.26	88.372
J-33	81.00	576	145.04	90.898
J-34	87.00	84	149.30	88.431
J-35	90.00	129	149.31	84.193
J-36	96.00	859	148.58	74.631
J-37	83.00	422	151.94	97.855
J-39	88.00	381	150.00	88.005
J-40	110.00	1,953	147.72	53.545
J-41	96.00	1,673	148.28	74.207
J-42	85.00	417	147.72	89.032
J-44	85.00	1,026	148.11	89.581
J-45	110.00	1,919	147.44	53.138
J-46	91.00	1,323	147.55	80.266
J-47	84.00	902	147.67	90.372
J-48	86.00	1,104	146.84	86.361
J-49	85.00	741	147.72	89.032
J-50	84.00	0	147.72	90.452
J-51	83.00	1,472	147.80	91.983
J-52	90.50	5,023	145.44	77.980
J-53	110.00	2,931	146.96	52.462
J-54	111.00	2,145	146.79	50.799

Scenario: Scenario 3
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m^3/day)	Calculated Hydraulic Grade (m)	Pressure (psi)
J-55	110.00	1,593	148.57	54.747
J-56	98.00	1,277	146.32	68.585
J-57	90.00	3,063	143.25	75.581
J-58	95.00	3,000	148.97	76.605
J-59	85.00	809	157.77	103.293
J-60	86.00	1,965	160.47	105.710
J-61	96.00	2,799	159.64	90.334
J-62	94.00	4,585	173.48	112.817
J-63	90.00	2,139	163.47	104.286
J-64	95.00	2,000	166.67	101.732
J-65	96.00	2,117	164.62	97.397
J-66	84.00	3,208	164.32	114.004
J-67	95.00	3,250	164.52	98.686
J-68	96.00	1,218	163.98	96.500
J-70	101.00	711	164.60	90.272
J-71	86.00	306	159.99	105.031
J-72	85.50	380	158.82	104.069
J-73	86.00	1,040	158.41	102.778
J-74	87.00	2,352	158.41	101.369
J-75	87.00	6,267	158.46	101.442
J-76	88.00	2,384	160.02	102.223
J-77	91.00	497	159.98	97.908
J-78	88.00	5,919	158.85	100.568
J-79	100.00	711	159.49	84.449
J-80	100.00	4,524	159.50	84.454
J-81	101.00	3,371	158.84	82.101
J-82	92.00	2,311	158.49	94.380
J-83	102.00	2,612	157.51	78.789
J-85	100.00	2,335	158.06	82.418
J-86	103.00	2,649	156.64	76.138
J-87	101.00	1,793	158.08	81.017
J-88	86.00	1,510	157.93	102.105
J-89	90.00	1,664	158.38	97.057
J-90	98.00	2,447	158.20	85.450
J-91	101.00	229	158.11	81.062
J-92	120.00	4,208	157.99	53.931
J-93	118.00	947	158.02	56.808
J-94	125.00	353	158.02	46.872
J-95	88.00	978	154.68	94.656
J-96	88.00	1,113	154.76	94.761
J-97	87.00	1,991	154.69	96.079
J-98	85.00	347	155.06	99.454
J-99	89.00	341	155.05	93.763
J-100	90.00	2,567	156.36	94.196
J-101	90.00	1,130	156.67	94.633
J-102	91.00	1,376	156.47	92.928
J-103	90.50	1,217	157.43	95.011
J-104	90.00	1,472	156.50	94.391
J-105	95.00	1,381	158.36	89.944
J-106	92.00	1,042	158.46	94.334
J-107	91.00	1,514	157.81	94.841
J-108	91.00	1,170	157.54	94.451

Scenario: Scenario 3
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m³/day)	Calculated Hydraulic Grade (m)	Pressure (psi)
J-109	90.00	2,376	157.48	95.782
J-110	94.00	1,220	158.76	91.920
J-111	107.00	1,314	159.97	75.188
J-112	109.00	367	159.96	72.343
J-113	91.00	1,808	157.45	94.321
J-114	90.00	591	157.50	95.810
J-115	100.00	940	159.09	83.874
J-116	97.00	2,225	158.82	87.752
J-117	99.00	2,910	161.16	88.233
J-118	105.00	0	159.76	77.724
J-119	107.00	362	159.76	74.885
J-120	120.00	2,068	181.11	86.741
J-121	117.00	407	181.11	90.999
J-122	128.00	1,482	181.11	75.382
J-123	130.00	863	182.02	73.846
J-124	123.00	2,515	182.02	83.783
J-125	113.00	739	183.12	99.536
J-126	100.00	0	159.40	84.314
J-129	95.00	0	163.78	97.625
J-130	90.00	0	161.59	101.616
J-136	95.00	0	169.22	105.358
J-137	105.00	0	154.88	70.800
J-138	98.00	0	157.98	85.134
J-139	108.00	0	184.40	108.448
J-140	110.00	0	184.05	105.109
J-141	113.00	0	183.38	99.901
J-142	115.00	0	158.28	61.435
J-143	117.00	0	166.56	70.350
J-144	117.00	0	174.84	82.104

Stantec

APPENDIX F

Alternative W4

Scenario: Scenario 4
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-2	965.00	350.0	PVC	140.0	1,401	148.50	148.41	0.09	0.09	0.17
P-3	661.00	350.0	PVC	140.0	399	148.41	148.41	0.01	0.01	0.05
P-4	400.00	150.0	PVC	140.0	102	140.69	140.67	0.02	0.04	0.07
P-5	661.00	150.0	PVC	140.0	452	140.69	140.23	0.46	0.69	0.30
P-6	845.00	350.0	PVC	140.0	-5,419	148.50	149.44	0.94	1.11	0.65
P-7	969.00	600.0	PVC	140.0	-11,650	149.44	149.76	0.32	0.33	0.48
P-8	733.00	350.0	PVC	140.0	-1,855	148.60	148.71	0.11	0.15	0.22
P-9	829.00	350.0	PVC	140.0	-4,769	148.71	149.44	0.73	0.88	0.57
P-10	937.00	350.0	PVC	140.0	1,115	148.71	148.66	0.06	0.06	0.13
P-12	662.00	150.0	PVC	140.0	-2,132	141.68	149.81	8.13	12.28	1.40
P-13	964.00	600.0	PVC	140.0	-17,047	149.81	150.46	0.65	0.67	0.70
P-14	805.00	150.0	PVC	140.0	-756	140.23	141.68	1.45	1.80	0.50
P-15	502.00	600.0	PVC	140.0	-17,045	150.46	150.80	0.34	0.67	0.70
P-16	839.00	600.0	PVC	140.0	-17,503	150.80	151.39	0.59	0.71	0.72
P-17	510.00	200.0	PVC	140.0	1,177	151.39	150.88	0.51	1.01	0.43
P-18	849.00	200.0	PVC	140.0	800	150.88	150.46	0.42	0.49	0.29
P-19	818.00	600.0	PVC	140.0	-19,346	151.39	152.09	0.70	0.85	0.79
P-20	229.00	600.0	PVC	140.0	-19,905	152.09	152.29	0.21	0.90	0.81
P-21	841.00	600.0	PVC	140.0	-21,182	152.29	153.14	0.85	1.01	0.87
P-22	877.00	900.0	PVC	140.0	-126,134	153.14	156.48	3.34	3.81	2.29
P-24	847.00	300.0	PVC	140.0	6,356	153.14	150.45	2.69	3.17	1.04
P-25	175.00	300.0	PVC	140.0	6,055	150.45	149.95	0.51	2.90	0.99
P-26	852.00	250.0	PVC	140.0	353	149.95	149.92	0.03	0.04	0.08
P-27	833.00	300.0	PVC	140.0	5,702	149.95	147.79	2.16	2.59	0.93
P-28	956.00	250.0	PVC	140.0	517	147.79	147.72	0.07	0.07	0.12
P-29	1,007.00	150.0	PVC	140.0	-512	148.79	149.67	0.88	0.87	0.34
P-30	473.00	150.0	PVC	140.0	84	149.67	149.66	0.01	0.03	0.06
P-31	822.00	150.0	PVC	140.0	-725	149.67	151.04	1.37	1.67	0.47
P-32	722.00	900.0	PVC	140.0	-97,267	151.04	152.74	1.70	2.35	1.77
P-34	789.00	150.0	PVC	140.0	-347	148.79	149.13	0.34	0.43	0.23
P-35	1,383.00	750.0	PVC	140.0	23,588	149.13	148.55	0.57	0.41	0.62
P-36	839.00	750.0	PVC	140.0	21,635	148.55	148.26	0.30	0.35	0.57
P-37	1,568.00	750.0	PVC	140.0	-8,143	148.26	148.35	0.09	0.06	0.21
P-38	1,025.00	250.0	PVC	140.0	-3,498	148.35	150.96	2.61	2.55	0.82
P-39	657.00	250.0	PVC	140.0	389	150.96	150.93	0.03	0.04	0.09

Scenario: Scenario 4
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-40	811.00	900.0	PVC	140.0	59,981	149.13	148.35	0.78	0.96	1.09
P-41	842.00	750.0	PVC	140.0	10,572	151.04	150.96	0.08	0.09	0.28
P-42	813.00	750.0	PVC	140.0	27,859	148.26	147.80	0.46	0.56	0.73
P-43	1,447.00	750.0	PVC	140.0	8,504	147.80	147.71	0.09	0.06	0.22
P-44	809.00	900.0	PVC	140.0	-54,013	147.71	148.35	0.64	0.79	0.98
P-45	826.00	750.0	PVC	140.0	5,659	150.96	150.94	0.02	0.03	0.15
P-46	1,061.00	250.0	PVC	140.0	3,848	150.94	147.71	3.23	3.04	0.91
P-47	1,681.00	250.0	PVC	140.0	-28	150.93	150.94	0.00	0.00	0.01
P-48	527.00	250.0	PVC	140.0	-28	150.94	150.94	0.00	0.00	0.01
P-49	879.00	750.0	PVC	140.0	16,424	147.80	147.61	0.19	0.21	0.43
P-50	1,777.00	750.0	PVC	140.0	-14,136	147.61	147.90	0.29	0.16	0.37
P-51	1,032.00	750.0	PVC	140.0	-15,729	147.90	148.10	0.20	0.20	0.41
P-52	815.00	350.0	PVC	140.0	0	148.10	145.04	0.00	0.00	0.00
P-53	1,042.00	350.0	PVC	140.0	-1,277	145.04	145.12	0.08	0.08	0.15
P-54	784.00	900.0	PVC	140.0	-88,653	145.12	146.67	1.55	1.98	1.61
P-55	1,598.00	750.0	PVC	140.0	-28,415	146.67	147.61	0.94	0.59	0.74
P-56	1,030.00	350.0	PVC	140.0	-13,013	145.12	150.94	5.81	5.65	1.57
P-57	805.00	750.0	PVC	140.0	-140	150.94	150.94	0.00	0.00	0.00
P-58	918.00	900.0	PVC	140.0	-65,261	146.67	147.71	1.03	1.12	1.19
P-59	869.00	750.0	PVC	140.0	-909	150.94	150.94	0.00	0.00	0.02
P-60	875.00	350.0	PVC	140.0	-18,729	148.10	157.79	9.69	11.08	2.25
P-61	1,663.00	750.0	PVC	140.0	-14,345	150.94	151.21	0.27	0.17	0.38
P-62	432.00	750.0	PVC	140.0	-15,154	151.21	151.29	0.08	0.18	0.40
P-63	605.00	750.0	PVC	140.0	0	151.29	169.70	0.00	0.00	0.00
P-68	939.00	300.0	PVC	140.0	7,520	165.18	161.11	4.07	4.33	1.23
P-70	584.00	150.0	PVC	140.0	-497	159.54	160.02	0.48	0.83	0.33
P-71	853.00	300.0	PVC	140.0	3,602	160.02	159.08	0.95	1.11	0.59
P-72	864.00	300.0	PVC	140.0	3,109	159.08	158.35	0.73	0.84	0.51
P-73	626.00	300.0	PVC	140.0	3,392	158.35	157.73	0.62	0.99	0.56
P-74	779.00	150.0	PVC	140.0	-306	159.76	160.02	0.26	0.34	0.20
P-75	805.00	150.0	PVC	140.0	-380	158.67	159.08	0.41	0.50	0.25
P-77	2,042.00	350.0	PVC	140.0	-5,807	159.08	161.66	2.59	1.27	0.70
P-79	2,037.00	350.0	PVC	140.0	-6,550	158.35	161.57	3.22	1.58	0.79
P-80	759.00	150.0	PVC	140.0	-711	160.78	162.00	1.22	1.61	0.47
P-81	837.00	750.0	PVC	140.0	23,183	162.00	161.66	0.34	0.40	0.61

Scenario: Scenario 4
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-82	869.00	750.0	PVC	140.0	11,192	161.66	161.57	0.09	0.10	0.29
P-84	1,026.00	300.0	PVC	140.0	8,184	-1,419.84	-1,425.04	5.20	5.07	1.34
P-85	1,015.00	300.0	PVC	140.0	5,737	-1,425.04	-1,427.70	2.66	2.62	0.94
P-87	1,383.00	350.0	PVC	140.0	2,649	161.07	160.66	0.41	0.30	0.32
P-88	1,001.00	350.0	PVC	140.0	2,813	161.66	161.33	0.33	0.33	0.34
P-90	867.00	350.0	PVC	140.0	-538	161.33	161.35	0.01	0.02	0.06
P-91	973.00	350.0	PVC	140.0	-2,331	161.35	161.57	0.23	0.23	0.28
P-92	1,031.00	150.0	PVC	140.0	-1,230	-1,424.41	-1,419.84	4.57	4.44	0.81
P-93	795.00	150.0	PVC	140.0	-1,040	155.14	157.73	2.58	3.25	0.68
P-94	1,039.00	300.0	PVC	140.0	5,508	-1,427.70	-1,430.23	2.53	2.43	0.90
P-95	536.00	250.0	PVC	140.0	4,208	-1,430.23	-1,432.16	1.93	3.59	0.99
P-96	678.00	150.0	PVC	140.0	353	-1,430.23	-1,430.53	0.30	0.44	0.23
P-97	970.00	150.0	PVC	140.0	848	-1,449.99	-1,452.15	2.16	2.22	0.56
P-99	1,110.00	150.0	PVC	140.0	-130	-1,452.15	-1,452.08	0.08	0.07	0.09
P-100	908.00	150.0	PVC	140.0	-2,121	-1,452.08	-1,441.03	11.05	12.17	1.39
P-101	853.00	150.0	PVC	140.0	1,960	-1,441.03	-1,449.99	8.97	10.51	1.28
P-102	1,439.00	150.0	PVC	140.0	341	-1,441.03	-1,441.62	0.59	0.41	0.22
P-103	347.00	150.0	PVC	140.0	-1,376	-1,435.61	-1,433.72	1.89	5.46	0.90
P-104	807.00	150.0	PVC	140.0	-905	-1,433.72	-1,431.69	2.03	2.51	0.59
P-105	695.00	200.0	PVC	140.0	4,770	-1,431.69	-1,441.03	9.34	13.44	1.76
P-106	915.00	250.0	PVC	140.0	-6,367	-1,431.69	-1,424.61	7.08	7.73	1.50
P-107	1,035.00	250.0	PVC	140.0	-7,497	-1,424.61	-1,413.78	10.83	10.47	1.77
P-108	889.00	150.0	PVC	140.0	1,775	-1,413.78	-1,421.55	7.77	8.74	1.16
P-109	807.00	150.0	PVC	140.0	564	-1,421.55	-1,422.40	0.84	1.05	0.37
P-110	425.00	200.0	PVC	140.0	2,511	-1,422.40	-1,424.14	1.74	4.10	0.93
P-111	395.00	150.0	PVC	140.0	124	-1,424.14	-1,424.16	0.03	0.06	0.08
P-112	873.00	150.0	PVC	140.0	280	-1,424.16	-1,424.41	0.25	0.29	0.18
P-113	1,020.00	350.0	PVC	140.0	-9,863	-1,413.78	-1,410.33	3.45	3.38	1.19
P-114	836.00	200.0	PVC	140.0	3,742	-1,410.33	-1,417.50	7.17	8.57	1.38
P-115	854.00	150.0	PVC	140.0	-955	-1,417.50	-1,415.13	2.37	2.78	0.63
P-116	815.00	500.0	PVC	140.0	15,170	-1,415.13	-1,416.20	1.08	1.32	0.89
P-117	868.00	350.0	PVC	140.0	11,078	-1,416.20	-1,419.84	3.64	4.19	1.33
P-118	1,020.00	150.0	PVC	140.0	-1,669	-1,424.16	-1,416.20	7.96	7.80	1.09
P-119	968.00	250.0	PVC	140.0	-6,266	-1,422.40	-1,415.13	7.27	7.51	1.48
P-120	1,019.00	200.0	PVC	140.0	-2,472	-1,421.55	-1,417.50	4.05	3.98	0.91

Scenario: Scenario 4
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-122	1,031.00	400.0	PVC	140.0	-23,612	-1,415.13	-1,405.97	9.15	8.88	2.17
P-123	1,047.00	150.0	PVC	140.0	1,381	-1,416.20	-1,421.95	5.75	5.49	0.90
P-124	631.00	150.0	PVC	140.0	367	-1,405.97	-1,406.27	0.30	0.47	0.24
P-125	823.00	450.0	PVC	140.0	-25,293	-1,405.97	-1,401.30	4.68	5.68	1.84
P-129	862.00	500.0	PVC	140.0	35,325	-1,002.66	-1,008.10	5.44	6.31	2.08
P-130	836.00	350.0	PVC	140.0	31,947	-1,008.10	-1,033.01	24.90	29.79	3.84
P-131	813.00	150.0	PVC	140.0	407	-1,033.01	-1,033.47	0.46	0.57	0.27
P-132	1,031.00	150.0	PVC	140.0	1,482	-1,033.01	-1,039.46	6.46	6.26	0.97
P-133	759.00	150.0	PVC	140.0	863	-1,008.10	-1,009.85	1.75	2.30	0.57
P-135	3,067.00	250.0	PVC	140.0	-27,990	-1,401.30	-1,033.01	368.29	120.08	6.60
P-136	784.00	300.0	PVC	140.0	4,312	161.11	159.90	1.21	1.55	0.71
P-137	433.00	300.0	PVC	140.0	17,119	159.90	151.29	8.61	19.88	2.80
P-138	917.00	350.0	PVC	140.0	14,946	166.59	159.90	6.69	7.30	1.80
P-139	1,075.00	350.0	PVC	140.0	3,650	166.59	166.01	0.58	0.54	0.44
P-140	826.00	150.0	PVC	140.0	822	166.01	164.27	1.74	2.10	0.54
P-142	826.00	750.0	PVC	140.0	-50,617	165.18	166.59	1.41	1.71	1.33
P-145	493.00	150.0	PVC	140.0	-396	164.27	164.54	0.27	0.54	0.26
P-146	581.00	750.0	PVC	140.0	-39,847	164.54	165.18	0.64	1.10	1.04
P-147	813.00	300.0	PVC	140.0	-6,789	160.02	162.94	2.91	3.58	1.11
P-148	1,236.00	750.0	PVC	140.0	32,663	162.94	162.00	0.94	0.76	0.86
P-151	580.00	150.0	PVC	140.0	0	161.11	150.00	0.00	0.00	0.00
P-152	1,082.00	150.0	PVC	140.0	0	150.00	-1,449.99	0.00	0.00	0.00
P-153	857.00	400.0	PVC	140.0	-213	-1,401.30	-1,401.29	0.00	0.00	0.02
P-154	858.00	300.0	PVC	140.0	-14,757	-1,401.29	-1,388.34	12.95	15.10	2.42
P-156	479.00	300.0	PVC	140.0	-14,545	-1,410.33	-1,403.29	7.04	14.70	2.38
P-157	552.00	400.0	PVC	140.0	-14,545	-1,403.29	-1,401.29	2.00	3.62	1.34
P-161	891.00	300.0	PVC	140.0	4,369	147.79	146.37	1.41	1.58	0.72
P-162	837.00	300.0	PVC	140.0	2,421	146.37	145.93	0.44	0.53	0.40
P-163	836.00	300.0	PVC	140.0	576	145.93	145.90	0.03	0.04	0.09
P-164	852.00	250.0	PVC	140.0	799	145.96	145.82	0.14	0.17	0.19
P-165	836.00	250.0	PVC	140.0	847	145.82	145.67	0.15	0.18	0.20
P-166	1,014.00	250.0	PVC	140.0	-1,296	145.96	146.37	0.41	0.41	0.31
P-167	1,127.00	250.0	PVC	140.0	-597	145.82	145.93	0.11	0.10	0.14
P-168	123.00	600.0	PVC	140.0	12,505	149.81	149.76	0.05	0.38	0.51
P-169	170.00	900.0	PVC	140.0	97,689	153.14	152.74	0.40	2.37	1.78

Scenario: Scenario 4
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-170	1,067.00	150.0	PVC	140.0	-249	165.76	166.01	0.25	0.23	0.16
P-171	1,789.00	150.0	PVC	140.0	-631	-1,426.44	-1,424.14	2.30	1.29	0.41
P-173	1,002.00	350.0	PVC	140.0	4,245	162.00	161.29	0.71	0.71	0.51
P-174	210.00	350.0	PVC	140.0	5,261	161.29	161.07	0.22	1.05	0.63
P-175	856.00	350.0	PVC	140.0	-1,016	161.29	161.33	0.04	0.05	0.12
P-176	837.00	150.0	PVC	140.0	-1,999	140.69	149.81	9.12	10.90	1.31
P-177	1,031.00	900.0	PVC	140.0	85,589	151.04	149.13	1.91	1.86	1.56
P-178	1,047.00	150.0	PVC	140.0	-1,875	-1,431.69	-1,421.55	10.14	9.68	1.23
P-179	921.00	900.0	PVC	140.0	126,381	160.00	156.48	3.52	3.82	2.30
P-180	1,095.00	150.0	PVC	140.0	-1,943	-1,433.72	-1,422.40	11.32	10.34	1.27
P-185	832.00	150.0	Ductile Irc	140.0	0	161.57	-1,419.84	0.00	0.00	0.00
P-186	437.00	750.0	PVC	140.0	-71,213	166.59	167.99	1.40	3.21	1.87
P-187	711.00	350.0	PVC	140.0	21,528	167.99	157.79	10.20	14.34	2.59
P-188	327.00	750.0	PVC	140.0	92,741	169.70	167.99	1.71	5.24	2.43
P-189	765.00	150.0	PVC	140.0	-0	-1,401.29	-1,401.29	0.00	0.00	0.00
P-190	2,296.00	150.0	PVC	140.0	-0	-1,008.10	-1,008.10	0.00	0.00	0.00
P-191	1,491.00	750.0	PVC	140.0	39,451	164.54	162.94	1.60	1.08	1.03
P-192	1,300.00	750.0	PVC	140.0	97,326	145.12	137.68	7.44	5.72	2.55
P-193	384.00	750.0	PVC	140.0	97,326	171.90	169.70	2.20	5.72	2.55
P-194	1,969.00	350.0	PVC	140.0	2,139	148.50	148.11	0.39	0.20	0.26
P-195	2,643.00	150.0	PVC	140.0	15,119	150.00	-1,071.34	1,221.34	462.10	9.90
P-196	686.00	150.0	PVC	140.0	15,119	-1,071.34	-1,388.34	317.00	462.10	9.90
P-197	456.00	150.0	PVC	140.0	20,425	150.00	-217.82	367.82	806.62	13.38
P-198	268.00	150.0	PVC	140.0	20,425	-217.82	-433.99	216.17	806.62	13.38
P-199	509.00	150.0	PVC	140.0	20,425	-433.99	-844.56	410.57	806.62	13.38
P-200	196.00	150.0	PVC	140.0	20,425	-844.56	-1,002.66	158.10	806.62	13.38
P-201	349.00	150.0	PVC	140.0	15,639	150.00	-21.69	171.69	491.96	10.24
P-202	494.00	150.0	PVC	140.0	15,639	-21.69	-264.72	243.03	491.96	10.24
P-203	508.00	150.0	PVC	140.0	15,639	-264.72	-514.64	249.92	491.96	10.24
P-204	992.00	150.0	PVC	140.0	15,639	-514.64	-1,002.66	488.02	491.96	10.24

Scenario: Scenario 4
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m³/day)	Calculated Hydraulic Grade (m)	Pressure (psi)
J-1	110.00	2,139	148.11	54.091
J-2	113.00	1,879	148.50	50.390
J-3	92.00	399	148.41	80.066
J-4	91.00	1,002	148.41	81.494
J-5	90.00	102	140.67	71.927
J-6	89.00	1,445	140.69	73.372
J-7	81.00	1,208	140.23	84.077
J-8	95.00	1,462	149.44	77.277
J-9	98.00	1,855	148.60	71.824
J-10A	93.00	1,799	148.71	79.081
J-11	79.00	1,376	141.68	88.973
J-12	89.00	411	149.81	86.318
J-13	87.00	855	149.76	89.091
J-14	84.00	1,115	148.66	91.777
J-15	83.00	458	150.80	96.237
J-16	80.00	798	150.46	100.015
J-17	79.00	377	150.88	102.029
J-18	83.00	666	151.39	97.080
J-19	82.00	559	152.09	99.489
J-21	83.00	1,277	152.29	98.361
J-22	80.00	247	156.48	108.562
J-23	83.00	907	153.14	99.564
J-24	80.00	353	149.92	99.243
J-25	83.00	301	150.45	95.749
J-25A	80.00	0	149.95	99.287
J-26	83.00	816	147.79	91.961
J-27	78.00	517	147.72	98.958
J-28	83.00	652	146.37	89.957
J-29	78.00	497	145.96	96.470
J-30	77.00	549	145.82	97.689
J-31	83.00	1,248	145.93	89.326
J-32	78.00	847	145.67	96.050
J-33	81.00	576	145.90	92.121
J-34	87.00	84	149.66	88.938
J-35	90.00	129	149.67	84.701
J-36	96.00	859	148.79	74.934
J-37	83.00	422	152.74	98.992
J-39	88.00	381	151.04	89.483
J-40	110.00	1,953	148.55	54.724
J-41	96.00	1,673	149.13	75.410
J-42	85.00	417	150.93	93.589
J-44	85.00	1,026	150.96	93.629
J-45	110.00	1,919	148.26	54.303
J-46	91.00	1,323	148.35	81.401
J-47	84.00	902	150.94	95.014
J-48	86.00	1,104	147.71	87.590
J-49	85.00	741	150.94	93.593
J-50	84.00	0	150.94	95.012
J-51	83.00	1,472	150.94	96.432
J-52	90.50	5,023	146.67	79.738
J-53	110.00	2,931	147.80	53.651
J-54	111.00	2,145	147.61	51.967

Scenario: Scenario 4
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m³/day)	Calculated Hydraulic Grade (m)	Pressure (psi)
J-55	110.00	1,593	147.90	53.792
J-56	98.00	1,277	145.04	66.774
J-57	90.00	3,063	145.12	78.243
J-58	95.00	3,000	148.10	75.371
J-59	85.00	809	151.21	93.983
J-60	86.00	1,965	151.29	92.676
J-61	96.00	2,799	157.79	87.712
J-62	94.00	4,585	169.70	107.454
J-63	90.00	2,139	159.90	99.214
J-64	95.00	2,000	166.59	101.613
J-65	96.00	2,117	166.01	99.375
J-66	84.00	3,208	161.11	109.453
J-67	95.00	3,250	165.18	99.613
J-68	96.00	1,218	164.27	96.910
J-70	101.00	711	165.76	91.930
J-71	86.00	306	159.76	104.700
J-72	85.50	380	158.67	103.866
J-73	86.00	1,040	155.14	98.149
J-74	87.00	2,352	157.73	100.396
J-75	87.00	6,267	158.35	101.277
J-76	88.00	2,384	160.02	102.234
J-77	91.00	497	159.54	97.290
J-78	88.00	5,919	159.08	100.893
J-79	100.00	711	160.78	86.276
J-80	100.00	4,524	162.00	88.007
J-81	101.00	3,371	161.66	86.111
J-82	92.00	2,311	161.57	98.757
J-83	102.00	2,612	161.07	83.845
J-85	100.00	2,335	161.33	87.060
J-86	103.00	2,649	160.66	81.845
J-87	101.00	1,793	161.35	85.659
J-88	86.00	1,510	-1,424.41	-2,143.976
J-89	90.00	1,664	-1,419.84	-2,143.163
J-90	98.00	2,447	-1,425.04	-2,161.897
J-91	101.00	229	-1,427.70	-2,169.937
J-92	120.00	4,208	-1,432.16	-2,203.229
J-93	118.00	947	-1,430.23	-2,197.657
J-94	125.00	353	-1,430.53	-2,208.016
J-95	88.00	978	-1,452.15	-2,186.191
J-96	88.00	1,113	-1,449.99	-2,183.128
J-97	87.00	1,991	-1,452.08	-2,184.662
J-98	85.00	347	-1,441.03	-2,166.142
J-99	89.00	341	-1,441.62	-2,172.661
J-100	90.00	2,567	-1,431.69	-2,159.985
J-101	90.00	1,130	-1,424.61	-2,149.938
J-102	91.00	1,376	-1,435.61	-2,166.970
J-103	90.50	1,217	-1,426.44	-2,153.245
J-104	90.00	1,472	-1,433.72	-2,162.862
J-105	95.00	1,381	-1,421.95	-2,153.263
J-106	92.00	1,042	-1,416.20	-2,140.839
J-107	91.00	1,514	-1,424.16	-2,150.719
J-108	91.00	1,170	-1,424.14	-2,150.684

Scenario: Scenario 4
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m^3/day)	Calculated Hydraulic Grade (m)	Pressure (psi)
J-109	90.00	2,376	-1,422.40	-2,146.793
J-110	94.00	1,220	-1,415.13	-2,142.151
J-111	107.00	1,314	-1,405.97	-2,147.609
J-112	109.00	367	-1,406.27	-2,150.871
J-113	91.00	1,808	-1,421.55	-2,147.014
J-114	90.00	591	-1,413.78	-2,134.559
J-115	100.00	940	-1,410.33	-2,143.863
J-116	97.00	2,225	-1,417.50	-2,149.776
J-117	99.00	2,910	-1,401.30	-2,129.615
J-118	105.00	0	-1,401.29	-2,138.130
J-119	107.00	362	-1,388.34	-2,122.581
J-120	120.00	2,068	-1,033.01	-1,636.649
J-121	117.00	407	-1,033.47	-1,633.051
J-122	128.00	1,482	-1,039.46	-1,657.168
J-123	130.00	863	-1,009.85	-1,617.973
J-124	123.00	2,515	-1,008.10	-1,605.559
J-125	113.00	739	-1,002.66	-1,583.638
J-126	100.00	0	-1,403.29	-2,133.869
J-129	95.00	0	164.54	98.710
J-130	90.00	0	162.94	103.532
J-136	95.00	0	167.99	103.604
J-137	105.00	0	-1,071.34	-1,669.768
J-138	98.00	0	161.29	89.838
J-139	108.00	0	-217.82	-462.488
J-140	110.00	0	-433.99	-772.178
J-141	113.00	0	-844.56	-1,359.224
J-142	115.00	0	-21.69	-194.032
J-143	117.00	0	-264.72	-541.839
J-144	117.00	0	-514.64	-896.585

Stantec

APPENDIX F

Alternative E1

Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-5	840	150.0	PVC	140.0	-815	117.76	119.50	1.74	2.07	0.53
P-6	1,168	500.0	PVC	140.0	-21,650	119.50	122.47	2.98	2.55	1.28
P-7	485	150.0	PVC	140.0	199	122.47	122.40	0.07	0.15	0.13
P-8	1,047	500.0	PVC	140.0	-35,266	122.47	129.07	6.59	6.30	2.08
P-9	962	600.0	PVC	140.0	-27,012	129.07	130.59	1.52	1.58	1.11
P-10	480	600.0	PVC	140.0	-27,653	130.59	131.38	0.79	1.65	1.13
P-11	1,047	600.0	PVC	140.0	30,755	131.38	129.27	2.11	2.01	1.26
P-13	1,046	250.0	PVC	140.0	2,011	118.76	117.80	0.96	0.92	0.47
P-14	793	300.0	PVC	140.0	2,473	117.80	117.36	0.44	0.55	0.40
P-15	2,064	900.0	PVC	140.0	-73,841	131.38	134.29	2.92	1.41	1.34
P-16	868	500.0	PVC	140.0	18,743	119.50	117.80	1.69	1.95	1.10
P-17	926	350.0	PVC	140.0	10,823	122.47	118.76	3.72	4.01	1.30
P-18	905	350.0	PVC	140.0	6,533	118.76	117.33	1.43	1.58	0.79
P-19	1,881	350.0	PVC	140.0	2,979	117.33	116.64	0.69	0.37	0.36
P-21	921	600.0	PVC	140.0	-9,442	129.07	129.27	0.21	0.23	0.39
P-22	2,752	600.0	PVC	140.0	18,302	129.27	127.16	2.12	0.77	0.75
P-23	325	300.0	PVC	140.0	17,940	127.16	120.11	7.05	21.68	2.94
P-24	801	300.0	PVC	140.0	7,517	120.11	116.64	3.47	4.33	1.23
P-25	2,755	600.0	PVC	140.0	15,111	131.38	129.89	1.49	0.54	0.62
P-26	242	300.0	PVC	140.0	6,114	129.89	129.18	0.71	2.95	1.00
P-27	2,520	250.0	PVC	140.0	-734	126.01	126.37	0.36	0.14	0.17
P-28	903	300.0	PVC	140.0	-2,995	126.37	127.08	0.71	0.79	0.49
P-30	805	350.0	PVC	140.0	42	152.67	152.67	0.00	0.00	0.01
P-31	841	300.0	PVC	140.0	-157	152.51	152.52	0.00	0.00	0.03
P-32	523	300.0	PVC	140.0	956	152.52	152.47	0.05	0.10	0.16
P-33	959	300.0	PVC	140.0	0	152.47	152.47	0.00	0.00	0.00
P-34	729	350.0	PVC	140.0	-1,323	152.81	152.87	0.06	0.08	0.16
P-35	1,675	350.0	PVC	140.0	-738	152.87	152.92	0.05	0.03	0.09
P-36	890	350.0	PVC	140.0	2,590	152.92	152.67	0.25	0.28	0.31
P-38	1,668	300.0	PVC	140.0	6,426	133.87	128.47	5.40	3.24	1.05
P-39	929	300.0	PVC	140.0	4,232	128.47	127.08	1.39	1.49	0.69
P-40	844	300.0	PVC	140.0	1,346	128.47	128.32	0.15	0.18	0.22
P-41	818	150.0	PVC	140.0	1,180	128.32	124.96	3.35	4.10	0.77
P-42	961	300.0	PVC	140.0	2,466	124.96	124.44	0.53	0.55	0.40
P-43	1,966	300.0	PVC	140.0	2,182	129.18	128.32	0.86	0.44	0.36

Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-44	1,998	300.0	PVC	140.0	-3,956	124.96	127.60	2.63	1.32	0.65
P-45	515	300.0	PVC	140.0	3,130	127.60	127.16	0.44	0.85	0.51
P-46	592	300.0	PVC	140.0	-7,086	127.60	129.89	2.30	3.88	1.16
P-47	1,056	400.0	PVC	140.0	9,351	120.11	118.42	1.69	1.60	0.86
P-48	975	300.0	PVC	140.0	462	118.42	118.40	0.02	0.02	0.08
P-49	1,041	350.0	PVC	140.0	4,473	116.64	115.83	0.81	0.78	0.54
P-50	997	350.0	PVC	140.0	8,587	115.83	113.22	2.61	2.61	1.03
P-51	533	300.0	PVC	140.0	742	113.22	113.19	0.03	0.06	0.12
P-52	807	300.0	PVC	140.0	-6,403	115.83	118.42	2.59	3.22	1.05
P-53	884	350.0	PVC	140.0	7,371	113.22	111.48	1.74	1.97	0.89
P-54	864	300.0	PVC	140.0	1,220	111.48	111.35	0.13	0.15	0.20
P-55	582	300.0	PVC	140.0	-2,183	111.48	111.73	0.26	0.44	0.36
P-56	1,453	300.0	PVC	140.0	-5,647	111.73	115.44	3.70	2.55	0.92
P-57	295	500.0	PVC	140.0	-2,863	115.44	115.46	0.02	0.06	0.17
P-58	594	300.0	PVC	140.0	-1,155	111.65	111.73	0.08	0.13	0.19
P-59	898	300.0	PVC	140.0	-3,990	115.44	116.64	1.20	1.34	0.65
P-60	962	500.0	PVC	140.0	14,729	117.80	116.60	1.20	1.25	0.87
P-61	330	500.0	PVC	140.0	13,602	116.60	116.24	0.36	1.08	0.80
P-62	614	500.0	PVC	140.0	12,327	116.24	115.69	0.55	0.90	0.73
P-63	672	500.0	PVC	140.0	7,404	115.69	115.46	0.24	0.35	0.44
P-64	901	300.0	PVC	140.0	-2,102	115.32	115.69	0.37	0.41	0.34
P-65	896	150.0	PVC	140.0	-509	115.47	116.24	0.77	0.87	0.33
P-66	758	150.0	PVC	140.0	-566	115.80	116.60	0.80	1.05	0.37
P-67	1,028	350.0	PVC	140.0	-1,471	152.87	152.98	0.10	0.10	0.18
P-69	1,006	350.0	PVC	140.0	-3,807	152.92	153.50	0.58	0.58	0.46
P-71	993	350.0	PVC	140.0	-7,501	133.87	135.89	2.02	2.04	0.90
P-72	1,475	300.0	PVC	140.0	-11,214	135.89	149.29	13.40	9.08	1.84
P-73	1,724	300.0	PVC	140.0	-7,186	149.29	156.15	6.87	3.98	1.18
P-74	1,074	300.0	PVC	140.0	-9,907	156.15	163.90	7.75	7.22	1.62
P-75	113	600.0	PVC	140.0	-73,149	163.90	165.03	1.13	10.00	2.99
P-76	416	300.0	PVC	140.0	977	165.03	164.99	0.04	0.10	0.16
P-77	717	600.0	PVC	140.0	-74,126	165.03	172.38	7.35	10.25	3.03
P-78	846	750.0	PVC	140.0	-116,512	172.38	179.14	6.76	7.99	3.05
P-81	751	200.0	PVC	140.0	-996	168.38	168.93	0.55	0.74	0.37
P-82	827	300.0	PVC	140.0	-1,268	168.93	169.06	0.13	0.16	0.21

Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-83	830	300.0	PVC	140.0	14,997	169.06	156.15	12.91	15.56	2.46
P-84	850	300.0	PVC	140.0	13,470	156.15	145.31	10.84	12.75	2.21
P-85	843	400.0	PVC	140.0	17,112	145.31	141.19	4.12	4.89	1.58
P-86	418	400.0	PVC	140.0	15,887	141.19	139.40	1.78	4.26	1.46
P-87	432	400.0	PVC	140.0	16,755	139.40	137.37	2.03	4.70	1.54
P-88	832	400.0	PVC	140.0	13,660	137.37	134.69	2.68	3.22	1.26
P-89	826	300.0	PVC	140.0	11,383	134.69	126.98	7.71	9.34	1.86
P-90	832	300.0	PVC	140.0	8,364	126.98	122.60	4.39	5.27	1.37
P-91	912	300.0	PVC	140.0	4,535	122.60	121.05	1.55	1.70	0.74
P-92	1,099	350.0	PVC	140.0	19,165	158.02	145.31	12.71	11.56	2.31
P-93	1,050	350.0	PVC	140.0	12,453	145.31	139.85	5.46	5.20	1.50
P-94	820	350.0	PVC	140.0	80	139.85	139.85	0.00	0.00	0.01
P-95	1,325	350.0	PVC	140.0	7,764	139.85	136.97	2.87	2.17	0.93
P-96	1,131	150.0	PVC	140.0	1,883	152.22	141.19	11.03	9.76	1.23
P-97	905	400.0	PVC	140.0	-9,425	124.25	125.72	1.47	1.62	0.87
P-98	828	400.0	PVC	140.0	-14,874	125.72	128.85	3.13	3.77	1.37
P-99	847	400.0	PVC	140.0	-21,585	128.85	135.22	6.37	7.52	1.99
P-100	836	400.0	PVC	140.0	-23,588	135.22	142.62	7.41	8.86	2.17
P-101	411	400.0	PVC	140.0	-25,797	142.62	146.92	4.30	10.46	2.38
P-102	433	400.0	PVC	140.0	-28,068	146.92	152.22	5.30	12.23	2.59
P-103	846	500.0	PVC	140.0	-36,916	152.22	158.02	5.80	6.85	2.18
P-104	263	600.0	PVC	140.0	-59,383	158.02	159.81	1.79	6.80	2.43
P-105	564	600.0	PVC	140.0	-61,544	159.81	163.90	4.10	7.26	2.52
P-106	1,013	150.0	PVC	140.0	746	159.81	158.03	1.78	1.76	0.49
P-107	1,115	150.0	PVC	140.0	-1,543	139.40	146.92	7.52	6.74	1.01
P-108	584	150.0	PVC	140.0	1,103	142.62	140.51	2.12	3.62	0.72
P-109	1,123	150.0	PVC	140.0	-365	134.69	135.22	0.52	0.47	0.24
P-110	390	150.0	PVC	140.0	989	135.22	134.06	1.15	2.96	0.65
P-111	787	150.0	PVC	140.0	-451	128.30	128.85	0.54	0.69	0.30
P-112	1,116	300.0	PVC	140.0	4,493	128.85	126.98	1.86	1.67	0.74
P-113	1,049	300.0	PVC	140.0	5,621	126.98	124.33	2.65	2.53	0.92
P-114	1,077	300.0	PVC	140.0	5,658	124.33	121.58	2.75	2.56	0.93
P-115	1,035	150.0	PVC	140.0	1,590	134.69	127.31	7.38	7.13	1.04
P-116	1,065	150.0	PVC	140.0	460	127.31	126.55	0.76	0.72	0.30
P-117	1,822	150.0	PVC	140.0	-669	125.88	128.49	2.62	1.44	0.44

Scenario: Scenario 1
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-118	860	200.0	PVC	140.0	-2,789	128.49	132.77	4.28	4.97	1.03
P-119	849	200.0	PVC	140.0	-3,687	132.77	139.85	7.08	8.34	1.36
P-120	844	300.0	PVC	140.0	-12,554	139.85	149.29	9.44	11.19	2.06
P-121	837	300.0	PVC	140.0	-18,097	149.29	167.73	18.44	22.03	2.96
P-122	848	300.0	PVC	140.0	309	167.73	167.72	0.01	0.01	0.05
P-124	1,560	600.0	PVC	140.0	-19,361	167.73	169.06	1.33	0.85	0.79
P-125	1,068	600.0	PVC	140.0	-38,877	169.06	172.38	3.31	3.10	1.59
P-126	851	300.0	PVC	140.0	9,630	139.85	134.02	5.83	6.85	1.58
P-127	827	300.0	PVC	140.0	7,337	134.02	130.59	3.42	4.14	1.20
P-129	835	300.0	PVC	140.0	7,137	130.59	127.31	3.28	3.93	1.17
P-130	827	300.0	PVC	140.0	6,806	127.31	124.33	2.98	3.60	1.11
P-131	847	300.0	PVC	140.0	5,268	124.33	122.44	1.90	2.24	0.86
P-135	746	150.0	PVC	140.0	-439	120.02	120.51	0.49	0.66	0.29
P-136	1,115	150.0	PVC	140.0	-1,058	120.51	124.25	3.74	3.35	0.69
P-137	658	300.0	PVC	140.0	6,494	124.25	122.08	2.17	3.30	1.06
P-138	989	300.0	PVC	140.0	705	122.08	122.03	0.05	0.05	0.12
P-139	449	300.0	PVC	140.0	5,350	122.08	121.05	1.04	2.31	0.88
P-140	1,732	300.0	PVC	140.0	7,423	121.05	113.72	7.32	4.23	1.22
P-141	1,048	250.0	PVC	140.0	5,940	113.72	106.60	7.13	6.80	1.40
P-142	439	250.0	PVC	140.0	2,485	106.60	106.00	0.59	1.35	0.59
P-143	599	250.0	PVC	140.0	1,821	106.00	105.55	0.46	0.76	0.43
P-144	1,179	250.0	PVC	140.0	630	105.55	105.42	0.13	0.11	0.15
P-145	657	250.0	PVC	140.0	110	105.42	105.42	0.00	0.00	0.03
P-146	1,055	300.0	PVC	140.0	5,466	122.44	119.91	2.53	2.40	0.89
P-147	506	300.0	PVC	140.0	9,194	119.91	116.73	3.18	6.29	1.51
P-148	556	300.0	PVC	140.0	8,471	116.73	113.72	3.00	5.40	1.39
P-150	1,055	150.0	PVC	140.0	-198	122.44	122.60	0.16	0.15	0.13
P-151	1,119	150.0	PVC	140.0	-958	122.60	125.72	3.13	2.79	0.63
P-152	763	150.0	PVC	140.0	821	125.72	124.12	1.60	2.10	0.54
P-153	1,462	300.0	PVC	140.0	6,210	113.72	109.28	4.44	3.04	1.02
P-154	905	300.0	PVC	140.0	6,834	109.28	106.00	3.28	3.63	1.12
P-155	2,544	300.0	PVC	140.0	-1,561	106.00	106.60	0.60	0.24	0.26
P-156	696	300.0	PVC	140.0	3,664	106.00	105.20	0.80	1.14	0.60
P-157	590	300.0	PVC	140.0	422	105.20	105.19	0.01	0.02	0.07
P-158	549	300.0	PVC	140.0	2,826	105.20	104.81	0.39	0.71	0.46

Scenario: Scenario 1
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-159	636	300.0	PVC	140.0	1,370	104.81	104.70	0.12	0.18	0.22
P-160	307	300.0	PVC	140.0	809	104.81	104.79	0.02	0.07	0.13
P-161	3,740	450.0	PVC	140.0	-2,058	115.25	115.46	0.20	0.05	0.15
P-164	1,023	300.0	PVC	140.0	-1,209	152.52	152.67	0.15	0.15	0.20
P-165	971	150.0	PVC	140.0	-1,064	128.47	131.76	3.29	3.39	0.70
P-166	403	300.0	PVC	140.0	-1,151	172.32	172.38	0.05	0.13	0.19
P-167	1,070	150.0	PVC	140.0	-886	125.91	128.49	2.58	2.41	0.58
P-168	1,183	150.0	PVC	140.0	-505	131.76	132.77	1.01	0.85	0.33
P-169	971	150.0	PVC	140.0	-630	132.77	134.02	1.25	1.29	0.41
P-170	854	150.0	PVC	140.0	-1,461	131.76	136.97	5.21	6.10	0.96
P-171	824	350.0	PVC	140.0	5,910	136.97	135.89	1.08	1.31	0.71
P-173	1,671	350.0	PVC	140.0	2,742	153.50	152.98	0.53	0.32	0.33
P-175	452	900.0	PVC	140.0	-77,953	134.29	135.00	0.71	1.56	1.42
P-176	1,049	250.0	PVC	140.0	-1,739	116.60	117.33	0.73	0.70	0.41
P-177	900	300.0	PVC	140.0	5,519	111.48	109.28	2.20	2.44	0.90
P-178	836	300.0	PVC	140.0	-4,957	119.91	121.58	1.67	2.00	0.81
P-179	1,040	150.0	PVC	140.0	-1,514	130.59	137.37	6.78	6.52	0.99
P-182	362	350.0	PVC	140.0	9,020	135.89	134.86	1.04	2.86	1.09
P-183	473	350.0	PVC	140.0	9,020	154.86	153.50	1.35	2.86	1.09
P-184	441	300.0	PVC	140.0	0	0.00	44.76	0.00	0.00	0.00
P-185	1,285	300.0	PVC	140.0	0	44.76	89.53	0.00	0.00	0.00
P-186	164	300.0	PVC	140.0	0	89.53	134.29	0.00	0.00	0.00
P-188	1,051	300.0	PVC	140.0	0	152.47	152.47	0.00	0.00	0.00
P-189	896	400.0	PVC	140.0	19,571	230.00	224.38	5.62	6.27	1.80
P-190	452	400.0	PVC	140.0	19,571	224.38	221.55	2.84	6.27	1.80
P-191	511	400.0	PVC	140.0	19,571	221.55	218.34	3.20	6.27	1.80
P-192	688	400.0	PVC	140.0	19,571	218.34	214.03	4.31	6.27	1.80
P-193	1,069	400.0	PVC	140.0	19,571	214.03	207.33	6.70	6.27	1.80
P-194	147	400.0	PVC	140.0	19,571	207.33	206.40	0.92	6.27	1.80
P-195	571	400.0	PVC	140.0	19,571	206.40	202.82	3.58	6.27	1.80
P-196	770	400.0	PVC	140.0	19,571	202.82	198.00	4.83	6.27	1.80
P-197	2,652	400.0	PVC	140.0	19,571	198.00	181.36	16.63	6.27	1.80
P-198	248	750.0	PVC	140.0	-118,892	179.14	181.20	2.06	8.29	3.11
P-199	1,474	750.0	PVC	140.0	-99,575	181.20	190.00	8.80	5.97	2.61
P-200	578	750.0	PVC	140.0	-19,317	181.20	181.36	0.17	0.29	0.51

Scenario: Scenario 1
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-201	385	300.0	PVC	140.0	-0	134.29	134.29	0.00	0.00	0.00
P-202	1,649	300.0	PVC	140.0	0	134.29	152.47	0.00	0.00	0.00
P-203	355	300.0	PVC	140.0	0	134.29	134.29	0.00	0.00	0.00
P-204	534	300.0	PVC	140.0	0	134.29	134.29	0.00	0.00	0.00

Scenario: Scenario 1
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m³/day)	Calculated Hydraulic Grade (m)	Pressure (lbs/in²)
J-00	92.00	0	127.60	50.530
J-1	80.00	815	117.76	53.596
J-2	84.00	2,092	119.50	50.384
J-3	90.00	2,594	122.47	46.097
J-4	88.00	199	122.40	48.831
J-5	87.00	1,188	129.07	59.711
J-6	98.00	641	130.59	46.255
J-7	96.00	322	131.38	50.219
J-8	90.00	3,011	129.27	55.748
J-9	99.00	4,112	134.29	50.099
J-10	80.00	2,473	117.36	53.034
J-11	84.00	3,552	117.80	47.978
J-12	86.00	2,279	118.76	46.499
J-13	81.00	1,815	117.33	51.572
J-14	81.00	2,300	116.60	50.530
J-15	80.00	566	115.80	50.817
J-16	80.00	509	115.47	50.345
J-17	79.00	2,102	115.32	51.558
J-18	82.00	766	116.24	48.606
J-18A	81.50	2,821	115.69	48.532
J-20	90.00	1,073	120.11	42.737
J-21	87.00	2,033	116.64	42.072
J-22	98.00	734	126.01	39.763
J-23	92.00	3,492	127.16	49.905
J-24	94.00	1,910	129.89	50.950
J-25	95.00	3,932	129.18	48.516
J-26	97.00	2,261	126.37	41.689
J-27	105.00	0	152.47	67.378
J-28	110.00	157	152.51	60.347
J-29	107.00	96	152.52	64.609
J-30	102.00	956	152.47	71.636
J-31	128.00	1,323	152.81	35.222
J-32	129.00	886	152.87	33.887
J-33	107.00	1,339	152.67	64.823
J-34	120.00	42	152.67	46.369
J-35	111.00	479	152.92	59.503
J-36	109.00	1,075	133.87	35.305
J-37	97.00	1,237	127.08	42.699
J-38	97.00	1,912	128.47	44.669
J-39	96.00	2,349	128.32	45.874
J-40	95.00	2,670	124.96	42.531
J-41	91.00	462	118.40	38.889
J-42	96.00	2,486	118.42	31.826
J-43	90.00	474	113.22	32.961
J-44	90.00	2,288	115.83	36.660
J-45	81.00	2,483	115.46	48.908
J-46	80.00	1,206	115.44	50.302
J-47	83.00	1,155	111.65	40.674
J-48	80.00	2,309	111.73	45.046
J-49	80.00	2,815	111.48	44.684
J-50	82.00	2,058	115.25	47.199
J-51	81.50	422	105.19	33.627

Scenario: Scenario 1
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m^3/day)	Calculated Hydraulic Grade (m)	Pressure (lbs/in²)
J-52	80.00	416	105.20	35.774
J-53	80.50	1,220	111.35	43.791
J-54	80.50	4,731	106.00	36.193
J-55	90.00	742	113.19	32.916
J-56	80.00	4,895	109.28	41.563
J-59	80.00	110	105.42	36.080
J-60	83.00	1,191	105.55	32.004
J-61	80.00	520	105.42	36.084
J-62	81.50	1,370	104.70	32.926
J-63	82.00	809	104.79	32.353
J-64	83.00	647	104.81	30.964
J-65	82.00	664	106.00	34.071
J-66	82.00	1,894	106.60	34.915
J-67	82.00	1,229	119.91	53.806
J-68	83.00	723	116.73	47.875
J-69	88.00	3,744	113.72	36.515
J-70	90.00	705	122.03	45.463
J-71	87.00	439	122.08	49.798
J-72	90.00	2,462	121.05	44.070
J-73	91.00	1,873	124.25	47.204
J-74	91.00	439	120.02	41.197
J-75	90.00	619	120.51	43.313
J-75A	90.00	0	122.44	46.042
J-76	90.00	4,589	122.60	46.268
J-77	93.00	3,670	125.72	46.446
J-78	90.00	821	124.12	48.433
J-79	90.00	451	128.30	54.369
J-80	91.00	701	121.58	43.406
J-81	93.00	1,501	124.33	44.477
J-82	94.00	1,891	126.98	46.820
J-83	91.00	1,767	128.85	53.722
J-84	91.00	989	134.06	61.124
J-85	91.00	650	135.22	62.763
J-86	91.00	1,052	134.69	62.020
J-87	91.00	1,461	127.31	51.541
J-88	91.00	460	126.55	50.456
J-89	91.00	2,466	124.44	47.460
J-90	91.00	886	125.91	49.555
J-91	91.00	669	125.88	49.508
J-92	94.00	1,234	128.49	48.962
J-93	95.00	902	131.76	52.181
J-94	97.00	393	136.97	56.737
J-95	99.00	603	135.89	52.367
J-96	110.00	2,471	153.50	61.750
J-97	123.00	1,271	152.98	42.549
J-100	107.00	309	167.72	86.193
J-101	97.00	1,023	132.77	50.774
J-102	100.00	1,183	139.85	56.559
J-103	97.00	1,662	134.02	52.545
J-104	95.00	1,715	130.59	50.524
J-105	95.00	1,580	137.37	60.149
J-106	94.00	1,106	142.62	69.019

Scenario: Scenario 1
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m^3/day)	Calculated Hydraulic Grade (m)	Pressure (lbs/in^2)
J-107	96.00	1,103	140.51	63.176
J-108	97.00	675	139.40	60.191
J-109	98.00	3,108	141.19	61.300
J-110	97.00	728	146.92	70.862
J-111	98.00	6,965	152.22	76.961
J-112	100.00	3,301	158.02	82.354
J-113	112.00	746	158.03	65.334
J-114	100.00	2,744	139.85	56.559
J-115	103.00	3,070	145.31	60.057
J-116	100.00	1,415	159.81	84.893
J-117	101.00	1,699	163.90	89.288
J-118	101.00	977	164.99	90.830
J-118A	100.00	0	165.03	92.308
J-119	96.00	2,358	172.38	108.414
J-120	95.00	1,151	172.32	109.757
J-121	97.00	4,247	156.15	83.965
J-122	104.00	1,515	149.29	64.284
J-123	100.00	955	167.73	96.143
J-125	100.00	3,251	169.06	98.032
J-126	104.00	996	168.38	91.379
J-127	104.00	272	168.93	92.166
J-128	105.00	2,380	179.14	105.237
J-129	130.00	254	181.36	72.910
J-130	112.00	0	44.76	-95.438
J-131	106.00	0	89.53	-23.379
J-132	106.00	0	134.29	40.163
J-133	108.00	0	152.47	63.119
J-134	188.00	0	224.38	51.642
J-135	190.00	0	221.55	44.779
J-136	190.00	0	218.34	40.234
J-137	185.00	0	214.03	41.206
J-138	138.00	0	207.33	98.405
J-139	138.00	0	206.40	97.097
J-140	125.00	0	202.82	110.467
J-141	118.00	0	198.00	113.552
J-142	110.00	0	181.20	101.064
J-143	107.00	0	134.29	38.744
J-144	103.00	0	134.29	44.422

Stantec

APPENDIX F

Alternative E2

Scenario: Scenario 2
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-5	840	150.0	PVC	140.0	-815	123.26	125.00	1.74	2.07	0.53
P-6	1,168	400.0	PVC	140.0	-12,614	125.00	128.24	3.25	2.78	1.16
P-7	485	150.0	PVC	140.0	199	128.24	128.17	0.07	0.15	0.13
P-8	1,047	600.0	PVC	140.0	-29,732	128.24	130.22	1.98	1.89	1.22
P-9	962	600.0	PVC	140.0	-28,414	130.22	131.89	1.67	1.74	1.16
P-10	480	600.0	PVC	140.0	-29,055	131.89	132.76	0.87	1.81	1.19
P-11	1,047	600.0	PVC	140.0	30,052	132.76	130.74	2.02	1.93	1.23
P-13	1,046	300.0	PVC	140.0	4,102	124.99	123.51	1.47	1.41	0.67
P-14	793	300.0	PVC	140.0	2,473	123.51	123.07	0.44	0.55	0.40
P-15	2,064	750.0	PVC	140.0	-73,385	132.76	139.77	7.01	3.39	1.92
P-16	868	400.0	PVC	140.0	9,707	125.00	123.51	1.49	1.71	0.89
P-17	926	400.0	PVC	140.0	14,324	128.24	124.99	3.26	3.52	1.32
P-18	905	400.0	PVC	140.0	7,944	124.99	123.92	1.07	1.18	0.73
P-19	1,881	400.0	PVC	140.0	1,996	123.92	123.74	0.17	0.09	0.18
P-21	921	300.0	PVC	140.0	-2,506	130.22	130.74	0.52	0.57	0.41
P-22	2,752	600.0	PVC	140.0	24,535	130.74	127.10	3.64	1.32	1.00
P-23	325	450.0	PVC	140.0	26,023	127.10	125.15	1.95	5.99	1.89
P-24	801	450.0	PVC	140.0	13,430	125.15	123.74	1.41	1.76	0.98
P-25	2,755	450.0	PVC	140.0	13,956	132.76	127.55	5.21	1.89	1.02
P-26	242	450.0	PVC	140.0	5,083	127.55	127.48	0.07	0.29	0.37
P-27	2,520	300.0	PVC	140.0	-734	126.30	126.45	0.15	0.06	0.12
P-28	903	300.0	PVC	140.0	-2,995	126.45	127.16	0.71	0.79	0.49
P-30	805	300.0	PVC	140.0	42	150.78	150.78	0.00	0.00	0.01
P-31	841	300.0	PVC	140.0	-157	150.77	150.77	0.00	0.00	0.03
P-32	523	300.0	PVC	140.0	26	150.77	150.77	0.00	0.00	0.00
P-33	959	500.0	PVC	140.0	-930	150.77	150.78	0.01	0.01	0.05
P-34	729	350.0	PVC	140.0	-1,323	150.89	150.95	0.06	0.08	0.16
P-35	1,675	300.0	PVC	140.0	-566	150.95	151.01	0.06	0.04	0.09
P-36	890	300.0	PVC	140.0	1,660	151.01	150.78	0.23	0.26	0.27
P-38	1,668	300.0	PVC	140.0	3,684	130.48	128.55	1.93	1.16	0.60
P-39	929	300.0	PVC	140.0	4,232	128.55	127.16	1.39	1.49	0.69
P-40	844	300.0	PVC	140.0	4,351	128.55	127.22	1.33	1.57	0.71
P-41	818	300.0	PVC	140.0	3,153	127.22	126.51	0.71	0.87	0.52
P-42	961	300.0	PVC	140.0	2,466	126.51	125.98	0.53	0.55	0.40
P-43	1,966	300.0	PVC	140.0	1,151	127.48	127.22	0.26	0.13	0.19

Scenario: Scenario 2
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-44	1,998	300.0	PVC	140.0	-1,983	126.51	127.25	0.73	0.37	0.32
P-45	515	450.0	PVC	140.0	4,980	127.25	127.10	0.14	0.28	0.36
P-46	592	450.0	PVC	140.0	-6,963	127.25	127.55	0.31	0.52	0.51
P-47	1,056	450.0	PVC	140.0	11,519	125.15	123.76	1.40	1.32	0.84
P-48	975	450.0	PVC	140.0	462	123.76	123.75	0.00	0.00	0.03
P-49	1,041	450.0	PVC	140.0	7,394	123.74	123.14	0.61	0.58	0.54
P-50	997	450.0	PVC	140.0	13,677	123.14	121.32	1.81	1.82	1.00
P-51	533	300.0	PVC	140.0	742	121.32	121.29	0.03	0.06	0.12
P-52	807	450.0	PVC	140.0	-8,571	123.14	123.76	0.62	0.77	0.62
P-53	884	450.0	PVC	140.0	12,461	121.32	119.97	1.35	1.53	0.91
P-54	864	300.0	PVC	140.0	1,220	119.97	119.84	0.13	0.15	0.20
P-55	582	300.0	PVC	140.0	359	119.97	119.96	0.01	0.02	0.06
P-56	1,453	300.0	PVC	140.0	-3,105	119.96	121.18	1.22	0.84	0.51
P-57	295	300.0	PVC	140.0	1,689	121.18	121.10	0.08	0.27	0.28
P-58	594	300.0	PVC	140.0	-1,155	119.88	119.96	0.08	0.13	0.19
P-59	898	300.0	PVC	140.0	-6,000	121.18	123.74	2.56	2.85	0.98
P-60	962	400.0	PVC	140.0	7,784	123.51	122.42	1.09	1.14	0.72
P-61	330	400.0	PVC	140.0	9,050	122.42	121.92	0.50	1.50	0.83
P-62	614	400.0	PVC	140.0	7,775	121.92	121.22	0.70	1.13	0.72
P-63	672	400.0	PVC	140.0	2,852	121.22	121.10	0.12	0.18	0.26
P-64	901	300.0	PVC	140.0	-2,102	120.85	121.22	0.37	0.41	0.34
P-65	896	150.0	PVC	140.0	-509	121.15	121.92	0.77	0.87	0.33
P-66	758	150.0	PVC	140.0	-566	121.62	122.42	0.80	1.05	0.37
P-67	1,028	350.0	PVC	140.0	-1,643	150.95	151.08	0.13	0.12	0.20
P-69	1,006	300.0	PVC	140.0	-2,705	151.01	151.67	0.66	0.65	0.44
P-71	993	300.0	PVC	140.0	-4,759	130.48	132.32	1.84	1.86	0.78
P-72	1,475	300.0	PVC	140.0	-8,389	132.32	140.14	7.83	5.30	1.37
P-73	1,724	300.0	PVC	140.0	-7,547	140.14	147.66	7.52	4.36	1.24
P-74	1,074	300.0	PVC	140.0	-4,518	147.66	149.47	1.81	1.69	0.74
P-75	113	750.0	PVC	140.0	-50,308	149.47	149.66	0.19	1.69	1.32
P-76	416	350.0	PVC	140.0	977	149.66	149.64	0.02	0.05	0.12
P-77	717	750.0	PVC	140.0	-51,285	149.66	150.91	1.25	1.75	1.34
P-78	846	750.0	PVC	140.0	-116,038	150.91	157.62	6.71	7.93	3.04
P-81	751	300.0	PVC	140.0	-996	148.11	148.19	0.08	0.10	0.16
P-82	827	300.0	PVC	140.0	-1,268	148.19	148.32	0.13	0.16	0.21

Scenario: Scenario 2
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-83	830	750.0	PVC	140.0	33,524	148.32	147.66	0.66	0.80	0.88
P-84	850	450.0	PVC	140.0	26,247	147.66	142.49	5.18	6.09	1.91
P-85	843	450.0	PVC	140.0	23,282	142.49	138.38	4.11	4.87	1.69
P-86	418	450.0	PVC	140.0	21,535	138.38	136.61	1.76	4.22	1.57
P-87	432	450.0	PVC	140.0	22,217	136.61	134.68	1.93	4.47	1.62
P-88	832	450.0	PVC	140.0	19,650	134.68	131.72	2.96	3.56	1.43
P-89	826	450.0	PVC	140.0	15,783	131.72	129.76	1.96	2.37	1.15
P-90	832	300.0	PVC	140.0	9,645	129.76	124.05	5.72	6.87	1.58
P-91	912	300.0	PVC	140.0	6,896	124.05	120.68	3.37	3.69	1.13
P-92	1,099	300.0	PVC	140.0	8,462	148.41	142.49	5.92	5.39	1.39
P-93	1,050	300.0	PVC	140.0	8,356	142.49	136.96	5.53	5.27	1.37
P-94	820	300.0	PVC	140.0	-1,609	136.96	137.16	0.20	0.25	0.26
P-95	1,325	350.0	PVC	140.0	9,321	137.16	133.13	4.03	3.04	1.12
P-96	1,131	150.0	PVC	140.0	1,361	144.42	138.38	6.04	5.34	0.89
P-97	905	300.0	PVC	140.0	-4,863	128.29	130.03	1.75	1.93	0.80
P-98	828	300.0	PVC	140.0	-10,715	130.03	136.95	6.91	8.35	1.75
P-99	847	450.0	PVC	140.0	-14,438	136.95	138.65	1.70	2.01	1.05
P-100	836	450.0	PVC	140.0	-17,548	138.65	141.07	2.41	2.89	1.28
P-101	411	450.0	PVC	140.0	-19,757	141.07	142.54	1.48	3.60	1.44
P-102	433	450.0	PVC	140.0	-21,842	142.54	144.42	1.88	4.33	1.59
P-103	846	500.0	PVC	140.0	-30,168	144.42	148.41	3.99	4.71	1.78
P-104	263	750.0	PVC	140.0	-41,931	148.41	148.73	0.32	1.20	1.10
P-105	564	750.0	PVC	140.0	-44,092	148.73	149.47	0.74	1.32	1.16
P-106	1,013	350.0	PVC	140.0	746	148.73	148.70	0.03	0.03	0.09
P-107	1,115	150.0	PVC	140.0	-1,357	136.61	142.54	5.93	5.32	0.89
P-108	584	150.0	PVC	140.0	1,103	141.07	138.95	2.12	3.62	0.72
P-109	1,123	150.0	PVC	140.0	-1,471	131.72	138.65	6.93	6.17	0.96
P-110	390	150.0	PVC	140.0	989	138.65	137.50	1.15	2.96	0.65
P-111	787	150.0	PVC	140.0	-451	136.40	136.95	0.54	0.69	0.30
P-112	1,116	150.0	PVC	140.0	1,505	136.95	129.76	7.19	6.44	0.99
P-113	1,049	300.0	PVC	140.0	5,751	129.76	127.00	2.76	2.64	0.94
P-114	1,077	300.0	PVC	140.0	5,637	127.00	124.26	2.74	2.54	0.92
P-115	1,035	300.0	PVC	140.0	4,287	131.72	130.14	1.58	1.53	0.70
P-116	1,065	150.0	PVC	140.0	460	130.14	129.37	0.76	0.72	0.30
P-117	1,822	300.0	PVC	140.0	-669	132.85	132.94	0.09	0.05	0.11

Scenario: Scenario 2
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-118	860	300.0	PVC	140.0	-2,789	132.94	133.53	0.59	0.69	0.46
P-119	849	300.0	PVC	140.0	-7,468	133.53	137.16	3.63	4.28	1.22
P-120	844	450.0	PVC	140.0	-19,580	137.16	140.14	2.98	3.54	1.42
P-121	837	450.0	PVC	140.0	-21,937	140.14	143.80	3.66	4.37	1.60
P-122	848	300.0	PVC	140.0	309	143.80	143.79	0.01	0.01	0.05
P-124	1,560	500.0	PVC	140.0	-23,201	143.80	148.32	4.52	2.90	1.37
P-125	1,068	750.0	PVC	140.0	-61,243	148.32	150.91	2.59	2.43	1.60
P-126	851	300.0	PVC	140.0	7,221	136.96	133.54	3.42	4.02	1.18
P-127	827	300.0	PVC	140.0	5,367	133.54	131.62	1.92	2.32	0.88
P-129	835	300.0	PVC	140.0	4,639	131.62	130.14	1.48	1.77	0.76
P-130	827	300.0	PVC	140.0	7,005	130.14	127.00	3.14	3.80	1.15
P-131	847	300.0	PVC	140.0	5,618	127.00	124.86	2.14	2.52	0.92
P-135	746	150.0	PVC	140.0	-439	124.05	124.55	0.49	0.66	0.29
P-136	1,115	150.0	PVC	140.0	-1,058	124.55	128.29	3.74	3.35	0.69
P-137	658	150.0	PVC	140.0	1,932	128.29	121.55	6.73	10.23	1.27
P-138	989	150.0	PVC	140.0	705	121.55	119.99	1.56	1.58	0.46
P-139	449	150.0	PVC	140.0	788	121.55	120.68	0.87	1.94	0.52
P-140	1,732	300.0	PVC	140.0	5,222	120.68	116.86	3.82	2.20	0.86
P-141	1,048	300.0	PVC	140.0	6,358	116.86	113.54	3.33	3.17	1.04
P-142	439	300.0	PVC	140.0	2,485	113.54	113.29	0.24	0.56	0.41
P-143	599	300.0	PVC	140.0	1,821	113.29	113.11	0.19	0.31	0.30
P-144	1,179	300.0	PVC	140.0	630	113.11	113.05	0.05	0.04	0.10
P-145	657	300.0	PVC	140.0	110	113.05	113.05	0.00	0.00	0.02
P-146	1,055	300.0	PVC	140.0	5,139	124.86	122.60	2.26	2.14	0.84
P-147	506	300.0	PVC	140.0	8,847	122.60	119.64	2.96	5.85	1.45
P-148	556	300.0	PVC	140.0	8,124	119.64	116.86	2.78	5.00	1.33
P-150	1,055	150.0	PVC	140.0	478	124.86	124.05	0.81	0.77	0.31
P-151	1,119	150.0	PVC	140.0	-1,361	124.05	130.03	5.99	5.35	0.89
P-152	763	150.0	PVC	140.0	821	130.03	128.43	1.60	2.10	0.54
P-153	1,462	300.0	PVC	140.0	3,244	116.86	115.53	1.34	0.91	0.53
P-154	905	300.0	PVC	140.0	6,416	115.53	112.61	2.92	3.23	1.05
P-155	2,544	300.0	PVC	140.0	-1,979	112.61	113.54	0.93	0.37	0.32
P-156	696	300.0	PVC	140.0	3,664	112.61	111.81	0.80	1.14	0.60
P-157	590	250.0	PVC	140.0	422	111.81	111.78	0.03	0.05	0.10
P-158	549	250.0	PVC	140.0	2,826	111.81	110.87	0.94	1.72	0.67

Scenario: Scenario 2
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m³/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-159	636	250.0	PVC	140.0	1,370	110.87	110.58	0.29	0.45	0.32
P-160	307	250.0	PVC	140.0	809	110.87	110.82	0.05	0.17	0.19
P-161	3,740	300.0	PVC	140.0	-2,058	119.63	121.10	1.47	0.39	0.34
P-164	1,023	300.0	PVC	140.0	-279	150.77	150.78	0.01	0.01	0.05
P-165	971	300.0	PVC	140.0	-6,810	128.55	132.05	3.50	3.61	1.12
P-166	403	350.0	PVC	140.0	-1,151	150.89	150.91	0.03	0.06	0.14
P-167	1,070	300.0	PVC	140.0	-886	132.85	132.94	0.09	0.08	0.15
P-168	1,183	300.0	PVC	140.0	-3,848	132.05	133.53	1.48	1.25	0.63
P-169	971	300.0	PVC	140.0	-192	133.53	133.54	0.00	0.00	0.03
P-170	854	300.0	PVC	140.0	-3,865	132.05	133.13	1.08	1.26	0.63
P-171	824	350.0	PVC	140.0	5,063	133.13	132.32	0.81	0.98	0.61
P-173	1,671	350.0	PVC	140.0	2,914	151.67	151.08	0.59	0.35	0.35
P-175	452	750.0	PVC	140.0	-26,618	139.77	140.00	0.23	0.52	0.70
P-176	1,049	300.0	PVC	140.0	-4,133	122.42	123.92	1.50	1.43	0.68
P-177	900	300.0	PVC	140.0	8,067	119.97	115.53	4.44	4.93	1.32
P-178	836	300.0	PVC	140.0	-4,936	122.60	124.26	1.66	1.99	0.81
P-179	1,040	150.0	PVC	140.0	-987	131.62	134.68	3.07	2.95	0.65
P-182	362	350.0	PVC	140.0	8,090	132.32	131.47	0.85	2.34	0.97
P-183	473	350.0	PVC	140.0	8,090	152.78	151.67	1.11	2.34	0.97
P-184	441	500.0	PVC	140.0	51,810	180.00	174.34	5.66	12.83	3.05
P-185	1,285	500.0	PVC	140.0	51,810	174.34	157.84	16.50	12.83	3.05
P-186	164	500.0	PVC	140.0	51,810	157.84	155.74	2.10	12.83	3.05
P-188	1,051	500.0	PVC	140.0	930	150.78	150.78	0.01	0.01	0.05
P-189	896	500.0	PVC	140.0	42,717	230.00	221.96	8.04	8.98	2.52
P-190	452	500.0	PVC	140.0	42,717	221.96	217.90	4.06	8.98	2.52
P-191	511	500.0	PVC	140.0	42,717	217.90	213.32	4.58	8.98	2.52
P-192	688	500.0	PVC	140.0	42,717	213.32	207.14	6.18	8.98	2.52
P-193	1,069	500.0	PVC	140.0	42,717	207.14	197.54	9.60	8.98	2.52
P-194	147	500.0	PVC	140.0	42,717	197.54	196.22	1.32	8.98	2.52
P-195	571	500.0	PVC	140.0	42,717	196.22	191.10	5.13	8.98	2.52
P-196	770	500.0	PVC	140.0	42,717	191.10	184.19	6.91	8.98	2.52
P-197	2,652	500.0	PVC	140.0	42,717	184.19	160.38	23.81	8.98	2.52
P-198	248	750.0	PVC	140.0	-118,418	157.62	159.67	2.05	8.23	3.10
P-199	1,474	750.0	PVC	140.0	-75,955	159.67	165.00	5.33	3.62	1.99
P-200	578	750.0	PVC	140.0	-42,463	159.67	160.38	0.71	1.23	1.11

Scenario: Scenario 2
Steady State Analysis
Pipe Report

Label	Length (m)	Diameter (mm)	Material	Hazen-Williams C	Discharge (m^3/day)	Upstream Structure Hydraulic Grade (m)	Downstream Structure Hydraulic Grade (m)	Pressure Pipe Headloss (m)	Headloss Gradient (m/km)	Velocity (m/s)
P-201	385	500.0	PVC	140.0	51,810	155.74	150.80	4.94	12.83	3.05
P-202	1,649	500.0	PVC	140.0	930	150.80	150.78	0.01	0.01	0.05
P-203	355	500.0	PVC	140.0	50,879	150.80	146.39	4.41	12.41	3.00
P-204	534	500.0	PVC	140.0	50,879	146.39	139.77	6.62	12.41	3.00

Scenario: Scenario 2
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m³/day)	Calculated Hydraulic Grade (m)	Pressure (lbs/in²)
J-00	92.00	0	127.25	50.031
J-1	80.00	815	123.26	61.405
J-2	84.00	2,092	125.00	58.193
J-3	90.00	2,594	128.24	54.287
J-4	88.00	199	128.17	57.021
J-5	87.00	1,188	130.22	61.351
J-6	98.00	641	131.89	48.108
J-7	96.00	322	132.76	52.179
J-8	90.00	3,011	130.74	57.833
J-9	99.00	4,112	139.77	57.865
J-10	80.00	2,473	123.07	61.139
J-11	84.00	3,552	123.51	56.083
J-12	86.00	2,279	124.99	55.338
J-13	81.00	1,815	123.92	60.918
J-14	81.00	2,300	122.42	58.788
J-15	80.00	566	121.62	59.075
J-16	80.00	509	121.15	58.404
J-17	79.00	2,102	120.85	59.411
J-18	82.00	766	121.92	56.665
J-18A	81.50	2,821	121.22	56.386
J-20	90.00	1,073	125.15	49.900
J-21	87.00	2,033	123.74	52.157
J-22	98.00	734	126.30	40.172
J-23	92.00	3,492	127.10	49.826
J-24	94.00	1,910	127.55	47.630
J-25	95.00	3,932	127.48	46.110
J-26	97.00	2,261	126.45	41.800
J-27	105.00	0	150.78	64.978
J-28	110.00	157	150.77	57.867
J-29	107.00	96	150.77	62.129
J-30	102.00	956	150.77	69.226
J-31	128.00	1,323	150.89	32.497
J-32	129.00	886	150.95	31.163
J-33	107.00	1,339	150.78	62.143
J-34	120.00	42	150.78	43.690
J-35	111.00	479	151.01	56.798
J-36	109.00	1,075	130.48	30.484
J-37	97.00	1,237	127.16	42.810
J-38	97.00	1,912	128.55	44.780
J-39	96.00	2,349	127.22	44.317
J-40	95.00	2,670	126.51	44.731
J-41	91.00	462	123.75	46.491
J-42	96.00	2,486	123.76	39.398
J-43	90.00	474	121.32	44.463
J-44	90.00	2,288	123.14	47.038
J-45	81.00	2,483	121.10	56.926
J-46	80.00	1,206	121.18	58.460
J-47	83.00	1,155	119.88	52.351
J-48	80.00	2,309	119.96	56.723
J-49	80.00	2,815	119.97	56.736
J-50	82.00	2,058	119.63	53.420
J-51	81.50	422	111.78	42.985

Scenario: Scenario 2
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m³/day)	Calculated Hydraulic Grade (m)	Pressure (lbs/in²)
J-52	80.00	416	111.81	45.157
J-53	80.50	1,220	119.84	55.843
J-54	80.50	4,731	112.61	45.576
J-55	90.00	742	121.29	44.418
J-56	80.00	4,895	115.53	50.432
J-59	80.00	110	113.05	46.917
J-60	83.00	1,191	113.11	42.734
J-61	80.00	520	113.05	46.919
J-62	81.50	1,370	110.58	41.282
J-63	82.00	809	110.82	40.904
J-64	83.00	647	110.87	39.558
J-65	82.00	664	113.29	44.420
J-66	82.00	1,894	113.54	44.767
J-67	82.00	1,229	122.60	57.633
J-68	83.00	723	119.64	52.013
J-69	88.00	3,744	116.86	40.971
J-70	90.00	705	119.99	42.569
J-71	87.00	439	121.55	49.048
J-72	90.00	2,462	120.68	43.552
J-73	91.00	1,873	128.29	52.927
J-74	91.00	439	124.05	46.920
J-75	90.00	619	124.55	49.036
J-75A	90.00	0	124.86	49.483
J-76	90.00	4,589	124.05	48.328
J-77	93.00	3,670	130.03	52.569
J-78	90.00	821	128.43	54.556
J-79	90.00	451	136.40	65.870
J-80	91.00	701	124.26	47.214
J-81	93.00	1,501	127.00	48.258
J-82	94.00	1,891	129.76	50.763
J-83	91.00	1,767	136.95	65.223
J-84	91.00	989	137.50	66.003
J-85	91.00	650	138.65	67.642
J-86	91.00	1,052	131.72	57.803
J-87	91.00	1,461	130.14	55.554
J-88	91.00	460	129.37	54.470
J-89	91.00	2,466	125.98	49.660
J-90	91.00	886	132.85	59.404
J-91	91.00	669	132.85	59.402
J-92	94.00	1,234	132.94	55.270
J-93	95.00	902	132.05	52.591
J-94	97.00	393	133.13	51.283
J-95	99.00	603	132.32	47.294
J-96	110.00	2,471	151.67	59.149
J-97	123.00	1,271	151.08	39.858
J-100	107.00	309	143.79	52.221
J-101	97.00	1,023	133.53	51.854
J-102	100.00	1,183	137.16	52.747
J-103	97.00	1,662	133.54	51.861
J-104	95.00	1,715	131.62	51.976
J-105	95.00	1,580	134.68	56.330
J-106	94.00	1,106	141.07	66.808

Scenario: Scenario 2
Steady State Analysis
Junction Report

Label	Elevation (m)	Demand (Calculated) (m³/day)	Calculated Hydraulic Grade (m)	Pressure (lbs/in²)
J-107	96.00	1,103	138.95	60.966
J-108	97.00	675	136.61	56.229
J-109	98.00	3,108	138.38	57.312
J-110	97.00	728	142.54	64.647
J-111	98.00	6,965	144.42	65.890
J-112	100.00	3,301	148.41	68.716
J-113	112.00	746	148.70	52.091
J-114	100.00	2,744	136.96	52.457
J-115	103.00	3,070	142.49	56.048
J-116	100.00	1,415	148.73	69.165
J-117	101.00	1,699	149.47	68.803
J-118	101.00	977	149.64	69.045
J-118A	100.00	0	149.66	70.492
J-119	96.00	2,358	150.91	77.948
J-120	95.00	1,151	150.89	79.331
J-121	97.00	4,247	147.66	71.911
J-122	104.00	1,515	140.14	51.305
J-123	100.00	955	143.80	62.171
J-125	100.00	3,251	148.32	68.590
J-126	104.00	996	148.11	62.614
J-127	104.00	272	148.19	62.724
J-128	105.00	2,380	157.62	74.699
J-129	130.00	254	160.38	43.126
J-130	112.00	0	174.34	88.488
J-131	106.00	0	157.84	73.588
J-132	106.00	0	155.74	70.606
J-133	108.00	0	150.78	60.731
J-134	188.00	0	221.96	48.202
J-135	190.00	0	217.90	39.602
J-136	190.00	0	213.32	33.096
J-137	185.00	0	207.14	31.426
J-138	138.00	0	197.54	84.519
J-139	138.00	0	196.22	82.647
J-140	125.00	0	191.10	93.824
J-141	118.00	0	184.19	93.953
J-142	110.00	0	159.67	70.504
J-143	107.00	0	150.80	62.168
J-144	103.00	0	146.39	61.590

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APPENDIX G

Consumption Memo

stantec.com

Memo

Stantec

To:	Bernie Marshall Kitchener Office	From:	Saeed Soltani Stantec
File:	161110576	Date:	February 4, 2007

Reference: **Raw Water for Agricultural Irrigation – Phase 2 – Water Consumption Study**

1. UNIT DEMANDS FOR TENDER FRUIT AND GRAPE

The latest version of the Water Consumption Study dated January 15, 2007 (hereafter referred to as the "Report") provides the basis for the following conclusions:

1. The following seasonal demands should be used for seasonal flow calculations:

Scenario	Irrigation System	Seasonal Demand (mm/year)	
		Peach	Grape
Average Year	Overhead	175	25
	Drip	140	20
Drought Year	Overhead	280	130
	Drip	225	105

2. The published peak Reference Evapotranspiration (ET_0)[1] of **5.2 mm/day** is supported by the data for 2006 season. Although day-to-day ET_0 values occasionally reached 6.0 mm/day, the average of daily ET_0 values over the typical irrigation cycle time (one to two weeks) did not exceed 5.2 mm/day (see Table A1 in the Report).

3. Peak Crop Factors (Kc) for peach and grape are **1.0** and **0.8**, respectively.

4. The assumed irrigation efficiencies of overhead (big gun) and drip (micro) irrigation systems are 68% and 84%, respectively. At the present time, overhead irrigation systems are prevalent in the target area. With the new irrigation infrastructure, we may expect a move toward more efficient irrigation practices within the region. Therefore, I suggest to base the

[1] OMAFRA Best Management Practices. Irrigation Management, Revised Edition, 2004, as cited in the Report

service level of the proposed irrigation system on an expected efficiency of **76%**[2].

For the purpose of designing the regional irrigation infrastructure, the demands are calculated using the following equation:

$$\text{Demand} = (ET_0 * Kc) / (\text{Efficiency})$$

Based on the above conclusions, the peak design demands for tender fruit and grape areas are **6.8 mm/day** and **5.0 mm/day**, respectively.

2.0 UNIT DEMAND FOR NURSERIES

The demand estimate for nursery production in the Feasibility Study was based on the data provided by OMAFRA. The following excerpt from an email from Rebecca Shortt provides further clarification on the demand of nurseries:

> ".. the peak use of 14.8mm/application would not be daily but every other day. This would only occur for a short period (1 – 2 weeks). Also note that these water use calculations are only for container production (which represents 30 to 35 % of nursery production). Irrigation is limited in "field production" and if used, is generally only applied during the first growing season."

Using this data, the design demand per unit area of nursery land is:

$$\text{Demand} = (14.8 / 2) * 0.35 = \mathbf{3.0\ mm/day}$$

3.0 UNIT DEMAND FOR GREENHOUSES

According to the Feasibility Study, the design demand for greenhouses is **7.0 mm/day**.

4.0 ADOPTION OF IRRIGATION

At the present time, a large portion of the potentially irrigated lands in the Region is not under irrigation. The exactly percentage of the lands that will be under irrigation once the irrigation infrastructure is in place is not clear. I have consulted with Kevin Ker and concluded the following lower and upper bounds for the extent of the potential service area:

---

[2] This efficiency is equivalent to converting 50% of the irrigation systems converted to drip systems. Alternatively, the user would accepts a slightly lower service level (approximately 10% less than maximum demand) if a less efficient irrigation system is used. This lower service level should have only a slight impact on the crop, while providing a moderate pressure to move toward higher system efficiencies.

Low Estimate = Existing Tender Fruit + Nurseries + Greenhouses + Juice Grape

High Estimate = Existing Tender Fruit + Nurseries + Greenhouses + Juice Grape + Existing Pomme Fruit + 50% of Existing Wine

5.0 IMPACT OF OPEN CHANNEL DISTRIBUTION SYSTEM ON IRRIGATION DEMANDS

The irrigation demands at farm gate are identical for the open channel and pipeline distribution systems. However, the system demand will be higher for open channel systems. "Task 5 Technical Memorandum 1: Channel Conveyance Efficiency" has provided observation on the efficiencies of some existing open channel systems in Niagara-on-the-Lake during 2006 irrigation season. Subsequent discussions led me to conclude that a maximum distribution efficiency of 80% may be achievable using open channel systems if the system is well controlled. To be somewhat conservative, I suggest using distribution efficiency of **75%** for open channel distribution systems. This implies that for design of open channel distribution systems, all unit demands will have to be multiplied by 1.33.

The distribution efficiency of pipeline systems can be practically 100% if the system is operated and maintained well.

6.0 COINCIDENCE OF PEAK DEMANDS

Although within a given crop category, it is quite possible to consider all the cropped area to reach peak demand concurrently, given the significant differences between demands of tender fruits and grapes, the peak demands of these two categories should rarely coincide. I recommend that for the purpose of designing a system with a ten year return risk[3], we assume that the peak tender fruit demand does not coincide with the peak grape demand. Therefore, the system will be sized to either provide the peak demand of the tender fruits (plus greenhouses and nurseries) or the peak demand of the grapes (plus greenhouses and nurseries), but not both[4]. This approach will substantially reduce the size of the required infrastructure.

7.0 CONCLUSION

The following table indicates the unit demands recommended for designing the irrigation infrastructure:

---

[3] Once in every ten years the system may fail to fully meet the demands.
[4] Often, such a system will provide "sub-peak" demands for both crops concurrently.

Crop	Peak Demands (mm/d)	
	Pipeline Systems	Open Channel Systems
Wine Grapes	5.5	7.3
Nurseries	3.0	4.0
Juice Grapes	5.5	7.3
Tender Fruit	6.8	9.1
Greenhouses	7.0	9.3
Pome Fruit	6.8	9.1

The "pipeline system" demands should also be used as unit demands for the groundwater study (above Escarpment).

The size of the service area will be between the following service area estimates:

Low Estimate = Existing Tender Fruit + Nurseries + Greenhouses + Juice Grape

High Estimate = Existing Tender Fruit + Nurseries + Greenhouses + Juice Grape + Existing Pomme Fruit + 50% of Existing Wine

Two servicing scenarios will be provided based on these limits.

Finally, the sizing of system components shall be based on satisfying the peak demands of tender fruit areas and grape areas separately (not concurrently).

STANTEC CONSULTING LTD.

Saeed Soltani

c. Le Patourel, Guy; Lewis, Hal

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APPENDIX H

Historical Water Intake Estimates for Niagara-on-the-Lake Irrigation System

Volume takings for NOTL Irrigation System

(Based on information provided by the Town of NOTL staff)

OPG Reservoir Siphon

Year	m3
2002	1830080
2003	1173054
2004	43608
2005	264555
2006	365580
Average	315067

Carlton St. Siphon

Year	m3
2002	-
2003	375846
2004	240843
2005	338528
2006	352914
Average	327033

ABL

Year	m3
2002	1117952
2003	1443302
2004	-
2005	1585205
2006	1659012
Average	1451368

Dee Rd. (Queenston PS)

Year	m3
2002	-
2003	-
2004	-
2005	-
2006	685917
Average	685917

Dee Rd. (Queenston PS)

Year	m3
2002	-
2003	-
2004	-
2005	-
2006	382307
Average	382307

		m3/d (based on 25 day/600 hour service)
Total Avg.	**3161691**	**126468**

APPENDIX I

Bench Options Memo

Memo

Stantec

To:	Mr. Drew Semple Regional Municipality of Niagara	From:	Nathan Sherwood Stantec Consulting Ltd.
File:	1611 10576	Date:	July 26, 2007

Reference: Niagara Irrigation – Servicing West District Zone A Bench Area

Hi Drew,

Thank you for your email of July 20, 2007 providing comments on the recent submissions. The purpose of this memo is to address comments regarding servicing the bench areas using a pipe-distribution system.

As you are aware, the Engineering Report prepared servicing alternatives for areas below the escarpment using pipes, open channels or a combination thereof. It was mentioned in the Engineering Report that the bench areas were excluded from servicing as the head needed to lift irrigation waters was weighed against the small size of the additional area serviced and it was decided that it was not practical. Also, it was our understanding that the grapes in the bench areas did not require irrigation waters.

We have re-visited the bench areas in the West District to ascertain the feasibility of providing irrigation using a piped system. The south servicing boundary in the Engineering Report was proposed to be Regional Road 81, with elevation around 110 m above MSL. The pressures in the pipeline proposed along Regional Road 81 would range from a minimum of 45 psi to a maximum of 60 psi for all the four alternatives proposed. The maximum ground elevation in the bench areas is approximately 140 m above MSL, which implies that the maximum ground elevation difference between RR 81 elevations and the top of the bench is 30 m, which equates to a pressure of 42 psi. This indicates that some of the bench areas could be serviced using the alternatives presented in the Engineering Report without the need for additional pressure boosting. Evaluating closely the bench areas, we think that about 50% of the bench area could be serviced without the need for additional boosting, whereas the remaining 50% with elevations towards or exceeding 140 m would require additional pressure boosting and possibly additional piping. However, it is our estimation that the cost for providing servicing infrastructure for the entire bench area would not significantly add to the overall proposed opinions of probable cost.

Furthermore, the intake capacities and capacities of large mains proposed in the Engineering Report took in to account the water demands for 75% of the bench areas and therefore would not change significantly as a result of providing irrigation infrastructure in the bench.

Reference: Niagara Irrigation – Servicing West District Zone A Bench Area

In conclusion, the current assessment made in our engineering report adequately services most bench growers, and to expand this to service all bench growers would not significantly impact our cost estimations. We will adjust the above mentioned section of the report for the Final Report to reflect this information.

A separate memo addressing the groundwater availability for the bench area is also attached.

STANTEC CONSULTING LTD.

Nathan Sherwood, B.A.Sc.
Environmental EIT
nathan.sherwood@stantec.com

APPENDIX J

NOTL Letter and Stantec's Response

Stantec Consulting Ltd.,
49 Frederick St.,
Kitchener, On N2H 6M7

August 14, 2007

Response to Engineering Report
From the NOTL Irrigation Committee

The NOTL Irrigation Committee appreciates the opportunity to respond to the Stantec Irrigation Study. Farmers in NOTL have had the benefit of an open channel irrigation system for many years. The system has been expanded several times to continue to meet the needs of those landowners who have shown a need for irrigation. The system is only expanded by a petition of growers who request irrigation.

This Report shows three alternatives for the east side (NOTL). Two are piped and one is an open channel system.

We offer the following comments.

UNIT DEMANDS

Unit demands for open channel are greater than pipeline to account for losses at the end of the system. The results of a conveyance efficiency study were used to evaluate system losses. However the study was only for part of one season and the year was not a dry year. In addition the one area where measurements were taken was upstream of one large user of irrigation water. This information should be highlighted in the study because in a dry year any losses would be far less.

WATER DEMANDS

The demand for water was based on the requirement of each crop and the area for each crop and the assumption that peak demands for each crop would not coincide.

It has been our experience that most grape growers do not use irrigation in a normal growing year. Some grape growers only use irrigation in a drought year. In a drought year, like 2007, the grape growers who did irrigate, irrigated at the same time as tender fruit growers so a rationing of water was put in place for some drains to meet demands. This information should be conveyed in the study.

The irrigation system in NOTL was initiated by a request from growers wanting water for irrigation. Expansions to the system are initiated by a petition from growers/landowners wanting water for irrigation. It has been our experience that not all property owners want water for irrigation. A survey should have been distributed to all property owners first to discover the number of interested property owners.

COST

The capital cost for a piped system is enormous. Has there been discussion with upper levels of government for financial support? How much would they contribute? Two thirds of the cost?

Will every landowner who fronts on a piped system be required to contribute financially or only those wishing to use the system? Again a survey of all property owners is required because it will make a big difference in individual landowner costs.

In the original Stantec Report the o/m costs for the piped system included a large cost for the replacement of piped infrastructure. The o/m costs for the three systems in the East District are relatively the same in the current proposal. Are the replacement costs for the pipes included? What is the breakdown for the o/m costs?

IRRIGATION LOSS

An irrigation loss factor was used based on one year's data (not a drought year) and the information (Harrison) was taken upstream of a large user. In 2007 this user also utilized two large ponds not normally used.

That information should be highlighted in the study because based on our usage of water this year, the loss would be much less. A schedule of rationing was implemented to conserve water and ponds not normally used (Harrison downstream user) were utilized and new ponds were constructed.

PROPOSED UPGRADES

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There are two additional areas identified for the use of irrigation. In the area of Concession 1 some growers who irrigate pull from the Niagara River individually and in the area north of Church Road, while the area is mostly tender fruit, some growers pull from Lake Ontario. It is unknown how many landowners would indicate a need for irrigation in these areas.

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OPINION OF PROBABLE COSTS

The cost of the proposed irrigation system was generated by assessing weekly crop needs for water over the entire system area. The cost of these studies is expensive. Again we question whether a survey of all possible landowners should not have been done first. What will the ultimate cost be to the landowners who choose to participate in an irrigation system? Or will the cost be spread between everyone who fronts on the system?

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This will be an issue.

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GENERAL

This section refers to an Environmental Impacts Report and then a public information meeting scheduled. Again we question further costs for studies when there has been no direct communication with growers to solicit a need for irrigation

SUMMARY OF THE ALTERNATIVES

We believe that the cost will be very important to the landowners. While we recognize the positive aspects of a piped system and would love to have one, we sincerely question whether any landowner will choose that system if there is no financial commitment from the upper levels of government to help defray the cost. How can they possibly afford it?

In summary, we thank the Region of Niagara for undertaking an Irrigation Study and for including NOTL in the study. We hope the information we have provided will be included in the Engineering Report.

Chair
Austin Kirkby
NOTL Irrigation Committee
Town of NOTL
arrowhead1@sympatico.ca/905-468-7433

Memo

Stantec Consulting Ltd.
49 Frederick Street
Kitchener ON N2H 6M7
Tel: (519) 579-4410

Stantec

To:	Austin Kirkby Chair, NOTL Irrigation Committee	From:	Rajan Sawhney Stantec Consulting Ltd., Kitchener ON
File:	1611 10576/10	Date:	September 28, 2007

Reference: NOTL Irrigation Committee Comments Regarding the Engineering Report

Thank you for providing comments on the Engineering Report via email. We offer our responses to your comments in this memo. Each comment has been provided a number, and our response follows the comment.

1. ***UNIT DEMANDS***

   Unit demands for open channel are greater than pipeline to account for losses at the end of the system. The results of a conveyance efficiency study were used to evaluate system losses. However the study was only for part of one season and the year was not a dry year. In addition the one area where measurements were taken was upstream of one large user of irrigation water. This information should be highlighted in the study because in a dry year any losses would be far less.

[Stantec] The unit demands were increased by 33% for the open channel options to account for losses:

- at the end of the system
- losses due to seepage, and
- losses due to evapotranspiration.

This demand increase is based on the original report titled "Channel Conveyance Efficiency." In the report, it is determined that the seepage and evapotranspiration losses accounted for between 7 to 10% of the overall losses. The observed losses due to "return flow" (unused water flowing at the end of the system) were between 80 to 85%. 2006 was a relatively wet year in comparison to others. In dry years demand would increase, and therefore, return flow would decrease. However, evapotranspiration and seepage would be expected to increase in relatively dry years. Therefore we estimated in the conclusion of that report, that the 70% conveyance efficiency (30% losses) was a good assessment for peak demand periods, based on a reduction in return flow when demand is high. A subsequent memo titled "Raw Water for Agricultural Irrigation – Phase 2 – Water Consumption Study" from Saeed Soltani concluded that a maximum distribution efficiency of 80% may be achievable using open channel systems if the system is well controlled. To be somewhat conservative, it was suggested that using distribution efficiency of 75% for open channel distribution systems. This implies that for design of open channel distribution systems, all unit demands would have to be multiplied by 1.33.

2. WATER DEMANDS

The demand for water was based on the requirement of each crop and the area for each crop and the assumption that peak demands for each crop would not coincide.

It has been our experience that most grape growers do not use irrigation in a normal growing year. Some grape growers only use irrigation in a drought year. In a drought year, like 2007, the grape growers who did irrigate, irrigated at the same time as tender fruit growers so a rationing of water was put in place for some drains to meet demands. This information should be conveyed in the study.

[Stantec] The capital cost of the proposed infrastructure is directly related to the sizing of the various components including pipes. In an attempt to prevent oversizing of a water distribution infrastructure, it is typically assumed that not all the users in the area will require water at the same time. Grape and tender fruit growers were chosen as opposing users because of simplicity, and also based on the recommendations provided by in the memo titled “Raw Water for Agricultural Irrigation – Phase 2 – Water Consumption Study.”

However, we are revisiting the scenario of simultaneous demands for Grape and tender fruit based on the indicated water usage pattern for 2007 to ascertain the impacts to the infrastructure sizing. We will include the findings in the final project report.

The irrigation system in NOTL was initiated by a request from growers wanting water for irrigation. Expansions to the system are initiated by a petition from growers/landowners wanting water for irrigation. It has been our experience that not all property owners want water for irrigation. A survey should have been distributed to all property owners first to discover the number of interested property owners.

[Stantec] This study was initiated by a recommendation from The Agricultural Task Force of the Regional Municipality of Niagara. The Region has decided to move forward with this study based on the recommendation that irrigation will have a positive impact on the agricultural industry in Niagara. The purpose of this study is to ascertain the feasibility of providing irrigation in terms of generating various servicing alternatives, providing opinions of costs involved, estimating the benefits accrued, and ascertaining the environmental impacts. The study has allowed for two points of public contact in terms of Public Information Centres, where the growers and grower associations have an opportunity to provide their input. Growers and grower associations are also members of the Technical Advisory Committee for the project.

If the Region decides to proceed to the next phase of this project, additional consultation would be necessary. This would include contact with property owners to confirm their interest in this project, determine localized demand for irrigation waters, and finalize the phasing of construction.

3. COST

The capital cost for a piped system is enormous. Has there been discussion with upper levels of government for financial support? How much would they contribute? Two thirds of the cost?

[Stantec] One of the objectives of this study is to provide an outline of the proposed irrigation scheme and obtain associated probable costs and benefits to submit to the appropriate government agencies for possible financial support. This project is part of an overall Environmental Assessment process, which is a prerequisite to applying for government funding. In the Technical Memo titled "Task #4 – Regulatory Requirements and Related Considerations" it states that submissions for federal and provincial funding should come after council approval for detailed design.

Will every landowner who fronts on a piped system be required to contribute financially or only those wishing to use the system? Again a survey of all property owners is required because it will make a big difference in individual landowner costs.

[Stantec] As a part of this study, Stantec will prepare a technical memorandum outlining various management structures in use to manage irrigation water. The memo will also provide recommendations on a preferred management structure for the implemented irrigation scheme. It is our understanding that in NOTL, the preferred structure is already in place (Irrigation Committee, Town Staff), and that structure will define and administer financial contributions for use in the operation of the system as they see fit. The preferred alternative, once constructed, will ultimately be operated by the Town of NOTL, just as it is now.

In the original Stantec Report the o/m costs for the piped system included a large cost for the replacement of piped infrastructure. The O&M costs for the three systems in the East District are relatively the same in the current proposal. Are the replacement costs for the pipes included? What is the breakdown for the o/m costs?

[Stantec] O&M costs are based on the existing NOTL system, with assumptions based on overall service area increases and cost of repairs (to pipes, pumps, drains, dams, etc.). We agree that the preferred alternative, once constructed, would have a design life which would be finite, and therefore need to be replaced eventually. However, an infrastructure replacement program was not included in the O&M costs as this would need to be an initiative of the management structure (i.e. the Town) to collect funds to help defray infrastructure upgrade and replacement costs.

4. IRRIGATION LOSS

An irrigation loss factor was used based on one year's data (not a drought year) and the information (Harrison) was taken upstream of a large user. In 2007 this user also utilized two large ponds not normally used.

That information should be highlighted in the study because based on our usage of water this year, the loss would be much less. A schedule of rationing was implemented to conserve water and ponds not normally used (Harrison downstream user) were utilized and new ponds were constructed.

[Stantec] One year of data was recorded based on budgetary and time restrictions. Information was collected from both the Harrison 6 and the Lavigne system. The use of ponds does increase efficiency in terms of losses at the end of the system; however, it will also increase evapotranspiration and seepage (even more in drought years). It is agreed that losses are less in a drought year compared to a wet year (2006), therefore total losses were decreased from 80% to 25% for ultimate demand calculations (please see our response to comment 1).

5. ***PROPOSED UPGRADES***

The Report states "Expansion of the system is needed in the south west part of the Town, where a large area of growers do not have access to irrigation". The area is large but most of the land is either cash crops or idle land. Some land is owned by the Seaway and only a few growers lease land in this area, mostly grape growers, who use less irrigation water except for plantings of new vines.

There are two additional areas identified for the use of irrigation. In the area of Concession 1 some growers who irrigate pull from the Niagara River individually and in the area north of Church Road, while the area is mostly tender fruit, some growers pull from Lake Ontario. It is unknown how many landowners would indicate a need for irrigation in these areas.

[Stantec] These areas were identified for expansion based on comparing with ultimate design of the piped alternatives, and in consultation with the Irrigation Superintendent at the Town. Phasing of detailed design and construction could be based on the actual and predicted grower demand at time of construction..

The proposed upgrades should state that variable controls are to be included on the new pump and the existing Dee Road pump to be able to decrease the amount of water flow when demand is not there (beginning of season, end of season or anything in between). This information should also be included in the Report.

[Stantec] These items are typically included in a detailed design and have minor impact to overall opinions of probable cost.

6. ***OPINION OF PROBABLE COSTS***

The cost of the proposed irrigation system was generated by assessing weekly crop needs for water over the entire system area. The cost of these studies is expensive. Again we question whether a survey of all possible landowners should not have been done first. What will the ultimate cost be to the landowners who choose to participate in an

> *irrigation system? Or will the cost be spread between everyone who fronts on the system?*

[Stantec] Please see our responses to Items 2 and 3.

> *We question why the O&M costs are relatively the same for the piped system and the open channel system. Has the replacement cost for the pipes in the piped systems been included?*

[Stantec] Please see our response to Item 3.

> *We question the high cost of the pumping stations for TMC and Church Street.*

[Stantec] The purpose of this study is to provide an outline of the irrigation scheme and provide and opinion of probable costs associated with providing irrigation infrastructure. The probable cost opinions provided are for the purpose of establishing an overall cost requirement. At the time of detailed design, each pumping station will be looked at in detail to find out the most cost effective method of increasing capacity. A much more detailed cost estimate would be prepared at that stage.

7. ***SERVICE LEVELS***

> *The Report states that there are operational issues with providing an intensified channel network in that all the channels need to be flowing with water thereby increasing the losses and consequently the water requirements. The Report should recognize the fact that the use of dams in the municipal drains allows the holding of water for the season, thereby decreasing the need to completely fill the channel every day. The holding of water also decreases water loss because the channel is kept wet. This information should be added to the study.*

[Stantec] This portion of the report had the intention of describing the possible constraints of operating an open channel network when compared to a piped network. Holding water does decrease losses, however it will not impact evapotranspiration or seepage; in fact these may be increased. Please see our responses to Items 1 and 4.

8. ***WATER AVAILABILITY AND PERMIT REQUIREMENTS***

> *This will be an issue.*

[Stantec] Efforts have been made to quantify and outline the permit and other regulatory requirements necessary to construct any of the alternatives (refer to John Kinkead's memo "Task #4 – Regulatory Requirements and Related Considerations" as a part of this study). Once the decision to go ahead with detailed design has been made, and the preferred alternative chosen, these issues can be addressed in more detail.

9. ***PIPE NETWORK VERSUS OPEN CHANNEL NETWORK***

> *The calculations of water losses for the open channel system should take into account:*

1, calculation of water losses did not take place during a drought year so they should be further amended

[Stantec] Please see our response to Items 1 and 4.

2, increased water usage during a drought

[Stantec] Please see our response to Items 1 and 4.

3, the use of dams in municipal drains to hold water and keep channels wet thereby reducing water loss to fill up system

[Stantec] Please see our response to Item 7.

4, Travel times will vary depending on whether dams are in the municipal drains and whether the channel already has water in these areas. This information should be included in the Report.

[Stantec] Travel times were fairly consistent in 2006 (wet or dry conditions). New dams will affect travel times, likely causing them to increase. The report indicated that travel times will be associated with any open channel alternatives, with the intention of qualifying the possible constraints of operating an open channel network when compared to a piped network. This will be a substantial consideration (especially operationally) since piped options will not have significant travel times.

10. GENERAL

This section refers to an Environmental Impacts Report and then a public information meeting scheduled. Again we question further costs for studies when there has been no direct communication with growers to solicit a need for irrigation

[Stantec] These are a part of the larger study, already approved by the Region. The public information center will provide an opportunity for growers to receive information and to comment and provide opinions on the project.

11. SUMMARY OF THE ALTERNATIVES

We believe that the cost will be very important to the landowners. While we recognize the positive aspects of a piped system and would love to have one, we sincerely question whether any landowner will choose that system if there is no financial commitment from the upper levels of government to help defray the cost. How can they possibly afford it?

[Stantec] Please see our response to Item 3. The growers, through the representation of the Town, the Region, and their respective grower organizations can and will approach the appropriate levels and branches of government for funding and approvals. This study is meant to provide the background and resources needed to apply for such funding and approvals.

Reference: NOTL Irrigation Committee Comments Regarding the Engineering Report

> *In summary, we thank the Region of Niagara for undertaking an Irrigation Study and for including NOTL in the study. We hope the information we have provided will be included in the Engineering Report.*

[Stantec] The letter provided, along with this response will be included in the Final Report, as a part of this overall study.

We hope that the above response is sufficient in addressing the concerns and comments provided by the Town's Irrigation Committee.

Sincerely,

STANTEC CONSULTING LTD.

Sent via email

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c. Drew Semple, Regional Municipality of Niagara
Guy Le Patourel, Stantec Consulting Ltd.
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Stantec

APPENDIX K

Figures