

Niagara Irrigation Initiative Project

Consolidated Irrigation System Engineering Report
Town of Niagara-on-the Lake
May 2026



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Town of Niagara-on-the-Lake
Consolidated Irrigation System Engineering Report
May 2026

Prepared for:

Town of Niagara-on-the Lake
1593 Four Mile Creek Road
Niagara-on-the-Lake, Ontario L0S 1T0

Prepared by:

AECOM Canada ULC
50 Sportsworld Crossing Road, Suite 290
Kitchener, Ontario N2P 0A4
Canada

T: 519.650.5313
aecom.com

Executive Summary

The Town of Niagara-on-the-Lake (“Town”) irrigation system serves approximately 8,300 acres of high-value agricultural land, including vineyards, tender fruit orchards, greenhouses, nurseries, and specialty crops. The system is composed of three primary delivery areas:

- Airport, Bright, Lavigne
- Four Mile Creek
- Harrison Routh

Water is supplied through five major intake sources from the Welland Canal, Niagara River, and Ontario Power Generation facilities. Water is conveyed through open channels, municipal drains, siphons, pumping stations, and control structures, many of which were constructed between 1995 and 1998 and have since undergone various incremental improvements.

This Consolidated Irrigation System Engineering Report provides a review of the existing infrastructure, operational challenges, hydraulic capacity, environmental and regulatory requirements, and future needs of the irrigation system. The report integrates findings from historical engineering studies, the 2021 Irrigation System Strategy and Master Plan, field investigations, user surveys, hydraulic modelling, climate-based irrigation demand assessments, and system-wide maintenance reviews. Key findings include:

- **System Capacity Deficit:** Current permitted supply can satisfy only about 41% of peak drought demand and about 32% of projected 10-year demand, based on the required 51 millimetres of irrigation water within a 14-day drought period.
- **Aging Infrastructure:** Critical assets, including the Eastchester, Dee Road, and Whirlpool pumping stations, the Ontario Power Generation (OPG) siphon, and multiple culverts and channels, are undersized, deteriorated, or hydraulically restrictive.
- **Operational Constraints:** System operation is largely manual, lacking automation, real-time flow measurement, or scheduling tools needed for efficient distribution during peak demand.
- **Hydraulic Bottlenecks:** Sedimentation, invasive phragmites, undersized culverts, and channel conveyance limitations significantly reduce flow capacity, limited area within the Right-of-Way (ROW) and system responsiveness.
- **Environmental and Regulatory Considerations:** Any infrastructure upgrades must navigate constraints related to the Fisheries Act, ESA/SCA species protections, Conservation Authority regulations, in-water timing windows, and numerous environmentally sensitive features.

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- Appendix B. Irrigation User Survey
- Appendix C. Water Requirements
- Appendix D. Process Information
- Appendix E. Cost Estimate

1. Introduction

The Town of Niagara-on-the-Lake (hereafter known as the “Town”) operates one of Ontario’s most extensive and strategically important municipal irrigation networks, serving a diverse and economically significant agricultural region. The system supports approximately 8,300 acres of high-value farmland, predominantly vineyards, tender fruit orchards, greenhouses, nurseries, and specialty crops, and is fundamental to maintaining the long-term productivity and economic resilience of the area. The irrigation network consists of three primary delivery systems: the Airport, Bright, Lavigne system; the Four Mile Creek system; and the Harrison Routh system. Together, these systems draw water from multiple sources, including the Welland Canal, Niagara River, and Ontario Power Generation (OPG) facilities, and convey it through a network of municipal drains, open channels, siphons, pumping stations, and control structures.

Construction of the municipal irrigation works began in 1995 with the Harrison Routh system and expanded through the late 1990s to include the Four Mile Creek and Airport, Bright, Lavigne Systems in response to agricultural growth, land-use changes, irrigation demand, and the operational requirements of the drainage network. Although improvements have been implemented over the past three decades, the system now faces increasing pressures related due to:

- aging and deteriorating infrastructure
- sedimentation
- limited conveyance capacity
- invasive vegetation
- growing impacts of climate change
- recurring drought conditions
- limited operational automation
- increased water demand driven by crop intensification
- capacity limitations in channels and pumping stations
- heightened regulatory and environmental requirements

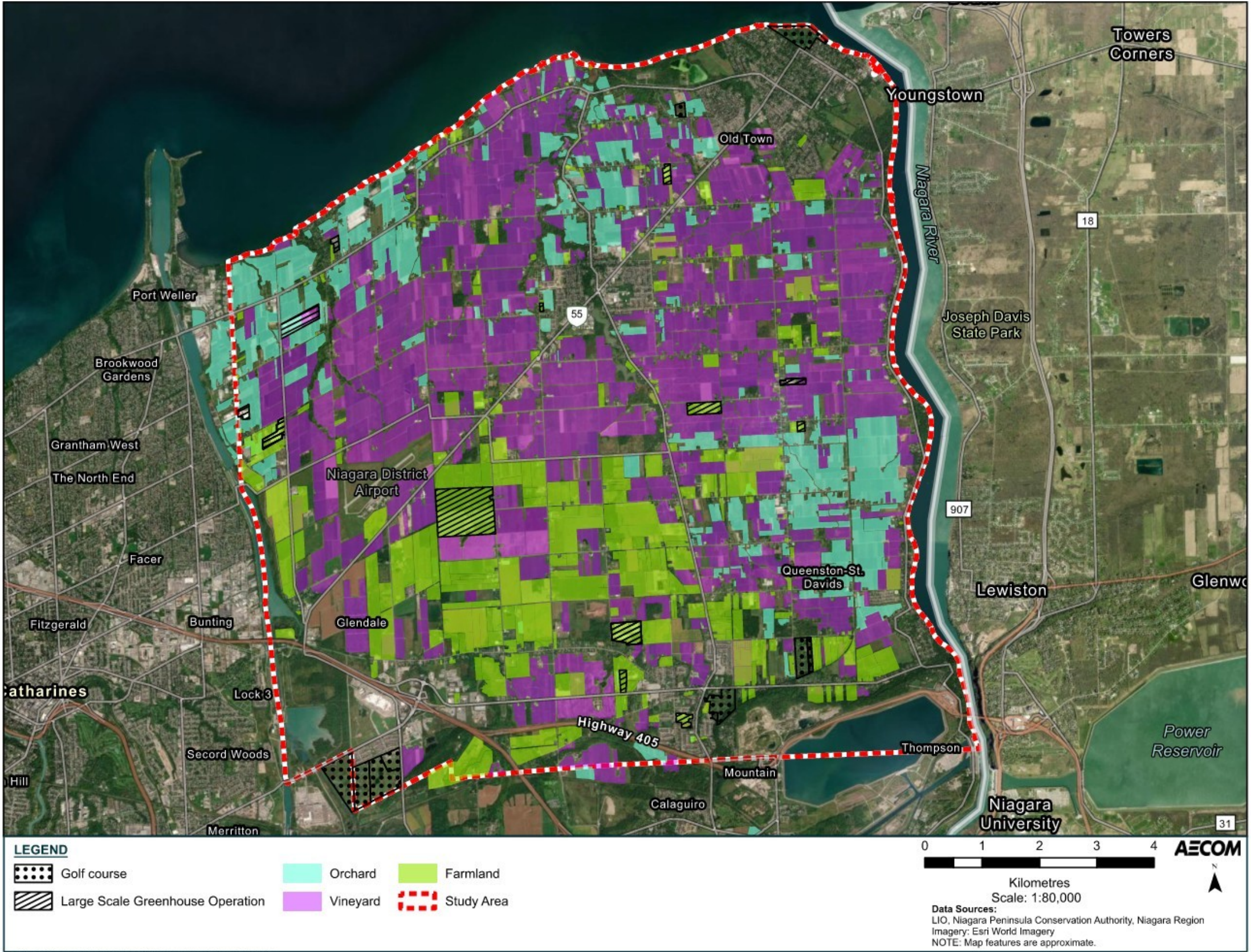
This Consolidated Irrigation System Engineering Report provides a comprehensive assessment of the existing infrastructure, operational practices, regulatory environment, and long-term needs of the irrigation network. The report integrates findings from past engineering documentation, field investigations, stakeholder consultations, an irrigation user survey, hydraulic modelling, climate-based water demand forecasting, and a review of the 2021 Irrigation System Strategy & Master Plan. Through this integrated approach, the report identifies the current and future challenges affecting system

performance and establishes a foundation for system upgrades and operational enhancements. The objectives of this report are to:

- Consolidate and update historical engineering information for all three irrigation systems into a single, comprehensive reference document.
- Assess the condition, performance, and capacity of existing infrastructure, including channels, culverts, siphons, pumping stations, and control structures.
- Evaluate current levels of service and identify system deficiencies relative to the required irrigation delivery standard of 51 millimetres within a 14-day period during drought conditions.
- Determine present and future irrigation water demand using climate-based calculations and crop-specific irrigation requirements.
- Model and analyze hydraulic capacity across the interconnected system using updated HEC RAS geometry and parameter sets.
- Document regulatory and environmental considerations, including constraints related to the Drainage Act, Fisheries Act, Conservation Authorities Act, endangered species legislation, and in water timing windows.
- Review system-wide maintenance practices and operational protocols and assess their adequacy relative to current and future system needs.
- Identify feasible, cost effective, and constructible upgrade options that address infrastructure deficits, improve reliability, and support long term agricultural resilience.

The methodology used to develop this report includes an extensive desktop review, hydraulic modelling, field assessments, environmental screening, engagement with the Town, Niagara Region (hereafter known as the “Region”), Town of Niagara-on-the-Lake Irrigation Committee (hereafter known as the “Irrigation Committee”), and agricultural stakeholders, and a user survey to capture the operational needs and experiences of irrigators. This multifaceted approach ensures that the findings and recommendations presented reflect both the technical requirements of the system and the practical requirements of its users. Overall, this report establishes an evidence-based pathway for modernizing the irrigation system to ensure continued support for the users of the irrigation system, while also providing history and specifications of the system.

Figure 1: Farm Parcels, Orchards and Vineyards



1.1 Legislative Basis

The overall report will discuss the existing system, analysis and solutions for the existing irrigation system. The irrigation system would not be possible without the use of municipal bylaws, the Drainage Act and Ontario Bill PR88. With the recommended improvements, it must be determined that the Act, By-Laws and existing bills remain sufficient to provide authority for the operation of the irrigation system, governance and roles, future growth and expansion.

1.1.1 Existing Legislature

1.1.1.1 Drainage Act

The Ontario Drainage Act R.S.O. 1990 provides a legal process for creating, improving, financing, and maintaining drainage systems. It is used manage excess water, reduce flooding, and provide legal drainage outlets for farms and other properties. It defines a municipal drain and the requirements to enter private land to construct, inspect, repair, and maintain drains. Landowners have the right to petition for drainage works, participate, review reports and appeal decisions.

The Drainage Act is discussed further in Section 3.

1.1.1.2 PR-88

Ontario Bill “Pr88 An Act respecting the Town of Niagara-on-the-Lake” is a 1990 private members provincial law that authorizes the Town to create operate, maintenance, finance and to pump irrigation water from the surrounding water systems to support the local growers and farmlands. The bill covers permits to take water and allows the town to:

- Establish the irrigation system as a municipal responsibility and owner
- Define the Town's authority to construct, maintain, expand, and operate
- Enforce compliance (By-law 4220-08 Irrigation Enforcement By-law
 - Outlines offences, penalties and enforcement mechanisms to protect the irrigation systems from unauthorized use
- Authorize charges, rates, assessments, or other funding requirements
 - local farmers financially support and pay for the system's operation and maintenance
 - the Town is able to recover costs from irrigation users (not taxpayers)
- Clarify responsibilities of irrigators, landowners, and the municipality
 - Allows landowners to petition for irrigation systems in designated areas the Town identifies
- Establish governance structures and reporting requirements

1.1.1.3 By-law 3534-01

By-law No. 3534-01 is the Town's Consolidated Irrigation By-law, governing access to and use of municipal irrigation systems. The allowances in Pr88 form the legal basis of this bill which includes:

- Rules, administration and fees for properties using the irrigation system
- Registration for owners who wish to irrigate from the system
- Billing/fee requirements
- April 15th deadline for the participation in the use of the system along with late access fees
- Water use reporting by the users that is to be submitted
- Allows Council to manage access based on available water supply

1.1.2 Governance

The governance structure for the irrigation system includes the following:

- Town of Niagara on the Lake Council
- Irrigation Committee of the Whole
 - helps identify, research, report, and assist Council by providing opinions and options on irrigation issues
 - acts as a voice of the irrigators
 - reviews policies and procedures
 - reviews operation budgets
 - assists with implementation of irrigation projects
 - The Committee consists of:
 - Six local growers appointed by Council
 - One member of Council

1.1.3 Relationships of Legislation

One of the key reasons additional private bills and bylaws are required is due to the Drainage Act. Municipal drains are primarily designed and regulated for drainage purposes under the Drainage Act, while the irrigation system looks to use many of the same drains for irrigation supply. Separate legislation such as Pr88 give the town special authority to establish and operate irrigation system but many parts of the system

are interconnected with municipal drains that predate the irrigation system. The PR88 allows the municipal to use stormwater from ditches for irrigation.

The existing legislative appears sufficient to operate and maintain the current irrigation system as the Town has successfully operated its irrigation system for many decades. Improvements include pumping stations, siphons, irrigation channels that overlap with municipal drains and overall governance by the irrigation committee and council seem to have proven fruitful for day-to-day operation, maintenance, delivery and administration. Following a detailed review of the existing irrigation system, like section 78(5) of Drainage Act a section to allow minor changes and required as-built reports, so minor changes and as-built information would be recorded in the existing reports. A reserve fund for emergency repairs and replacement of failed critical infrastructure would make the existing system more resilient.

There is a chance that to fully support the scale of expansion, modernization, cost recovery, governance, and interconnection being contemplated in this report, the existing legislation may need improvements. The most significant issue is that many irrigation channels are also municipal drains, and they fall under both the Drainage Act and Pr88. The drains were not designed to govern a large municipal irrigation utility.

As the system grows in complexity and capital value, Council may wish to determine the role of the irrigation committee and grant further privileges. As is today, the committees' roles are informal and acts on a guidance basis but in the future, it may need to be granted authority to be formally recognized and membership, voting, reporting, and consultation requirements to be codified as the system grows. A legal review is warranted to confirm that existing authorities remain sufficient. Where gaps or ambiguities are identified, amendments to existing by-laws or updates to the enabling legislative framework should be considered.

2. Existing System

2.1 Harrison-Routh

2.1.1 History

The landowners, along the Harrison Routh systems, have been requesting irrigation water since the 1940s. The Harrison Municipal Irrigation System reports collectively document the planning, implementation, expansion, and long-term evolution of municipal irrigation infrastructure within the Town of Niagara-on-the-Lake. Initiated under the authority of Bill PR-88, the private member's bill that received royal assent in June 1990 to govern and empower the Town's municipal agricultural irrigation networks, these reports establish a framework for utilizing existing municipal drainage systems to provide reliable irrigation water to agricultural lands while maintaining the primary drainage function of the watercourses. Beginning with the foundational Harrison Municipal Irrigation System report, by Wiebe Engineering Group Inc. in December 1994 the system was introduced for dual use and is the first system created within the Municipality.

In 1999, the scheme was updated with a subsequent report by Wiebe Engineering Group Inc, "Harrison Municipal irrigation System B: Diversions from Harrison No. 1 to Three Mile Creek" and further updated in 2007 in by Weibe Engineering Group Inc in "Harrison/Routh Irrigation System Niagara River Supply Engineers Report" to address system extensions and a major new water supply initiative, increasing irrigation demand, recurring drought conditions, and the need for secure and sustainable water sources. These reports covered works downstream of Concession 1 Road and Line 9 Road which are part of municipal drains that are governed by the following reports:

- Routh Drain (Byron Wiebe, February 1993)
- Harrison Drain 4 (Byron Wiebe, P.Eng., June 1989)
- Harrison Drain 6 (Byron Wiebe, P.Eng., June 1989)
- Harrison Drain 1 (Byron Wiebe, P.Eng., June 1989)

The reports summarized in Table 1 and Table 2 address system design, hydraulic capacity, environmental considerations, costs, funding mechanisms, and operational policies.

The original Harrison Municipal Irrigation System, as revised in 1994, documented cumulative expenditures of \$255,492.15 from 1989 to 1994, inclusive of capital construction, operating costs, and reserve contributions. These costs were funded through assessments levied on benefiting landowners, with revenues directed to a dedicated irrigation account to recover capital costs, fund ongoing operations and maintenance, and establish reserves. The report projected that approximately \$75,000 annually would be required to sustain the system, equating to an indicative irrigation charge of roughly \$75 per acre per year, subject to annual municipal review.

Table 1: Summary of Engineering Reports

Report	Overview	Demand and Capacity	Components	Operation	Governance and Permitting
Harrison Municipal Irrigation System Engineers Report December 1994 Weibe Engineering Group Inc	■ The Harrison Municipal Drainage System was designated for dual use as an irrigation system under Bill Pr88. ■ Covers a drainage area of ~2,205 hectares within Niagara-on-the-Lake. ■ Irrigation water is introduced during low flow periods via: – Ontario Hydro Reservoir siphon – St. Davids Wells – Hydro Canal Recharge Pumps – Four Mile Creek diversion	■ Recommended flow rate: 2,000 US Gallons per minute (1 inch of water per week for ~500 acres). ■ Siphon capacity: – Average flow: ~2,000 US Gallons per minute – Peak flow: up to 3,500 US Gallons per minute (under full head conditions) ■ Irrigation flow represents 1–5% of channel capacity across various locations, ensuring minimal impact on drainage.	■ Drain No. 4: Includes Line 8 Pumping Station, open channels, culverts, riprap, and a 300-millimetre PVC siphon. ■ Drain No. 6: Receives water via roadside ditch and discharge pipe from Drain No. 4. ■ Drain No. 2 and No. 1: Receive water from Four Mile Creek and recharge systems.	■ Irrigation season: May 15 – September 15 ■ Dams allowed (max 0.5-metre height) with permit; must be removed during storms or off-season. ■ Siphon shut down during large storm events to preserve drainage capacity. ■ Early-season activation recommended for in-system storage.	■ Permit system regulates dam installation and water use. ■ Landowners responsible for dam removal and any damage caused. ■ Non-abutting landowners must negotiate access agreements. ■ Annual rate per acre to be reviewed and set by the Town.
Harrison Municipal irrigation System B: Diversions from Harrison No. 1 to Three Mile Creek Engineers Report April 1999 Weibe Engineering Group Inc	■ Purpose: Divert irrigation water from Harrison Drain No. 1 to Three Mile Creek. ■ Initiated by Falk, Froese, and Hunter farms during the 1998 drought	■ Pumping station capacity: 400–450 US Gallons per minute ■ Three Mile Creek drainage capacity: ~134,000 US gallons per minute ■ Irrigation flow represents ~0.4% of creek capacity—minimal impact on drainage.	■ Pumping station on Concession 3 Road – 4-inch Berkeley pump (Model B4ZPKS) – 10 Horsepower electric motor – Rotary phase converter – Electrical panels and switches – Steel-clad shed ■ 610 metres of 150-millimetre PVC pipe ■ Three Mile Creek downstream of Concession 3 to Lake Ontario	■ Irrigation season: May 15 – September 15 ■ Early activation recommended for in-system storage and efficiency. ■ Dams allowed (max 0.5-metre height) with permit; must be removed during storms or off-season. ■ Town responsible for system operation and dam enforcement.	■ Governed under Bill Pr88 and the Drainage Act ■ Permit system regulates dam installation and water use ■ Town owns and maintains all irrigation works ■ Future upgrades (gravity feed) require detailed analysis and funding
Harrison/Routh Irrigation System Niagara River Supply Engineers Report February 2007 Weibe Engineering Group Inc	■ Establishes a new irrigation supply from the Niagara River via the Queenston Pump Station. ■ Supplements and eventually replaces the OPG Reservoir siphon and pump system.	■ Ultimate service area: 6,099 acres for Harrison + 977 acres for Routh ■ Ultimate flow requirement: 15,708 US gallons per minute (Harrison/Routh combined) ■ Current supply: – OPG siphon: ~3,200 US gallons per minute – OPG pump: ~2,700 US gallons per minute – Proposed Niagara River pump station: 5,000 US gallons per minute (expandable)	■ Designed for ultimate flow capacity of 15,000 US gallons per minute ■ Includes: – 1,095 metres of 750-millimetre PVC pipe – 770 metres of open ditch for Routh connection – Diversion structure with dual valves (300 millimetre and 400 millimetre) – Erosion protection and control structures – Pumping station	■ Irrigation season: May 15 – September 15 ■ Dams allowed (max 0.5 metre height) with permit; must be removed during storms ■ Rationing schedule implemented during droughts: – Days 1–2: North of Line 2 – Days 3–4: Between Line 2 and Line 5 – Days 5–6: South of Line 5 – Day 7: System recharge only ■ Off-line ponds required for properties irrigating >25 acres	■ Governed under Bill Pr88 and the Drainage Act

The report Harrison Municipal Irrigation System B (1999), serving lands along Three Mile Creek, had a total estimated capital cost of \$25,000. Initial works were largely privately funded by petitioning landowners during the 1998 irrigation season, with the municipality later assuming ownership of the system and recovering costs through irrigation rates. Based on the approved rate structure and an estimated annual revenue of approximately \$2,500, the Town anticipated recovering the capital investment over a 12- to 13-year amortization period, while also covering limited operational and maintenance costs.

The Harrison/Routh Irrigation System – Niagara River Supply, revised in 2007, introduced a new, secure water supply sourced directly from the Niagara River. This report estimated a total capital cost of \$1,305,900 (exclusive of GST), encompassing electrical servicing, pump station construction, large-diameter force main, drainage connections, erosion protection, contingencies, and engineering and contract administration. Funding was structured on a user-pay basis, with capital and operating costs to be recovered through irrigation rates and fees assessed to benefiting landowners under the Town's consolidated irrigation by-laws. Revenues were to be credited to an irrigation account to support capital recovery, system operation, maintenance, and future system expansion, with rates subject to annual review by Council.

Table 2: Historical Costs & Funding

Report	Total Costs	Funding/Fees
Harrison Municipal Irrigation System Engineers Report December 1994 Weibe Engineering Group Inc	■ Total cost (1989–1994): \$255,492.15 – Capital: \$108,879.42 – Operating: \$116,538.29 – Reserve: \$30,074.44	■ Recommended annual funding: \$75,000 – Implies \$75 per acre if 1,000 acres are serviced
Harrison Municipal Irrigation System B: Diversions from Harrison No. 1 to Three Mile Creek Engineers Report April 1999 Weibe Engineering Group Inc	■ Total capital cost (1998–1999): \$25,000 – \$17,000 (Froese Farms initial works) – \$3,500 (pump finalization) – \$4,000 (engineering report) – \$500 (miscellaneous)	■ Rate schedule: – 1–5 acres: \$100 minimum – 5.1–30 acres: \$300 minimum – 30 + acres: \$10 per acre – Special rates for golf courses, greenhouses, nursery stock
Harrison/Routh Irrigation System Niagara River Supply Engineers Report February 2007 Weibe Engineering Group Inc	■ Total capital cost: \$1,305,900 – Electrical service: \$290,000 – Pump station: \$125,000 – Pipe and trenching: \$595,000 – Routh connection: \$100,000 – Miscellaneous: \$195,900	■ Capital rates (2000–2009): \$5.55–\$17.31 per acre ■ Operational rates: – 1–5 acres: \$100 minimum – 5.1–20 acres: \$200 minimum – 20+ acres: \$10 per acre – Golf courses: \$25 per acre – Greenhouses: \$0.01 per sq ft + \$13 per acre for nursery stock – Nursery stock: \$13 per acre (min \$400)

2.1.2 Current Site Description

The system starts in the village of Queenston with the Dee Road Pump Station, which was expanded in 2017 with two new pumps, with space for one additional pump in the future along the Niagara River. From the pumping station the water is pumped into a 750-millimetre pipe with a capacity of 946.35 litres per second (15,000 gallons per minute). The pipe runs for approximately 1,095 metres starting at the Niagara River, then westerly to a point east of the Queenston Road Bridge, then southerly to the Dee Road right-of-way, then westerly along the Dee Road right-of-way, to a point approximately 505 metre west of the Niagara River Parkway. The outlet of the force main is in an open channel along the Dee Road right of way to Concession 1 Road then turns north and runs along the east side of Concession 1 Road. At the southeast side of the intersection Line 9 Road and Concession 1 Road, there is a diversion structure. The diversion has a 300-millimetre pipe to the west on the south side of Line 9 Road and a 400-millimetre pipe to the north along the east side of Concession 1 Road.

The Routh portion of the irrigation system runs north along Concession 1 Road before turning east at Line 4 Road with a channel that has a 0.5 metre to 0.9 metre bottom width and 1.5:1 to 1:2 side slopes. The channel runs along Line 4 Road and enters an inlet and drop structure at the Niagara Parkway and outlets into the ravine which flows eastwards into the Niagara River. The open channel along Line 4 Road has a 1.2 metre bottom width and 2:1 side slope.

The Harrison portion of the irrigation system runs on the south side of Line 9 to Harrison Drain 4 which, in its entirety is part of the irrigation works but is considered a municipal drain. There is an existing drainage ROW to the OPG Reservoir from this system, and a siphon was designed with a 265 metre, 300-millimetre, PVC pipe from the OPG reservoir to the Niagara Escarpment upstream of a Bruce Trail crossing which then runs north to Queenston Road and Line 9. Before turning west and crossing Line 9 Road the culvert runs north for approximately 700 metres to a diversion in Harrison Drain 6. The diversion consists of a rock check dam, a maintenance hole and a gate to an approximately 380 metre long, 750-millimetre, HPDE pipe. The pipe runs north to Arnold Road along the property line with a jog at Arnold to run north along the property line to Line 8 Road, crossing the road and outlets into the top end of Harrison Drain 6. The original Harrison Drain 4, and Harrison Drain 6 transfer was a pump system that ran along Line 8 Road, but this system is currently not operating.

Figure 2: Routh/Harrison Force Main and Irrigation Channel



Figure 3: Routh Drain

NOTL Irrigation Infrastructure Routh Drain



The main irrigation works runs in a northwest direction and crosses Concession 2 Road, Line 8 Road and outlets into Harrison Drain 1 directly upstream of the Line 7 Road crossing. The irrigation channel runs north along Concession 3 Road from about 2.5 kilometre to Line 1 Road. About 100 metres north of Line 1 Road, the channel runs northeast. At this point there is a transfer pump and 610 metre long, 150-millimetre, PVC pipe that runs north along Concession 3 Road before discharging into Three Mile Creek. Harrison Drain 1 continues for about 900 metres to the northeast at which point Harrison Drain 6 enters Harrison Drain 1. After the confluence with Harrison Drain 6, the Harrison Drain 1 runs to the north crossing East West Line. The drain runs north for about 630 metres, at which point the municipal drain ends and outlets into Two Mile Creek a natural watercourse. Two Mile Creek flows to the north along Old Niagara-On-The-Lake to Lake Ontario about 3.6 kilometres away. The Harrison irrigation channel runs north between Concession 1 Road and Concession 2 Road for about 7.5 kilometres before crossing Concession 2 Road and flowing northwest for about 700 metres before it outlets into Lake Ontario. There was a 200-millimetre pipe from Four Mile Creek around the old canary to the top end of Harrison Drain 2 but this system is not operational and defuncted.

Three Mile Creek irrigation system starts about 780 metres upstream of East West Line and continues north to Niagara Stone Road about 575 metres at which point the channel enters the Three Mile Creek a natural water course. Three Mile Creek flows northwest for about 3.3-kilometres and outlets into Lake Ontario.

Figure 4: Harrison Drain

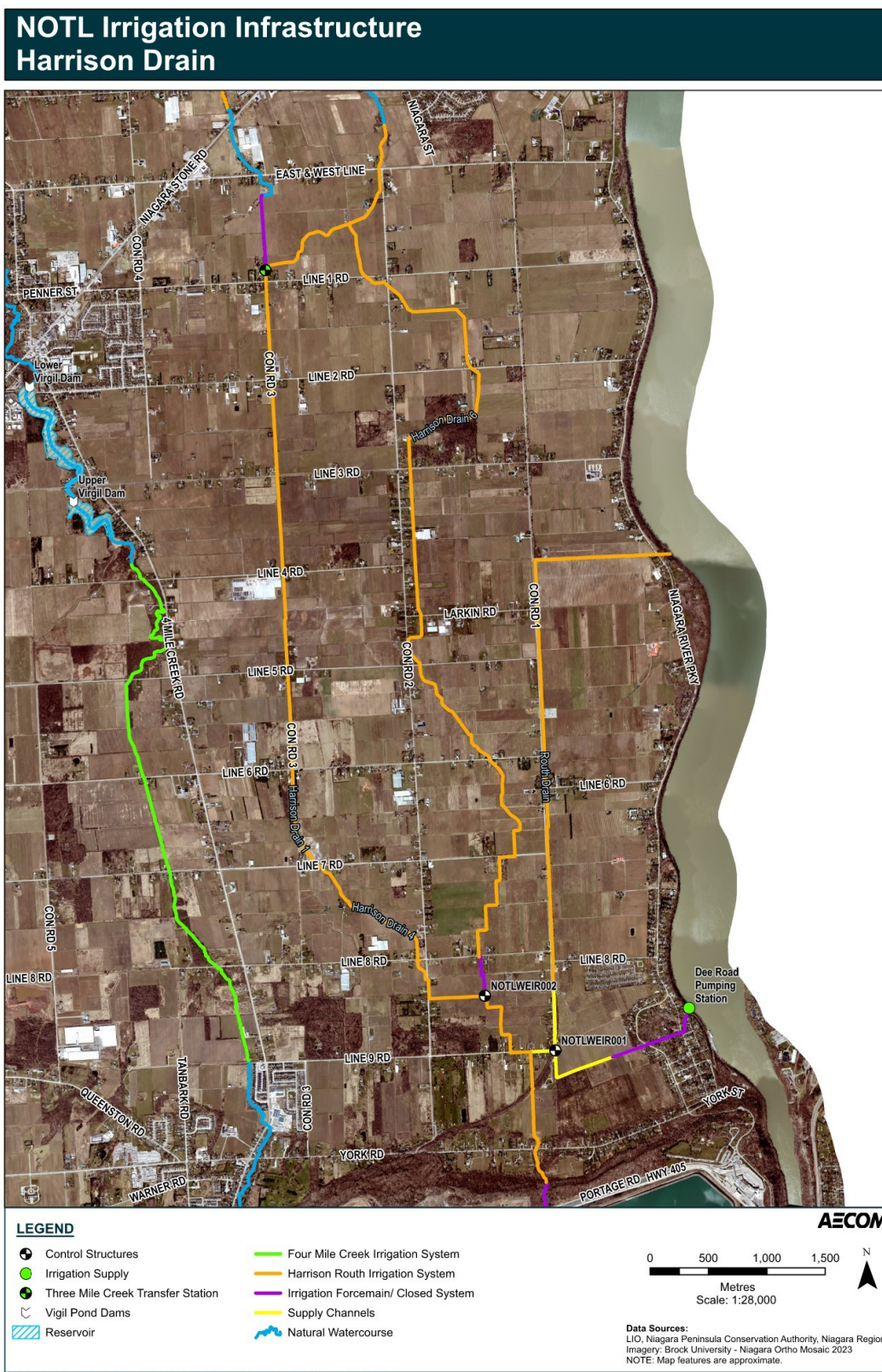


Figure 5: OPG Siphon



Figure 6: Harrison 4 to Harrison 6 Diversion

**NOTL Irrigation Infrastructure
Harrison 6 to Harrison 4 Diversion**

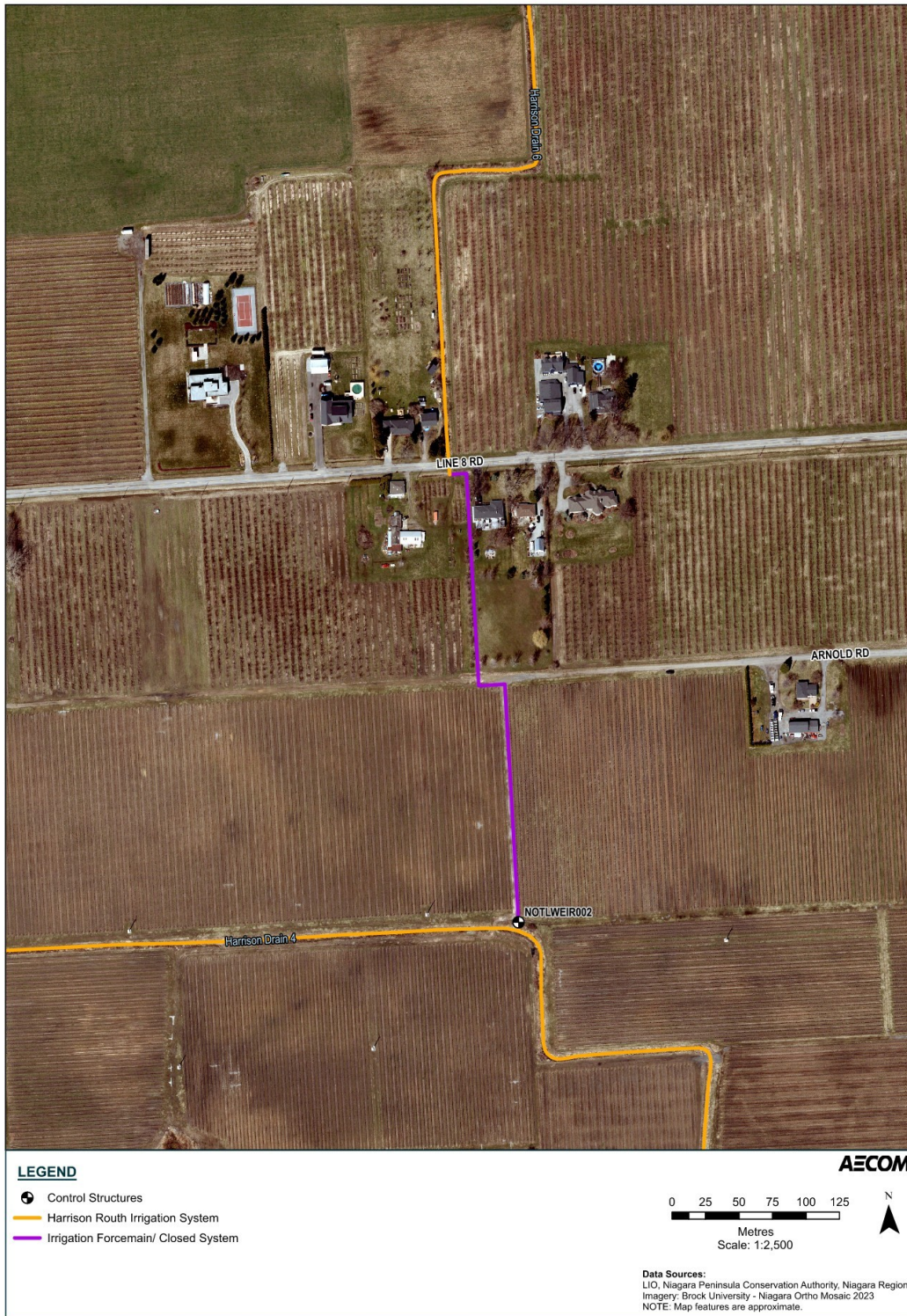
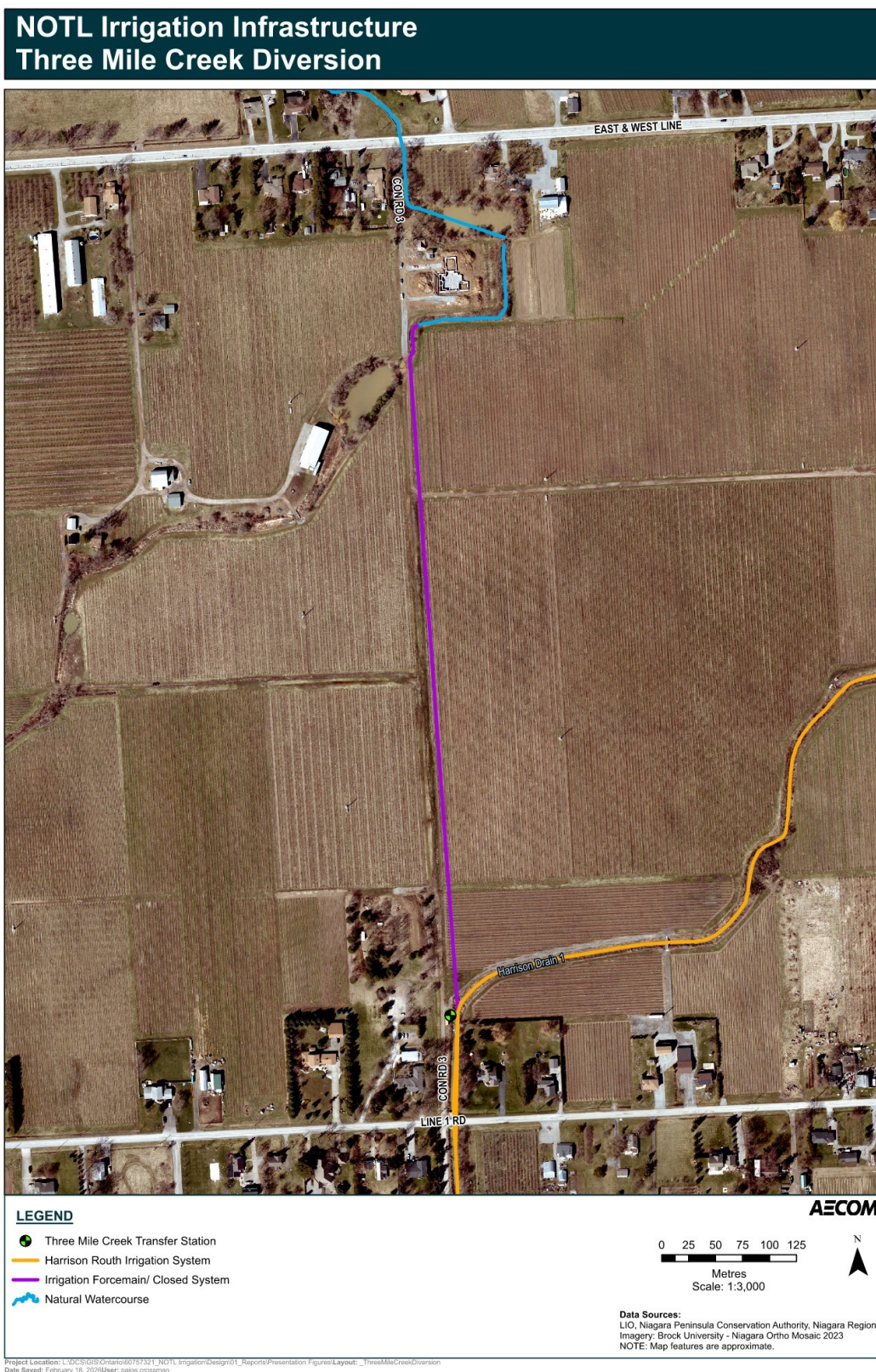


Figure 7: Three Mile Creek Diversion



2.1.3 System Inventory

Table 3: Harrison Routh Inventory

Name	Item	Location	Description
Line 8 Pumping Station	-	Drain Number 4 at Line 8	Lift station currently not in use and not needed due to the NOTLWIER002
Dee Road Pumping Station	Two 200 horsepower Centrifugal pump 5,000 US gallons per minute initial; 15,000 US gallons per minute ultimate	43°10'9.38" N, 79°3'19.18" W	Includes two pumps + full electrical system + building
Force main/Pipe	4 pipes totaling 2,350 metres	Lots, 5, 6, 40, 45, 68 and 69	PVC/Aluminum pipe, varying sizes
Municipal Drain Channel	21,901 metres	Military Reserve, lots, 15 to 6 and 44 to 26 and 53 to 69.	Open channel- Harrison Drain,
Natural Channel	13,100 metres	Military Reserve Lot 5,6,42	Creeks/Rivers- Three Mile Creek, Two Mile Creek, Harrison Drain
NOTLWEIR001	Wier	43°9'58.59N", 79°4'10.41" W	Concrete headwalls, with a 300-millimetre Pipe to the Routh Drain and 400-millimetre pipe to the Harrison Drain 4
NOTLWEIR002	Wier	43°10'14.15N", 79°4'36.70" W	Rock check dam, valve, maintenance hole and 750-millimetre HDPE
Transfer station to Three-mile creek (Berkeley pump)	4-inch pump; 10 horsepower motor	43°13'36.83N", 79°5'53.73" W	610 metres of 150-millimetre PVC and pump
OPG Siphon	~2,000 US gallons per minute average; 300-millimetre PVC siphon	Drain. 4 / Hydro Reservoir	Currently siphon is destroyed along the OPG reservoir, due to ice shoving

2.1.4 Maintenance

The Harrison Municipal Irrigation System reports establish a coordinated framework for the ongoing inspection, operation, and maintenance of municipal irrigation infrastructure, with the primary objective of ensuring reliable irrigation service while preserving the drainage function of the municipal drain network. Across all three reports, maintenance responsibilities are clearly structured to balance municipal oversight with

landowner obligations, and to address both routine system upkeep and event-based maintenance requirements.

Maintenance of the Harrison Municipal Irrigation System is centered on the Town's responsibility to maintain the municipal drains at their original design profiles, ensuring that the introduction of irrigation flows does not impair drainage capacity or structural integrity along with temporary irrigation dams. While dams are permitted as part of system operation, these structures introduce additional maintenance considerations. The Town assumes responsibility for maintaining the pumping station, buried discharge pipe, and associated works. Routine maintenance activities include:

- Periodic inspection of channels, culverts, pipes, pumping facilities, siphons, and diversion structures prior to and during the irrigation season.
 - Specific attention to erosion control measures, sediment accumulation, debris management, and the condition of control structures that regulate irrigation flows.
 - Management of temporary irrigation dams installed by landowners within municipal drains.
- Dams must be inspected for compliance with permit conditions, must never fully obstruct flow, and must not exceed the prescribed height.
 - Debris is required to be removed outside of the irrigation season and immediately prior to or during significant storm events.
 - Failure to comply triggers municipal intervention, with removal undertaken by the Town and associated costs charged back to the responsible landowner.
 - Landowners also remain responsible for any damage to the drain resulting from under-designed or poorly maintained dam structures.
- Pumping station maintenance.
 - Including inspection of mechanical and electrical components, pipe integrity, intake structures, valves.
 - Testing of pumps, flow control.
 - Ongoing monitoring for erosion, blockage, or changes in channel condition is required downstream.

All irrigation-related maintenance costs—such as minor erosion repair, debris removal following dam failures, and repairs arising from the operation of siphons or pumps—are charged to the designated irrigation account and recovered through user assessments.

Across all systems, the reports emphasize event-based maintenance triggers, particularly storm events, which require temporary shutdown of irrigation works to preserve drainage capacity and system integrity. Post-event inspections are required to identify erosion, structural damage, or debris accumulation before irrigation operations resume.

2.2 Four Mile Creek

2.2.1 History

The landowners along the Four Mile Creek had requested irrigation since 1988 and the original system was prepared pursuant to Bill PR 88 as outlined in the Four Mile Creek Municipal Irrigation System Engineering Report by Wiebe Engineering Group Inc. (Byron Wiebe, P.Eng. May 1997). The proposed system utilizes the existing Four Mile Creek watercourse, including portions of the established Four Mile Creek Municipal Drainage System, to provide supplemental irrigation water to agricultural lands during periods of low flow and limited precipitation. The intent of the system is to support agricultural operations while preserving the primary drainage function of the watercourse. The Four Mile Creek irrigation scheme originally sourced its water from St. Davids Wells number 2, 4, 6 and 7 and the OPG canal pumping station three. The water was pumped to the St. David's Pond Recharge Area, which was a retired quarry along on the Niagara Escarpment, that was owned and operated by the Regional Municipality of Niagara. The St. Davids wells are now defuncted and not used for the irrigation system. The water course upstream of Line 9 Road, is a natural watercourse and is not maintained, between Line 9 Road and Line 5 Road is part of the Four-Mile Creek Drain (Byron Wiebe, P.Eng., March 1997). Downstream of Line 5 Road is natural watercourse to Lake Ontario and there are two reservoirs located in the Village of Virgil: The Upper and Lower Virgil Reservoirs which are owned by the Niagara Peninsula Conservation Authority and operated by the Town under a Memorandum of Understanding (MOU).

Technical analysis confirms that the proposed irrigation flows represent a proportion of the existing channel capacity and can be conveyed without adverse impacts on drainage, provided that the appropriate operational controls and permitting requirements are followed. The Four Mile Creek Municipal Irrigation System is considered feasible and compatible with existing infrastructure and watershed conditions. The report recommends that the system be formally designated and operated by the Town through municipal by-law, with irrigation use regulated to ensure continued protection of drainage capacity, downstream landowners, and overall system performance.

Table 4: Summary of Engineering Reports

Report	Overview	Demand and Capacity	Components	Operation	Governance and Permitting
Four Mile Creek Municipal Irrigation System Engineers Report Wiebe Engineering Group Inc. May 1997	■ The system spans from the Town boundary with Niagara Falls to Lake Ontario, including the Four Mile Creek Municipal Drain (Drain 1). ■ Governed under Bill Pr88 and the Drainage Act. ■ Designed to introduce irrigation water during low flow and drought conditions.	■ Target service area: ~500 acres. ■ Recommended flow rate: 2,000 US gallons per minute (1 inch of water per acre per week). ■ Available supply exceeds demand: – St. Davids Wells: 1,590 US Gallons per minute – Hydro Canal Pumps: 3 pumps @ 1,000,000 US gallons per minute each – Total available: ~4,590,000 US gallons per minute	■ Existing infrastructure already in place; no new capital construction is required. ■ Water sources: – Natural springs in headwaters – St. Davids Wells and Recharge Pond (Region-owned) – Ontario Hydro Canal Pumping Station – Upper and Lower Virgil Dams (Niagara Peninsula Conservation Authority - owned)	■ Irrigation season: May 15 – September 15 ■ Dams allowed (max 0.5 metre height) with permit; must be removed during storms or off-season. ■ Siphon shut down during large storm events to preserve drainage capacity. ■ Early-season activation recommended for in-system storage.	■ Permit system regulates dam installation and water use. ■ Landowners responsible for dam removal and any damage caused. ■ Non-abutting landowners must negotiate access agreements.

In 1993, the engineering report outlined that the Four Mile Creek system does not require any capital construction expenditures, as all necessary infrastructure is already in place. The financial requirements for the system are limited to implementation and annual operating costs, which were estimated at \$14,900 in 1997. These costs include water purchases, staffing, equipment, hydro, contractual services, engineering and legal services, and miscellaneous administration. For the initial year of operation, there was only seven petitioning landowners leading to a lack of funds and an operating deficit of \$12,800, which the Town would finance through a reserve fund. As users grow for this system, with an anticipated service area of approximately 500 acres, the assessment rate structure is expected to generate revenue to cover operating costs in future years.

Table 5: Historical Costs & Funding

Report	Total Costs	Funding/Fees
Four Mile Creek Municipal Irrigation System Engineers Report Wiebe Engineering Group Inc. May 1997	■ Annual operating cost \$14,900 ■ Revenue from petitioning landowners: \$2,100 (7 landowners) ■ Deficit: \$12,800 (covered by Town reserve)	■ Rate schedule: – \$300–\$500 for pumping to pond – \$400–\$600 for direct irrigation from drain

2.2.2 Current Site Description

The Four Mile Creek Irrigation System supplies the central part of the municipality, with the majority of the agricultural lands in this area being vineyards as well as a small pocket of orchards just north of the Village of Virgil. The existing system is supplied by the Whirlpool Pump Station that was built in 1972 by the Niagara Region and then rebuilt in 2017. The pump station has a 300-millimetre inlet pipe from the OPG power canal, with two pumps operational producing 2,000 US gallons per minute. From the pump station there is a 300-millimetre watermain for 15.9 metres before increasing to 400-millimetres for 1,081 metres, then reducing to 300-millimetre for 1,038 metres. The watermain runs straight to the southeast side of Church's Lane and Whirlpool Road, then runs along the east side of Whirlpool Road for about 206 metres turning west and crossing Whirlpool Road and the CN Railway. The watermain then runs along the southwest side of the CN Railway for about 4,591 metres before crossing the CN railway line and turning north, running about 235 metres and outlets into a splash box and the St. David's Recharge Pond which has an existing weir. This infrastructure was downloaded to the Town of Niagara-on-the-Lake.

The Recharge Pond outlets to an existing watercourse that flows to the north under highway 405 and Niagara Townline Road and continues to the north through the Village of St. David's and connects into the Four Mile Creek Drain, at Line 9 Road at about 2.9

kilometre. The Four Mile Creek drain flows north for about 3,360 metres and outlets about 325 metres north of Line 5 Road at the upper end of the Upper Virgil Reservoir. Between Line 9 Road and Line 8 Road, the channel has a 1.5-metre bottom width with 2:1 side slopes. From Line 8 Road to Line 5 Road, the channel has 3.05-metre bottom width with 2:1 side slopes while the last part of the channel has a 3.66 metre bottom width with 2:1 side slopes.

The Upper Virgil Reservoir is about 125 metre south of Line 3 Road, is about 700 metres long, and is 8.75 hectares in area with a dam about 125 metres long and 4.9 metres high. The dam was constructed in 1968 to provide a storage for the irrigation of the expansion of fruit and vegetable crops. The Lower Virgil Reservoir is about 1 kilometre north of Line 3 Road, is 95 metres long, 4.4 metres high and creates a reservoir that is 13.5 hectares. There is an existing private pump station near the Lower Virgil Reservoir at the end of Line 2 Road where a 200-millimetre pipe runs along Line 2 Road and outlets into a catch basin at the top end of the Szockyj Drain. Downstream of the Virgil Reservoirs, Four Mile Creek is a natural watercourse to Lake Ontario about 8.1 kilometres to the north. About 3.1 kilometres from the Lower Virgil Reservoir is the confluence of the Bright Drain outlet and further 1.7 kilometres is the confluence with the Lavigne Drain Outlet.

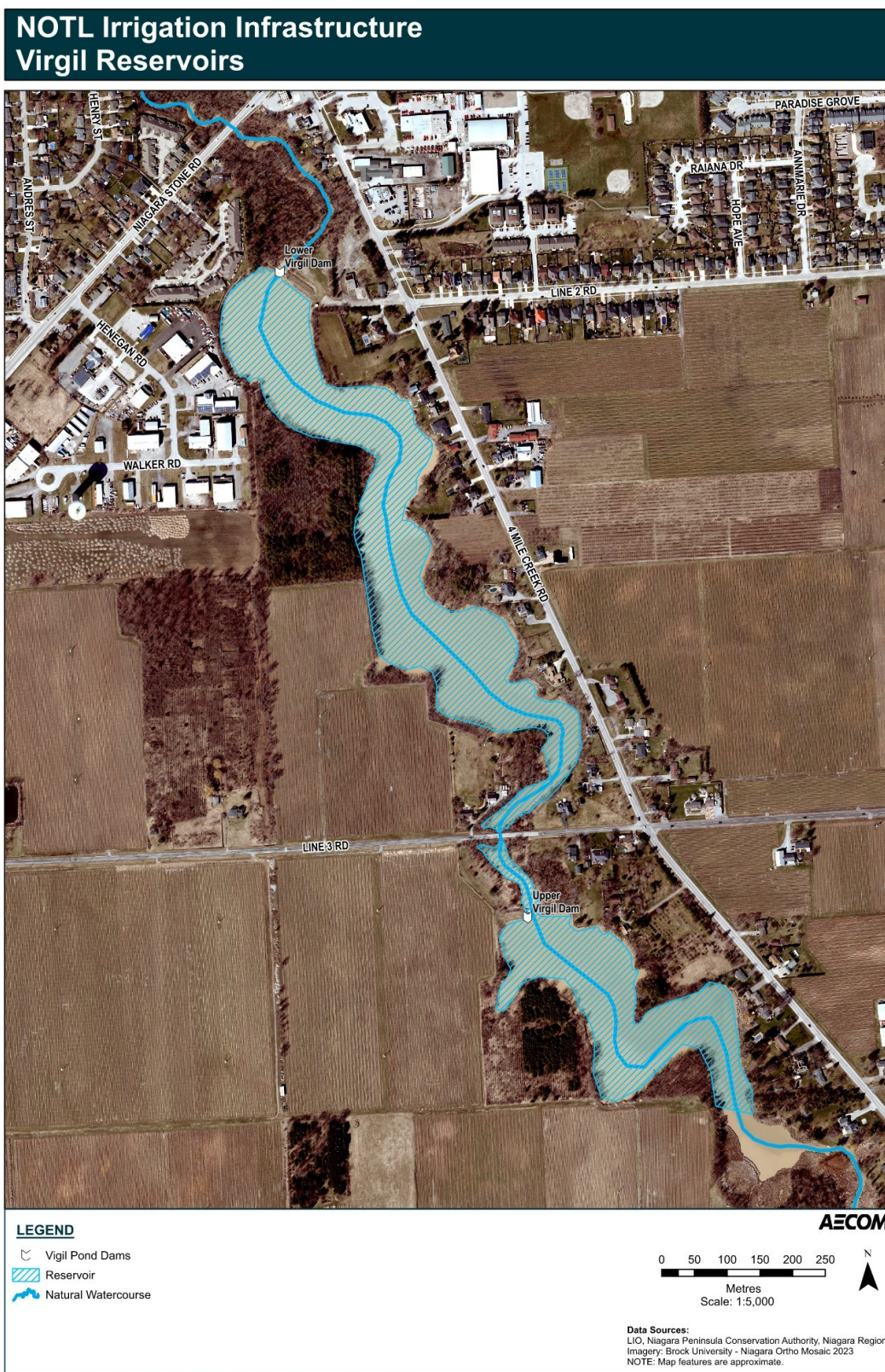
Figure 8: Whirlpool Force Main



Figure 9: Four Mile Creek Drain



Figure 10: Virgil Reservoirs



2.2.3 System Inventory

Table 6: Four Mile Creek Inventory

Name	Item	Location	Description
Whirlpool Pumping Station	Two pumps, 2,000 US gallon per minute	43°7'42.82" N, 79°4'55.73" W	Pump + Valves + Building
Force Main/Pipe	2,185 metres	Lots 42,38,37,24,17 & 4	PVC, varying sizes
Municipal Drain Channel	3,364 metres	Lots 102 to 106 and 83 to 87	Open Channel- FMC Drain 1, St Davids
Natural Channel	13,105 metres	Lot 5 Gore, 92 to 88, 108 to 112, 119 to 116, Military Reserve, Lot 193 to 194	Creeks/Rivers- Four Mile Creek
Upper Virgil Reservoir	Dam	43°12'34.13N", 79°7'8.09" W	Operated by Niagara Peninsula Conservation Authority
Lower Virgil Reservoir	Dam	43°13'6.18N", 79°7'24.19" W	Operated by Niagara Peninsula Conservation Authority
Transfer Station to Szockyj Drain	One pump	43°13'4.43N", 79°7'21.73" W	200 millimetre PVC and pump Privately Owned
St Davids Wells	Wells 2, 6 and 7	43° 8'41.83"N, 79° 5'54.41"W	Currently, not in use and defuncted
St. Davids Wier	Wier	43° 8'41.83"N, 79° 5'54.41"W	Owned by Town

2.2.4 Maintenance

The Four Mile Creek Municipal Irrigation System relies on existing watercourses, municipal drains, and water supply infrastructure. Maintenance requirements are focused on protecting drainage function, ensuring safe seasonal irrigation use, and preventing localized impacts to infrastructure and properties. The Town of Niagara-on-the-Lake is responsible for maintaining the Four Mile Creek Municipal Drain to ensure the existing design profile and hydraulic capacity remain. Standard municipal drain maintenance practices include:

- Inspection and debris removal:
 - Prior to each irrigation season, undertake inspections to ensure:
 - Channels are clear of obstructions and unauthorized works
 - Banks, bed, and control points are stable and serviceable
 - Conditions are suitable for the introduction of irrigation water

- During the irrigation season, periodic inspections to verify compliance with permits, monitor channel condition, and address maintenance needs.
 - Post weather event inspections
 - Privately owned Dams
 - repair of erosion
 - correction of deficiencies that may impair drainage or system performance.
- Maintains records of:
 - authorized users
 - permitted structures
 - maintenance activities
 - inspections
- Coordinate with owners of dams/reservoirs for monitoring, activation and shutdown of system.

Temporary irrigation dams installed by landowners are permitted only during the irrigation season, must be kept below the allowable height, and must not obstruct flow or impact upstream or downstream properties. The Town is to monitor permitted installations to ensure compliance and system protection. Unauthorized, unsafe, or non-compliant dams may be removed by the Town, with associated restoration and maintenance activities as required. Any localized damage to the drain is addressed through routine maintenance, with responsibility in accordance with applicable by-laws and policies. In addition to the above, irrigation is to be stopped during significant rainfall events, and the town is not responsible for deepening or modifying the channel to enhance irrigation storage or access. Temporary dams must be removed, and The Town may install or remove control structures at road crossings or other locations.

2.3 Airport-Bright Lavigne

2.3.1 History

In 1998, the Airport Carlton Siphon Number 1 Municipal Irrigation System Engineers Report was prepared by Wiebe Engineering Group Inc to satisfy Bill PR 88 respecting the Town of Niagara-on-the-Lake. The Airport Number 1 irrigation system was supplied by a siphon located near the south side of Carlton Road and the Welland Canal. This report formalized the use of the Airport Municipal Drain Number 1 and downstream watercourses as a municipal irrigation system. The Airport No 1 Irrigation scheme outlets into the Airport Drain 1 which is outlined in the most current Airport Drain 1 report by Wiebe Engineering group Inc. (Byron Wiebe, P.Eng.) in November 1986.

As irrigation demand increased due to expanded agricultural activity, higher water requirements, and recurring dry growing seasons, the Airport-Bright Lavigne Irrigation system was expanded in May 2000, with a pump on the Welland Canal at the end of Eastchester Avenue. The system included a 4,000 US gallons per minute pump, 310 metres of 400-millimetre PVC running along northside of Eastchester Avenue, 3,640 metres of open ditch, 3 control structures and 3 diversion dams. The irrigation system outlets into the following drains:

- Airport Drain 1 and Airport Drain 3 (Wiebe Engineering Group Inc, Byron Wiebe P.Eng., November 1986)
- Lavigne Drain K. Smart Associates (John Kuntze, P.Eng., May 1995)
- Bright Drain (Byron Wiebe, P.Eng., January 1991)

The system was designed to operate in coordination with the existing municipal drainage infrastructure and analyses in the reports confirmed that the introduction of irrigation flows would represent a small proportion of the available drainage capacity and could be managed without adversely affecting drainage performance.

The reports, which like other systems, establish clear roles and responsibilities for operation, permitting, and maintenance, with all irrigation works overseen and operated by the Town. Temporary irrigation dams, where permitted, are subject to strict height limits, seasonal restrictions, and removal requirements to mitigate risks to drainage function and upstream landowners. Together, the 1998 and 2000 Engineer's Reports support consistent irrigation service delivery while maintaining compliance with applicable legislation and safeguarding the integrity of the municipal drainage network.

Table 7: Summary of Engineering Reports

Report	Overview	Demand and Capacity	Components	Operation	Governance and Permitting
Airport (Carlton Siphon) No. 1 Municipal Irrigation System Engineers Report, August 1998 Wiebe Engineering Group Inc.	■ The Carlton Siphon system was designed to utilize the Airport Municipal Drain 1 and downstream watercourses for irrigation. ■ The system extends from Carlton Road north to Lake Ontario, incorporating Eight Mile Creek.	■ Initial service area: ~125 hectares. ■ Ultimate service area: ~700 hectares. ■ Recommended flow rate: 2,000 US gallons per minute, based on servicing 200 hectares with 1 inch of water per week. ■ Existing siphons (100-millimetre and 150-millimetre) provide 300–500 US gallons per minute; future upgrades proposed a 300-millimetre (12 inch) siphon.	■ Existing system includes siphons at Carlton Street and the Welland Canal. ■ Proposed upgrades include: – 12-inch siphon – Relocated roadside ditch – Berming and flap gates for flood mitigation	■ Manual start-up system; potential for flooding if multiple siphons operate simultaneously. ■ Dams allowed (max 0.5 metre height) with strict permit conditions. ■ Irrigation season: May 15 – September 15. ■ Shutdown procedures during heavy rainfall (>40 millimetre in 24 hours).	■ Governed under Bill Pr88 and Town of Niagara-on-the-Lake Act. ■ Permits required for dam installation and water use.
Airport, Bright and Lavigne Municipal Irrigation System Engineers Report, May 2000 Wiebe Engineering Group Inc.	■ Designed to service ~1,900 hectares of agricultural land. ■ Source: Welland Ship Canal at Eastchester Avenue. ■ Includes: – Pumping station at the canal – Force main to Stewart Road – Diversion channels connecting Airport Drain No. 3, Lavigne Drain, and Bright Drain ■ Use of existing municipal drains	■ Designed to deliver 4,000 US gallons per minute, servicing 754 hectares. ■ Ultimate system capacity planned for 12,000 US gallons per minute. ■ Ideal irrigation rate: 1 inch of water per acre per week. ■ Currently provides ~0.80 inches per week, considered adequate with early-season operation. ■ Existing municipal drains designed for 2-year storm events. ■ Stage I irrigation flow uses <10% of channel capacity. ■ Control structures isolate irrigation from drainage functions.	■ 400-millimetre PVC pressure pipe ■ Deepening/widening roadside ditches ■ New diversion channels ■ Culverts, control structures, temporary dams ■ Erosion protection and hydro supply ■ Estimated Cost: \$482,500 (2000) ■ Estimated Cost for Ultimate Flows: \$375,000 (2000)	■ Operated by Town staff under Irrigation Committee direction. ■ Activated by May 15 to allow in-system storage. ■ Shut down during rainfall >40 millimetre in 24 hours. ■ Only Town staff may operate system controls.	■ Governed under Bill Pr88 and the Drainage Act. ■ Permit system regulates dam installations and water use. ■ Landowners must remove dams outside irrigation season or during storm events.

The 1998 Engineer's Report identified minimal capital requirements for implementation, as the system relied on existing siphon infrastructure and drainage works, with costs limited to minor remedial works and annual operating expenses. Future upgrades, including a larger siphon and channel modifications, were identified as longer term improvements to be undertaken only if demand warranted. The 2000 Engineer's Report reflected a substantially expanded scope, with works involving new pumping infrastructure, diversion channels, control structures, and improvements to existing municipal drains, followed by provisions for further system expansion to accommodate ultimate irrigation flows. Capital works should be implemented on a phased basis to align with demand, and that operation and maintenance are funded through user-based assessments and irrigation. term improvements to be undertaken only if demand warranted. The 2000 Engineer's Report reflected a substantially expanded scope, with works involving new pumping infrastructure, diversion channels, control structures, and improvements to existing municipal drains, followed by provisions for further system expansion to accommodate ultimate irrigation flows. based assessments and irrigation.

Table 8: Historical Costs & Funding

Report	Total Costs	Funding/Fees
Airport (Carlton Siphon) No. 1 Municipal Irrigation System Engineers Report, August 1998 Wiebe Engineering Group Inc.	■ Annual operating cost (1998): \$5,000 ■ Estimated cost for upgrade: \$219,000 (1998)	■ Revenue model based on parcel size and irrigation method.
Airport, Bright and Lavigne Municipal Irrigation System Engineers Report, May 2000 Wiebe Engineering Group Inc.	■ Estimated Cost for upgrades: \$482,500 (2000) ■ Estimated Cost for Ultimate Flows: \$375,000 (2000)	■ Annual capital/debt repayment charge: \$11 per acre (2000–2005) ■ Based on parcel size and user category (e.g., golf courses, greenhouses). ■ Properties irrigating directly from natural sources pay a reduced rate but must pay full rate if accessing municipal system.

2.3.2 Current Site Description

The Airport, Bright and Lavigne (ABL) irrigation system supplies the western part of the municipality. Water entering the Bright and Lavigne drains drain into the Four Mile Creek downstream of the Village of Virgil. The irrigation shed can divided into three zones, the northwest side is mostly tender fruit orchards, the south side of the irrigation shed is a mix of hay fields, vineyards and greenhouses. The middle and northeast side

of irrigation shed is mostly vineyards. There are two existing water supply locations, both get water from the Welland Canal in between Lock 2 and 3.

About 275 metres to the south of the Carlton Street canal crossing, is a siphon that was originally two pipes, a 100-millimetre diameter and a 150-millimetre diameter pipe. These pipes were decommissioned and replaced with the existing 200-millimetre diameter PVC pipe. The 150-millimetre pipe was decommissioned after 2014. The siphon has approximately 50 metres of 200-millimetre PVC pipe with a 2,000 US gallons per minute capacity. The original Weibe Report called for a 300-millimetre PVC pipe, but a 200-millimetre PVC is currently installed. The siphon outlets into the south side of Carlton Street and runs east for about 1760 metre, then outlets into Airport Road 1.

The Eastchester Pumping Station is located at the top of the berm along the Welland Canal, at the end of Eastchester Avenue. There is a 310 metre 400-millimetre PVC pipe running along the north side of Eastchester Avenue and outlets into the north ditch of Eastchester Avenue east of Steward Road. The irrigation channel runs east in the Eastchester Avenue roadside ditch for 260 metres, then south to the south side road ditch for 620 metres. The channel crosses Niagara Stone Road and runs to the east in the south roadside ditch and along an existing unopened right of way for 460 metres before intersecting a diversion weir (NOTLWIER003) on Airport Drain 1.

Figure 11: Carlton Siphon

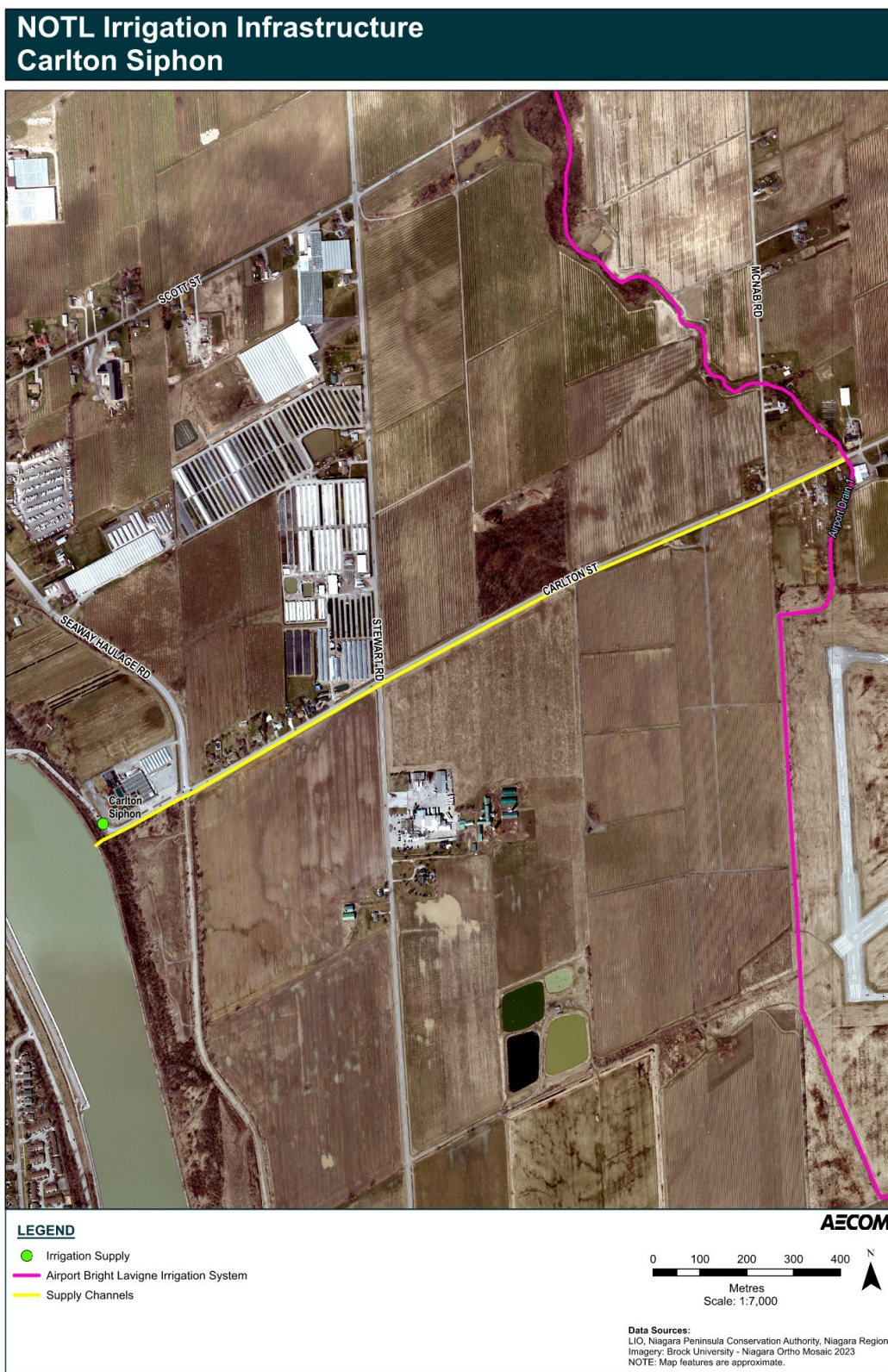


Figure 12: ABL Irrigation Channels



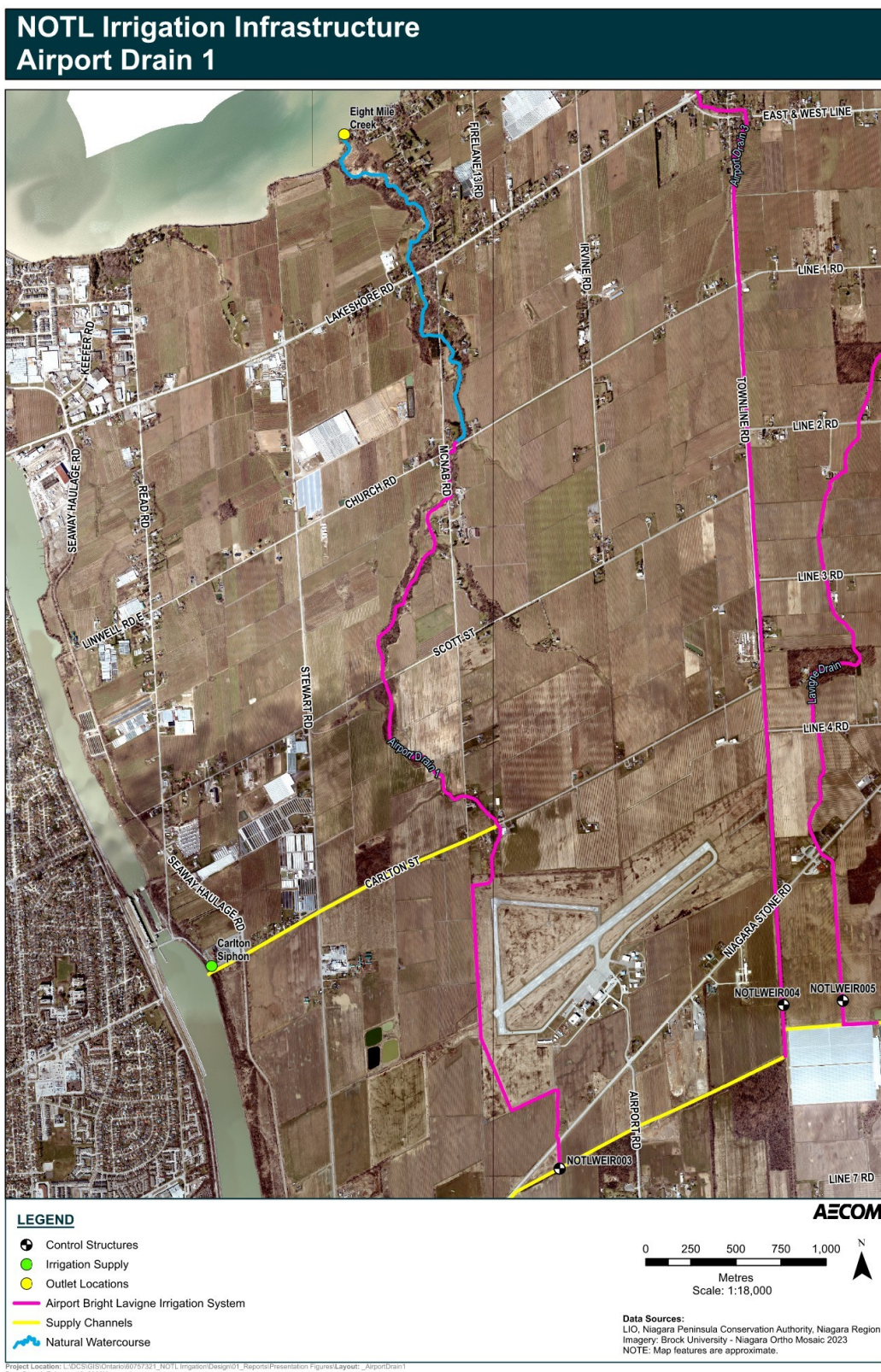
The Airport Drain 1 turns to the north and runs for about 2,560 metres beside the Niagara District Airport and intersects with Carlton Street irrigation channel to the west. The drain continues to flow to the north crossing McNab Road twin, Scott Street and Church Road for 3,008 metres. The channel between Scott Street and McNab Road has a 3.0 metre bottom width and 1.5:1 side slopes. Between McNab Road and Church Street the channel has a 3.3 metre bottom width and 1.5:1 side slopes. The drain outlets into the existing Eight Mile Creek 100 metres downstream of Church Road. The Eight Mile Creek continues for about 2,310 metres before entering Lake Ontario. While listed as a municipal drain, the Town of Niagara-on-the-Lake has no report currently of this being a drain, and it is assumed that Eight Mile Creek is a natural water course, crossing Lakeshore Road and McNab Road.

After the NOTLWIER003 on Airport Drain 1, the irrigation channel continues runs run east for about 1,400 metres along the Eastchester Avenue unopen road allowance to Airport Drain 3 which crosses Airport Road. At Airport Drain 3, the irrigation works turn to the north for about 155 metres, where diversion structure, NOTLWIER004, is located. The diversion weir controls water to the north on Airport 3 and to the east to the Lavigne Drain and Bright Drain.

The Airport Drain 3 continues to the north to Niagara Stone Road for about 690 metres then continues north along the Townline Road to the south of East West Line. The Airport Drain 3 generally flows to the north along the Old Township boundary and outlets into Lake Ontario. From Niagara Stone Road to Lake Ontario the channel is 6,052 metres long and there are eight road crossings.

- Line 4 Road
- Line 3 Road
- Line 2 Road
- Line 1 Road,
- East West Line
- Lakeshore Road
- Fire Lane 11a Road

Figure 13: Airport Drain 1



After the NOTLWIER004, an irrigation channel runs east for 335 metres where diversion structure NOTLWIER005 is located which diverts water to the south along the Lavigne Drain and to the east to the Bright Drain. The Lavigne Drain runs 6,618 metres to the northeast to Four Mile Creek and has a bottom width of 1.2 metre near the top end to 1.8 metre at the bottom end with 1:1.5 side slopes. The Lavigne Drain crosses:

- Niagara Stone Road
- Line 4, Road
- Line 3 Road
- Line 2 Road
- Line 1 Road
- East-West Line

After NOTLWIER005, the irrigation channel runs east for 180 metres along part of the Lavigne Drain continuing east for an additional 490 metre at the northwest corner of Concession 7 Road and Line 6 Road which is at STA 5+016 on the Bright Drain. There is 5,176 metres of drain before it outlets into a natural watercourse downstream of Concession 6 Road. The Bright Drain runs due north along Concession 7 Road for 455 metres with a bottom width of 1.2 metre and 1.5:1 side slopes. At the Concession 7 Road the drain turns northeast and runs for 434 metres at where the Bergman Branch enters and the bottom width changes from 1.8 metre to 2.1 metre with 1.5:1 side slopes. The Drain runs northeast for 2,317 metres crossing Line 5 Road, Line 4 Road and Line 3 Road. After crossing Line 3 Road, the drain runs north for 1,158 metres crossing Niagara Stone Road, Concession 6 Road and Line 2 Road with 2.4 metre bottom width and 1.5:1 side slopes. 149 metres downstream of Line 2 Road, the bottom width changes to 2.7 metre width with 1:2 side slopes and runs north for 617 metres. The drain continues 560 metres to the northeast crossing Line 1 Road and outlets upstream of Concession 6 Road, with a 3.0 metre bottom width and 2:1 side slopes. The irrigation channel runs north for about 860 metres and outlets into the Four Mile creek which is a natural watercourse.

Figure 14: Airport Drain 3

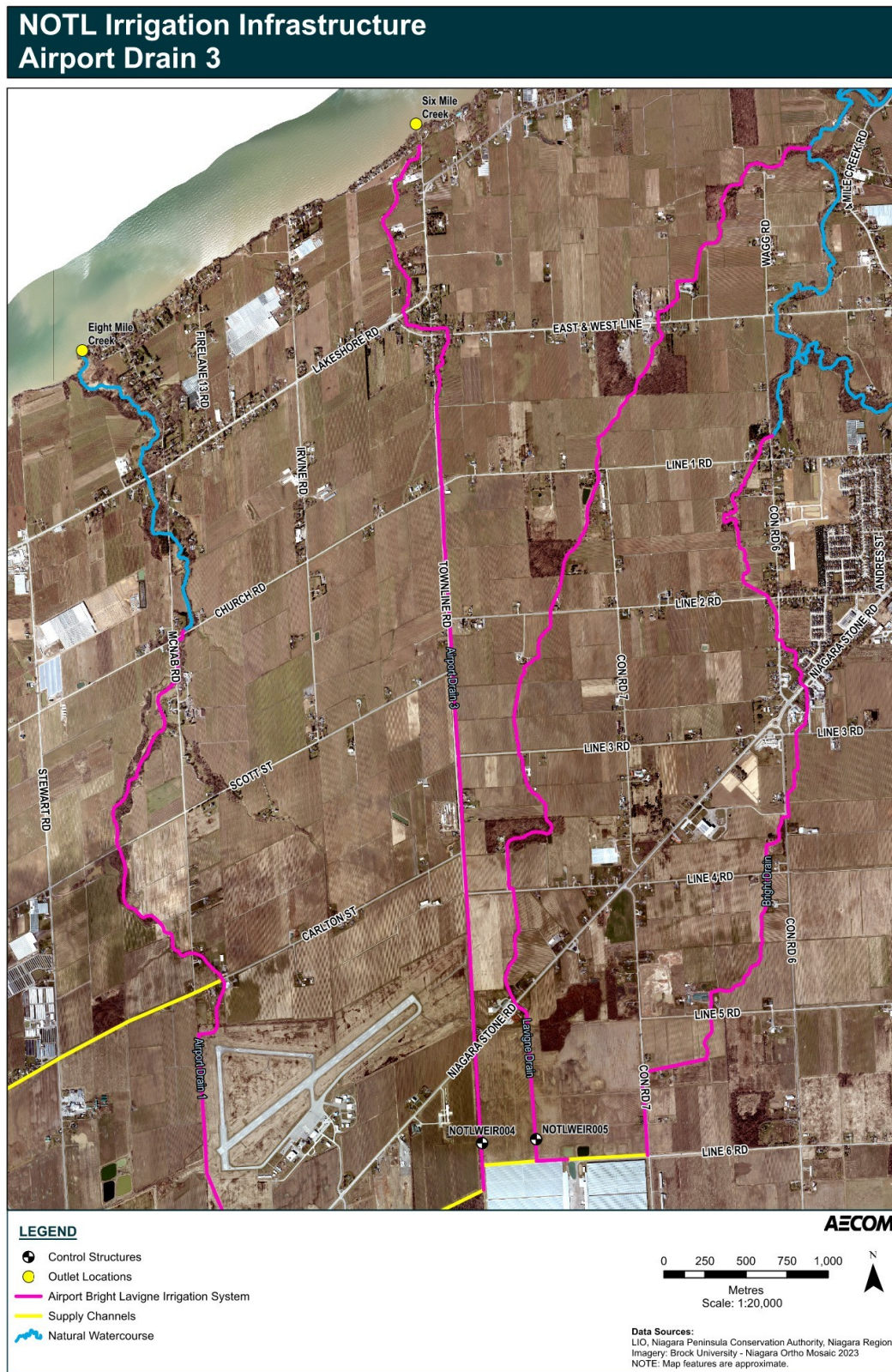


Figure 15: Lavigne Drain

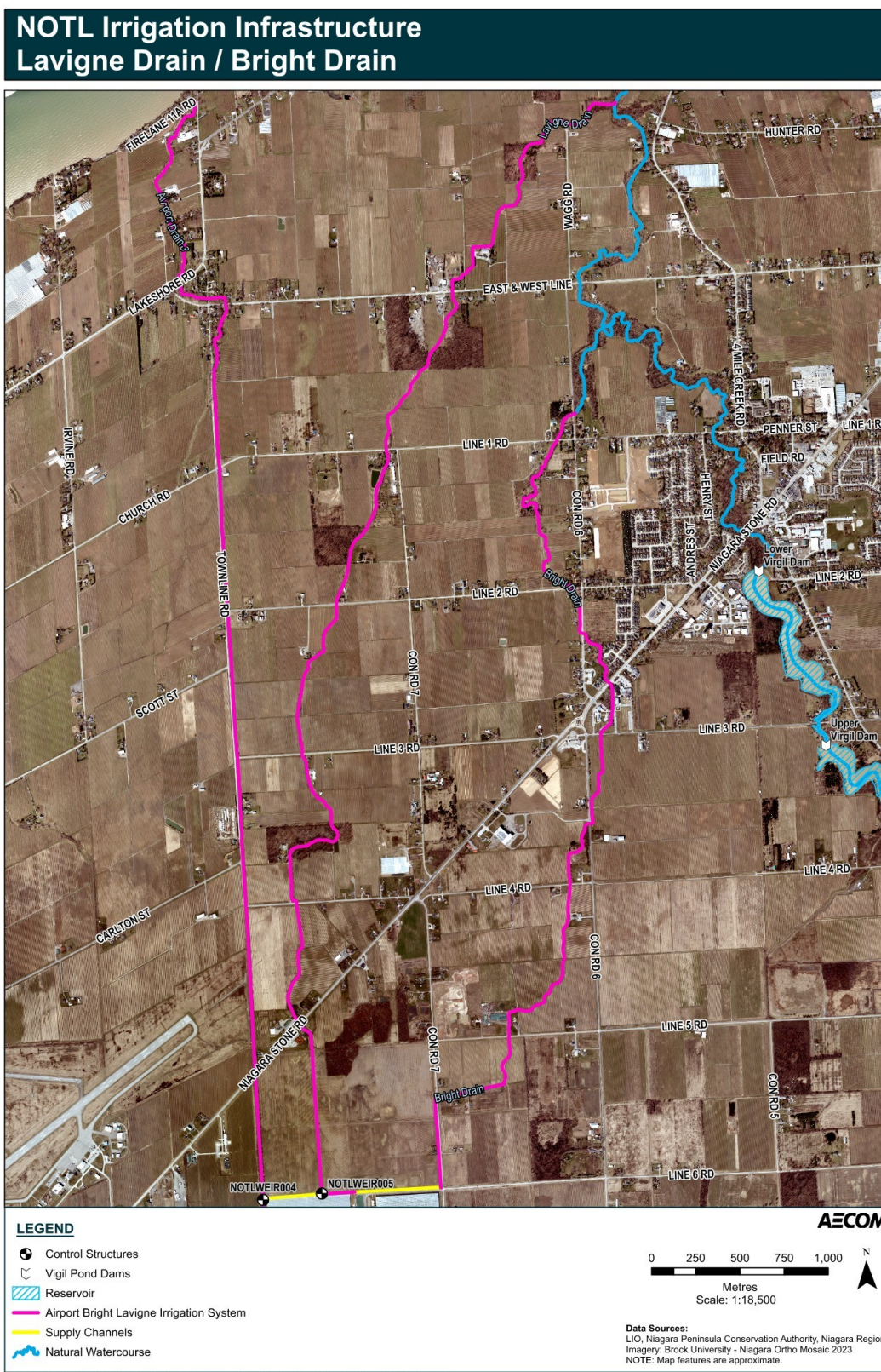
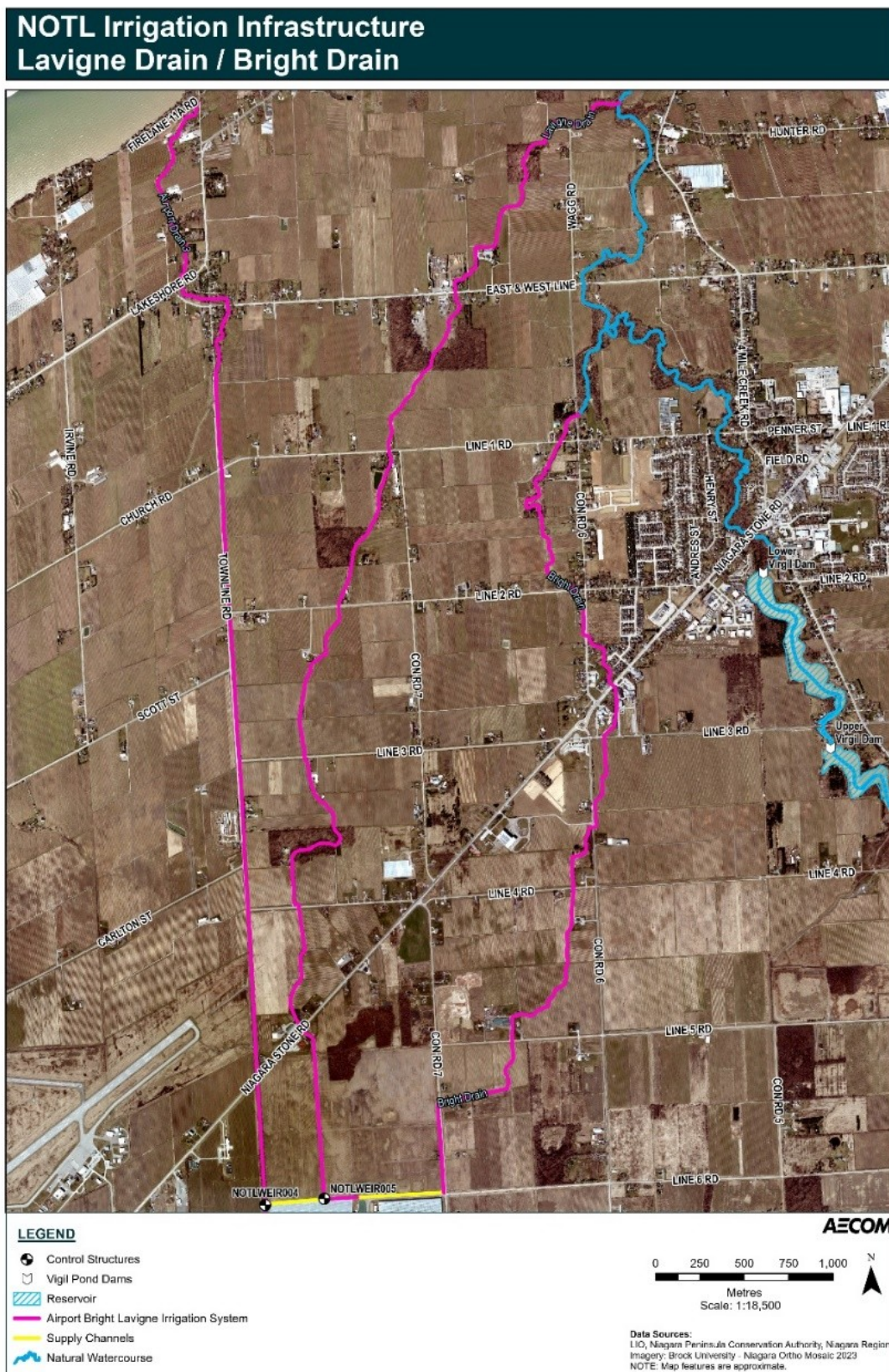


Figure 16: Bright Drain



2.3.3 System Inventory

Table 9: ABL Inventory

Name	Item	Location	Description
Eastchester Pumping Station	One pump 4,000 gallons per min	43°10'24.68" N, 79°11'31.66" W	Pump + 310 metre of 400-millimetre PVC pipe, pump in poor condition
Carlton Street Siphon	200-millimetre PVC pipe and valve	43°11'25.18"N 79°11'52.60"W	PVC + valve 50 metre of 200-millimetre PVC pipe Originally 100-millimetre and 150-millimetre diameter siphons conveying water from the Welland Canal into the irrigation system
Force main/Pipe	50 metres of 200-millimetre PVC and 310 metres of 400-millimetre PVC	Lot 7 Con 6, Lot 6 Con 6 and Lot 8 Con 5	PVC, various sizes
Irrigation Channel	6,345 metres	Lot 6 to 1 Con 6, Lot 8 to 5 Con 5, Lot 174 and 173	Open Channel- Carlton St Roadside Ditch, Eastchester roadside ditch
Municipal Drain Channel	26,440 metres	Lots 102 to 106 and 83 to 87	Open Channel- Airport Drains, Lavigne and Bright Drain
Natural Channel	2,870 metres	Lot 5 Con 1 to 2, and Lot 4 Con 2, lot 117 and 116	Creeks/Rivers- Four Mile Creek, Eight Mile Creek, Welland canal
NOTLWIER003	Weir	43°10'49.11"N 79°10'27.71"W	Armtec weir and gate system
NOTLWIER004	Weir	43°11'13.08"N 79° 9'32.00"W	Armtec weir and gate system
NOTLWIER005	Weir	43°11'13.72"N 79° 9'17.31"W	Armtec weir and gate system

2.3.4 Maintenance

The Airport, Bright, and Lavigne Municipal Irrigation System are operated in conjunction with existing municipal drainage infrastructure and t require ongoing maintenance practices that preserve their drainage function while supporting seasonal irrigation use. The Town is responsible for the overall operation, inspection, and maintenance of the municipal irrigation systems. Standard municipal drain maintenance practices mentioned in the reports include:

- Irrigation Works Inspection
 - Prior to the start of each irrigation season, the Town is required to inspect all system components including siphons, pumping facilities, force mains, open channels and diversion structures.

- Inspections are to confirm that channels are free of debris, obstructions, unauthorized dams, and excessive vegetation
- Open channels and diversion corridors inspection
- Identify erosion, bank instability, sediment buildup, or blockages
- Municipal Drains inspection
 - Should be maintained at their original design profile.
 - The Town has no obligation to deepen or modify drains beyond their approved design for irrigation purposes.
 - Damage to drain banks or bottoms from irrigation operations is subject to repair
- Siphons, pumping works, and irrigation control structures regular inspection and servicing
 - Checking mechanical components, valves, gates, and electrical systems
 - Confirming that intake and discharge points remain unobstructed.
- At the end of the irrigation season, system is to be shut down, and temporary structures removed.
 - A post-season inspection should be conducted to assess system condition, identify erosion or maintenance needs, and ensure channels are prepared to function during non-irrigation periods.
 - Any required repairs or clean-up activities are addressed prior to the next irrigation season.
 - Remove temporary irrigation dams.
 - At the end of the irrigation season, all irrigation works are to be shut down, and temporary structures removed.
 - The Town is responsible for shutting down irrigation works during significant rainfall events.
- Monitoring during the irrigation season.
 - The system must be monitored to ensure irrigation flows are being distributed
 - Any sediment, debris, or erosion is to be addressed through routine maintenance practices

Like other systems, temporary irrigation dams placed in municipal drains are subject to strict maintenance and operational controls. Landowners are responsible for constructing, maintaining, and removing these dams and they must not exceed

prescribed height limits, must not fully obstruct flow, and must not cause upstream impacts. They are permitted only during the irrigation season and must be removed promptly at the end of the season or during significant rainfall events. The Town is responsible for inspecting dams and enforcing removal when they are not compliant. The Town retains authority over system operation, inspections, and enforcement, while landowners are responsible for maintaining any privately installed irrigation appurtenances, pumps, or storage facilities connected to the system.

2.4 Other Drain Reports

The municipal drain reports document a series of construction, improvement, extension, and amendment works undertaken under Section 78 of the Ontario Drainage Act to maintain effective drainage infrastructure within the Town of Niagara-on-the-Lake. Collectively, they address a wide range of municipal drainage systems, including the Routh, Harrison, Bright, Airport, Four Mile Creek, Lavigne, Cole, MacDougall, and Thompson Municipal Drains, among others. The reports span multiple decades and collectively establish the engineering rationale, legal authority, assessment framework, and maintenance responsibilities for several key municipal drains.

Most projects were undertaken to address sediment accumulation, vegetation growth, localized erosion, undersized or poorly aligned culverts, and insufficient outlets, rather than to expand drainage capacity or construct new systems. The majority of recommended works focus on cleanout and restoration to original design grades, targeted erosion protection using riprap or filter fabric, culvert maintenance or resetting, and clarification of long-term working corridors and access rights.

Several reports, notably the Routh (1993), Harrison (1989), and Airport Drainage System (1986) reports, also formalized or expanded the use of municipal drains for irrigation, introducing permit-based controls, seasonal restrictions, and limits on dam height and duration. These provisions balance agricultural water use with downstream drainage capacity and infrastructure protection. Between 1987 and 2016, new drainage works were constructed and existing systems expanded where historical drains were unable to adequately convey surface and subsurface flows. The MacDougall Municipal Drain (1987) and Routh Drain – Cass Branch (2016) addressed chronic outlet limitations, surcharge conditions, and watershed growth by providing new or lower outlets, deepening existing channels, installing upgraded culverts, and, where appropriate, abandoning obsolete branch drains. These works ensured reliable drainage for agricultural lands and municipal roadways while aligning with provincial design standards.

System-wide rehabilitation was undertaken through the Thompson Drain Repair and Improvement Report (1988), which restored hydraulic capacity lost to sedimentation,

vegetation growth, and aging infrastructure. Major cleanouts, culvert replacements, and erosion control measures were implemented to protect downstream receiving systems and improve service to upstream lands draining to Four Mile Creek. In 2001, a site-specific Thompson Drain Relocation was reviewed following an unauthorized landowner-initiated realignment undertaken to accommodate changing land use. Engineering review confirmed the technical acceptability of the relocation with minor conditions, and the existing governing Engineer's Report was formally amended through the Ontario Drainage Referee to recognize the new alignment.

Across all reports, project costs were allocated in accordance with the Drainage Act, including assessments to benefiting lands, special assessments to the Town for road-related works, and full cost responsibility to individual landowners where works were undertaken for private benefit. Project costs range from small-scale repairs to large, multi-branch system rehabilitations exceeding several hundred thousand dollars. All drains are to be maintained by the Town, with maintenance costs assessed per approved schedules, while abandoned drain sections were removed from municipal responsibility.

The table below provides a consolidated overview of key municipal drain engineer's reports prepared for the Town of Niagara-on-the-Lake and surrounding drainage systems over the past several decades. The purpose of this summary is to document the historical context, scope of work, and policy direction established through these reports, and to support informed decision-making related to drainage system operation, maintenance, irrigation use, and future capital planning.

Table 10: Other Municipal Drain Reports

Document Title	Author (year)	System	Summary
Routh Drain 1993 – Engineer’s Report & By-law No. 2648-93	Wiebe Engineering Group Inc. (1993)	Harrison Routh	■ Most up to date Routh Drain report. ■ Established the Routh Municipal Drain under the Ontario Drainage Act, servicing a total drainage area of approximately 273.5 hectares (676 acres) ■ Addresses severe erosion and structural failure at the outlet near the Niagara Parkway, replacement of the deteriorated culvert and construction of a new outfall to the Niagara River, and system-wide cleanout and maintenance of the main drain and branches – Total estimated project cost was \$330,900. ■ The entirety of the Routh drain is part of the irrigation works and outlets into the Niagara River near Line 4 Road and the Niagara River Parkway
June 23, 1989, Harrison Municipal Drain Engineer’s Report	Wiebe Engineering Group Inc. (1989)	Harrison Routh	■ Most up to date Harrison Drain report. ■ Prepared under Section 78 of the Drainage Act to update the Harrison Municipal Drain, formalize use of the drain system for irrigation. ■ 2,205 hectares (5,450 acres) watershed and includes 17 municipal drains which ultimately outlet into Two Mile Creek. ■ Primarily cleanout and restoration to original design grades, including sediment removal, brushing, localized deepening, culvert maintenance, and erosion protection; no major system expansion proposed. ■ Establishes a permit-based system allowing seasonal irrigation use of municipal drains. ■ Total estimated project cost of \$537,600
November 30, 1986, Wiebe Engineer’s Report – Airport Municipal Drainage System	Wiebe Engineering Group Inc. (1986)	Airport Bright Lavigne	■ Prepared under Section 78 of the Drainage Act to reconstruct and improve the Drainage System, address erosion issues ■ 3,100 hectares (7,660 acres) watershed and includes 6 individual municipal drains with multiple outlets to Lake Ontario and local watercourses ■ Primarily cleanout to original design grades, sediment and vegetation removal, and erosion protection (rip-rap, rubble rock); no major widening, but outlet extensions for Drain No. 1 and Drain No. 4 ■ Total estimated project cost ~\$283,700
January 31, 1991, Wiebe Engineer’s Report – Bright Municipal Drain (including Bergman Branch)	Wiebe Engineering Group Inc. (1991)	Airport Bright Lavigne	■ Prepared under Section 78 of the Drainage Act to improve, repair, and update the Bright Municipal Drain, including the Bergman Branch ■ 618 hectares (1,527 acres) Watershed for the Bright Municipal Drain. ■ Insufficient outlet due to downstream silting and debris, inconsistent channel widths between Line 1 and Line 2 Roads, localized flooding during moderate rainfall events, and sediment buildup ■ Cleanout, localized widening and deepening to original or revised design grades, culvert cleaning/resetting, minor channel realignment, limited outlet extension and targeted erosion protection (rip-rap, filter fabric); no full system expansion. ■ Total estimated project cost ~\$125,460, including ~\$102,080 for the main drain and ~\$23,380 for the Bergman Branch;
Four Mile Creek Municipal Drain Engineer’s Report January 16, 1996	Wiebe Engineering Group Inc. (1996)	Four Mile Creek	■ Prepared under Sections 77(2) and 78 of the Drainage Act to review, repair, and improve Four Mile Creek Drains 1–5, relocate portions of drains off Line 8 Road, incorporate the Lowrey Requisition Drain ■ Approximately 1,480 hectares (3,657 acres) across Niagara-on-the-Lake ■ Vegetation and silt accumulation, irregular channel profiles, localized erosion and bank sloughing, undersized or improperly set culverts, safety concerns along road-side drains (Line 8 Road), and outlet inefficiencies for the Lowrey Drain ■ Mowing, brushing, cleanouts, culvert resetting/lowering, erosion protection with rip-rap and filter fabric, construction of sediment basins, and relocation of Drains No. 3 and 5 from the road allowance ■ Total estimated project cost ~\$356,170, including Drains 1–5 and the Lowrey Drain. ■ Recognizes fish habitat, imposes seasonal work restrictions (Mar 1–Jul 15) unless dry, mandates erosion and sediment controls
1995 Lavigne Drain Engineer’s Report	K. Smart (1995)	Airport Bright Lavigne	■ Most up to date Lavigne Drain report ■ Covers 552.6 hectares and ~9.2 kilometres of open channel ■ Total estimated cost \$206,735, initiated under Section 78 of the Drainage Act. ■ Drain system generally stable with capacity for a 2-year storm, but requires routine maintenance ■ Combination of Type I (brushing/clearing), Type II (bottom cleanout + brushing), and limited Type III (new channel) works; culvert repairs/replacements, localized riprap, tile outlet repairs ■ Maintaining existing channel geometry, protecting vegetated banks, no major widening or deepening except where required for function or culvert alignment. ■ \$38,050 in allowances for damages and right-of-way

Document Title	Author (year)	System	Summary
Cole Municipal Drain Engineer's Report	K. Smart (1991)	Currently not part of the irrigation system, future service system	■ Maintenance and repair under Section 78 of the Drainage Act ■ Total drainage area ~646 hectares with ~7.0 kilometres of open channel work. ■ Drain originally constructed in 1968; channels generally stable but impaired by sediment buildup, vegetation, debris, and localized erosion. ■ Bottom cleanout and brushing, selective silt bar removal, debris and boulder removal, riprap at ~40 erosion and inlet locations, 7 temporary sediment traps, minor culvert lowering/cover improvements, and localized bank and laneway reconstruction. ■ Maintain existing channel geometry and stable vegetated banks; minimize disturbance. ■ Total estimated project cost \$106,250, including \$17,715 in allowances for damages and right-of-way.
MacDougall Municipal Drain Engineer's Report	Wiebe Engineering Group Inc. (1987)	Currently not part of the irrigation system, future service system	■ Drainage improvements initiated by petition under Section 8 of the Drainage Act to address chronic flooding along Line 7 Road. ■ Area previously drained indirectly to the Cole Municipal Drain, which surcharges during high flows and prevents adequate outlet; proposed drain provides a lower, reliable outlet to the Cole Drain for a total contributing area of ~108 hectares (267 acres). ■ Cleanout and deepening of ~2,113 metres of open ditch, selective riprap protection at bends and culverts, replacement of the Line 7 Road culvert with a larger and lower 900-millimetre CSP, and minor roadside ditch. ■ Total estimated project cost \$37,565, including \$9,465 in allowances for right-of-way and damages; a special assessment of ~\$5,350 applied to the Town for Line 7 Road works.
Routh Drain – Cass Branch Engineer's Report	K. Smart (2016)	Routh System	■ Report prepared under Sections 78 and 65 of the Drainage Act to improve drainage conditions and to reapportion assessments for additional lands and roads being connected to the Routh Drain -apportion assessments for additional lands and roads being connected to the Routh Drain. ■ Extend and deepen the Routh Drain south of Line 8 along Concession 1 Road, lower the Line 8 culvert, install new open ditch and closed pipe sections, construct a catch basin, and backfill and abandon the Cass Branch as a municipal drain. ■ Drain sized per provincial guidelines (2-year storm for open ditch); works provide sufficient outlet to an existing municipal drain discharging to the Niagara River-year storm for open ditch); works provide sufficient outlet to an existing municipal drain discharging to the Niagara River. ■ Total estimated cost: \$64,270, including construction, engineering, administration, and \$3,000 in allowances. ■ The Cass Branch is abandoned and no longer maintained; the Routh Drain 2016 (Main Drain Extension) will be maintained by the Town, and future connections require municipal approval under the Drainage Act.
Thompson Drain – Repair and Improvement Engineer's Report	J.K. Young Company Ltd. (1988)	Currently not part of the irrigation system, future service system	■ Report prepared under Section 78 of the Drainage Act (RSO 1980) following a Council resolution (March 23, 1987) to repair and improve the Thompson Drain between Line 5 and Line 7 Roads. ■ Drain is a 2.42 kilometre open municipal drain discharging to the Four Mile Creek, serving approximately 130 hectares (320 acres). ■ Capacity had been reduced by siltation, brush growth, undersized culverts, and buried tile outlets. ■ Cleanout of ~2.0 kilometres of drain, removal of brush and trees, replacement of the Line 6 road culvert with a larger pipe at a lower grade, cleaning and minor repair of farm culverts, installation of riprap protection at tile outlets and Line 7. ■ Total estimated cost: \$36,500
Thompson Municipal Drain – Relocation Engineer's Report	Wiebe Engineering Group Inc. (2001)	Currently not part of the irrigation system, future service system	■ Prepared under the Drainage Act (RSO 1990) to address an unauthorized landowner-initiated relocation of a portion of the Thompson Municipal Drain and to amend the 1988 J.K. Young Engineer's Report and by-law No. 1902-88, with approval sought through the Ontario Drainage Referee (July 3, 2001) ■ The landowner (Property Roll No. 2018602) relocated the drain at their own cost so the property would no longer be bisected, abandoning ~568 metres of the original channel and constructing ~275 metres of new open ditch along the property boundary, discharging to the Four Mile Creek Municipal Drain. ■ 18602) relocated the drain at their own cost so the property would no longer be bisected, abandoning ~568 metres of the original channel and constructing ~275 metres of new open ditch along the property boundary, discharging to the Four Mile Creek Municipal Drain. -186-02) relocated the drain at their own cost so the property would no longer be bisected, abandoning ~568 metres of the original channel and constructing ~275 metres of new open ditch along the property boundary, discharging to the Four Mile Creek Municipal Drain. ■ The relocated channel matched the original 1.0 metre bottom width but was built at a flatter grade (≈0.08% vs. original 0.15%), potentially reducing capacity; it was recommended that future cleanout restore the original design grade, reseed exposed banks, and reset riprap at the outlet if needed.

2.4.1 Maintenance

The maintenance items outlined in this section have been identified from the reports in Table 10 to address deficiencies in the municipal drainage system from sedimentation, vegetation growth, hydraulic inefficiencies, erosion, and structural wear. These works are intended to restore and preserve the drains to their design profiles and hydraulic capacities, ensure the long-term stability of channel banks and crossings, and maintain access for ongoing and future maintenance activities. Implementation of the identified maintenance measures is necessary to sustain system performance under design flow conditions, mitigate erosion and localized flooding risks, and fulfill the municipality's statutory obligations for municipal drain maintenance in accordance with the Drainage Act and the governing engineer's reports.

Table 11: Maintenance Requirements for Municipal Drains from Reports

Task	Frequency	Responsibility	Description
Inspection & Monitoring	Monthly	Operations	■ Inspect channel condition, sedimentation, debris accumulation, bank stability, culvert performance, and access corridor condition. ■ Identify erosion-prone/high-velocity sections and locations requiring armouring or re-sloping. ■ Suggest creating an Inspection & Monitoring log to capture any deficiencies for presentation for Capital Funding
Vegetation Management	Monthly	Operations	■ Mow and brush within the maintenance corridor to maintain access and prevent encroachment. ■ Clear/grub trees and remove woody vegetation causing channel obstructions within the limits of banks/working space.
Debris Removal & Restoration	Monthly + As needed	Operations	■ Remove debris from ditch bottoms and banks (fallen timber, rubbish, accumulated organic material) to maintain free flow. ■ Remove debris at/under bridge locations where applicable. ■ When work occurs remove waste material and leave the premises in a clean and safe condition. ■ Restore disturbed grassed areas by seeding and reinstate paved/gravel surfaces where disturbed.

Task	Frequency	Responsibility	Description
Channel / Ditch Bottom & Culvert Cleanout	Yearly	Project	■ Perform bottom cleanout to remove silt/sediment build-up and restore hydraulic capacity (typical cleanout depths noted in reports range ~150–400 millimetres depending on reach). ■ Remove localized sandbars and areas of siltation as required. ■ Maintain the drain to the approved design profile grade; avoid unauthorized deepening beyond the design profile. ■ Clean out road crossing culverts and private crossing culverts (where part of the municipal drain) to prevent backwater and overtopping.
Access Preservation	Yearly	Operations	■ Level spoil banks to restore/maintain future maintenance access. ■ Maintain required working space/corridors for cleanouts, spoil levelling, and routine mowing/brushing as specified in the governing reports.
Operating Constraints	Review Yearly Complete work as needed	Operations	■ Ensure irrigation dams (where permitted) comply with height limits, seasonal restrictions, and permit requirements; remove non-compliant obstructions.
Bank Stabilization & Erosion Repair	Review Yearly Complete work as needed	Project	■ Repair bank erosion by over-excavating, re-sloping, and reinstating stable side slopes where sloughing/undermining is present. ■ Armour eroded banks/critical bends using rock protection with filter fabric underlay.
Erosion Protection (Rip Rap / Rubble Rock + Filter Fabric)	Review Yearly Complete work as needed	Project	■ Install/maintain rip rap or rubble rock (with filter fabric underlay) at erosion sites, bends, and at culvert inlets/outlets. ■ Typical rock sizes referenced: rubble rock 300 to 600-millimetre diameter; rip rap 200 to 250-millimetre diameter (where specified).
Culverts, Crossings & Structures	Review Yearly Complete work as needed	Project	■ Repair culvert ends and associated erosion; place rip rap protection at outlets/inlets as required. ■ Where applicable, reset/replace/lower culverts to restore function and match design grades. ■ Private crossing maintenance responsibilities may be shared between the landowner and upstream landowners where specified; new crossings typically require consultant sizing and design under the Drainage Act process.

2.5 Evaluation of 2021 Master Plan

2.5.1 Master Plan Summary

The Town of Niagara-on-the-Lake commissioned Associated Engineering to prepare an “Irrigation System Strategy and Master Plan” in March 2021 to develop a long-term plan for the irrigation system. The report looks to improve customer service, long-term sustainability, agricultural growth, and maintain the system for irrigation infrastructure. The report overviews the system and covers the following key findings:

- Supply/demand imbalance: during drought conditions (notably in July–August), the system cannot meet peak irrigation demand, particularly for downstream users.
- Target level of service: a minimum of 51 millimetre depth (application rate per irrigation) of irrigation water within a two-week period during drought conditions was established as the benchmark based on past studies and discussions with the Town.
- Infrastructure constraints: pumping capacity, channel conveyance limits, aging culverts, and sediment/vegetation (invasive phragmites) significantly restrict the system.
- Regulatory limitations: several Permits to Take Water have not been updated to reflect current and future demand.
- Operational gaps: lack of metering, scheduling, and automation for water distribution and enforcement.

The report discusses potential solutions for improving the system such as upgrades to the pumping systems at Eastchester, Dee Road and Whirlpool Pumping Stations, channel and culvert upgrades, storage solutions, inter system connections, scheduling and reporting and maintenance item which will be discussed further in this document. Associated Engineering also presents a phased 25-year capital program that focuses on improving service in the Airport Bright Lavigne and Four Mile Creek systems, followed by system expansion, storage, and long-term asset renewal. The full 25-year plan would require rate increases that are much higher than current user may expect for yearly increase and a 10-year action plan was developed with a rate increase to approximately \$40/acre, with a 20% increase in 2021 and 1% annually in following years.

2.5.2 Master Plan Solutions

The Master Plan contains an assessment of existing system conditions, irrigation demands, and levels of service, and Table 12 summaries the asset renewal strategies and recommended solutions presented. The proposed solutions in the Master Plan were developed to close the gap between available supply and peak demand, particularly during drought conditions, while maintaining fairness among irrigators and ensuring regulatory compliance. The solutions were evaluated across the three irrigation systems and focus on a combination of infrastructure upgrades, operational improvements, storage solutions, and inter-system connectivity. These recommendations are intended to achieve the target level of service of providing a minimum of 51 millimetres of irrigation water depth within a two-week period. The solutions outlined in Table 12 are also considered further in the report as part of Section 2.5.2.1.

Table 12: Summary of Master Plan Solutions

System / Asset	Recommended Solution	Technical Considerations	Economic Considerations	Constructability Considerations
Airport, Bright, Lavigne	Upgrade Eastchester Pumping Station (increase capacity to 0.50 cubic metres per second initially and provision for 0.75 cubic metres per second)	- Improves system supply - Directly addresses largest supply and demand deficit - Compatible with future Permit to take water increase	- Moderate capital cost - Strong benefit to cost due to immediate service improvement to largest area	- Constructible within existing footprint - Minimal land acquisition - Staged upgrades possible
Airport, Bright, Lavigne	Add storage reservoir near top of system	- Provides backup during peak demand - Improves drought resilience and operational flexibility	- Higher capital cost - Reduces need for oversized pumping and emergency measures	- Requires land availability - Geotechnical and environmental approvals - Longer implementation timeline
Airport, Bright, Lavigne	Connect Airport, Bright, Lavigne system to Four Mile Creek/Whirlpool supply via Bright's Drain	- Adds redundancy and system resilience - Technically complex due to cross-system hydraulics	- Higher cost - Justified by improved security of supply and emergency backup	- Requires new channels/temporary pumping - Coordination across systems and agencies
Airport, Bright, Lavigne	New pumping station south of Eastchester with force main and gravity supply to new areas	- Enables long-term growth - Scalable design - Dependent on updated demand forecasts	- Significant capital investment - New irrigated acreage and future revenue	- Complex routing - Land access and approvals required - Best implemented after near-term upgrades
Four Mile Creek	Acquire and rehabilitate Virgil Ponds and dams	- Improves storage and controlled release - Enhances downstream reliability - Addresses aging dam infrastructure	- Moderate to high cost - Potential cost-sharing and external funding opportunities	- Requires agreement with NPCA - Dam safety and environmental reviews - Phased construction feasible
Four Mile Creek	Upgrade Whirlpool Pumping Station (increase capacity to 0.30 cubic metres per second)	- Addresses severe supply shortfall - Supports Four Mile Creek and potential Airport Bright Lavigne support	- Moderate capital cost - High service improvement per dollar spent	- Constructible at existing site - Short construction window - Minimal network disruption
Four Mile Creek	Connect Four Mile Creek to Dee Road Pumping Station	- Increases redundancy - Allows supply balancing between systems	Higher cost but improves overall system reliability	- Requires new channel/force main - Cross-system coordination
Harrison Routh	Increase Permit to take water and maximize existing Dee Road pump capacity	- Improves supply without immediate major expansion - Relies on regulatory approvals	- Low to moderate cost - Strong short-term benefit if Permit to take water approved	- Minimal construction - Dependent on permit approvals
Harrison Routh	Add third pump at Dee Road Pumping Station	- Increases peak supply - Supports Harrison Routh and Four Mile Creek interconnection	- Moderate capital cost - Scalable and future-proofed	- Pumping station designed for expansion - Straightforward installation
Harrison Routh	Add storage reservoir near top of system	Improves drought resilience and operational control	- Higher upfront cost - Long-term operational savings	- Requires land, excavation, environmental approvals - Longer schedule
System Wide	Irrigation scheduling and rotational supply operations	- Essential to meet 51 millimetre and 2-week service target - Reduces peak instantaneous demand	- Very low capital cost - High operational benefit	- Implementable quickly - Requires irrigator cooperation and enforcement
System Wide	Allow 24-hour irrigation during drought (Noise By-law exemption)	- Effectively doubles usable pumping time - Improves delivery without new assets	- No capital cost - Strong short-term benefit	- Requires policy change - Operational controls needed
System Wide	Channel rehabilitation (culvert upsizing, sediment and phragmites management)	- Removes hydraulic bottlenecks - Restores designed conveyance capacity	- Moderate cost - Prevents premature asset failure	- Conventional construction - May require traffic and environmental management
System Wide	Metering, reporting, and automation	Enables demand tracking, permit to take water compliance, and fair scheduling	- Low to moderate cost - Improves governance and long-term efficiency	- Minimal physical construction - Primarily technology deployment

2.5.2.1 Technical

Technical considerations from the “Irrigation System Strategy and Master Plan” focus on ensuring that proposed upgrades can meet the target level of service while remaining adaptable to climate variability, regulatory constraints, and long-term system growth. We will discuss in more detail on the technical aspects of the solutions in Section 6.

Overall, the main technical objective of the recommended solutions is to deliver a minimum of 51 millimetres of irrigation water within a two-week period during drought conditions. Hydraulic analyses completed by Associated Engineering demonstrated that the current system is constrained by limited pumping capacity, conveyance bottlenecks, and insufficient storage, particularly during peak summer demand. The technical solutions listed in Table 12 to increase supply through pumping station upgrades, improved channel conveyance, and storage solutions to balance demand.

Upgrades to pumping stations such as Eastchester, Dee Road, and Whirlpool are able to address supply shortfalls and improve operational resilience. The upgrade to the pumping stations look to increase peak flow capacity to meet drought period demands, allow for staged expansion where growth is anticipated and attempt to operate with the existing Permits to Take Water. Design solutions in the Master Plan include additional pumps, increasing electrical capacity, and control systems as well as updating aging equipment and building structures. In addition to upgrades at the pumping stations, the gradual introduction of flow measurement, monitoring, and digital reporting tools can be used improve system management. Data collection would help support real-time decision, permit to take water compliance, and enforcement of irrigation scheduling.

Channel capacity limitations, undersized culverts, sediment accumulation, and invasive vegetation (phragmites) were identified as recurring items that affect water delivery. The recommended improvements outlined in Table 12 focus on restoring or enhancing hydraulic capacity to match upgraded pumping outputs. This includes culvert upsizing, channel regrading, sediment removal, and vegetation management. These measures are essential to ensure that upstream supply improvements translate into meaningful downstream service improvements, and these will be investigated further.

Storage reservoirs are another viable technical solution to improve drought resilience and operational flexibility. Storage allows pumping to occur during off-peak periods while supplying irrigation demand during peak usage, reducing system stress. From a technical standpoint, storage also enhances system redundancy, provides buffering during equipment downtime, and supports equitable water distribution. Similar to storage reservoirs, interconnections between the systems would improve overall supply security. Connectivity allows water to be redistributed during shortages or infrastructure

outages. These solutions require careful hydraulic balancing, control structures, and operational protocols to prevent adverse impacts and will need to be considered during detailed design.

2.5.2.2 Economic

All the solutions in the “Irrigation System Strategy and Master Plan” were evaluated on an economic level that focused on overall financials, affordability for users and long-term value to the Town. The main approach that should be taken is phased and prioritised approach which focuses on essential upgrades that deliver the greatest improvement first while continuing to invest regularly. The first of the improvements to be made should focus on pumping capacity upgrade, overall operational changes and conveyance improvements which overall have a lower cost but the most impact to the users. Higher costs investment such as storage reservoirs and expansions should be considered in later years when demand grows and funding increases.

The solutions in the Master Plan were assessed based on whether they offer operation and service benefits such as reliability during drought conditions, reduced emergency pumping, reduced operational inefficiencies, improved irrigation use and protection of agriculture production. Irrigation scheduling and policy adjustment are low costs solutions that offer system benefits right away without the need for large capital investments. Additional considerations in the Master Plan included maintenance and asset failure. If known deficiencies are treated proactively, the solutions support a more predictable capital planning and lower total cost addressing known deficiencies proactively. The recommended solutions support more predictable capital planning and lower total cost of ownership over the life of the assets. The solutions specific to targeted asset renewal, such as upgrading Eastchester and Whirlpool Pumping stations, reduces the likelihood of emergency repairs, service disruptions, and unplanned expenses, all of which carry higher lifecycle costs.

In addition to assessing the solutions, the Master Plan evaluated the overall rate structure for irrigation users and highlighted the importance of a stable and predictable rate structure. The Master Report supports modest, gradual rate increases, rather than sharp increases associated with large capital projects and emergency repairs. Having a predictable rate structure allows for stability in registered irrigation users and the capital, supports ongoing maintenance and planned renewal and capital project, and enhances overall irrigation user satisfaction. Since the system is primarily funded through user rates, some of the recommended solution and upgrade, such as large-scale storage, major channel rehabilitation, or system expansion, may not be fully achievable through the gathered rates. The Master Plan recommends the use of external funding for some of the upgrades which ideally the Niagara Irrigation Initiative Project will provide.

From an economic standpoint, the recommended solutions along with the phased approach and rate escalation in the Master Plan represent well thought out financial plan that would benefit the irrigation system, the Town and users. A proactive approach in maintenance is a strong recommendation that should be implemented immediately with little costs.

2.5.2.3 Constructability

Constructability of the asset renewals and solutions from the “Irrigation System Strategy and Master Plan” discusses sequencing and how to minimize disruption to irrigations. Table 12 lists some of the constructability requirements in a high level for each of the solutions ranging from using existing infrastructure, regulator requirements and co-ordination along with estimated level of effort. As irrigation is seasonal in nature, construction activities must be phased to avoid impacts during peak irrigation periods (July and August) such as blocking access roads, private lanes, farm accessways and noting crop cycles and their water demand. Temporary solutions such as bypass pumps, temporary channels and water storage may be required during construction. Upgrades to pumping stations, channels, and control structures should be completed during the non-irrigation season or during periods when system demand is reduced (May, June, September, October). Phased construction would allow for portions of the system to remain operational while individual assets are worked on. For pumping station upgrades, the facilities will have to have some operation capacity during construction if only one pump is available for use. Early engagement with irrigators is essential to coordinate service interruptions, access requirements, and construction planning.

Many of the recommended solutions prioritize upgrades and expansions at existing facilities, such as at Eastchester, Dee Road, and Whirlpool Pump Stations. These upgrades can occur within existing facility boundaries, using modular pump installations and provisions for future expansion. This minimizes land acquisition requirements, reduces permitting complexity, and lowers overall construction risk. Similarly, channel and culvert improvements are located within existing rights-of-way or drainage corridors, which simplifies access and reduces property impacts. Construction within channels, drains, and near watercourses requires consideration of environmental protection and coordination with conservation authorities, regulatory bodies and other agencies. Works such as channel rehabilitation, sediment removal, dam upgrades, and reservoir construction may require environmental studies, permit approvals, and adherence to timing windows to protect habitats. Solutions such as upgrading the reservoir and interconnecting system will require more permitting and approvals which will take longer and ideally should be considered further into the upgrade schedule.

The solutions and upgrades rely on conventional construction techniques, including pump replacement, electrical upgrades, culvert replacement, channel excavation, and embankment work. As these are well known methods lower costs, use of local contractors, no specialised tools, and stabilized budget and schedule should be expected for the solutions. The solutions include standardization of equipment to simplify installation, maintenance, and future replacement. Interconnections between the Airport, Bright, Lavigne, Four Mile Creek, and Harrison Routh systems have higher constructability challenges due to hydraulic complexity, new conveyance requirements, and coordination across multiple systems. These works may involve temporary pumping, new channels or force mains, and control structures. Interconnection activities should be considered for medium to long term projects that should be undertaken after other system upgrades are completed.

With all projects, during construction, weather, subsurface conditions, sediment and erosion control pose risks of delay and increased costs during implementation of the solutions. Some of these risks can be mitigated by completing full predesign investigations (geotechnical analysis, topographical survey, bathymetric surveys, wildlife and environmental studies), completing preliminary schedules and cost estimates with generous contingencies, and also taking into consideration the irrigation users opinions and knowledge of the agriculture for the time during construction.

All the solutions listed in Table 12 are constructable and should be implemented by phase with detailed scheduling over the next few years which is outlined in the Master Plan. Upgrades to existing facilities with consideration to seasonal demand and construction methods should be the first to be completed where more complex works would be implemented at a later date to allow of sufficient planning, approvals, irrigation user co-ordination. This approach will allow for easily seen benefits in the near future while opening opportunities to further the larger more complex projects.

3. Drainage Act Review

The Drainage Act provides a robust legal framework that can be used to:

- Protect drainage infrastructure
- Ensure long-term access across private land
- Enable municipal maintenance and repair
- Share costs fairly among beneficiaries
- Construct dual-use stormwater/irrigation projects
- Secure grant funding for qualifying farm properties

For irrigation systems, especially large, shared, or multi-property systems like those in Niagara-on-the-Lake, the Drainage Act is one of the most powerful tools available to ensure long-term viability and legal protection. The following are key items to the use within the Drainage Act with irrigation systems:

Table 13: Drainage Act Irrigation Impact Summary

Item	Summary	Section
Definition of Works	Irrigation elements such as pumping stations, reservoirs, dams, embankments, siphons, and channels qualify as “drainage works,” since the Act includes works regulating water levels, reservoirs, dams, and pumping stations.	s.1, s.18
Access Rights on Private Property	Engineers and their employees may enter any land to survey, stake, and inspect drainage works. Contractors and drainage superintendents also have entry authority during construction, improvement, maintenance, or repair.	s.12, s.13, s.63, s.93(3)
Cost-Sharing Mechanism	Costs must be assessed based on benefit, outlet. The engineer assigns proportional costs to all lands benefiting or contributing flow.	s.21–28
Land Compensation	Owners must receive compensation for land used for drainage works, including for pumping station sites, access routes, spoil disposal, and damages to crops or property.	s.29–33
Drainage Act Petitions	Drainage projects (including dual use irrigation and drainage works) may be initiated by petition. Petitions trigger the engineer’s report and municipal by-law process.	s.4
Major Improvements Without Petition	Once a drain exists, municipalities may undertake major improvements such as new pumping stations, reservoirs, extensions, protective works, or alterations without a petition	s.78

Item	Summary	Section
Municipal Maintenance Responsibility	Municipalities must maintain and repair drainage works (including incorporated irrigation components) in perpetuity, with costs assessed to upstream lands	s.74
Provincial Grants for Agriculture	Agricultural lands assessed under a Drainage Act report may receive provincial grants detailed by the Agricultural drainage infrastructure program: administrative policies.	s.85–87
Mutual Agreement	Landowners may voluntarily create and register a Mutual Agreement Drain, establishing shared responsibilities without a petition; these agreements bind future owners.	s.2

The Drainage Act, R.S.O. 1990 plays an important and ongoing role in supporting, protecting, and maintaining the irrigation infrastructure within the Town of Niagara-on-the-Lake. The legal authority for integrating irrigation works with drainage infrastructure originates from Private Bill Pr88, where Section 2(8)(d) explicitly references the Drainage Act. Under this legislation, the irrigation system is permitted to use all or part of any municipal drain but “the costs for maintaining that portion shall be divided so that one-half is the persons responsible for the drain and one half is done by the persons described in clause (c)”. The Drainage Act has been used to incorporate irrigation works, channels and associated structures. For example, in the Harrison Drain Report by Wiebe Engineering in 1989, the siphon was incorporated with a right-of-way allowance for long term maintenance. By making the siphon part of a Drainage Act report, it allows the irrigation community to protect their infrastructure on private property ensuring continued access for operation and maintenance and allows the municipality to maintain the infrastructure in perpetuity, even if the owner changes or denies access. The irrigation committee may choose to use the Drainage Act to formally incorporate additional infrastructure, particularly in situations where future access could be at risk. Examples of Town system components that could be incorporated include Eastchester Avenue Pump and Carlton Street Siphon

Stormwater Management Ponds have been built using the Drainage Act as the basis for their need. Some of the proposed storage ponds in the Master Plan and discussed in this report, if they are dual use, both irrigation storage and stormwater management can be built using the Drainage Act, to compensate property owners for the loss of land. While the Drainage Act allows the province to offer a 1/3 grant for works done under the Drainage Act, but this grant only applies to assessment issued to lands that hold an eligible farm property tax call. Since the irrigation committee does not have lands with the farm property tax classes, any assessments are not eligible for grant. Individual landowners with the farm property tax class, may be eligible for grant for dual use infrastructure. Farmers with a purely agricultural pond are not grant eligible and need to be considered dual use for any approvals

To start works under the Drainage Act a valid petition would be required. The irrigation committee cannot sign a petition as it is not a Road Authority or a landowner. The roads superintendent or the manager of public works may initiate a petition work if there is a road controlled by the road authority

The majority of the existing irrigation system is located on an existing Right of Way. After reviewing the parcel fabrics, four areas have been found to be on private properties.

- the OPG Siphon is on private property but is currently protected on the 1989 Harrison Drain Report.
- The Eastchester pumping station and Carlton street siphon are both located on Seaway Authority property.
 - The Eastchester pumping station has an existing legal agreement for the allowance of the irrigation board to access water and complete maintenance of the system; this information was confirmed by the irrigation board and a retired irrigation superintendent.
- The irrigation channel between Airport Drain 3 and Bright Drain runs along a private roadway.
 - The current landowner has let the irrigation board complete maintenance to the channel and weirs. To protect this for future infrastructure, the Town has an easement contained in By-Law 4165-07 or it is recommended that a written landowner agreement (English - 003-0180e - Agreement by Owners - Mutual Agreement Drains) be prepared.

Based on the review of the Niagara-on-the-Lake irrigation system and its relationship to the Drainage Act, the Town should consider the following:

- Utilize the Drainage Act to protect critical irrigation infrastructure:
 - The Town should initiate the incorporation of priority irrigation assets located on private or agency-owned lands into municipal drainage reports under the Drainage Act.
 - Any additional works identified as access-vulnerable during detailed design.
 - This action will ensure secure long-term access, maintenance rights, and asset protection.
- Pursue Drainage Act easements or Mutual Agreement Drains where appropriate:
 - The Town should look to negotiate Drainage Act easements or Mutual Agreement Drains (Form 003-0180e) arrangements with affected landowners for irrigation channels, siphons, and related works not incorporated into a municipal drain report.
 - This ensures continued operational access and system sustainability.

- Authorize the Municipal Road Authority to initiate Drainage Act petitions where required:
 - The Town should look to authorize the Roads Superintendent or Director of Public Works to submit petitions under the Drainage Act for works located within municipal road allowances, enabling timely initiation of Drainage Act processes when irrigation infrastructure intersects municipal road rights-of-way.
- Coordinate with the Regional Municipality of Niagara on shared jurisdiction roads:
 - The Town should look to collaborate with the Regional Municipality of Niagara to confirm road authority jurisdiction and to support petitioning or co-petitioning for Drainage Act projects located within regional road corridors.
- Maintain and Update Legal Agreements with the Seaway Authority:
 - The Town should review, reaffirm, or update legal agreements governing irrigation system components situated on St. Lawrence Seaway Management Corporation lands, including the Eastchester Pumping Station and Carlton Street Siphon, ensuring ongoing legal access for maintenance and operation.
- Document and Map All Irrigation System Components and Access Requirements:
 - The Town should develop and maintain a comprehensive mapping and documentation package identifying irrigation infrastructure locations, access rights, easements, and drainage report boundaries to support long-term asset management and risk mitigation.

The Ontario Drainage Act establishes the process for constructing and maintaining municipal drains; however, any drainage activity that may interact with fish or fish habitat is also subject to federal requirements under the Fisheries Act. Drain maintenance works undertaken under the Drainage Act must comply with the Fisheries Act where fish habitat is present, because federal legislation prohibits carrying out works that would result in the death of fish or the harmful alteration, disruption, or destruction (HADD) of fish habitat unless authorized by Fisheries and Oceans Canada (DFO). The Fisheries Act does not distinguish between natural and artificial watercourses, meaning municipal drains that function as fish habitat are regulated similarly to natural streams. As a result, drainage authorities are expected to incorporate mitigation measures and, using the Drainage Act and Conservation Authorities Act Protocol (DART protocol) for drain maintenance and repair where needed, seek DFO review or authorization to align Drainage Act obligations with federal fish habitat protection requirements.

4. System Wide Analysis

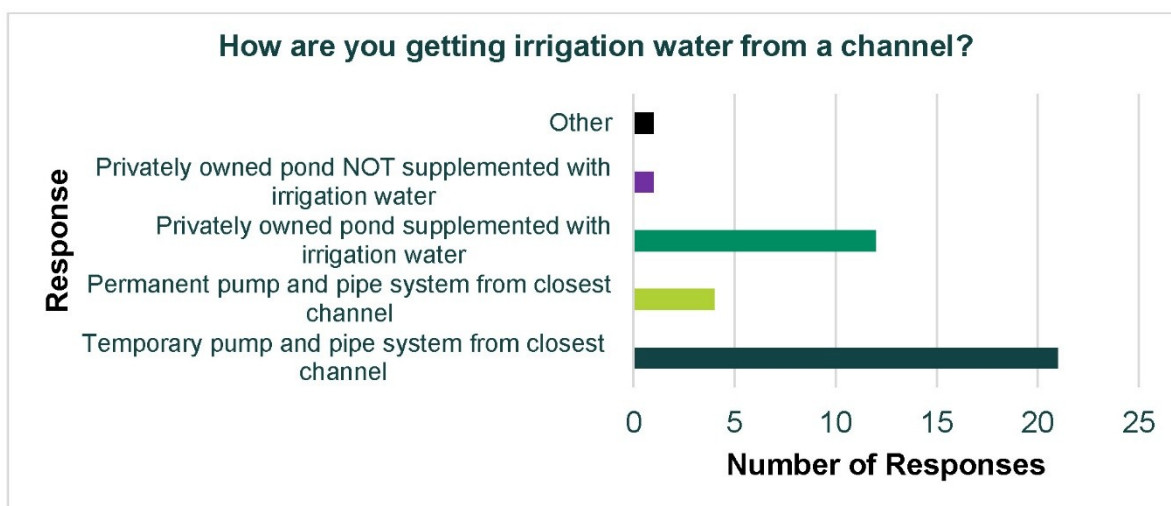
4.1 Irrigation User Survey

An online survey was developed for the Project to gather input from Registered Irrigation Users to better understand current practices, water use, irrigation methods and expectations. The survey was sent to Registered Irrigation Users on December 9, 2025, with reminders sent on December 19, 2025, and on January 5, 2026. The survey closed on January 16, 2026, and received 27 responses. The complete list of questions included in the survey is available in Appendix B.

4.1.1 Feedback – Current Irrigation Practices

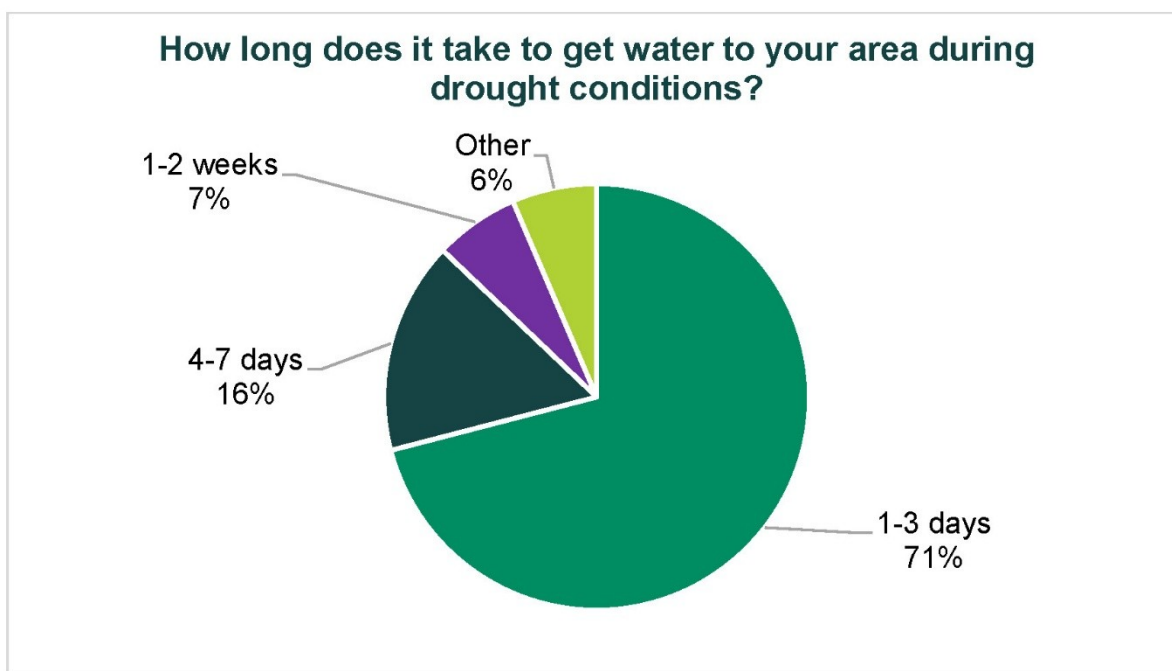
- ◆ Most respondents are connected to multiple irrigation systems, with Harrison Routh (15 responses) and Airport-Bright Lavigne (15 responses) being the most common service areas. Nine respondents indicated they were connected to Four Mile Creek, and 10 respondents connect directly to Lake Ontario, Niagara River or used other systems for irrigation.
- ◆ More than half of respondents (57%) are less than 100 metres from an irrigation water source.
- ◆ 21 respondents reported that they collect irrigation water from a temporary pump and pipe system from the closest channel; 12 respondents reported that they use a privately owned pond that is supplemented with irrigation water. Figure 17 shows a detailed breakout of responses.

Figure 17: Irrigation Water Connection Responses



- ◆ 42% of respondents reported that there is typically water readily available in the irrigation system near their property, except during years of drought. 29% reported that there is always water available and only 6% said there is not typically water in their local system.
- ◆ As shown in the figure below most respondents stated that it usually takes 1 to 3 days to get water to their area during drought conditions.

Figure 18: Water Sourcing Timelines During Drought Among Respondents



- ◆ During drought conditions, several respondents reporting using overhead irrigation as their primary method and that the irrigation system is their only water source. Other respondents maintained private storage ponds to supplement their irrigation water. Respondents that did not have access to an alternative water supply often only watered their highest value crops (e.g. grapes).
- ◆ Most respondents use an overhead/gun irrigation method or a combination of drip/trickle and overhead/gun. Few respondents use drip/trickle.

Figure 19: Irrigation Methods Used by Respondents

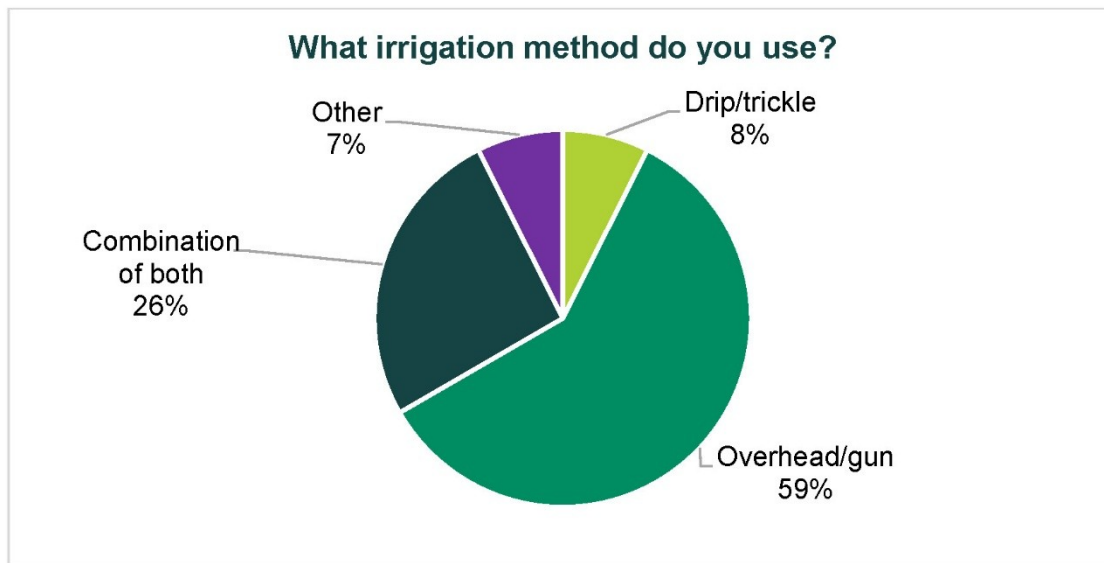
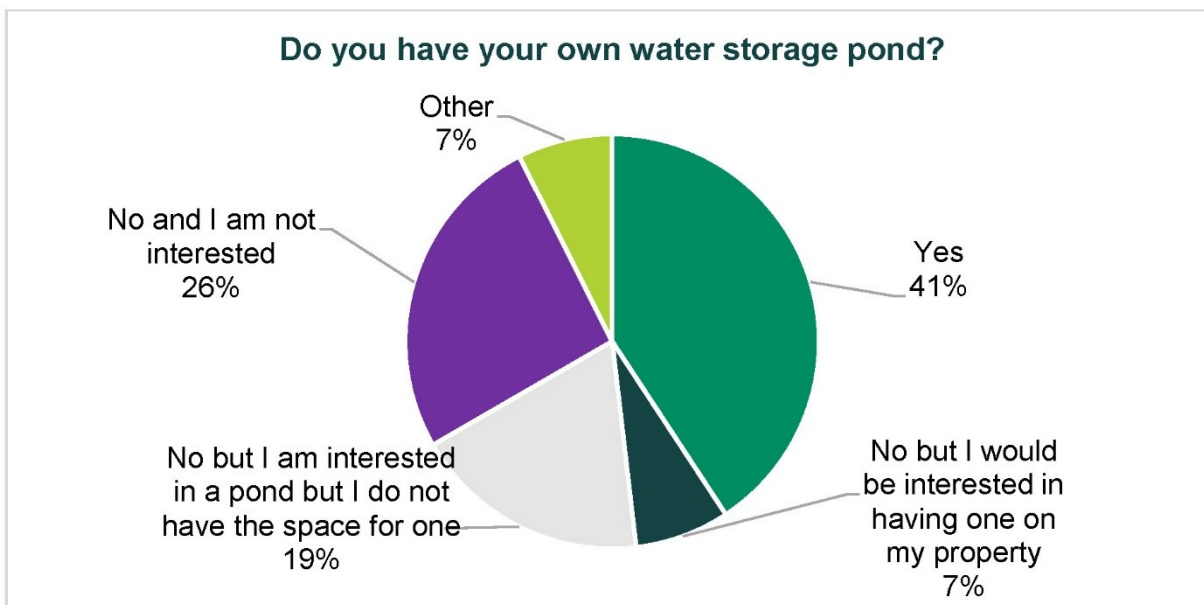


Figure 20: Water Storage Pond Usage Among Respondents



- ◆ Almost half of respondents have, or are interested in, a water storage pond (48%)

4.1.2 Feedback – Crop Types and Future Changes

- ◆ Grapes and tender fruit/orchards were by far the most reported land use, with 74% of respondents currently growing grapes and 33% currently growing tender fruit. Participants could select multiple options.

- ◆ A large majority of respondents are not considering changing the type of crops they grow. Even with greater access to water through this project, most users would still not make any changes to their crop type(s). Figure 21 shows the number of users currently considering changing their crops and the number of users who may consider changing the crops they grow with greater access to water.

Figure 21: Future Changes to Crop Selection – Current Conditions

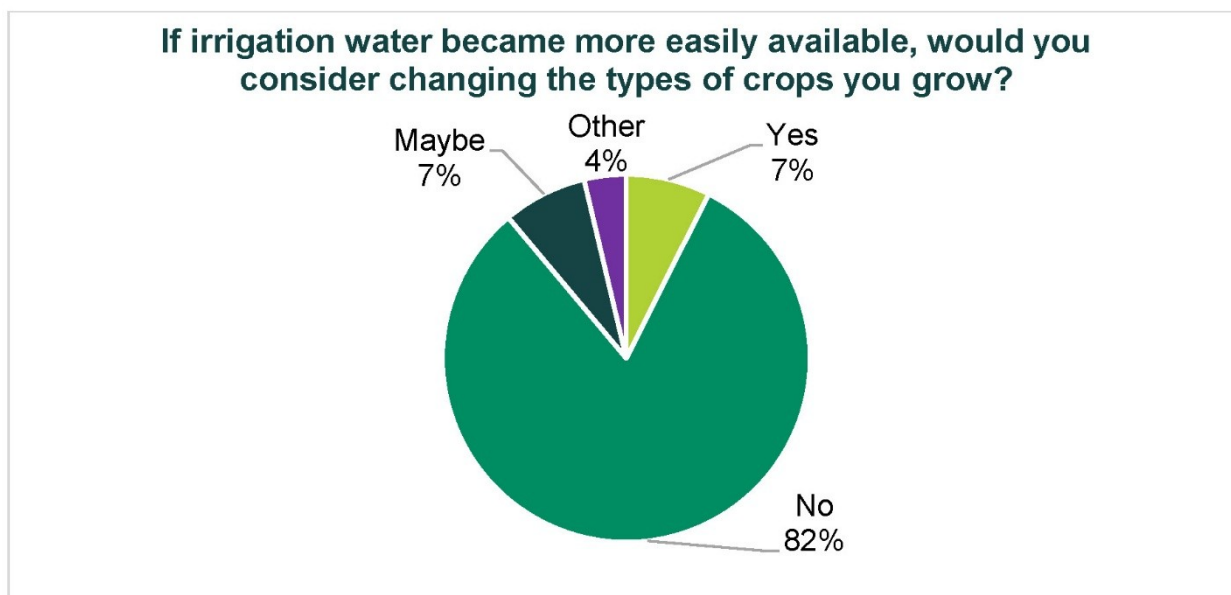
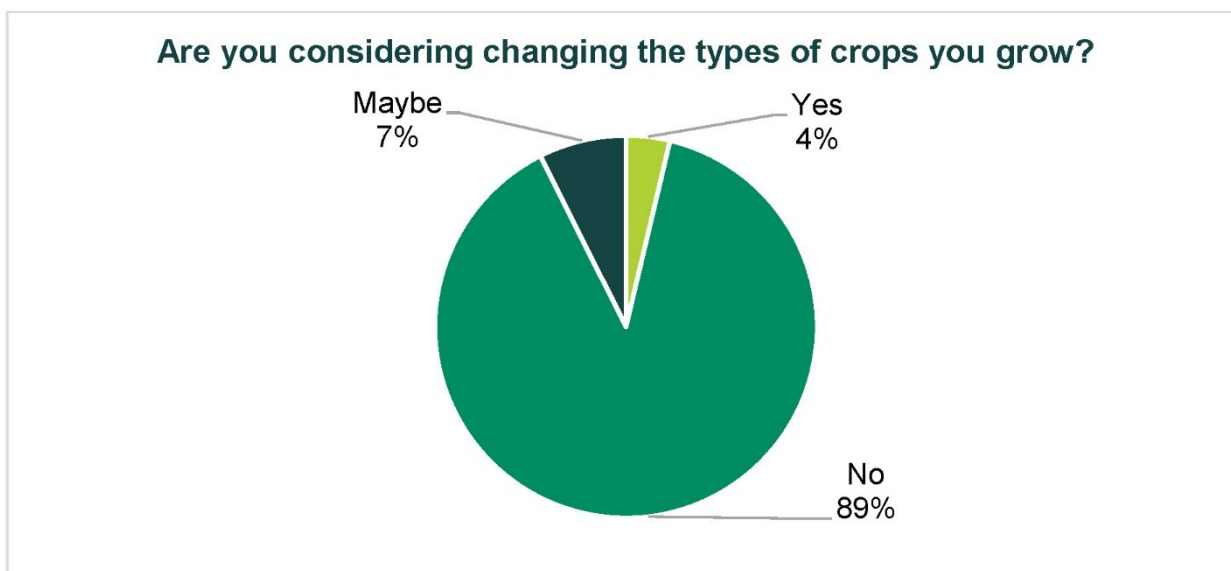


Figure 22: Future Changes to Crop Selection – Improved Conditions



- ◆ Out of the respondents who are considering changing the crops they grow, there was no clear preference for a specific crop type. Each of the following crops received one selection: greenhouse/nursey, tender fruit and orchard, vegetable / melon and grapes. Only floriculture received more two selections for this question.
- ◆ Out of the respondents who are considering changing their crop type if they had greater access to water, three respondents would switch their irrigation method, and one would not.

4.1.3 Feedback – Current Water Use

- ◆ Respondents reported very different rates of water use, with some as high as 7,000 litres per minute and others as low as 400 litres per minute. Users also varied in their daily water usage with responses averaging around 1.27 megalitres per day. However, not all respondents irrigate daily, and many responses did not offer a defined time period for their water use.

4.2 Immediate & Future Water Demand

4.2.1 Irrigation Water Requirements

The determination of water requirements is the fundamental driver for the detailed design of the Niagara-on-the-Lake irrigation infrastructure upgrades. This section summarizes the agronomic parameters, climate analysis, and volumetric projections used to size the proposed system components. A comprehensive technical memorandum detailing these calculations is provided in Appendix C.

4.2.2 Objective and Design Standard

The primary objective of the water demand assessment is to ensure the long-term viability of high-value specialty crops—including vineyards, tender fruit orchards, greenhouses, and nurseries—against the increasing frequency of severe drought events.

The design is anchored by the target Level of Service established in the 2021 Town of Niagara-on-the-Lake Irrigation System Strategy & Master Plan, which stipulates that the infrastructure must provide a minimum of 51 millimetres of net irrigation water over a 14-day cycle during a severe drought.

4.2.3 Background

In the 2021 Master Plan, through discussion with the Town and the review of past studies, it was identified that during a severe drought, all irrigators within the system

would require a minimum of 51 millimetre over a two week period to sustain their crops. This was established to be the target level of service within the system moving forward.

Table 14: Irrigation Area and Demand

ABL Branch Name	Total Irrigation Area (hectares)	51 millimetre Demand (cubic metres per second)	Available Supply (cubic metres per second)
Bright's Drain	374	2.76	0.24
Lavigne Drain	353	2.61	0.24
Airport #3 Drain	371	2.74	0.24
Airport #1 Drain	459	3.39	0.28

Four Mile Creek Branch Name	Total Irrigation Area (hectares)	51 millimetre Demand (cubic metres per second)	Available Supply (cubic metres per second)
Four Mile Creek	486	3.59	0.076

Harrison Routh Branch Name	Total Irrigation Area (hectares)	51 millimetre Demand (cubic metres per second)	Available Supply (cubic metres per second)
Routh Drain	112	0.83	0.30
Harrison #3 Drain	301	2.22	0.49
Harrison #1 Drain	755	5.57	0.49
3 Mile Creek	163	1.20	0.49

As can be seen above, and as highlighted in the 2021 Irrigation System Strategy and Master Plan, there is a large gap between the irrigation demand during a drought and the available supplied flow when all farmers along the branch require irrigation simultaneously.

In developing the above values, the following assumptions were outlined in the Master Plan:

- On farm irrigation efficiency was 80%
- A channel efficiency of 95% was assumed
- The demand for each irrigator was estimated based on 51 millimetres and 76 millimetres for application scenarios
- The typical irrigation cycle can last 1 to 3 days for each field based on the crop type and stage of growth
- The noise by law prohibits farmers from pumping during the night, the model assumes continuous pumping for 12 hours over a span of 2 days

The previous analysis carried out in the Master Plan is considered an adequate estimation of the current water demand during a drought period. AECOM has carried out a further analysis to determine the future estimated water demand that any upgrades should be designed to meet.

As stated in the Master Plan, currently, there is a low incentive for farmers to join the irrigation system as the supply is already inadequate in supplying current members. By developing a solution that accounts for an increasing need for irrigation, the number of irrigators in Niagara-on-the-Lake can increase which will thereby increase crop yield and encourage economic growth.

To help close the gap between the demand the available supply the Master Plan outlines these options:

- Upgrading pumping capacity and the permit to take water at Dee Road PS, Whirlpool PS and Eastchester Pumping Station;
- Using temporary pumps owned by the Town to supplement existing supply;
- Emergency pumping regulation allowing for 24-hour irrigation during periods of low rainfall, including:
 - Possibility of exempting the existing Noise By-law 4588-12;
 - Storage reservoirs within the ABL and Harrison Routh systems to add additional supply flow;
 - Connecting Dee Road Pumping Station to supply flow to the Four Mile Creek System; and
 - Scheduling rotations within each branch of the system to ensure that each user has irrigation supply within a two-week time frame.

4.2.4 Methodology and Climate Analysis

To refine historical data and account for recent climate trends, water requirements were calculated using the FAO-56 Penman-Monteith methodology and simulated via CROPWAT 8.0 software.

- **Design Scenario:** While a 5-year drought is standard for many irrigation schemes, a 1-in-10-year drought return period was utilized for this Assignment given the extreme economic value of Niagara's perennial crops.
- **Climate Data:** Meteorological inputs were sourced from the Environment Canada "Vineland" station, utilizing data from 2003–2024 to capture the accelerated impacts of climate change.
- **Precipitation:** The estimation of monthly drought returns levels for 5 and 10 year periods is based on a curve fitting approach. The Generalized Extreme Value (GEV) distribution was fitted to the monthly drought metric, and the fitted GEV model was then used to derive desired return levels.

- **System Efficiency:** An overall system efficiency of 56% was adopted for open-channel delivery, reflecting a 70% conveyance efficiency and an 80% on-farm application efficiency.

4.2.5 Unit Demand Requirements (GIR)

The peak Gross Irrigation Requirements (GIR) represent the volume of water that must be pumped into the system to satisfy the 51-millimetre net target at the farm gate. The calculated daily peak demands for the four primary crop categories are:

- Vineyards:.....4.9 millimetres per day
- Orchards (Tender Fruit):.....6.5 millimetres per day
- Greenhouses: 10.0 millimetres per day
- Nurseries:21.1 millimetres per day
- Golf Courses: 7.8 millimetres per day

These values reflect specific crop coefficients (K_c) of 1.0 for orchards and 0.8 for vineyards during the critical July-August window.

4.2.6 Volumetric Demand Projections

Integrating these unit demands with updated GIS acreage data reveals the total daily volume required for the three municipal systems. As detailed in Appendix C, these figures account for both current permit holders and future intensification.

Table 15: Water Requirement

Demand Horizon	Total Gross Water Volume Requirement
Current (Project Completion)	185,126 cubic metres
10-Year Horizon (Projected)	240,665 cubic metres

The 10-year projection assumes a 30% increase in demand, driven by the anticipated conversion of unpermitted lands to active irrigation and the expansion of the nursery and greenhouse sectors.

4.2.7 Gap Analysis: System Capacity vs. Demand

A comparison between the current physical/regulatory capacities and the calculated 10-year drought demand highlights a critical infrastructure deficit.

- Existing Supply Capacity: The combined allowable taking for the Airport-Bright Lavigne, Four Mile Creek and Harrison/Routh systems is approximately 98,527 cubic metres.
- The Deficit: The current supply covers only 53% of the immediate peak demand and less than 41% of the 10-year projected demand.
- Infrastructure Implications: Meeting this gap necessitates the major upgrades identified in the Master Plan, including doubling the Eastchester Pumping Station capacity, and installing a third pump at Dee Road PS to facilitate inter-system transfers.

4.2.8 Integration of Scheduling and Modelling

The analysis confirms that the instantaneous flow required to satisfy all users simultaneously would exceed current channel capacities and binational Permit to Take Water limits and thus irrigation scheduling/cycling may be required to improve access to all potential water users.

4.3 Hydraulic Model Construction

4.3.1 Model Consolidation

4.3.1.1 Received Model Integration

AECOM received six individual HEC-RAS hydraulic models developed in the mid-2000s for the Niagara-on-the-Lake municipal area. These models are:

- Eight Mile Creek
- Six Mile Creek
- Four Mile Creek
- Three Mile Creek, referred to as Four Mile Pond in the provided model
- Two Mile Creek
- One Mile Creek

Five of these models represent the majority of hydraulic components within the three primary delivery areas:

- Airport-Bright Lavigne irrigation system: Eight Mile Creek, Six Mile Creek, and part of Four Mile Creek
- Four Mile Creek irrigation system: part of Four Mile Creek
- Harrison Routh irrigation system: Three Mile Creek and Two Mile Creek

As the Airport-Bright Lavigne and Four Mile Creek irrigation systems are connected at the downstream part of Four Mile Creek, and the *Town of Niagara-on-the-Lake Irrigation System Strategy and Master Plan* (referred as Master Plan) identified a potential solution to connect the Four Mile Creek irrigation system to the Dee Road pumping station in the Harrison Routh irrigation system, a consolidated hydraulic model incorporating all three irrigation systems is required. The geometry from five individual HEC-RAS models was consolidated into an integrated system. The consolidated model uses the NAD 83 UTM Zone 17N projection.

4.3.1.2 Development of Unrepresented Geometry

The received model geometry did not represent all the hydraulic components in the three irrigation systems, based on the Niagara-On-The-Lake Irrigation System Schematic figure in the Master Plan. Below are components that are unrepresented in the models received:

- Airport-Bright Lavigne irrigation system:
 - Carlton siphon
 - Irrigation road ditch, approximately 350 metres in length, located downstream of the Carlton siphon.
 - Eastchester pumping station
 - Eastchester pipe system, approximately 285 metres in length, located downstream of the Eastchester pumping station.
 - Irrigation road ditch and channel, approximately 2,760 metres in length, extending from the end of the Eastchester pipe system to Six Mile Creek.
 - Irrigation channel, approximately 340 metres in length, connecting Six Mile Creek to the west branch of Four Mile Creek.
 - Irrigation channel, approximately 1,490 metres in length, connecting the west branch of Four Mile Creek to another branch of Four Mile Creek.

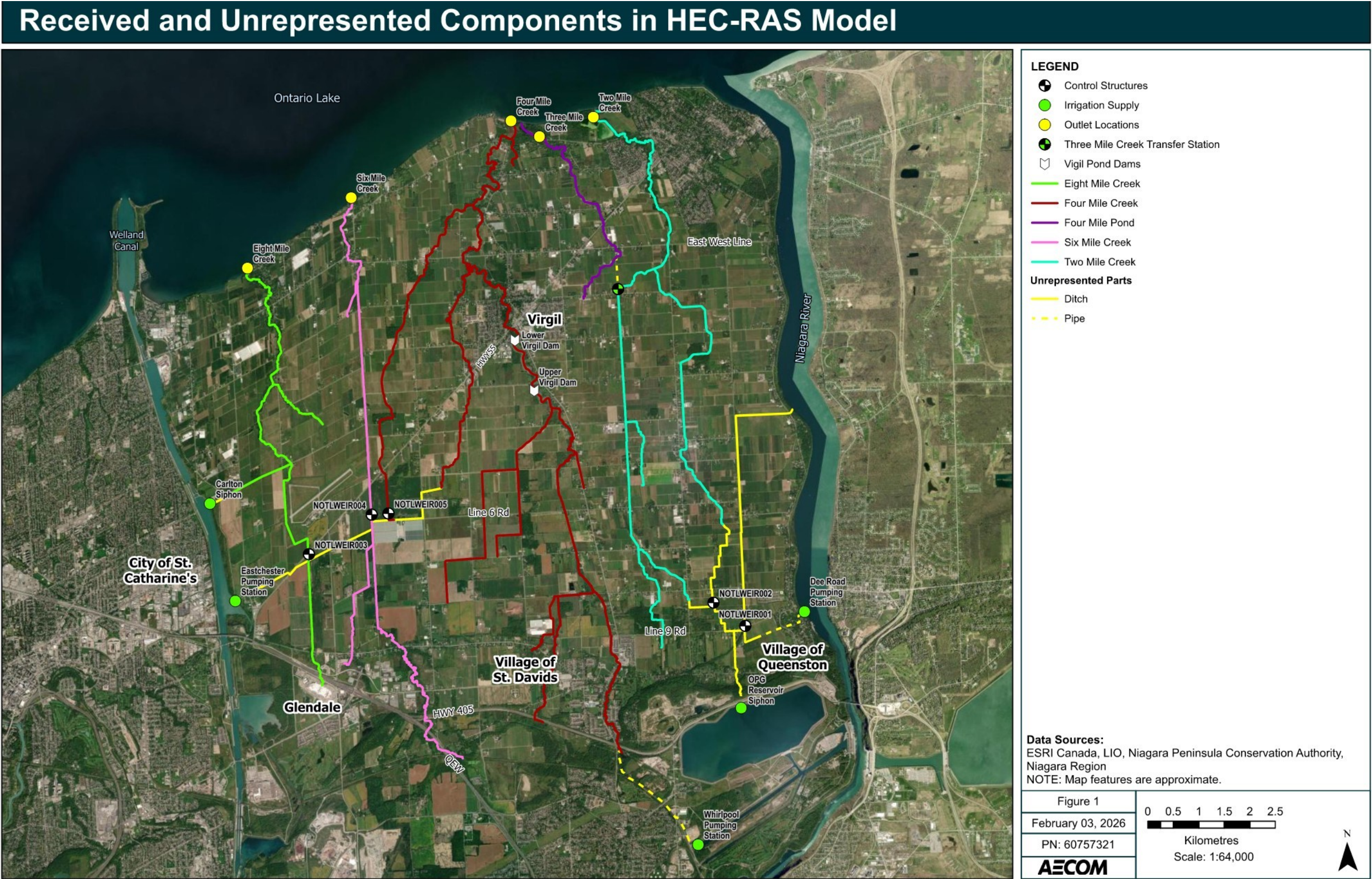
- Three control structures.
- Culverts along the unrepresented ditches.
- Four Mile Creek irrigation system:
 - Whirlpool pumping station.
 - Whirlpool pipe system, approximately 2,610 metres in length, located downstream of the Whirlpool pumping station.
- Harrison Routh irrigation system:
 - OPG siphon.
 - OPG siphon pipe system, approximately 250 metres in length, located downstream of the OPG siphon.
 - Municipal drain, approximately 1,280 metres in length, extending from the end of the OPG siphon pipe system to Line 9 Rd.
 - Municipal drain, approximately 1,060 metres in length, extending from the intersection of Line 9 Rd and Concession 1 Rd to a control structure near Arnold Rd.
 - Municipal drain, approximately 625 metres in length, extending from the control structure near Arnold Rd to the west branch of the Two Mile Creek
 - Municipal drain, approximately 2,030 metres in length, extending from the control structure near Arnold Rd to the east branch of the Two Mile Creek
 - Dee Road pumping station.
 - Dee Road pipe system, approximately 1,100 metres in length, located downstream of the Dee Road pumping station.
 - Dee Road irrigation channel, approximately 500 metres in length, extending from the end of the Dee Road pipe system to the Routh control structure in Concession 1 Rd.
 - Routh drain, approximately 5,360 metres in length, extending from the Routh control structure in Concession 1 Rd to the Niagara River discharge point near Niagara River Parkway.
 - Two Mile Creek transfer station.
 - Pipe system, approximately 605 metres in length, connecting the Two-Mile Creek transfer station to the Four Mile Pond system.
 - Two control structures.
 - Culverts along the unrepresented ditches and channels.

The received river reaches of five creeks, and the unrepresented components are demonstrated in Figure 23.

Most of the demonstrated unrepresented components were built into the HEC-RAS model as 1-D geometry, except for pump stations and pipe systems. Cross section data along the unrepresented ditches were obtained from the Hamilton-Niagara LiDAR Digital Surface Model in 2021, which has a resolution of 0.5 metres. Hydraulic infrastructure data was obtained from drawings and reports received:

- Harrison Routh irrigation system:
 - Information on culverts from the Dee Road Pumping Station to the Routh diversion structure (NOTLWEIR001) and a portion of the south ditch in Line 9 Road (until Line 9 Road at Harrison Municipal Drain #4) was obtained from the Dee Road Pump House original drawing set.
 - Information on culverts on the Routh Municipal Drain was obtained from the Routh Municipal Drain Engineer's report in 1993.
 - Information on culverts from Line 9 Road at Harrison Municipal Drain #4 to the start of the Harrison Drain #1 and Harrison Drain #6 was not available. Therefore, culverts within these segments were not included, except for the control structure NOTLWEIR002, which contains a 300-millimetre diameter culvert with a length of 379 metres.
- Airport-Bright Lavigne irrigation system:
 - Information on culverts along Eastchester Ave was obtained from the Airport-Bright Lavigne irrigation system improvements report.
 - Information on culverts along Line 6 Road, between control structures NOTLWEIR004 and NOTLWEIR005, was obtained from the 2007-2010 Airport-Bright Lavigne expansion issued drawings.
- Information on culverts between NOTLWEIR005 and the start of Bright Drain was not available. Therefore, culverts within this segment were not included.

Figure 23: Received and Unrepresented Components in HEC-RAS Models



4.3.2 Model Validation and Parameter Adjustment

4.3.2.1 Received Hydraulic Model Validation

Some errors were found in the geometry of the received hydraulic models, which were developed in an early HEC-RAS version in the mid-2000s and might have applied different model construction rules. Major errors, such as the reversed cross-section lines, which contribute to inaccurately self-intersecting riverbank lines and cross-section edge lines, were adjusted. Information on errors can be found in Table 17.

The geometry of the received hydraulic models was validated to better comply with the rules under HEC-RAS version 6.7 Beta 5 and provide more accurate geometry.

4.3.2.2 Model Hydraulic Parameters Adjustment

Hydraulic parameters can significantly impact model results.

It is mentioned especially by clients that phragmites were found in the irrigation ditch system. To better understand the impact of phragmites on hydraulic performance, an investigation was conducted. Published academic studies indicate that phragmites create significantly greater flow resistance than traditional, less-dense vegetation types. The Manning's N can range from 0.129 to 0.56 when phragmites are present in irrigation channels. In drainage channels colonized by dead, dense phragmites, particularly in front of culverts, Manning's N value can reach as high as 0.71.

Table 16 shows the roughness coefficients applied along the irrigation ditch system under two scenarios: clean ditch and ditch with phragmites.

Table 16: Roughness Coefficients for Ditch

Description of ditch	Main Channel	Overbank Area
Ditch of clean bottom and light brush overbank area	0.035	0.055
Ditch with phragmites	0.4	0.5

Table 17: Received HEC-RAS Model Validation

Model Information	HEC-RAS Checks	Eight Mile Creek	Six Mile Creek	Four Mile Creek	Three Mile Creek	Two Mile Creek	Total
Geometric Data	River Reach	5	5	17	1	7	35
Geometric Data	Junction	2	2	8	0	3	15
Geometric Data	Bridge	0	0	4	0	0	4
Geometric Data	Culvert	21	26	59	8	30	144
Geometric Data	Cross-section	138	181	484	65	366	1234
Geometric Errors	Total Errors	143	188	507	66	376	1280
Geometric Errors	Disconnection from river line	3	3	15	0	4	-
Geometric Errors	Multiple upstream connections to Rivers with the same name	2	2	8	0	3	-
Geometric Errors	Cross-section is reversed (must draw left to right downstream)	2	0	0	0	366	-
Geometric Errors	Cross-section intersects < 2 bank lines	135	180	483	65	-	-
Geometric Errors	Cross-section naming error - River station out of order	1	1	1	0	2	-
Geometric Errors	Polyline has duplicate points	0	2	0	1	7	-
After Validation	Total Errors	2	1	35	4	2	44
After Validation	Cross-section intersects < 2 bank lines	2	0	0	0	0	-
After Validation	Cross-section intersects > 2 bank lines	0	1	11	2	2	-
After Validation	Polyline has self-intersections	0	0	8	1	0	-
After Validation	This is an edge line self-intersection point	0	0	16	1	0	-

Note: The construction year for all models is 2007.

4.4 Levels of Service, Gaps and Infrastructure Needs

The project design is anchored by a target Level of Service of 51 millimetres of net irrigation water delivered over a 14-day cycle during a 1-in-10-year drought event. To achieve this at the farm gate, the system must be sized based on the Gross Irrigation Requirements (GIR), which account for a 56% global efficiency (70% conveyance efficiency in open channels and 80% on-farm application efficiency).

The specific daily peak requirements specified imply that meeting these demands necessitates significant infrastructure expansion, including (as per the irrigation committee's requested demand) doubling the capacity of the Eastchester Pumping Station to 0.505 cubic metres per second (8,000 US gallons per minute), adding a second pump at Whirlpool Pumping Station to reach 0.126 cubic metres per second (2,000 US gallon per minute), and installing a third pump at Dee Road Pumping Station. Solutions to increase the levels of service are explored further in the Design Requirements and Upgrades section.

Hydraulic analysis confirms a substantial deficit between current pumping assets and peak drought demand. The total allowable supply for all the systems is approximately 76,582 cubic metres per day.

- **Immediate Gap:** Current peak demand is estimated at 185,126 cubic metres per day, meaning existing infrastructure covers only 41% of the need.
- **10-Year Horizon Gap:** With a projected 30% increase in irrigation permits and agricultural intensification, demand is expected to reach 240,665 cubic metres per day, leaving current capacity able to satisfy less than 32% of future requirements.

4.4.1 Operational Constraints and Inefficiencies

The existing system faces significant limitations that impede the delivery of these increased volumes:

- **Manual downstream Control Logic:** The system currently operates on an "on-demand" basis, where pumps are manually activated in response to producer requests. This represents a manual downstream control method that lacks the automation and responsiveness required to manage peak flows without risking channel depletion or erratic service.
- **Hydraulic Bottlenecks:** Specific structures, such as the 800-millimetre culverts at Eastchester Avenue, have a capacity (0.2091 cubic metres per second)

significantly lower than the proposed pumping output (0.2524 cubic metres per second), creating a flow-choke point that increases headwater elevation and threatens road stability.

- **Conveyance Losses and Vegetation:** Excessive sedimentation and the invasion of Phragmites significantly restrict channel flow and increase Manning's roughness coefficients, reducing the overall hydraulic capacity of the network.

Solutions to these constraints and inefficiencies will be discussed further in Design Requirements and Upgrades.

4.4.2 System Optimization

To bridge the service gaps and manage higher flow rates, the detailed design must integrate advanced modelling and control strategies such as:

- **Channel Capacity and Manning's Analysis:** It is imperative that the next phase includes high-fidelity modelling of open channel reaches. This analysis must utilize updated Manning's coefficients to verify that the existing channel geometries can safely convey the doubled pumped volumes without overtopping or insufficient freeboard.
- **Transition to Automated Control:** Optimization should explore a transition from manual "on-demand" operation to a more structured control logic (evaluating Upstream vs. Downstream control). Implementing automated weirs (at Virgil Ponds) is essential to provide the precise regulation needed for an intensified system.
- **Mandatory Scheduling (Tour d'eau):** Since the instantaneous demand of all users exceeds the physical and regulatory capacity of the channels and PTTW limits, the system must utilize mandatory rotation scheduling. By rotating flow between branches, the system can ensure every producer receives their Net Irrigation Requirements indicated in the Irrigation Water Requirements memo in Appendix C.

Solutions for optimizations will be discussed further in the Design Requirements and Upgrades section.

4.4.3 System Maintenance

The sustainability of the system relies on a rigorous "state-of-good-repair" program to maintain design capacities. From the background review of the reports, Master Plan and system wide analysis, the following summarized maintenance items organized by

timing/requirements and responsibilities should be followed for the entire system in upcoming years in addition to the tasks laid out in Table 11. Some of these items will be discussed further in the Design Requirements and Upgrades section. Responsibilities of the tasks fall under the following:

- Town: Town staff to complete as part of normal operation and maintenance
- Landowner: Irrigation user to complete
- Project: task is large enough to fall outside of normal operation and maintenance and should be considered a project due to task and length of time required to complete

Table 18: System Maintenance

Task	Frequency	Responsibility	Description
Pre-Season System Inspection	Yearly (Before Irrigation Season)	Town	■ Inspect municipal drains, channels, culverts, siphons, force mains, pumping stations, diversion structures; verify design profile; confirm channels free of debris/ vegetation/ obstructions; assess erosion, bank stability, sediment buildup, and structural integrity.
Pre-Season Pump Station & Mechanical Inspection	Yearly (Before Irrigation Season)	Town	■ Inspect pumps, valves, gates, electrical systems, flow-control equipment; verify intake/discharge points unobstructed; ensure mechanical integrity before system start-up. ■ Complete any required maintenance before start of season.
Preparation for Irrigation Season	Yearly	Landowner & Town	■ Prepare and maintain private pumps/appurtenances; confirm intended temporary dams meet permit requirements (not yet installed). ■ Address deficiencies identified in the pre-season system inspection
Routine Irrigation Inspection & Monitoring	Ongoing	Town	■ Inspect channels, pumps, valves, weirs, drains, culverts, siphons; monitor erosion, sediment, debris, vegetation; evaluate downstream impacts; verify dam compliance; maintain user and inspection records.
Temporary Dam Operation & Compliance	During Irrigation Season	Landowner	■ Install permitted dams only during irrigation season; ensure dams meet height limits, do not block flow, and do not cause upstream/downstream impacts; maintain dams against failure.
Storm Event Shutdown & Post-Event Inspection	As Needed	Town	■ Shut down irrigation during significant rainfall; conduct post-storm inspections for erosion, damage, debris; ensure drainage capacity and system integrity before restart.
Temporary Dam Removal for Storm Events	As Needed	Landowner	■ Remove dams prior to or during significant storm events; ensure dams do not worsen flooding.
Non-Compliance Enforcement	As Needed	Town	■ Remove unauthorized/unsafe dams; restore channel conditions; charge costs to responsible landowner; enforce permit and by-law compliance. ■ Ensure irrigation dams comply with height and seasonal limits; identify and remove non-compliant structures; enforce seasonal restrictions.
End-of-Season Shutdown	Yearly (End of Season)	Town	■ Shut down irrigation works; inspect system condition; identify erosion, debris, sediment, or structural issues; plan and complete repairs and clean-up before next season.
End-Season Dam Removal	Yearly (End of Season)	Landowner	■ Remove all temporary dams; shut down private pumps/appurtenances.
Cost Recovery & Administration	Ongoing	Town	■ Track irrigation-related maintenance costs; charge to irrigation account (where applicable); recover costs through assessments; keep complete documentation.
Vegetation Management	Monthly	Town	■ Mow/brush maintenance corridor; remove woody vegetation within channel limits; maintain access and prevent encroachment.
Debris Removal & Restoration	Monthly + As Needed	Town	■ Remove debris from ditch bottoms and banks (timber, rubbish, organic material); clear debris at/under bridges; remove waste and restore disturbed areas; seed grassed areas and reinstate gravel/paved surfaces.
Channel Bottom & Culvert Cleanout	Yearly	Project	■ Perform bottom cleanout to remove silt/sediment and restore hydraulic capacity (typical depth 150–400 millimetres depending on reach); remove sandbars; maintain drain to design grade; clean road and private crossing culverts to prevent backwatering.
Access Preservation	Yearly	Town	■ Level spoil banks; maintain working corridors for cleanouts, spoil placement, mowing, and brushing as defined in drainage reports.
Bank Stabilization & Erosion Repair	Yearly Review + As Needed	Project	■ Repair bank erosion by over-excavating/re-sloping; reinstate stable slopes; armour eroded banks/bends using rock rip rap with filter fabric. Install or maintain rip rap/rubble rock with filter fabric at erosion sites, bends, culvert inlets/outlets.

5. Design Options

5.1 Alternatives Investigated

Following the background review, discussions with users, the Town and the Region, numerous alternatives were proposed in past reports and were consolidated into a list that was presented to the Irrigation Committee Meeting on November 12th, 2025, along with potential new solutions. Many solutions were eliminated from the study during the meeting and are shown below:

Table 19: Solutions Not Recommended

System	Description	Comments from 11/12/2025 Irrigation Committee Meeting
Harrison/Routh	Adding storage reservoirs	■ No storage reservoirs to be considered due to property acquisition requirements
Four Mile Creek	Automated weirs and sediment control of the upper and lower dams	■ Automated weirs solved by piping and valves off pipes
Four Mile Creek	St. Davids Well (defunct)	■ Decommissioned- origin of drinking water, contamination found in the area, pavement over top of wells
Airport / Bright / Lavigne	New pumping station and force main for the unserved area south of Eastchester	■ In the short term, no, long term perhaps, not much agricultural growth in the area since the land is poor, poor soil, good for greenhouses, need a petition to service the area to the south
Overall	Implementing scheduled irrigation rotations to ensure equitable water access every two weeks.	■ The Town has tried to implement this solution during drought conditions but has rationed only once. The overall system needs more water. ■ This solution may be implemented when the water supply is closer to demand during drought conditions.
Overall	Deploying temporary pumps.	■ Do not have enough water to move around currently. ■ This solution may be implemented when the water supply is closer to demand during drought conditions.
Overall	Allowing 24-hour irrigation during dry periods (possibly bypassing local noise by-laws).	■ Noise reduction bylaws restrict this option; currently, temporary measures are used to reduce noise if required to pump overnight. Difficult to monitor and enforce, and not in control of this option.
Overall	Increase costs to users	■ Currently system is not delivering water supply as requested, increased 3-4 years ago, capital vs operating costs. Ideally would like to keep costs down for farmers.

In addition to the solutions in Table 19, other solutions were presented using the figure Map of Alternative Solutions to help guide the discussion and show impacted areas. Many were eliminated based on past discussions, permitting requirements, and land acquisition requirements that the Irrigation Committee has previously reviewed. Some of the proposed new irrigation channels and culverts would extend into private properties along each route, and the Committee, Town, and Region indicated a preference to avoid land acquisition. Some solutions involved having major infrastructure outside of the Town of Niagara-on-the-Lake. While the Drainage Act may allow land acquisition, the process can be lengthy and subject to many appeals.

One of the transfer alternatives proposed included taking water from Four Mile Creek via a new pumping station at Line 9, and a pipe to the Cole Drain, Airport, Bright, and Lavigne drains. The Airport, Bright, and Lavigne drains were eliminated because the Four Mile Creek system supplies about 3% to 8% of the total system water. The existing Whirlpool pumping station is at capacity, and upgrades to the station would be required before this transfer option can be built. A second alternative would transfer water from Harrison Drain 4 west crossing private property with outlets into Harrison Drain 1- and Four-Mile Creek Drain and was eliminated mainly due to land acquisitions.

Additionally, the Welland lock-based solutions and Steward Road Pumping Station were not recommended based on the following:

- The Welland Canal Lock 6 reservoir
 - A long and large pipe is needed for this system to convey water from Lock 6 to distribution system, which would be more costly.
 - Permit to Take Water required.
 - One option would go to the east to a tributary of six-mile creek and another to the south, crossing the QEW and entering Airport Drain 1, 2, 3 and 6.
 - As an unpumped system, the total capacity of this system is less than that of a pumped system.
 - The route of the pipe would also include a railway crossing or a QEW crossing.
 - As the QEW is planned to be expanded in the next decade, this would complicate any QEW crossing requirements.
- The Welland Canal Lock 3 reservoir
 - A long and large pipe is needed for this system to convey water from Lock 3 to distribution system, which would be more costly.
 - One option required a storage pond to the south of the QEW.

- Three crossings of the QEW could be considered, one at Conn Road, one at Niagara Stone Road and one at Seaway Haulage Road.
- From the QEW, the piped system is run along Queenston Rd and outlets into Airport Drain 1, 2, 3, 6 and the Cole Drain.
- As the QEW is planned to be expanded in the next decade, this would complicate any QEW crossing requirements.

■ Steward Pumping Station

- Alternative would use a new pumping station near the intersection of Steward Road and Niagara Stone Road
- Would source water from a branch of the old Welland Canal.
- From the new pumping station, a piped system could take two routes, one along Queenston Rd and outlets into Airport Drains 1, 2,3,6 and the Cole Drain. The other runs due east, crossing private property, then along Lincoln Avenue, and outlets into Airport Drains 1, 2, and 3.
- Discussion with the irrigation committee notes that there were concerns of sediment in the old Welland Canal at this inlet location.

The additional solutions are presented in Table 20 and highlights their considerations and reasons for elimination.

Figure 24: Map of Alternative Solutions

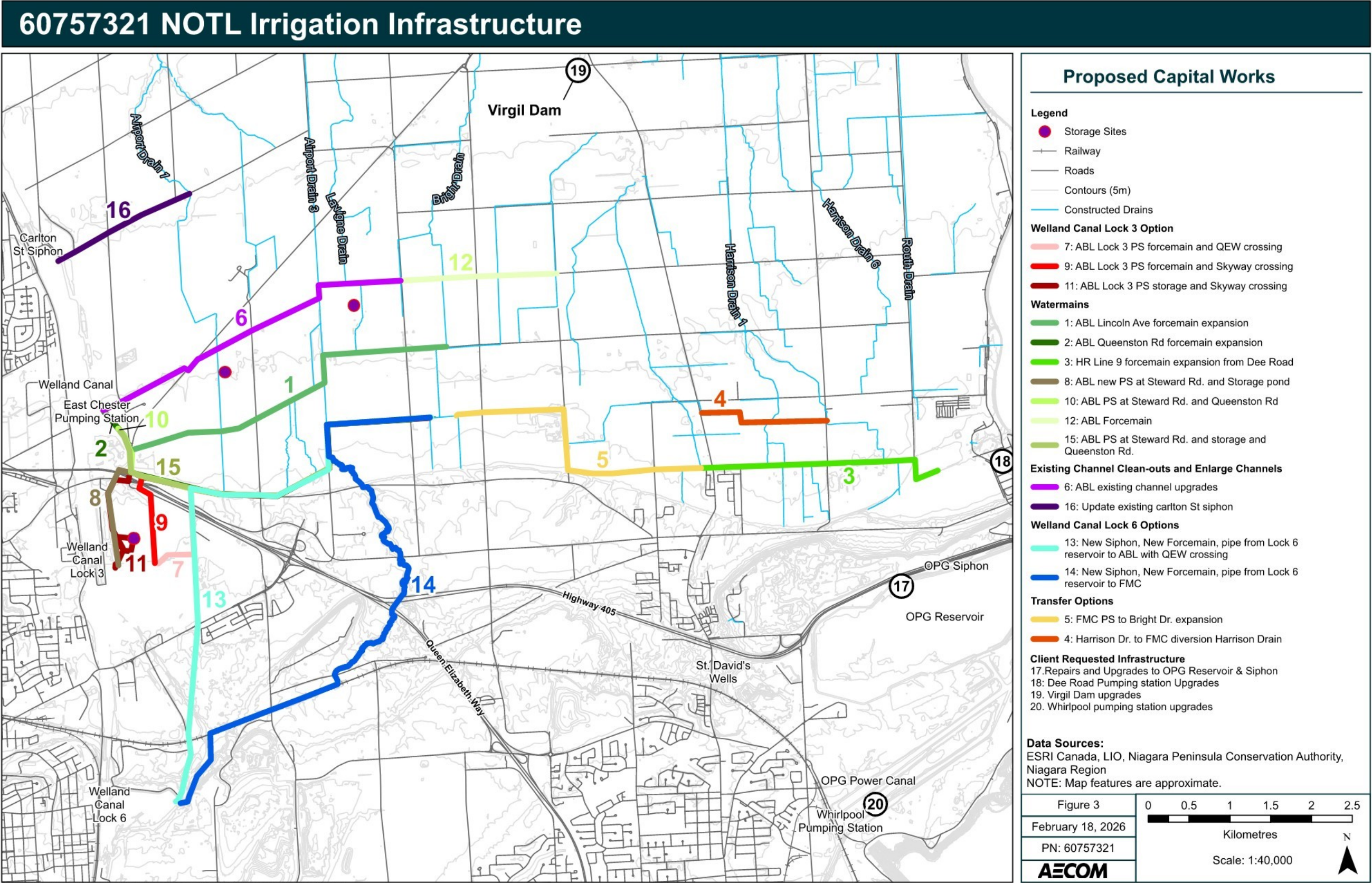


Table 20: Summary of Alternative Solutions

Alternative ID	System	Description	Considerations	11/12/2025 Irrigation Committee Meeting
1	ABL	Lincoln Avenue force main expansion	■ New force main or open channel supply route from either Welland Canal or Niagara River. ■ Private property, outside of existing service area, new pump station needed, landowner consultation, local contractor, increased amount of equipment and materials will increase costs. ■ From the irrigation committee's requested demand: install a new force main or open channel supply route to Four Mile Creek from either the Welland Canal or the Niagara River	■ Not proceeding with analysis
2	ABL	Queenston Road force main expansion	■ New force main or open channel supply route from either Welland Canal or Niagara River. ■ From the irrigation committee's requested demand: install a new force main or open channel supply route to Four Mile Creek from either the Welland Canal or the Niagara River ■ New pump station needed, landowner consultation, outside service area, road is approximately 17 metres above Welland Canal water level, many underground utilities on Queenston Road	■ Not proceeding with analysis
3	HR	Line 9 force main expansion from Dee Road	■ From the irrigation committee's requested demand: install a new force main or open channel supply route to Four Mile Creek from the Niagara River ■ Connection via open channels or force main from Dee Road Pumping Station to FMC. ■ Landowner consultation, local contractor, increased amount of equipment and materials will increase costs, local road	■ Priority Capital project with Irrigation Committee: item 6.2 "Piping Across Line 9" ■ Required as per the irrigation committee's requested demand ■ Proceed with Solution in Report
4	HR	Harrison Drain transfer to Four Mile Creek Drain	■ New force main or open channel supply route from either Welland Canal or Niagara River. ■ From the irrigation committee's requested demand: install a new force main or open channel supply route to Four Mile Creek from either the Welland Canal or the Niagara River ■ Private property, landowner consultation, local contractor, increased amount of equipment and materials will increase costs, currently no request for this infrastructure.	■ Not proceeding with analysis
5	FMC	Four Mile Creek PS transfer to Bright Drain	■ New force main or open channel supply route from either Welland Canal or Niagara River. ■ From the irrigation committee's requested demand: install a new force main or open channel supply route to Four Mile Creek from ■ Private property; pump station required; landowner consultation; local contractor; increased amount of equipment and materials will increase costs; currently, no request for this infrastructure.	■ Not proceeding with analysis
6	ABL	Eastchester/ABL channel expansion	■ Channel and culverts requirements- cleaning and maintaining to increase capacity, Private property; pump station required; landowner consultation; local contractor; increased amount of equipment and materials will increase costs; currently, bottleneck for Airport Lavigne bright system	■ Not proceeding with analysis
7	ABL	Lock 3 pump station force main and QEW crossing.	■ Private property; pump station required; landowner consultation; local contractor; increased amount of equipment and materials will increase costs; QEW crossings, new water source location; increase in service area.	■ Not proceeding with analysis
8	ABL	New Steward Road pumping station and storage pond	■ Private property; pump station required; landowner consultation; local contractor; increased amount of equipment and materials will increase costs; QEW crossings, legal consultation required for land acquisition; increase in service area.	■ Not proceeding with analysis
9	ABL	Lock 3 pump station force main and skyway crossing	■ Private property; pump station required; landowner consultation; local contractor; increased amount of equipment and materials will increase costs; QEW crossings with planned skyway expansion, many underground utilities under skyway; new water source location; increase in service area.	■ Not proceeding with analysis
10	ABL	PS at Steward Road and Queenston Road	■ Private property; pump station required; landowner consultation; local contractor; increased amount of equipment and materials will increase costs; QEW crossings; many underground utilities on Queenston Road; new water source location.	■ Not proceeding with analysis
11	ABL	Lock 3 pump station storage and skyway crossing	■ Private property; pump station required; landowner consultation; local contractor; increased amount of equipment and materials will increase costs; QEW crossings, new water source location; increase in service area; many underground utilities under skyway.	■ Not proceeding with analysis
12	ABL	Eastchester Pumping Station Upgrades	■ From the irrigation committee's requested demand: double the capacity to 8,000 gallons per minute through the installation of an additional 75-kilowatt variable speed pump. ■ Pump station required; landowner consultation; local contractor; increased amount of equipment and materials will increase costs; location of existing irrigation channel	■ Priority Capital project with Irrigation Committee: item 6.2 "Eastchester to Line 6 FMC" ■ Required as per the irrigation committee's requested demand ■ Proceed with Solution in Report

Alternative ID	System	Description	Considerations	11/12/2025 Irrigation Committee Meeting
13	ABL	Siphon, pipe from Lock 6 reservoir to ABL with QEW crossing	Private property; landowner consultation; local contractor; increased amount of equipment and materials will increase costs; QEW crossings; new water source location; water level is approximately 54 metres above service area; low maintenance; outside municipality; crossing railway line.	Not proceeding with analysis
14	FMC	Siphon, pipe from Lock 6 reservoir to FMC	Private property; landowner consultation; local contractor; increased amount of equipment and materials will increase costs; new water source location; water level is approximately 54 metres above service area; low maintenance; outside municipality; crossing railway line.	Not proceeding with analysis
15	ABL	ABL Pump Station at Steward Road and storage, force main along Queenston Road	Private property; pump station required; landowner consultation; local contractor; increased amount of equipment and materials will increase costs; QEW crossings, legal consultation required for land acquisition; many underground utilities on Queenston Road; increase in service area.	Not proceeding with analysis
16	ABL	Update Carlton Street existing siphon	- From the irrigation committee's requested demand: upgrade and enhance the current ABL system - Carlton street siphon update + piping - Uses local contractor, equipment and materials	Proceed with Solution in Report
17	HR	Repairs and Upgrades to OPG Reservoir and Siphon	- From the irrigation committee's requested demand: repairs and upgrades to the OPG Siphon - Private property, landowner consultation, specialized contractor, increased amount of equipment and materials will increase costs, currently no request for this infrastructure. - Uses specialized contractors, equipment, and materials, and permits to work on OPG, Escarpment Commission, NPC, and MTO property.	- Priority Capital project with Irrigation Committee: item 6.2 bullet 4 "Repair Siphon in reservoir" - Required as per the irrigation committee's requested demand - Proceed with Solution in Report
18	HR	Dee Road Pumping Station Upgrades	- As per the irrigation committee's requested demand: Upgrade Dee Road Pumping Station to include a third 150-kilowatt pump. The additional pump at Dee Road will be installed with the intention of servicing the Four Mile Creek System. - Owned infrastructure, Landowner consultation, local contractor, increased amount of equipment and materials will increase costs.	- Required as per the irrigation committee's requested demand - Proceed with Solution in Report
19	FMC	Virgil Dam upgrades	- As per the irrigation committee's requested demand sediment control of the upper and lower Four Mile Creek Reservoir dams - Will require time to consult with local landowners, a staging area needed, transport and storage of spoil, and will require major survey work - Acquisition of the dams is no longer an option. The NPCA wants to retain the property, however, through a recently signed MOU the Town now operates the dams and is responsible for the costs to maintain. - Clean out option still	- Priority Capital project with Irrigation Committee: item 6.2 "clean out ponds in Virgil to store water" - Proceed with Solution in Report
20	HR	Whirlpool pumping station upgrade	- Aging building and equipment - Private property, specialized contractor would be required, increased amount of equipment and materials will increase costs.	- Priority Capital project with Irrigation Committee: item 6.2 "Repair hydro canal pump house" - Proceed with Solution in Report
-	Overall	Control Structures and Automation	- Would reduce Town staff time, - Town staff prefer to go to the site and the operator system. - Control structures may be eliminated if the system is piped - Owned infrastructure, local contractor, increased amount of equipment and materials will increase costs	Proceed with Solution in Report
-	Overall	Vegetation Management and Phragmites Control	- Based on the hydraulic modelling, vegetation management dramatically increases the channel capacity. - Owned infrastructure, local contractor, increased amount of equipment and materials will increase costs - The system is too large to do everywhere - No operator plan for focus maintenance	- Would help increase existing channel capacity - Proceed with Solution in Report
-	Overall	Sediment Removal in channels	- channel and culverts requirements- cleaning and maintaining to increase capacity - Owned infrastructure, local contractor, increased amount of equipment and materials will increase costs. - The system is too large to do everywhere - No operator plan for focus maintenance - Currently request bases - ADIP grant for maintenance for drainage works	- Would help increase existing channel capacity - Proceed with Solution in Report
-	Overall	Storage	Storage possibilities- reservoirs, ponds, water towers, a program for farmers to add a storage point or vessel	Proceed with Solution in Report

From the table, the following will be considered and analysed further in the report:

- Alternative 3: Line 9 force main expansion from Dee Road
- Alternative 12: Eastchester Pumping Station Upgrades and ABL piped system
- Alternative 16: Update Carlton Street existing siphon
- Alternative 17: Repairs and Upgrades to OPG Reservoir and Siphon
- Alternative 18: Dee Road Pumping Station
- Alternative 19: Vigil Dam Upgrades
- Alternative 20: Whirlpool pumping station upgrade
- Overall Solutions
 - Control Structures and Automation
 - Vegetation Management
 - Sediment Removal
 - Storage

5.2 Approvals, Permits, and Environmental Considerations

As part of the natural environment component of this study, an evaluation of the aquatic and terrestrial natural heritage features and functions associated with the irrigation systems and alternative design solutions was completed. This evaluation was based on a desktop review of background documents and databases to identify environmental constraints associated with each route alternative. The study area encompassed existing irrigation systems and the alternative design solutions presented plus 120 metres extending on either side to capture potential environmental impacts. The study has been completed for all potential solutions (eliminated and ones that are to be investigate) to highlight the impact of each option for future use and consideration if required. The following background sources were reviewed:

- Niagara Region Official Plan (2022),
- Niagara Region Open Data (2024),
- Niagara Peninsula Conservation Authority (NPCA) Open Data (2024),
- Ministry of Natural Resources (MNR) Natural Heritage Information Centre (NHIC) database (MNR, 2025a),
- Aquatic Resources Area (ARA) database (MNR, 2025b),
- Ontario Breeding Bird Atlas (Bird Studies Canada, 2021),
- Ontario Reptile and Amphibian Atlas (Ontario Nature, 2019),
- Ontario Butterfly Atlas (Toronto Entomologists' Association, 2024),

- Ebird (2025),
- iNaturalist (2025),
- Fisheries and Oceans Canada (DFO) Species at Risk (SAR) mapping (DFO, 2025),
- Ministry of Agriculture, Food, and Agribusiness AgMaps (MNR, 2025c), and
- Ministry of Environment, Conservation and Parks (MECP) species range maps (MECP, 2019).

The results of the desktop review indicate that there are unevaluated wetlands, evaluated-other wetlands, Provincially Significant Wetlands (PSWs), Significant Woodlands, and woodlands within the study area. Other key considerations of the natural environment evaluation for each alternative are outlined below and detailed in Table 21.

Class C drains indicate a permanent feature containing spring spawning fish, but no sensitive species. The in-water works timing window (when works are permitted) is from July 16 – March 14 of any given year (i.e. no in-water works from March 15 – July 15). Class D drains indicate a permanent feature containing spring and fall spawning fish, as well as sensitive species. The in-water works timing window (when works are permitted) is from July 16 – August 31 of any given year (i.e. no in-water works from September 1 – July 15 of any given year). Clean outs in Class D drains require a site-specific review. Class F drains indicate an intermittent feature (i.e., flows for several weeks following snow melt, during wet seasons, and after major rain events (Irwin, *et al.*, 2013). No review is required when the work can be conducted in dry, frozen, or no flow conditions. Activities that can be completed without review in these conditions include Bottom-only Cleanout, Bottom Cleanout Plus One Bank Slope, Full Cleanout, Bank Stabilization, Culvert Removal/Replacement, and Top of Bank and Bank Slope Vegetation Removal.

All intake pumps must follow DFO's End-of-pipe fish protections screens for small water intakes in freshwater to prevent the entrainment (cannot escape water intake pressure) or impingement (cannot free itself from contact with intake screen) of fish (DFO, 2020).

Table 21: Environmental Considerations

Alternative ID	System	Description	Conditions and Environmental Considerations	Potential Permits and Approvals	Restricted Timing Window	Assessment of Impacts
1	ABL	Lincoln Avenue force main expansion	Natural Heritage Features: ■ 6 watercourses / drains, including two Class D drains ■ 1 evaluated-other wetland (Lincoln Airport Wetland Complex) and 5 unevaluated wetlands ■ 6 woodlands ■ SWH: Colonial Waterbird Nesting Area SAR: ■ Terrestrial: Bat SAR (including Eastern Red Bat (<i>Lasiurus borealis</i>), Eastern Small-footed Myotis (<i>Myotis leibii</i>), Hoary Bat (<i>Lasiurus cinereus</i>), Little Brown Myotis (<i>Myotis lucifugus</i>), Northern Long-eared Myotis (<i>Myotis septentrionalis</i>), Silver-haired Bat (<i>Lasionycteris noctivagans</i>), and Tri-coloured Bat (<i>Perimyotis subflavus</i>)), Bank Swallow (<i>Riparia riparia</i>), Bobolink (<i>Dolichonyx oryzivorus</i>), Chimney Swift (<i>Chaetura pelagica</i>), Cucumber Tree (<i>Magnolia acuminata</i>), Eastern Flowering Dogwood (<i>Cornus florida</i>), Eastern Meadowlark (<i>Sturnella magna</i>), Least Bittern (<i>Ixobrychus exilis</i>), Red-headed Woodpecker (<i>Melanerpes erythrocephalus</i>) Policy Areas: ■ NPCA Regulation Lands ■ NPCA Ground Water Protection Quantity HVA ■ Greenbelt Designated Area	■ DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization ■ Section 28 permit for work within NPCA Regulation Lands and wetlands ■ Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: ■ No in-water works from September 1 – July 15 of any given year at Six Mile Creek/Airport Drain 2 and Airport Drain 6 (Class D). ■ No in-water work from March 15 – July 15 at the remaining watercourses/drains. Terrestrial: ■ No vegetation removal within the breeding bird nesting period of April 1 to August 31 ■ No tree removal within active bat season of March 15 to November 30	4
2	ABL	Queenston Road force main expansion	Natural Heritage Features: ■ 6 watercourses / drains, including two Class D drains ■ 1 wetland evaluated-other wetland (Lincoln Airport Wetland Complex) and 6 unevaluated wetlands ■ 2 significant woodlands ■ 8 woodlands ■ SWH: Colonial Waterbird Nesting Area SAR: ■ Terrestrial: Bat SAR, Bank Swallow, Bobolink, Chimney Swift, Cucumber Tree, Eastern Flowering Dogwood, Eastern Meadowlark, Least Bittern, Red-headed Woodpecker Policy Areas: ■ NPCA Regulation Lands ■ NPCA Groundwater Protection Quantity SGRA and HVA ■ Greenbelt Designated Area	■ DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization ■ Section 28 permit for work within NPCA Regulation Lands and wetlands ■ Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: ■ No in-water works from September 1 – July 15 of any given year at Six Mile Creek /Airport Drain 2 and Airport Drain 6 (Class D). ■ No in-water work from March 15 – July 15 at the remaining watercourses/drains. Terrestrial: ■ No vegetation removal within the breeding bird nesting period of April 1 to August 31 ■ No tree removal within active bat season of March 15 to November 30	4

Alternative ID	System	Description	Conditions and Environmental Considerations	Potential Permits and Approvals	Restricted Timing Window	Assessment of Impacts
3	HR	Line 9 force main expansion From Dee Road	Natural Heritage Features: 8 watercourses / drains, including two Class C and one Class D drains 1 evaluated provincially significant wetland (Laurent Wetland Complex) and 11 unevaluated wetlands 4 significant woodlands 2 woodlands - SWH: Mixed Wader Nesting Colony SAR: - Aquatic: American Eel (<i>Anguilla rostrata</i>) - Terrestrial: American Chestnut (<i>Castanea dentata</i>), American Columbo (<i>Frasera carolinensis</i>), Bank Swallow, Bat SAR, Bobolink, Butternut (<i>Juglans cinerea</i>), Chimney Swift, Deerberry (<i>Vaccinium stamineum</i>), Eastern Flowering Dogwood, Eastern Meadowlark, Fern-leaved Yellow False Foxglove (<i>Aureolaria pedicularia</i>), Red Mulberry (<i>Morus rubra</i>), Red-headed Woodpecker, White Wood Aster (<i>Eurybia divaricate</i>) Policy Areas: - NPCA Regulation Lands - NPCA Groundwater Protection Quantity SGRA and HVA - Greenbelt Designated Area	- DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization - Section 28 permit for work within NPCA Regulation Lands and wetlands - Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: - No in-water works from September 1 – July 15 of any given year at Four Mile Creek Drain (Class D). - No in-water works from September 15 – July 15 of any given year Niagara River (Dee Road pump station). - No in-water works from March 15 – July 15 at Harrison Drain 1 and 2 (Class C) and the remaining watercourses/drains. Terrestrial: - No vegetation removal within the breeding bird nesting period of April 1 to August 31 - No tree removal within active bat season of March 15 to November 30	5
4	HR	Harrison Drain transfer to Four Mile Creek Drain	Natural Heritage Features: 3 watercourses / drains, including one Class C and one Class D drain 1 evaluated provincially significant wetland (Laurent Wetland Complex) 4 significant woodlands 1 woodland - SWH: Mixed Wader Nesting Colony SAR: - Aquatic: American Eel - Terrestrial: Bank Swallow, Bat SAR, Bobolink, Butternut, Eastern Meadowlark, Fern-leaved Yellow False Foxglove, Deerberry, Least Bittern, Red Mulberry, Red-headed Woodpecker Policy Areas: - NPCA Regulation Lands - NPCA Groundwater Protection Quantity SGRA - Greenbelt Designated Area	- DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization - Section 28 permit for work within NPCA Regulation Lands and wetlands - Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: - No in-water works from September 1 – July 15 of any given year at Constructed Drain 3 (Class D). - No in-water works from March 15 – July 15 at Harrison Drain 1 (Class C). - No in-water works from September 15 – July 15 of any given year should works be required at Dee Road pump station (Niagara River). Terrestrial: - No vegetation removal within the breeding bird nesting period of April 1 to August 31 - No tree removal within active bat season of March 15 to November 30	3
5	FMC	Four Mile Creek PS transfer to Bright Drain	Natural Heritage Features: 6 watercourses / drains, including two Class D drains 2 unevaluated wetlands 3 significant woodlands 1 woodland - SWH: Colonial Waterbird Nesting Area, Mixed Wader Nesting Colony SAR: - Terrestrial: Bank Swallow, Bat SAR, Bobolink, Butternut, Chimney Swift, Eastern Meadowlark, Deerberry, Least Bittern, Red-headed Woodpecker Policy Areas: - NPCA Regulation Lands - NPCA Groundwater Protection Quantity SGRA and HVA - Greenbelt Designated Area	- DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization - Section 28 permit for work within NPCA Regulation Lands and wetlands - Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: - No in-water work from September 1 – July 15 of any given year in Four Mile Creek/Drain or Constructed Drain 5 (Class D). - No in-water work from March 15 – July 15 at the remaining watercourses/drains. Terrestrial: - No vegetation removal within the breeding bird nesting period of April 1 to August 31 - No tree removal within active bat season of March 15 to November 30	3

Alternative ID	System	Description	Conditions and Environmental Considerations	Potential Permits and Approvals	Restricted Timing Window	Assessment of Impacts
6	ABL	Eastchester/ABL channel expansion	Natural Heritage Feature: ■ 4 watercourses / drains, including one Class D drain ■ 1 evaluated-other wetland (Lincoln Airport Wetland Complex) and 5 unevaluated wetlands ■ 2 significant woodlands ■ 1 woodland ■ SWH: Colonial Waterbird Nesting Area SAR: ■ Terrestrial: Bank Swallow, Bat SAR, Bobolink, Chimney Swift, Cucumber Tree, Eastern Flowering Dogwood, Eastern Meadowlark, Least Bittern, Red-headed Woodpecker Policy Areas: ■ NPCA Regulation Lands ■ NPCA Groundwater Protection Quantity HVA ■ Greenbelt Designated Area	■ DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization ■ Section 28 permit for work within NPCA Regulation Lands and wetlands ■ Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: ■ No in-water work from September 1 – July 15 of any given year in Six Mile Creek/Airport Drain 3 (Class D). ■ No in-water work from March 15 – July 15 at the remaining watercourses/drains. Terrestrial: ■ No vegetation removal within the breeding bird nesting period of April 1 to August 31 ■ No tree removal within active bat season of March 15 to November 30	3
7	ABL	Lock 3 Pump Station force main and QEW crossing	Natural Heritage Features: ■ 1 watercourse/ drain ■ 5 unevaluated wetlands ■ 1 significant woodland ■ 3 woodlands ■ SWH: Colonial Waterbird Nesting Area SAR: ■ Terrestrial: Bank Swallow, Bat SAR, Bobolink, Chimney Swift, Cucumber Tree, Eastern Flowering Dogwood, Eastern Meadowlark, Least Bittern, Red-headed Woodpecker Policy Areas: ■ NPCA Regulation Lands ■ NPCA Groundwater Protection Quantity HVA ■ Greenbelt Designated Area	■ DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization ■ Section 28 permit for work within NPCA Regulation Lands and wetlands ■ Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: ■ No in-water work from March 15 – July 15 in the Welland Canal. Terrestrial: ■ No vegetation removal within the breeding bird nesting period of April 1 to August 31 ■ No tree removal within active bat season of March 15 to November 30	3
8	ABL	New Pump Station at Steward Road and storage pond	Natural Heritage Features: ■ 1 watercourse/ drain ■ 7 unevaluated wetlands ■ 4 significant woodlands ■ 8 woodlands ■ SWH SAR: ■ Terrestrial: Bank Swallow, Bat SAR, Bobolink, Chimney Swift, Cucumber Tree, Eastern Flowering Dogwood, Least Bittern, Red-headed Woodpecker Policy Areas: ■ NPCA Regulation Lands ■ NPCA Groundwater Protection Quantity HVA ■ Greenbelt Designated Area	■ DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization ■ Section 28 permit for work within NPCA Regulation Lands and wetlands ■ Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: ■ No in-water work from March 15 – July 15 in the Welland Canal. Terrestrial: ■ No vegetation removal within the breeding bird nesting period of April 1 to August 31 ■ No tree removal within active bat season of March 15 to November 30	4

Alternative ID	System	Description	Conditions and Environmental Considerations	Potential Permits and Approvals	Restricted Timing Window	Assessment of Impacts
9	ABL	Lock 3 Pump Station forcemain and Skyway crossing	Natural Heritage Features: ■ 2 watercourses/ drains ■ 1 evaluated provincially significant wetland (Welland Canal North Turn Basin Wetland Complex) and 7 unevaluated wetlands ■ 2 significant woodlands ■ 4 woodlands ■ SWH: Colonial Waterbird Nesting Area SAR: ■ Terrestrial: Bank Swallow, Bat SAR, Bobolink, Chimney Swift, Cucumber Tree, Eastern Flowering Dogwood, Eastern Meadowlark, Least Bittern, Red-headed Woodpecker Policy Areas: ■ NPCA Regulation Lands ■ NPCA Groundwater Protection Quantity HVA ■ Greenbelt Designated Area	■ DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization ■ Section 28 permit for work within NPCA Regulation Lands and wetlands ■ Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries ■ No in-water from March 15 – July 15 in the Welland Canal and remaining watercourses/drains. Terrestrial: ■ No vegetation removal within the breeding bird nesting period of April 1 to August 31 ■ No tree removal within active bat season of March 15 to November 30	4
10	ABL	PS at Steward Road and Queenston Road	Natural Heritage Features: ■ 1 watercourse/ drain ■ 2 unevaluated wetlands ■ 1 significant woodland ■ 9 woodlands ■ SWH: Colonial Waterbird Nesting Area SAR: ■ Terrestrial: Bank Swallow, Bat SAR, Bobolink, Chimney Swift, Cucumber Tree, Eastern Flowering Dogwood, Eastern Meadowlark, Least Bittern, Red-headed Woodpecker Policy Areas: ■ NPCA Regulation Lands ■ NPCA Groundwater Protection Quantity HVA ■ Greenbelt Designated Area	■ DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization ■ Section 28 permit for work within NPCA Regulation Lands and wetlands ■ Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: ■ No in-water work from March 15 – July 15. Terrestrial: ■ No vegetation removal within the breeding bird nesting period of April 1 to August 31 ■ No tree removal within active bat season of March 15 to November 30	3
11	ABL	Lock 3 Pump Station storage and Skyway crossing	Natural Heritage Features: ■ 5 watercourses / drains, including two Class D drains ■ 1 evaluated-other wetland (Lincoln Airport Wetland Complex) and 9 wetlands ■ 4 significant woodlands ■ 8 woodlands ■ SWH: Colonial Waterbird Nesting Area SAR: ■ Terrestrial: Bank Swallow, Bat SAR, Bobolink, Chimney Swift, Cucumber Tree, Eastern Flowering Dogwood, Eastern Meadowlark, Least Bittern, Red-headed Woodpecker Policy Areas: ■ NPCA Regulation Lands ■ NPCA Groundwater Protection Quantity HVA and SGRA ■ Greenbelt Designated Area	■ DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization ■ Section 28 permit for work within NPCA Regulation Lands and wetlands ■ Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries ■ No in-water work from September 1 – July 15 of any given year at Six Mile Creek/Airport Drain 2 and Airport Drain 6 (Class D). ■ No in-water from March 15 – July 15 in the Welland Canal and remaining watercourses/drains. Terrestrial: ■ No vegetation removal within the breeding bird nesting period of April 1 to August 31 ■ No tree removal within active bat season of March 15 to November 30	5

Alternative ID	System	Description	Conditions and Environmental Considerations	Potential Permits and Approvals	Restricted Timing Window	Assessment of Impacts
13	ABL	Siphon, pipe from Lock 6 reservoir to ABL with QEW crossing	Natural Heritage Features: 5 watercourses / drains, including two Class D drains 1 evaluated provincially significant wetland (Welland Canal North Turn Basin Wetland Complex), 1 evaluated-other wetland (Lincoln Airport Wetland Complex), and 12 unevaluated wetlands 5 significant woodlands 7 woodlands - SWH: Mixed Wader Nesting Colony, Colonial Waterbird Nesting SAR: - Aquatic: American Eel, Redside Dace (<i>Clinostomus elongatus</i>) - Terrestrial: Allegheny Mountain Dusky Salamander (<i>Desmognathus ochrophaeus</i>), Bank Swallow, Bat SAR, Bobolink, Chimney Swift, Cucumber Tree, Eastern Flowering Dogwood, Eastern Meadowlark, Least Bittern, Northern Dusky Salamander (<i>Desmognathus fuscus</i>), Mottled Duskywing (<i>Erynnis martialis</i>), Red-headed Woodpecker Policy Areas: - NPCA Regulation Lands - NPCA Groundwater Protection Quantity HVA and SGRA - Greenbelt Designated Area	- DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization - Section 28 permit for work within NPCA Regulation Lands and wetlands - Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: - No in-water work from September 1 – July 15 of any given year at Six Mile Creek/Airport Drain 2 and Airport Drain 6 (Class D). - No in-water from March 15 – July 15 in the Welland Canal and remaining watercourses/drains. Terrestrial: - No vegetation removal within the breeding bird nesting period of April 1 to August 31 - Avoid activities at or near springs and seeps within salamander breeding and migration window of March 1 to October 30 - No tree removal within active bat season of March 15 to November 30	5
14	FMC	Siphon, pipe from Lock 6 reservoir to FMC	Natural Heritage Features: 2 watercourses / drains 1 evaluated provincially significant wetland (Welland Canal North Turn Basin Wetland Complex), 2 evaluated-other wetland (Lincoln Airport Wetland Complex and Upper Six Mile Creek Wetland Complex), and 14 unevaluated wetlands 7 significant woodlands 5 woodlands - SWH: Mixed Wader Nesting Colony, Colonial Waterbird Nesting SAR: - Aquatic: American Eel - Terrestrial: Allegheny Mountain Dusky Salamander, Bank Swallow, Bat SAR, Bobolink, Chimney Swift, Cucumber Tree, Eastern Flowering Dogwood, Eastern Meadowlark, Least Bittern, Northern Dusky Salamander, Mottled Duskywing, Red-headed Woodpecker Policy Areas: - NPCA Regulation Lands - NPCA Groundwater Protection Quantity HVA and SGRA - Greenbelt Designated Area	- DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization - Section 28 permit for work within NPCA Regulation Lands and wetlands - Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: - No in-water from March 15 – July 15 in the Welland Canal (to be confirmed with MNR) and remaining watercourses/drains Terrestrial: - No vegetation removal within the breeding bird nesting period of April 1 to August 31 - Avoid activities at or near springs and seeps within salamander breeding and migration window of March 1 to October 30 - No tree removal within active bat season of March 15 to November 30	5
15	ABL	ABL Pump Station at Steward Road and storage, force main along Queenston Road	Natural Heritage Features: 4 watercourses / drains, including two Class D drains 3 unevaluated wetlands 1 significant woodland 9 woodlands - SWH: Colonial Waterbird Nesting SAR: - Terrestrial: Bank Swallow, Bat SAR, Bobolink, Chimney Swift, Cucumber Tree, Eastern Flowering Dogwood, Eastern Meadowlark, Least Bittern, Red-headed Woodpecker Policy Areas: - NPCA Regulation Lands - NPCA Groundwater Protection Quantity HVA and SGRA - Greenbelt Designated Area	- DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization - Section 28 permit for work within NPCA Regulation Lands and wetlands - Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: - No in-water work from September 1 – July 15 of any given year in Six Mile Creek/Airport Drain 2 and Airport Drain 6 (Class D). - No in-water from March 15 – July 15 in the Welland Canal (to be confirmed with MNR) and remaining watercourses/drains. Terrestrial: - No vegetation removal within the breeding bird nesting period of April 1 to August 31 - No tree removal within active bat season of March 15 to November 30	4

Alternative ID	System	Description	Conditions and Environmental Considerations	Potential Permits and Approvals	Restricted Timing Window	Assessment of Impacts
16	ABL	Update Carlton Street existing siphon	Natural Heritage Features: ■ 2 watercourses / drains ■ 1 evaluated-other wetland (Upper Eight Mile Creek Wetland) and 1 unevaluated wetland ■ 1 significant woodland ■ SWH: Colonial Waterbird Nesting Area SAR: ■ Terrestrial: Bank Swallow, Bat SAR, Bobolink, Chimney Swift, Cucumber Tree, Eastern Meadowlark, Least Bittern, Red-headed Woodpecker Policy Areas: ■ NPCA Regulation Lands ■ NPCA Groundwater Protection Quantity HVA and SGRA ■ Greenbelt Designated Area	■ DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization pending syphon updates ■ Section 28 permit for work within NPCA Regulation Lands and wetlands ■ Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: ■ No in-water from March 15 – July 15 in the Welland Canal (to be confirmed with MNR) and remaining watercourses/drains. Terrestrial: ■ No vegetation removal within the breeding bird nesting period of April 1 to August 31 ■ No tree removal within active bat season of March 15 to November 30	2
17	HR	Repairs and Upgrades to OPG Reservoir and Siphon	Natural Heritage Features: ■ 2 unevaluated wetlands ■ 1 significant woodland ■ 4 woodlands ■ SWH: Mixed Wader Nesting Colony SAR: ■ Terrestrial: American Chestnut, Bank Swallow, Bat SAR, Bobolink, Butternut, Eastern Flowering Dogwood, Eastern Meadowlark, Deerberry, Fern-leaved Yellow False Foxglove, Least Bittern, Red Mulberry, Red-headed Woodpecker, White Wood Aster Policy Areas: ■ NPCA Regulation Lands ■ NPCA Groundwater Protection Quantity HVA and SGRA ■ Greenbelt Designated Area	■ DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization pending syphon updates ■ Section 28 permit for work within NPCA Regulation Lands and wetlands ■ Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: ■ No in-water work from September 15 – July 15 of any given year. Terrestrial: ■ No vegetation removal within the breeding bird nesting period of April 1 to August 31 ■ No tree removal within active bat season of March 15 to November 30	3
18	HR	Dee Road Pumping Station Upgrades	Natural Heritage Features: ■ 1 watercourse ■ 1 significant woodland ■ SWH: Mixed Wader Nesting Colony SAR: ■ Aquatic: American Eel, Lake Sturgeon (Great Lakes - Upper St. Lawrence River population; <i>Acipenser fulvescens</i>) ■ Terrestrial: American Chestnut, American Columbo Allegheny Mountain Dusky Salamander, Bank Swallow, Bat SAR, Bobolink, Butternut, Chimney Swift, Deerberry, Fern-leaved Yellow False Foxglove, Least Bittern, Red Mulberry, Red-headed Woodpecker, White Wood Aster Policy Areas: ■ NPCA Regulation Lands ■ NPCA Groundwater Protection Quantity HVA ■ Greenbelt Designated Area	■ DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization (pump installation) ■ Section 28 permit for work within NPCA Regulation Lands and wetlands ■ Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: ■ No in-water works from September 15 – July 15 of any given year Niagara River (Dee Road pump station). Terrestrial: ■ No vegetation removal within the breeding bird nesting period of April 1 to August 31 ■ Avoid activities at or near springs and seeps within salamander breeding and migration window of March 1 to June 30 ■ No tree removal within active bat season of March 15 to November 30	3

Alternative ID	System	Description	Conditions and Environmental Considerations	Potential Permits and Approvals	Restricted Timing Window	Assessment of Impacts
19	FMC	Virgil Dam Upgrades	Natural Heritage Features: 1 evaluated-other wetland (Virgil Conservation Area Wetland Complex) 1 significant woodland 1 woodland SAR: - Terrestrial: Bank Swallow, Bat SAR, Bobolink, Chimney Swift, Deerberry, Eastern Meadowlark, Fern-leaved Yellow False Foxglove, Least Bittern, Red-headed Woodpecker Policy Areas: - NPCA Regulation Lands - NPCA Groundwater Protection Quantity HVA - Greenbelt Designated Area	- DFO Request for Review should in-water work be required - Section 28 permit for work within NPCA Regulation Lands and wetlands - Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: - No in-water work from March 15 – July 15 (to be confirmed with MNR). Terrestrial: - No vegetation removal within the breeding bird nesting period of April 1 to August 31 - No tree removal within active bat season of March 15 to November 30	2
20	HR	Whirlpool pumping station upgrades	Natural Heritage Features: 2 woodlands - SWH: Mixed Wader Nesting Colony SAR: - Aquatic: Fawnsfoot (<i>Truncilla donaciformis</i>), Hickorynut (<i>Obovaria olivaria</i>), Kidneyshell (<i>Ptychobranthus fasciolaris</i>), Lake Sturgeon (Great Lakes - Upper St. Lawrence River population), Round Pigtoe (<i>Pleurobema sintoxia</i>) - Terrestrial: American Water-willow (<i>Justicia americana</i>), Bank Swallow, Bat SAR, Bobolink, Butternut, Chimney Swift, Eastern Meadowlark, Deerberry, Drooping Trillium (<i>Trillium flexipes</i>), Four-leaved Milkweed (<i>Asclepias quadrifolia</i>), Northern Dusky Salamander, Least Bittern, Red-headed Woodpecker Policy Areas: - NPCA Regulation Lands - NPCA Groundwater Protection Quantity HVA - Greenbelt Designated Area	- DFO Request for Review should in-water work be required; potential for <i>Fisheries Act</i> Authorization pending upgrades - Section 28 permit for work within NPCA Regulation Lands and wetlands - Potential approval/authorization under the amended ESA and/or registration under the SCA* for SAR	Fisheries: - No in-water work from September 15 – July 15 of any given year. Terrestrial: - No vegetation removal within the breeding bird nesting period of April 1 to August 31 - No vegetation removal near wetlands within salamander breeding and migration window of March 1 to June 30 - No tree removal within active bat season of March 15 to November 30	3

Notes: Systems: Airport-Bright Lavigne (ABL), Harrison / Routh (HR), Four Mile Creek (FMC)
Natural Heritage Features: Species at Risk (SAR), Significant Wildlife Habitat (SWH)
Policy Areas: Highly Vulnerable Aquifers (HVA), and Significant Groundwater Recharge Area (SGRA)
Regulatory Agencies: Niagara Peninsula Conservation Authority (NPCA), Fisheries and Ocean Canada (DFO), Ministry of Natural Resources (MNR)
Private Landowners: Ontario Power Generation (OPG)
*Species Conservation Act, 2025 (SCA) is not yet in effect. Upon commencement, the SCA will replace the amended Endangered Species Act, 2007 (ESA).

Assessment of Impacts Ranking System:

- 1: Low impact
- 2: Low to moderate impact
- 3: Moderate impact
- 4: Moderate to high impact
- 5: High impact

5.2.1 Potential Permit & Approval Summary

5.2.1.1 Endangered Species Act, 2007 (ESA; as Amended 2025)

The *Endangered Species Act, 2007* sets out Ontario's framework for identifying Species at Risk (SAR), protecting their habitats, and supporting their recovery. It includes prohibitions on harming listed species or damaging their habitat and provides mechanisms such as recovery strategies, management plans, and permits that outline conditions under which certain activities may proceed.

The proposed irrigation solution activities have the potential to affect SAR and/or SAR habitat. As a result, further evaluation of the preferred alternative solutions will be required to confirm the type and extent of potential impacts and to identify whether any permitting or approval considerations under the ESA may apply.

5.2.1.2 Species Conservation Act, 2026 (SCA)

The forthcoming *Species Conservation Act, 2026* is expected to replace the current amended ESA and introduce a streamlined, "registration-first" framework intended to speed up provincial approvals while retaining core species and habitat protections. It is anticipated to protect roughly the same suite of species through new regulations, outline which activities may proceed through online registration versus MECP permitting, and establish conditions for registerable and permit-based activities. For preferred alternatives or solutions, additional field investigations would be required to confirm the presence or absence of SAR and SAR habitat, and to determine applicable permitting and regulatory requirements.

5.2.1.3 Fisheries Act, 1985

In-water works that may result in the harmful alteration, disruption, or destruction of fish habitat (HADD) or the death of fish may require authorization under the federal *Fisheries Act*, administered by Fisheries and Oceans Canada (DFO). Proponents must assess potential impacts to fish and fish habitat, implement avoidance and mitigation measures, and, where residual effects remain, provide offsetting measures. Where works are proposed below the 2-year water level (i.e., within the active channel), proponents should assess the potential for impacts to fish and fish habitat. If the works cannot avoid causing harm, or if uncertainty exists, a request for review may be submitted to Fisheries and Oceans Canada (DFO) to determine whether authorization is required.

5.2.1.4 Species at Risk Act, 2002

The *Species at Risk Act*, 2002 (SARA) is federal legislation requiring monitoring and protection of Species at Risk in Canada. Species listed as Extirpated, Endangered or Threatened under SARA, and their residences are only protected on federal lands unless they are also aquatic species or migratory birds listed on Schedule 1 under the MBCA. No federally regulated aquatic species were identified for any of the proposed alternatives.

5.2.1.5 Conservation Authorities Act, 1990

Under Section 28 of the *Conservation Authorities Act*, a permit is required for development, interference with wetlands, or alterations to shorelines and watercourses within regulated areas. The purpose is to prevent or reduce risks related to flooding, erosion, dynamic beaches, and unstable soils. Applications must include technical studies demonstrating that the proposed works will not adversely affect natural hazards or ecological functions.

5.2.1.6 Ontario Water Resources Act, 1990

Under the *Ontario Water Resources Act* and *Ontario Regulation 387/04*, a Permit to Take Water (PTTW) is required for any water taking exceeding 50,000 litres per day. Any surface water withdrawal above this threshold must be authorized by the Ontario Ministry of the Environment, Conservation and Parks (MECP).

Given the scale of irrigated land and the anticipated seasonal irrigation demand, irrigation systems serving this area would exceed the 50,000 L/day threshold and therefore require a Permit to Take Water.

6. Design Requirements & Upgrades

6.1 Investigated System Solutions

6.1.1 Control Structures and Automation

With in the Irrigation system there are currently five weirs

- NOTLWIER003, 004 and 5 are Armttec control structures installed as part of the 1998 report. The existing controls are currently working well but are manually operated.
- NOTLWIER 001 is a custom concrete structure and headwall with a 300-millimetre and 450-millimetre pipe with a valve to direct the flow.
- NOTLWER 002 is rock check dam with a 750-millimetre HDPE pipe.

The existing weirs are manual, and currently, if an irrigation user upstream of the weirs wants water to irrigate their crop, they will call the irrigation superintendent to manually open the weirs to direct the water. The same applies to the pumping system: it is operated manually when water is needed. The newer Dee Road pumping station utilize VFDs which assist with energy efficiency but many of the other pumping station in the systems do not currently have this available.

The addition of monitoring, level and flow equipment with a SCADA system can automate the process of opening and closing weirs and starting and stopping pumps would save time for the irrigation superintendent and Town staff and greatly enhance delivery to irrigation users. A SCADA system would allow for full operation control across the municipality allowing for real time changes and data that takes weather into consideration for automatic adjustments in operation. Long term data such as energy and water usage information can also be added to the functionality for trend analysis and reporting requirements. The data collected can also help the Town find efficiencies in the system and determine where operational spending is needed and using condition based monitoring to detect issues with pumps and valves can allow the Town to react in a planned approach instead of running till failure.

An automated system can be hardwired using local internet connection (lower investment) and would provide remote access and monitoring. Advancements in PLC technology, equipment can be installed with wireless functionality using a web-based application. A wireless solution would allow for connectivity across a large area which would allow for online, cloud-based access anywhere in the area but would run at a higher investment.

Overall, an automated system would provide the following benefits:

- **Labor Reduction:** reduces the need for manual operation of weirs and pump
- **Energy Efficiency:** Pumps using VFDs can run at optimum speeds, minimizing energy consumption
- **Water Usage:** Automated systems use water more efficiently, reducing overall usage
- **Improved Agriculture:** Automated system can predict water needs based on local weather patterns and the type of crop.
- **Accessibility:** The Town would be able to monitor and access real time information from any device to check the status of the system
- **Reduced Maintenance:** monitoring can detect issues with pumps, valves and low water levels ahead of time to prevent expensive repairs and unplanned downtime.

Upon discussions with the irrigation superintendent and irrigation board, there is a preference to the manual nature of the system which allows for workers to be present during the start up and shut down of equipment and to monitor any issues right at the source. AECOM's recommendation would still be to consider automation in some capacity to assist with data collection and overall health of the system.

6.1.2 Channel/Culvert Cleaning/Maintenance

As discussed in previous sections and outlined in Table 11 and Table 18 the long-term success of the existing system and the proposed infrastructure upgrades, specifically the doubling of pumping capacity at the Eastchester Pumping Station and the intensification of the Harrison/Routh system, is fundamentally dependent on a rigorous and proactive maintenance regime. The open-channel network, comprised of municipal drains and natural creeks, currently suffers from significant hydraulic inefficiencies that must be addressed to sustain the target Level of Service.

6.1.2.1 Vegetation Management and Phragmites Control

The invasion of Phragmites Australis and other aquatic vegetation (e.g., cattails) represents a critical risk to system conveyance. These species significantly increase the Manning's roughness coefficient, which reduces the maximum flow velocity and effective capacity of the channels. Overgrowth of plants and invasive species takes up water that could be used by irrigators.

Figure 25: Phragmites in Irrigation Channel



A targeted intensive, seasonal herbicidal and mechanical removal program is mandatory to prevent these invasive species from choking flow-critical reaches. Failure to control vegetation will lead to unauthorized overtopping and insufficient freeboard when the doubled pumping rates are active. This should be done in the upper reaches of the system in the irrigation channels and the top 500 metres of the drains. In areas of heavy phragmites this should be done multiple times a season.

Current recommended herbicides for phragmite use in Canada include glyphosate and imazapyr for overland application. These are not species specific, and care should be taken to avoid harming native plants. The use of a licensed Contractor in Ontario is also required to undertake a screening, particularly with the presence of water where “Ontario’s in water Work Timing Window Guidelines” would apply. The Government of Ontario has issued “Invasive Phragmites best management practices” that summarises the following for herbicide placement based on proximity to:

Table 22: Phragmites Control Best Management Practices

Phragmites Location	Herbicide Use	Other Alternative
Where there is standing water present	Herbicides CANNOT be applied.	Cut/mow the stalks as low as possible. Tarping/solarization is another option, but may not be as effective in standing water
Where the water level can be controlled	Only if there is no water present	Cut/mow the stalks as low a height as possible. Maintain the water level so that it remains a minimum of 1.5 metres taller than the entire stand for a period of at least 6 weeks
Where there is no standing water present:	Perform wildlife assessments and time herbicide application appropriately. Monitor and perform follow-up treatments as necessary	If necessary, mow or roll the stand to compact the dead biomass. If appropriate, perform a prescribed burn in the area.

The Ministry of Transportation “Environmental Guide for Managing Invasive Phragmites (*Phragmites australis australis*) – Best Management Practices Indigenous Relations and Environmental Policy Branch” provides details for herbicide application and section 5.2 outlines requirements for spraying near water that would apply to the irrigation system.

As use of herbicides is limited near water, the Town may consider partnering with Agriculture and Agrifood Canada and The University of Toronto who are currently studying biological control such as caterpillars/moths for the control of phragmites.

6.1.2.1.1 Phragmites Control References

Multiple resources are available on the Town’s website including:

- “Phragmites Australis Fact Sheet”
- “Smart Practices for Controlling Invasive Phragmites in Ontario’s Roadside Ditches Vegetated Buffers & Invasive Species (Phragmites)”.
- Presentation materials from a public workshop that was conducted by the Town in March 2016 on invasive species (phragmites) to discuss vegetated buffers along municipal drain watercourses

An article from July 2026 titled “Town Niagara-on-the-Lake Undertaking Targeted Vegetation Management to Control Invasive Phragmites and Maintain Road Safety”. There are multiple groups aimed at tackling the phragmites issues in Ontario and they provide multiple resources:

- Invasive Species Center: funded by the Invasive Species Action Fund (ISAF) and is a program designed to facilitate on-the-ground management and

monitoring of invasive species in Ontario. The program is supported by the Ontario Ministry of Natural Resources (MNR), and they have issued the document “Best Management Practice Technical Document for Land Managers”

- Ontario Phragmites Action: is a program funded by the Ontario’s Ministry of Natural Resources and is implemented by the Invasive Species Centre, Nature Conservancy of Canada.
- Ontario Phragmites Working Group: aimed at reducing the current threats posed by this aggressive invasive plant to biodiversity and Species at Risk (SAR) through habitat protection and restoration.

6.1.2.2 Sediment Removal and Reservoir Desilting

Site investigations have confirmed that many system segments and storage assets, such as the Virgil Ponds (Four Mile Creek Reservoir), are currently compromised by heavy sedimentation. Excessive sediment not only reduces storage volumes but also leads to premature wear on pump impellers and clogs intake screens.

Regular desilting of these reservoirs and the primary supply channels (e.g., the Eastchester supply line) is required to restore the design cross-sections used in the hydraulic model. The irrigation channels and culverts should also be cleaned and returned to the original designed sloping to improve delivery.

6.1.3 Hydraulic Bottleneck Remediation

Conveyance capacity is often restricted by undersized or damaged culverts. A notable example is the 800-millimetre culverts at Eastchester Avenue, which provide a capacity (0.2091 cubic metres per second) that is lower than the required pumping output (0.2524 cubic metres per second).

Maintenance Objective: Maintenance inspections must prioritize identifying "choke points" where debris accumulation further reduces the already limited capacity of these structures. Culvert cleaning and the repair of damaged soffits (e.g., at Stone Road) are essential to prevent backwater effects and road-base saturation.

6.1.3.1 Verification via Manning’s Analysis and Modelling

To move from a manual "on-demand" system toward an optimized, scheduled delivery model, maintenance must be treated as a hydraulic benchmark.

Technical Integration: It is recommended that the Town utilize high-fidelity hydraulic modelling (InfoWater) to establish "Post-Maintenance" vs. "Pre-Maintenance" flow capacities.

Standardized Roughness Targets: Maintenance teams should aim to maintain channels to specific Manning's coefficients assumed in the 2026 design phase (e.g., for vegetated traps vs. for clean earthen channels) to ensure that the increased volumes resulting from the upgrades can be safely conveyed without risk of system-wide overflows.

6.1.3.2 State-of-Good-Repair Funding

Given the dual nature of these conduits as both irrigation supply and municipal drainage, the Town should continue to leverage the Drainage Act and the Town Act to facilitate cost-sharing for maintenance. This ensures that the financial burden of desilting and vegetation control is equitably distributed, supporting the 25-year capital plan's sustainability goals.

6.1.4 Storage

Four potential storage sites were reviewed to provide drought storage for the Airport Lavigne Bright system and can be seen labelled in Figure 24. The criteria for ideal storage sites should be considered for selection:

- Be near the top of the system:
 - A storage location near the top of the system, if large enough, could provide water to the entire system.
- Be on vacant land that is not good for agricultural use:
 - The irrigation board indicated that they did not want to remove buildings, orchards, or vineyards.
- Be within the municipality:
 - A site within the municipality's boundary would allow the municipality staff to more easily maintain and operate the storage area
- Be near the existing system channels and culverts:
 - Having the storage site near the existing system would allow for quick and easy water transfer
- Be accessible by road.

From the four considered locations, three met the criteria above. These storage areas would require land acquisition, and, based on reviewing the existing MLS listings in the area for vacant land, an estimated value of \$95,000 to \$400,000 per hectare would be expected, with a 10-hectare storage area costing between \$950,000 and \$4,000,000. Construction costs for a pond this size would be about \$30 per cubic metre or \$30,000,000 for excavating 100,000 cubic metres of soil. Due to high land values and construction costs in the area, creating large storage reservoirs would be cost-prohibitive, and the Region and Irrigation Committee has indicated that land acquisition would not be a preferred option.

An alternative to purchasing land and implementing a storage point would be to use existing privately owned farm ponds more effectively. Using GIS data and available maps, an analysis of the existing ponds and waterbodies within the municipality was conducted. It was found that approximately 59 hectares of land in the municipality are currently waterbodies, excluding the Virgil reservoirs. If 50% of these existing waterbodies can be used for storage and irrigation, the municipality may currently have more storage capacity than the existing reservoirs or the creation of a new storage area. In addition, the private farm ponds are already located where irrigators need and want them, and they would have direct access to them. A municipal program to inventory these ponds and educate farmers on their use and the management of existing waterbodies would assist the irrigation system during drought conditions.

Figure 26: Photo of Existing Irrigation Pond



6.2 Harrison/Routh System Investigated Solutions

6.2.1 Ontario Power Generation Siphon

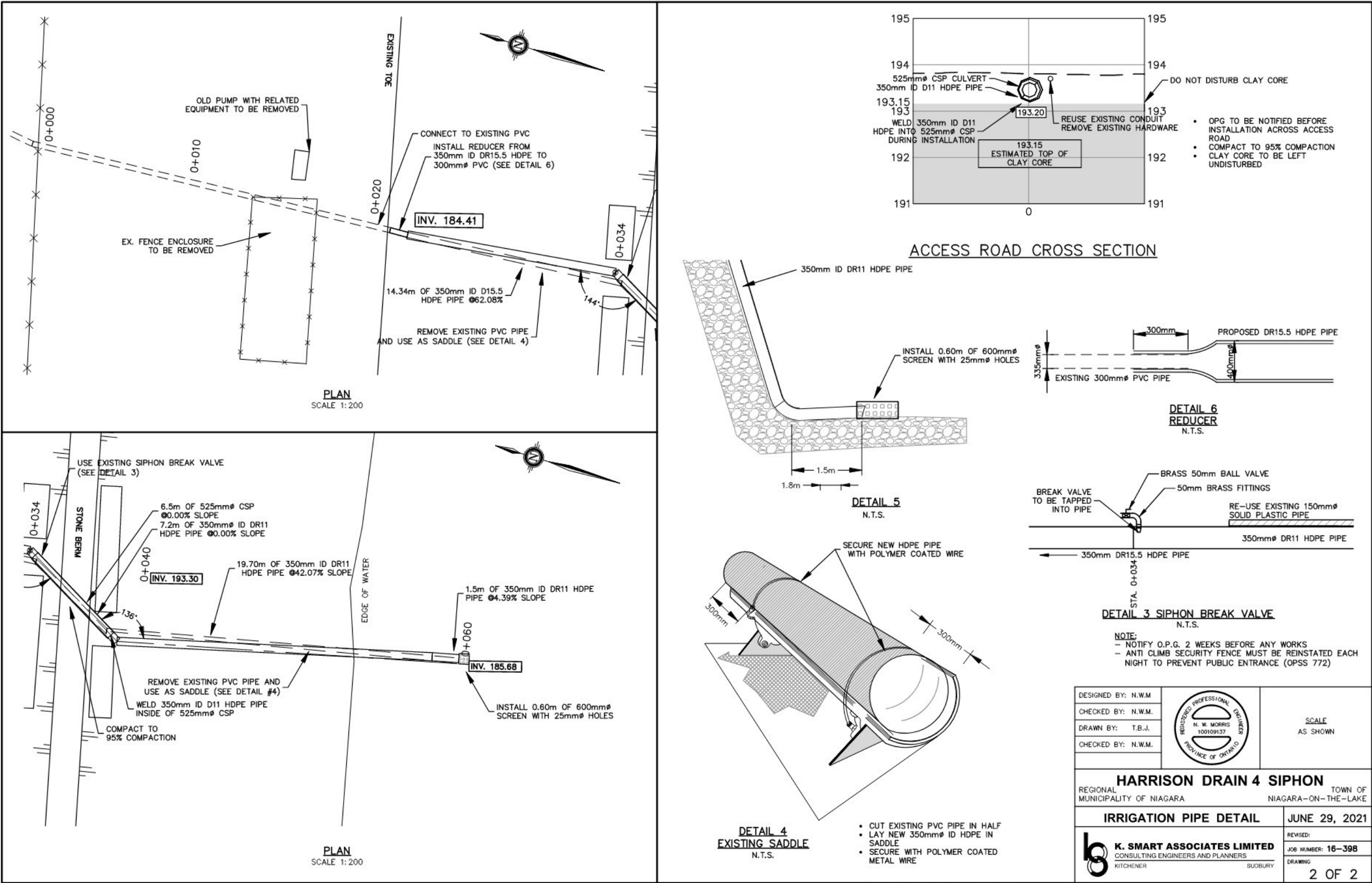
The Ontario Power Generation (OPG) siphon is an existing infrastructure, but it did not operate in 2013, 2016, 2021, 2022, 2023, 2024, and 2025, according to the town flow records. As shown in the 2013 aerial photograph, the pipe was destroyed, and the Town has since attempted to repair the system, as shown in the 2018 aerial photograph. The Town staff have not been able to maintain the siphon's operations since 2021, and it has not been used since. Based on photos and site visits, the remaining part of the siphon to the north of the crest of the Ontario Power Generation berm appears to be in good condition and operational.

Figure 27: Destroyed Siphon 2013 and Repaired Siphon 2018



Based on available information at the time of review, there is an existing plan to repair the damaged siphon by K. Smart Associates in 2021, which would replace the existing 300-millimetre PVC pipe with a 300-millimetre HDPE fused pipe. The fused pipe is recommended because it would be a continuous, jointless pipe that is flexible and strong enough to withstand the ice shove in the reservoir, but it would need to be installed by a specialized contractor.

Figure 28: OPG Siphon Repair by K. Smart



The old siphon design was set at an elevation above the reservoir's low operating level, and the siphon would be broken throughout the year when the reservoir was emptied. It is critical that any updates to the siphon inlet be placed below the reservoir's low operating level, or a sensor should be installed at the inlet to automatically shut off the siphon to prevent damage. In the design, a bleed valve was proposed at the top of the siphon to drain it during the winter season, along with a tee at the north side of the Ontario Power Generation berm to allow the siphon to be primed with a vacuum pump.

The existing berm is sensitive infrastructure for Ontario Power Generation; replacing or repairing the siphon can only be done while working on the berm and cannot include excavation or tunnelling of any part of the berm, based on past discussions. Extensive consultation and coordination with Ontario Power Generation would be required to repair the siphon and the construction access, and progress would be closely monitored. The reservoir is fenced and gated, and municipal staff are permitted entry throughout the irrigation season. The proximity to the highway also makes this work more difficult and may require additional coordination with the Ministry of Transportation, as seen in Figure 29.

Figure 29: OPG Siphon Highway Crossing



If the siphon is to be repaired as part of this project, the outlet would need to be extended north of the Bruce Trail, as the existing outlet is approximately 10 metres from the Bruce Trail on the other side of the highway, as seen in Figure 30. The current outlet is a public safety hazard, as water freely flows over the trail and along the escarpment, and there have been concerns about washout and flooding of the trail. The Bruce Trail is a public trail, and any additions or changes would require input from the Bruce Trail Conservancy, the Niagara Escarpment Commission, the Niagara Parks Commission, and the Niagara Peninsula Conservation Authority. Ongoing discussions have indicated the need for a proper crossing (small bridge) if the irrigation water is to remain free-flowing, or the system will have to be piped to a proper, safer outlet location outside the trail area.

Figure 30: OPG Siphon Outlet



At this time, the Ontario Power Generation siphon, when running, provides about 35% of the water for the Harrison/Routh system. Repairing the siphon would not supply the Harrison/Routh system with the required 18.93 cubic metres per minute (5,000 gallons per minute) and would only supply about 12.11 cubic metres per minute (3,200 gallons per minute). This should be considered a secondary source during drought or pump maintenance periods.

6.2.2 Dee Road Pumping Station

6.2.2.1 Existing Conditions

The Harrison/Routh Irrigation System originates in the village of Queenston at the Dee Road Pumping Station (the location of the Dee Road Pump Station is shown in (Figure 31), which withdraws water directly from the Niagara River. The pumping station was expanded in 2017 and currently contains two electrically driven centrifugal pumps shown in Figure 32, with provision made within the station layout for the future installation of a third pump.

Figure 31: Location of the Dee Road Pump Station

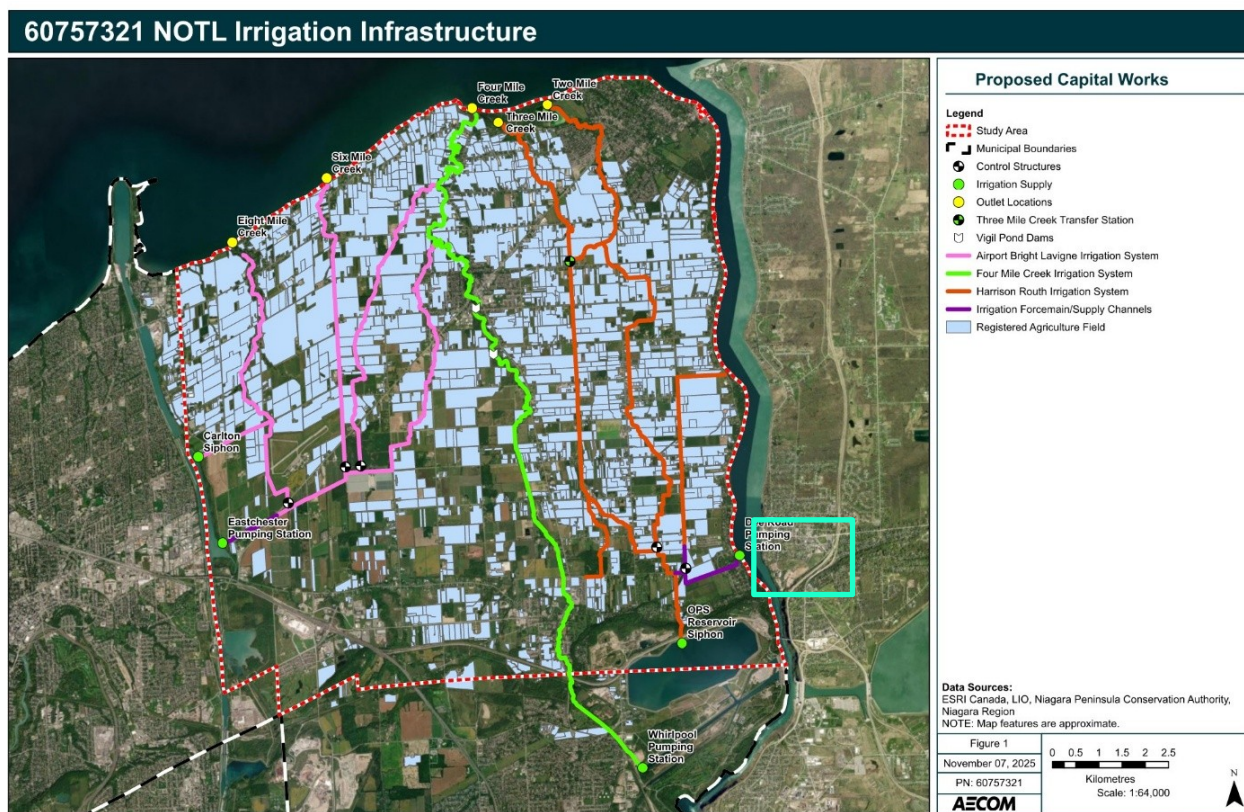


Figure 32: Existing Pumps at Dee Road Pump Station



The existing pumps each rated at approximately 150-kilowatt (200-horsepower). The pumps are equipped with Variable Frequency Drives (VFD) to allow modulation of pump output in response to varying irrigation demands. Technical data of the existing pumps is provided below.

Table 23: Technical Data Existing Pumps at Dee Road Pump Station

Item	Existing Pumps
Manufacturer/ Pump Type	Goulds Pumps
Model	3175
Number of Units	2
Specified Unit Capacity, Litres per Second	315
Firm Capacity, Litres per Second	569
Motor Power, Kilowatts	122.3
Head, Metres	33

Water from the pumping station is conveyed through a 750-millimetre diameter transmission main, which extends approximately 1,095 metres toward the irrigation distribution system.

A preliminary condition assessment of the Dee Road Pumping Station pumping equipment has been undertaken as part of a preliminary design. The assessment is based on available background information, installation records, and a high-level review

of system performance. Detailed mechanical, electrical, and structural inspections will be completed during subsequent stages of design if this option proceeds.

Based on the preliminary review, the following observations are noted:

- **Mechanical and Hydraulic Condition:** The two existing centrifugal pumps are operational and are currently performing in accordance with their intended design duty. No significant mechanical deficiencies have been identified at this stage. The pump configuration and hydraulic performance are appropriate for raw water withdrawal and irrigation conveyance service.
- **Age and Remaining Service Life:** The pumps were installed in 2017 and are therefore considered relatively modern assets with the potential for a substantial portion of their service life remaining, subject to maintenance and condition assessments. At the preliminary design level, the pumps are assumed to be suitable for continued operation, subject to routine maintenance and confirmation through detailed condition assessments at later project stages.
- **Consultation with the original equipment supplier** indicated that maintenance requirements at approximately 10 years of service should be informed by a review of available maintenance records, including confirmation of servicing performed, component replacements, and any operational issues experienced to date. With access to this information, the supplier can provide a more detailed condition assessment and refined maintenance recommendations.
- **As general guidance**, the supplier recommends undertaking a condition-based assessment to verify continued performance. This may include confirming that the pumps achieve their original shut-off head under controlled testing conditions and assessing operational performance through observation of noise and vibration. Routine maintenance should continue in accordance with the manufacturer's Installation, Operation, and Maintenance (IOM) manual (Appendix X). Depending on observed condition and service history, maintenance activities at this stage may include lubrication, mechanical and alignment checks, bearing replacement, and consideration of a power-end refurbishment kit.
- **Operational Flexibility:** The inclusion of variable frequency drives provides operational flexibility, allowing the pumping station to efficiently respond to fluctuating seasonal and daily irrigation demands. Variable speed operation also reduces hydraulic transients and limits wear associated with frequent start-stop cycles.

- **Capacity and Redundancy:** Based on the findings of the Master Plan, the Dee Road Pumping Station operates two pumps with a combined allowable discharge rate of approximately 315 litres per second (5,000 US gallons per minute). Although the pumping station infrastructure has a theoretical installed capacity of up to 569 litres per second (9,030 US gallons per minute), full utilization of this capacity is constrained by downstream hydraulic limitations within the receiving ditch, which cannot accommodate the higher flow rates.

Two potential upgrade options for the Dee Road Pumping Station have been identified to support increased pumping capacity and future system expansion. Option 1 reflects the irrigation committee's requested demand to add a third pump at the Dee Road Pumping Station and can meet the peak Harrison/Routh irrigation demand of 820 litres per second; however, it provides limited operational redundancy and only partial supply to the Four Mile Creek system during peak conditions. Option 2 suggests larger-capacity pumping upgrades informed by the water demand analysis for both the Harrison-Routh and Four Mile Creek systems while maintaining appropriate system redundancy.

6.2.2.2 Proposed Upgrade Option 1- Additon of Third 200 HP Pump

As per the requirements outlined in the irrigation committee's requested demand, to support future system demands and facilitate servicing of the Four Mile Creek System, it is proposed to upgrade the Dee Road Pumping Station by installing a third 150-kilowatt (200-horsepower) variable speed electric pump to increase the capacity of the pump station to 946 liters per second (15,000 US gallons per minutes).

A new pump has been selected to serve as the proposed third unit. The pump selection is based on the required operating flow range, available system head, and compatibility with the existing pumping station configuration.

The technical data of the selected pump are summarized in Table 24.

Table 24: Technical Data Existing Pumps at Dee Road Pump Station

Item	Proposed Pump
Manufacturer/ Pump Type	Goulds Pumps
Model	3175
Number of Units	1
Specified Unit Capacity, Litres per Second	315
Motor Power, Kilowatts	122.3
Head, Metres	33

The pumping station was originally designed with sufficient space to accommodate a third pump. Based on a preliminary assessment, the existing pumps, discharge piping, and overall operational philosophy are compatible with the future installation of an additional unit. Under the increased pumping capacity to 946 liters per second, the discharge velocity in the existing force main is approximately 2 metres per second, which is within acceptable design limits. Accordingly, the existing 750-millimetre force main is adequate to convey the increased pumping capacity.

A preliminary investigation of the intake components has been completed. The existing intake screen consists of a 1.22 metre diameter tee screen with an effective screen length of 2.28 metres and a maximum rated capacity of approximately 631 litres per second. Based on this assessment, the existing intake screen is not capable of accommodating the increased flow associated with the addition of a third pump. To address this limitation of the intake screen, a new intake screen has been selected to accommodate the increased design capacity of 946 liters per second, with a maximum intake screen velocity of 9.75 centimetre per second at peak flow. The key parameters of the proposed intake screen are summarized in Table 25.

Table 25: Key Parameters of The Proposed Intake Screen and Airburst System for Dee Road Pump Station

Component	Key Parameters
Intake Screen	Type: _____ T-Intake Screen OD: _____ 1.22 metres ESL: _____ 3.56 metres Capacity: _____ 946 litres per second Material: _____ 90/10 Copper Nickel Slot Size: _____ 1.02 millimetres Outlet Connection: _____ 760 millimetres Airburst Connection: _____ 102 millimetres

Regarding the airburst system, discussions were held with the vendor to evaluate the capability of the existing system in relation to the increased intake screen size. Based on these discussions and supporting calculations, it was confirmed that the existing airburst system is capable of accommodating a new intake screen and the associated piping as proposed.

The addition of a third pump is expected to result in the following operational benefits:

- **Increased Total Capacity:** With three pumps installed, the station would have a maximum theoretical capacity of up to 946 litres per second (15,000 US gallons per minute), subject to intake, discharge, and downstream system constraints.

- **Operational Flexibility:** Variable speed operation across three pumps will enable more efficient matching of pump output to system demand, potentially reducing energy consumption and wear on individual units.

System Expansion Capability: The added capacity is intended to also support delivery of water from Dee Road PS to the Four Mile Creek System.

While the addition of a third 150-kilowatt pump would increase overall station capacity and improve operational flexibility under average demand conditions, the following limitations have been identified at the preliminary design stage:

- The combined capacity of three 150-kilowatt (200-horsepower) pumps is sufficient to supply Harrison/Routh peak demand of approximately 820 litres per second, and the available residual capacity to supply the Four Mile Creek system during peak Harrison/Routh demand is limited to approximately 126 litres per second, which is approximately half of the full FMC peak demand of 270 litres per second.
- During peak demand periods (820 litres per second), all three pumps would be required to operate concurrently, resulting in no effective standby capacity and limited operational redundancy. Therefore, the configuration does not adequately address future system resilience during extreme drought events or unplanned pump outages.

The following considerations are identified and would require confirmation should this option advance.

- Evaluation of electrical service capacity, Motor Control Centres (MCC), Transformers and VFD integration to support the additional 150-kilowatt (200-horsepower) load.
- Review of control logic and instrumentation to ensure coordinated operation of all three pumps.
- It is suggested that a generator can be considered to provide power backup for the pumping station.

6.2.2.3 Proposed Upgrade Option 2- Larger Additional Pump(s) to Provide Redundancy

This option evaluates the feasibility of providing additional pumping capacity at the Dee Road Pumping Station through the installation of larger-capacity pump unit(s) to address the limitations identified under Option 1. While Option 1 can meet the peak Harrison/Routh irrigation demand, it does not provide sufficient operational redundancy during peak conditions. Option 2 is therefore assessed to determine whether additional

pumping capacity could be provided from Dee Road to the Four Mile Creek system and to improve overall system redundancy, while maintaining reliable operation under typical and peak demand conditions.

Implementation of Option 2 would require a comprehensive review of system constraints and supporting infrastructure. At the preliminary design stage, the following key considerations have been identified:

- **Hydraulic Capacity:** Verification of the capacity of the existing 750-millimetre discharge pipeline, intake works, and downstream conveyance system to confirm their ability to accommodate increased flow rates without excessive head losses or adverse hydraulic impacts.
- **Intake Works:** Assessment of the Niagara River intake structure to confirm sufficient submergence, approach velocities, and screening capacity under higher pumping rates.
- **Pumping Station Structure:** Review of available space, structural capacity, and layout within the existing pumping station building to accommodate larger pump units or additional equipment.
- **Mechanical Systems:** Evaluation of discharge piping, valves, manifolds, and appurtenances to confirm compatibility with increased flows and pressures.
- **Electrical Systems:** Assessment of available electrical service capacity, motor control centres, VFD sizing, and standby power provisions to support larger motor loads.
- **Controls and Operations:** Modifications to control philosophy, instrumentation, and operating sequences to ensure safe, efficient, and coordinated operation of mixed-capacity pump units.

As noted above, Option 2 offers the potential to enhance system redundancy and operational flexibility at the Dee Road Pumping Station; however, its feasibility is dependent on confirmation that the existing intake, discharge pipeline, structural, mechanical, and electrical systems can support the increased hydraulic and motor loading. Advancement of this option will require detailed hydraulic modelling, verification of intake and conveyance capacity, structural and spatial assessments within the existing facility, and confirmation of electrical service availability. The results of these investigations will determine whether additional larger pump(s) can be implemented within the existing facility or if supporting infrastructure upgrades are required to safely and reliably accommodate the increased capacity.

6.3 Four Mile Creek System Investigated Solutions

6.3.1 Upgrades to Virgil Dam

The reservoirs in Virgil were constructed in 1968 and are currently owned and operated by the Niagara Peninsula Conservation Authority. The upper reservoir is 7.9 hectares, 4.4 metres high, with a storage area of approximately 61,000 cubic metres, and the lower reservoir is about 11 hectares, 4.9 metres high, with a storage area of 99,500 cubic metres. There are 17 metres long flashboard spillways that have fallen into disrepair. The existing reservoirs were constructed to provide irrigation water for surrounding lands, serve as a buffer during drought periods, support wildlife conservation, and provide recreational use. Currently, much of the lower reservoir is bordered by residential estates and urban areas, with little farmland nearby. The reservoirs are located near the centre of the municipality, with few areas around them suitable for irrigation and no easy way to get water to the head of the irrigation channels, where irrigation demand is located. Currently, very few farmers use the reservoirs for irrigation water.

Based on the investigation conducted, the reservoirs have not been cleaned out, and the dams have not been updated over the years. There is an existing sediment-release pipe at the Lower Virgil Dam, and approximately out 6 years ago, Town staff opened the valve to remove sediment; the following photo was taken during that event. From the photo, it appears the reservoirs are full of sediment, and the whole reservoir may need to be dredged. Dredging a large pond like the Virgil Reservoirs would require specialized equipment, a large staging area, and a spoil-drying area and would need to take place in favourable weather, which may overlap with irrigation season and recreation use. From a desktop review, an estimated 160,000 cubic metres of fill would need to be dredged from reservoirs, analyzed, and disposed of properly in accordance with O.Reg. 406/19, Excess Soil Management. Based on soil analysis results, disposal methods would vary and could be costly if a specialized facility or disposal site is required. In addition to the clean out and dredging, the existing dams and spillways need improvement and replacement.

Figure 33: Virgil Pond Drained



The reservoirs are currently not being used as an efficient buffer for the irrigation system due to their location, the lack of irrigated lands around the Virgil Dam, and the loss of storage capacity from the original design. Cleaning them out is costly based on a desktop review, technically challenging based on the equipment needed and spoil drying areas and may not be within the irrigation committee's budget. Alternative uses for the reservoirs and dams may provide community benefits, while monitoring and restricting access during drought periods would allow the irrigator to obtain some benefit from the reservoirs at minimal cost to the irrigation committee.

6.3.2 Line 9 Piping

Based on the irrigation committee's requested demand and discussions with the Irrigation Committee, there is interest in adding piping to the existing irrigation system, particularly regarding Four Mile Creek. A piped outlet into Four Mile Creek would provide additional capacity to the Four Mile Creek system if the Whirlpool Pumping Station is down and would provide a reliable source of water to irrigators in the area.

Ideally, a piped system on the north side of Line 9, with outlets into Four Mile Creek that would run along the edge of the existing pavement, would be the preferred investigated

placement. After reviewing engineering locates, there are fewer utilities on the north side of the road compared to the south:

- Estimated 11 hydro, 5 gas, and 4 telecommunications lines
- 20 driveway/laneway crossings
- 2 minor road crossings
- 1 Regional Road crossing

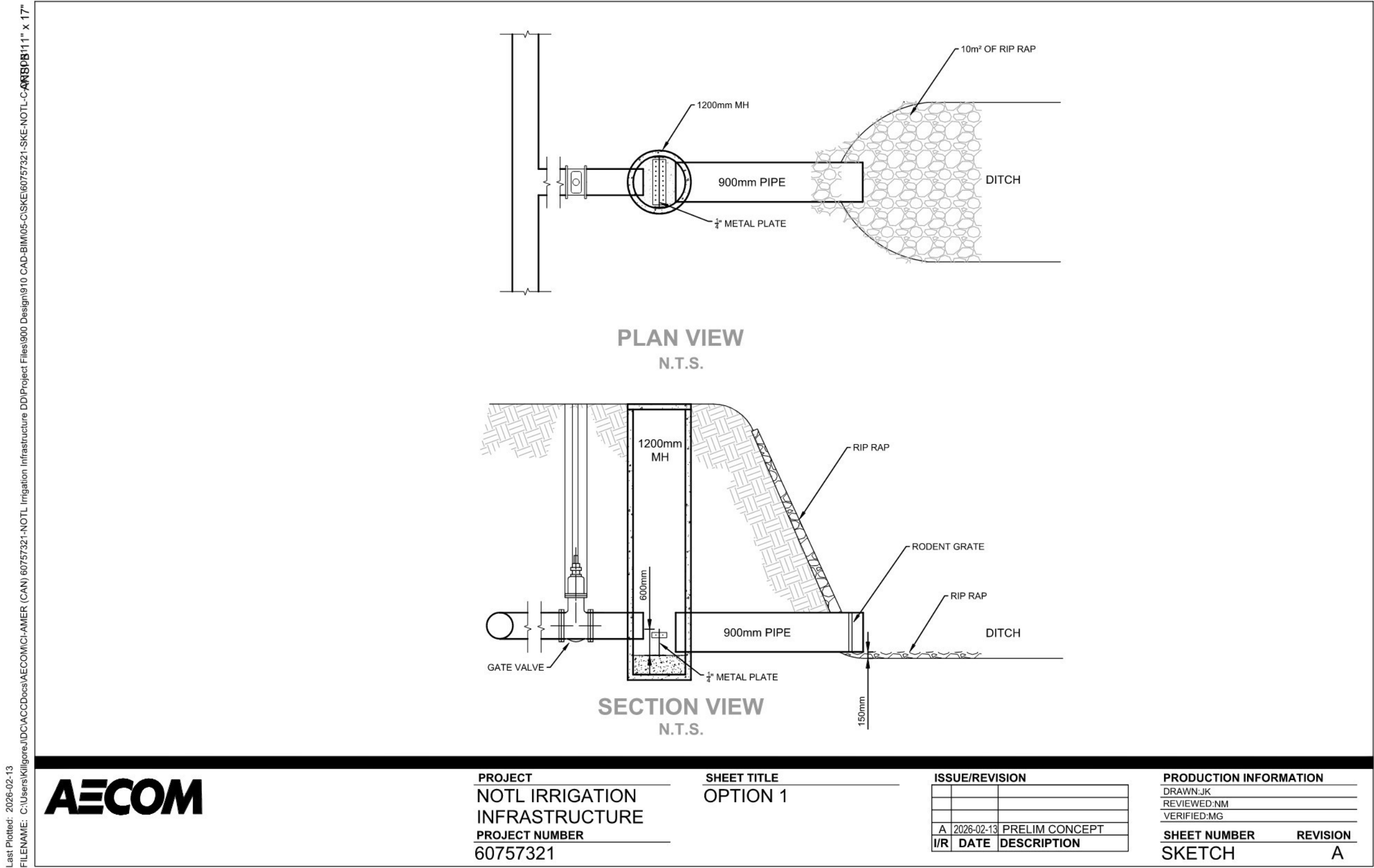
The total length of the piped system would be approximately 3,200 metres. Two different pipe sizes can be utilized and will depend on the selected pump sizes for the Dee Road Upgrade. Based on the calculated irrigation demand and the requested demand from the irrigation committee, an additional 5,000 gallons per minute. A piped system could be installed with or without upgrades to the Dee Road pumping station, but to supply the required water flows, the Dee Road station would need to be upgraded. The existing 750-millimetre diameter pipe would not have sufficient capacity to carry the flow; therefore, it would have to be replaced to the Dee Road pumping station, which is station -1+095. A 750-millimetre or 900-millimetre pipe would be used at the start of Line 9, then reduced to a 375-millimetre or 450-millimetre pipe after Harrison Drain 4 Station 0+990, where it would continue until Four Mile Creek.

Table 26: Pipe Size

System	Station	Pipe Size (millimetre)	Length (metre)
Requested Demand	0+000 to 0+990	750	990
Requested Demand	0+990 to 3+215	375	2,225
Calculate Irrigation Demand	-1+095 to 0+990	900	2,085
Calculate Irrigation Demand	0+990 to 3+215	450	2,225

The proposed route would require at least 2 bends and 4 outlet structures throughout the selected path. There are two proposed piped outlet designs which would allow the force main to outlet into the existing municipal drains without causing damage. Option 1 would have a water main discharging into a 1,200-millimetre diameter maintenance hole with a 6.35-millimetre metal plate or weir 600-millimetre high to dissipate the energy from the watermain before entering the existing ditches through a 900-millimetre pipe. The ditch is lined with 10 square metres of 150-millimetre diameter riprap on filter fabric. Option 2 would be to have a standard OPSD 804.040 concrete headwall. Both options use locally available materials, standard construction techniques, and a valve and tee to open the watermain to the discharge point. The weir would need to be installed on site but could be designed for variable flows. The maintenance hole would be a typical precast structure. The OPSD headwall can be cast in place or precast and assembled on site.

Figure 34: Pipe Outlet Concept 1



AECOM

PROJECT
NOTL IRRIGATION
INFRASTRUCTURE
PROJECT NUMBER
60757321

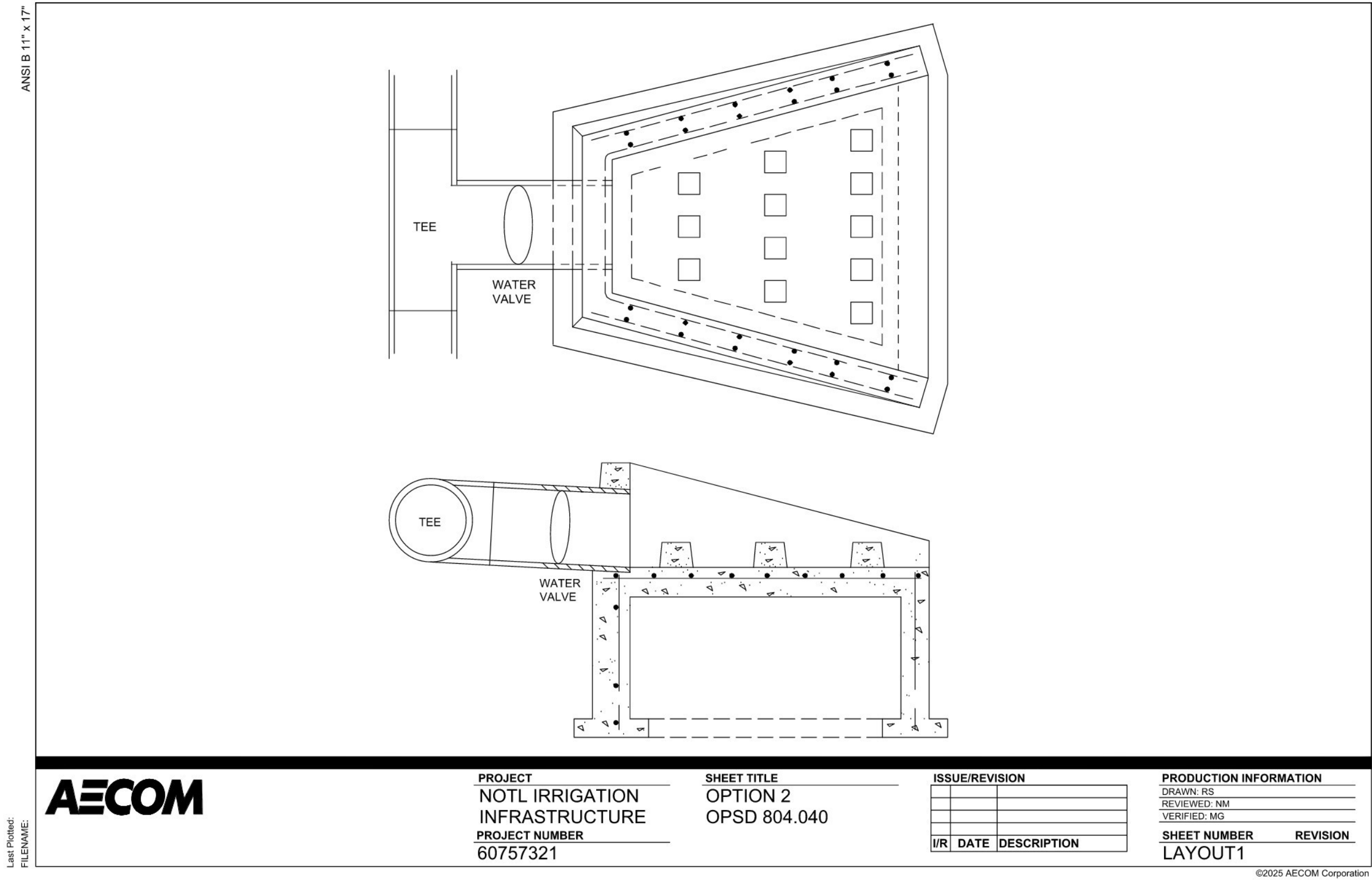
SHEET TITLE
OPTION 1

ISSUE/REVISION		
I/R	DATE	DESCRIPTION
A	2026-02-13	PRELIM CONCEPT

PRODUCTION INFORMATION	
DRAWN:JK	
REVIEWED:NM	
VERIFIED:MG	
SHEET NUMBER	REVISION
SKETCH	A

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Figure 35: Pipe Outlet Concept 2



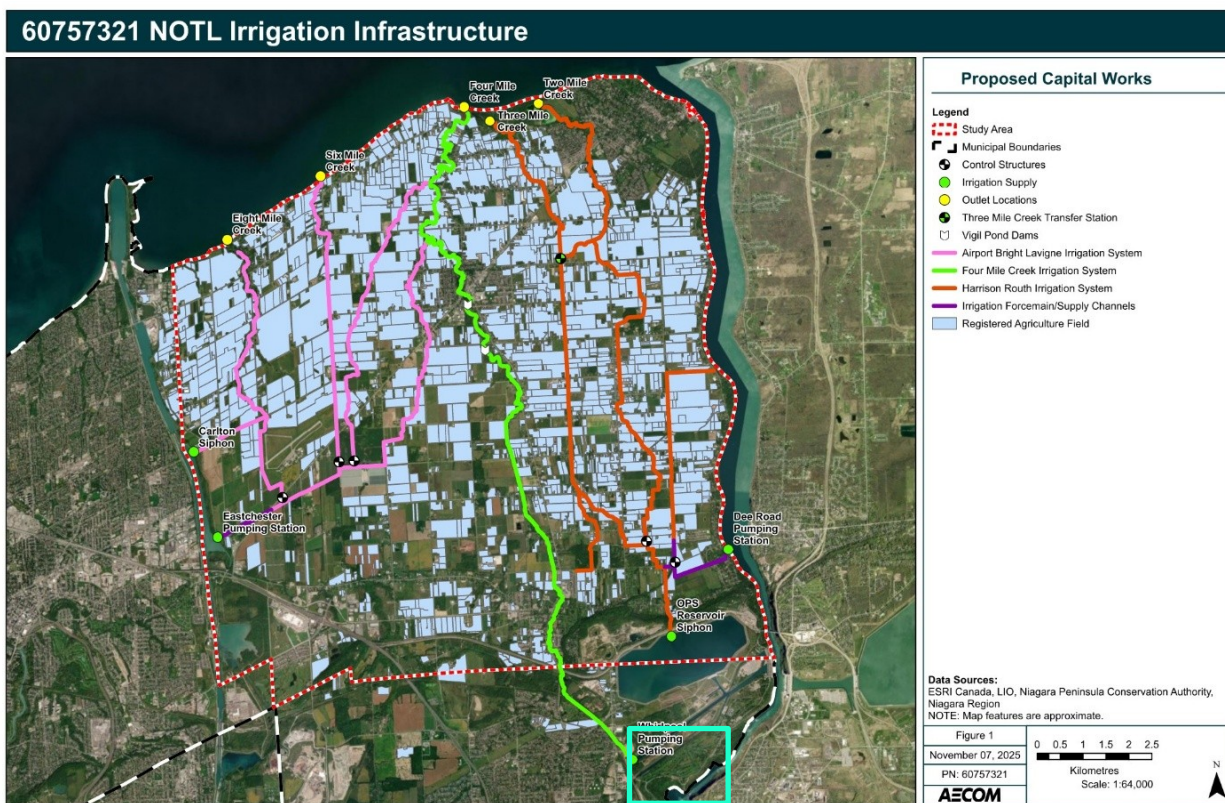
The watermain pipe would be between 3,215 metres and 4,310 metres in length, and between 800-millimetres and 375-millimetres in diameter. Running a force main along existing ROW, with few utilities and major road crossings, and performing focused municipal drain clean-outs, the piped system would provide the requested flows to the irrigators at minimal cost, loss, and time, and would be considered a preferred alternative.

6.3.3 Whirlpool Pumping Station Upgrades

6.3.3.1 Existing System

The Whirlpool Pump Station supplies the Four Mile Creek Irrigation System and is the sole source of irrigation water for agricultural lands in the central portion of the Town. The station was originally constructed in 1972 by the Niagara Region and was partially rebuilt in approximately 2017–2018.

Figure 36: Whirlpool Pump Station



The pump station structure includes provisions for three pumps. One pump has been decommissioned, while the remaining two pumps, each rated at approximately 37.3-kilowatt (50-horsepower), were rebuilt around 2018 and are currently operational. These are vertical centrifugal turbine pumps manufactured by Layne and Bowlers Inc shown in Figure 37. The combined pumping capacity is reported to be up to approximately 95 litres per second (1,500 US gallons per minute); however, uncertainty remains regarding the effective system capacity due to intake and downstream conveyance constraints.

Figure 37: Existing Pumps at Whirlpool Pump Station



The pump house structure is located on OPG property and above the regulatory flood elevation; however, the surrounding ground elevations are lower and based on site conditions the area surrounding the station may be subject to flooding of approximately 1.0 metre during high water conditions. While the station remains protected, conditions complicate inspection, operation, and maintenance of intake-related infrastructure.

Figure 38: Existing Whirlpool Pumping Station



Raw water is supplied to the station through a 300-millimetre diameter intake pipe connected to the OPG Chippawa Power Canal. The intake piping is equipped with a gate intended to control inflow to the station. At present, the gate valve is non-operational, resulting in the intake pipe remaining permanently open.

In addition, observed turbulence at the intake location suggests the potential presence of partial blockage, internal deterioration, or structural damage within the intake pipe. The condition of the intake pipe has not been confirmed, and its performance represents a potential operational and reliability concern. The original intake drawings for the Whirlpool Pump Stations are included in Appendix D.

Figure 39: Existing Gate Valve



Figure 40: Turbulence at the Intake Location



The station's electrical systems are reported to be aging and may not meet current standards for reliability, redundancy, or capacity expansion. The station also requires general maintenance to address operational deficiencies and improve long-term reliability.

Downstream of the pump station, water is conveyed via a buried force main system approximately 2.1 kilometres in length, consisting of multiple pipe diameters (300-millimetres and 400-millimetres). The age and condition of the force main, as well as its suitability to accommodate increased flow rates, have not yet been fully assessed. In discussion with Town staff, this pipe was discovered a few years ago and was assessed near Stanely Avenue to be in good condition.

6.3.3.2 Required Upgrades and Preliminary Considerations

To support the proposed increase in irrigation supply to a target flow rate of approximately 300 litres per second (4750 US gallons per minute), upgrades to the Whirlpool Pump Station and associated infrastructure will be required.

Reinstatement of reliable intake flow control is considered a priority. Rehabilitation or replacement of the existing intake gate valve will be required to restore the ability to regulate inflow to the pump station and prevent excessive sump drawdown during pump operation. Any intake upgrades must also account for the surrounding flood-prone conditions, including appropriate valve selection, access provisions, and protection measures to ensure operability during high water events.

Given the observed turbulence at the intake and uncertainty regarding the condition of the intake pipe, a detailed inspection of the intake piping is recommended. This may include hydraulic assessment, structural evaluation, and internal inspection which will need to be performed by specialized personnel due to the variable water levels and flows at the Whirlpool Pump Station inlet within the Ontario Power Generation (OPG) Power Canal to determine whether cleaning, repair, lining, or full replacement is required to support increased flow rates and reliable operation.

As part of the intake system upgrades, consideration should be given to the installation of an appropriate intake screen to reduce the potential for debris entry, minimize blockage risk, and protect pump equipment. Screen selection will need to consider hydraulic capacity, debris loading, maintenance access, and operational constraints associated with fluctuating water levels.

The existing pump layout includes space for three pumps, presenting an opportunity to replace the decommissioned unit with a higher-capacity pump or to reconfigure the pumping arrangement to meet future flow requirements. However, pump upgrades must

be coordinated with intake capacity improvements, electrical system upgrades, and downstream hydraulic constraints.

Electrical system upgrades will be required to accommodate increased pumping capacity and modern operational requirements, including motor control, protection, instrumentation, and system reliability improvements.

These upgrades will be further evaluated and refined as part of this project to support a secure, reliable, and resilient irrigation water supply for the Four Mile Creek service area.

The Whirlpool Pump Station represents a critical component of the Four Mile Creek Irrigation System, as it is the sole source of irrigation supply for the central service area. While the pumping station was rebuilt in 2017, portions of the broader system—including the force main and reservoir infrastructure, are aging and were originally constructed several decades ago. Based on the available information, there is uncertainty about the system's effective hydraulic capacity, particularly regarding the relationship among pump capacity and inlet pipe capacity. The reported inlet pipe capacity appears to be lower than the nominal combined pump capacity, which may restrict achievable flow rates under certain operating conditions.

In addition, the force main includes multiple diameter transitions along its length, which may contribute to hydraulic losses and operational inefficiencies. The long-term condition and remaining service life of the force main, as well as its suitability to accommodate increased flow rates, require further assessment.

The Four Mile Creek upper and lower reservoirs, including associated dam structures, also form a key part of the irrigation system. Given their age, a Consolidated Engineering Report is required to assess the condition, operational safety, and long-term viability of these structures, and to determine appropriate future operation and rehabilitation requirements.

In summary, the Whirlpool Pump Station and associated infrastructure require improvements to support the proposed increase in irrigation flow, as the existing pumps are aging and cannot accommodate the peak water demand of 270 litres per second. Key priorities include intake control rehabilitation, intake and piping inspection, pump and electrical system enhancements, and consideration of intake screening. Further assessment of downstream conveyance, force mains, and reservoir structures is also necessary to confirm system capacity and long-term reliability. The next steps involve detailed inspections, engineering evaluations, and coordinated planning to define specific upgrade scopes, timelines, and budget requirements, supporting a resilient, and efficient irrigation supply for the Four Mile Creek service area.

6.4 Airport-Bright Lavigne System Investigated Solutions

6.4.1 Eastchester Pumping Station Upgrades

6.4.1.1 Eastchester Pumping Station – Existing Conditions

The Eastchester Pump Station is an existing raw water pumping station forming part of the Municipal Irrigation System. The station withdraws water from the Welland Canal and conveys it via a dedicated force to an open irrigation ditch that distributes flow by gravity to downstream service areas.

Figure 41: Location of the Eastchester Pump Station

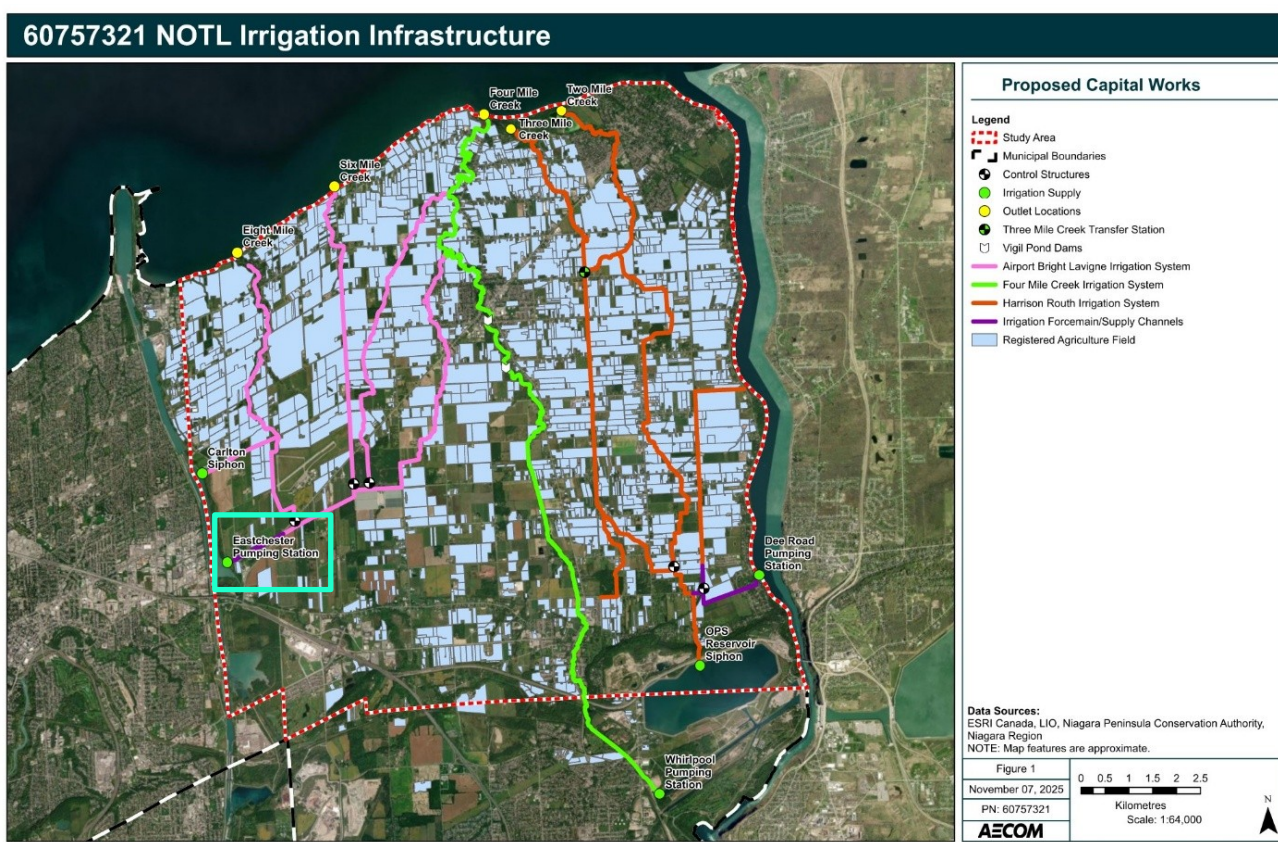


Figure 42: Irrigation Ditch with 400-millimetre Forcemain from Eastchester



Figure 43: Existing Self-priming Pump at Eastchester



According to "Airport, Bright and Lavigne Municipal Irrigation System Expansion Feasibility Study Report, 2007" (the Study), The pumping station was constructed in 2001 and was designed to provide a total pumping capacity of approximately 252 litres per second (4,000 US gallons per minute) at an estimated total dynamic head (of 18.9 metres. Raw water is withdrawn from the Welland Canal using a self-priming pump arrangement shown in Figure 42. Pumped flows are conveyed through a single 400-millimetre force main approximately 310 metres in length (Figure 44) to an open irrigation ditch located at the northwest corner of Stewart Road and Eastchester Avenue. From this discharge point, irrigation water is distributed by gravity through the open ditch network.

Figure 44: Existing 400-millimetre Forcemain at Eastchester Pump Station



The technical data for the existing effluent pumps is shown in Table 27.

Table 27: Existing Pump at Eastchester Pump Station Technical Data

Item	Existing Pump
Manufacturer/ Pump Type	Gorman Rupp self-priming pump
Model	112B60-B
Serial Number	90790N
Number of Units	1
Specified Unit Capacity, litres per second	252
Head, metre	18.9

As noted previously, pumped flows are conveyed via a single 400-millimetre PVC force main approximately 310 metres in length, discharging into an open irrigation ditch. During the site visit in September 2024, the process team observed non-uniform, surging flow entering the ditch, characterized by intermittent splashing and sudden inflow events.

Following this observation, the pump supplier, John Brooks, was contacted to assess the potential cause of the issue. Their preliminary assessment suggests that the pump may be cycling between priming and dynamic operation. This behavior is consistent with intermittent loss of suction, similar to conditions where the suction inlet temporarily drops below the liquid level and is subsequently replenished. As a result, the pump alternates repeatedly between priming and normal dynamic operation.

To further investigate this condition, the following actions are recommended:

- Confirm that the suction inlet pipe is positioned well below the water level and is not obstructed.
- Inspect the suction side for leaks that may only become evident under dynamic suction conditions (e.g., at the inspection cover).
- Verify that, with the pump turned off, the suction flap valve can maintain vacuum within the suction pipe.

Two upgrade options for the Eastchester Pumping Station have been developed and assessed to address the need for increased pumping capacity. Option 1 involves doubling the existing pumping capacity in accordance with the requirements outlined in the irrigation committee's requested demand. Option 2 proposes capacity upgrades informed by the water demand analysis which indicates a design flow requirement of approximately 1,000 litres per second.

6.4.1.2 Proposed Upgrade Option 1-Doubling the Capacity of the Eastchester Pump Station

As per the irrigation committee's requested demand, the required upgrade for the Eastchester Pump Station is to double the existing system capacity from 252 litres per second (4,000 US gallons per minute) to 505 litres per second (8,000 US gallons per minute); the feasibility of this upgrade is evaluated through the hydraulic scenarios discussed below.

These scenarios are based on whether the existing intake and discharge piping to and from the pump station can be retained, or whether replacement of the piping is feasible. The analyses presented herein are preliminary in nature and are subject to confirmation upon receipt of updated water level information.

The hydraulic assessments are based on available water surface elevation data obtained from the Airport, Bright and Lavigne Municipal Irrigation System Expansion Feasibility Study Report (2007) and the Associated Engineering Eastchester Irrigation Pumping Station Addition Study (2022). Updated water elevations have been requested from the St. Lawrence Seaway Authority and were received immediately prior to submission. Based on the information we received from Seaway and also the follow up

discussion with them on 21st May 2026, the following are design considerations for the Eastchester Pump Station:

- According to Seaway, we don't have the permit to micro tunneling or open cut through the dyke.
- The Seaway provided the detailed canal water levels.
- The Seaway provided the riprap specifications for restoration along the canal.
- They have provided the Geotech report for the dyke construction.
- They provided the brushing requirements for removing the vegetation on the dyke.

These considerations will be incorporated in the detailed design.

Scenario 1 – Retention of Existing Intake and Discharge Piping

Under this scenario, the existing intake and discharge piping associated with the Eastchester Pump Station are retained. The existing piping consists of 400-millimetre diameter PVC DR25 pipe.

Based on accepted industry criteria for limiting velocities in pump suction piping and pump discharge piping, the existing pipe diameter imposes a constraint on the maximum achievable flow rate. Using conservative velocity limits to ensure stable hydraulic performance and minimize head losses and operational risks, the maximum flow that can be conveyed through the existing piping is estimated to be approximately 312 litres per second (4,940 US gallons per minute).

Under this scenario, the achievable flow is governed by piping limitations rather than pump capacity alone. While this option minimizes civil works and reduces capital cost associated with pipe replacement, it may limit the ability of the system to meet higher peak irrigation demands or provide additional operational flexibility.

Scenario 2 – Replacement of Open Ditch with Closed Conduit and Pumped Conveyance

Under this scenario, the existing open ditch conveyance is replaced with a closed conduit system to accommodate the increased irrigation flow requirements. The proposed closed conduit would extend approximately 7,000 metres between the intake location and Four Mile Creek. Due to the length of the conduit and the associated hydraulic losses, gravity or siphon conveyance alone would not be sufficient to reliably convey the required flow under all operating conditions. As a result, this scenario would require the installation of a pumping system at the Eastchester Pump Station.

The proposed pump station expansion would be located at the end of Eastchester Road, as illustrated in Figure X. The upgraded facility is designed to meet an increased capacity of 505 litres per second (8,000 US gallons per minute), representing a doubling

of the existing station capacity. To achieve this, the station will incorporate a 2+1 configuration consisting of two duty pumps and one standby unit. This arrangement provides operational redundancy and ensures continued service during maintenance activities or in the event of mechanical failure. The proposed units are self-priming pumps manufactured by Gorman-Rupp. Pump selection has been undertaken to satisfy the required operating flow range and total dynamic head while maintaining compatibility with the overall hydraulic configuration of the pumping station.

An intake screen and automated airburst system have been preliminarily selected to accommodate the increased flow associated with the proposed pumping configuration. The selected intake screen capacity is based on maintaining acceptable approach velocities under clean-screen conditions. The airburst system has been selected to support the screen size and provide automated cleaning capability consistent with the proposed intake configuration. Key parameters of the proposed intake screen and airburst system are summarized in Table 28.

Table 28: Key Parameters of The Proposed Intake Screen and Airburst System for Eastchester Pump Station

Component	Key Parameters
Intake Screen	Type: _____ T-Intake Screen OD: _____ 1.07 metres Capacity: _____ 505 litres per second Material: _____ 90/10 Copper Nickel Slot Size: _____ 1.02 millimetres Outlet Connection: _____ 760 millimetres Airburst Connection: _____ 102 millimetres
Automated Airburst System	20 HP reciprocating compressor 660 Gallon Horizontal Receiver

This scenario provides a controlled and reliable means of conveying increased flows independent of open-channel limitations and water surface variability. However, it introduces additional capital, operational, and maintenance requirements associated with pumping infrastructure, electrical power supply, and mechanical systems. The feasibility of this scenario will be further evaluated based on updated water surface elevations, hydraulic modelling results, and lifecycle cost considerations.

Scenario 3 – Replacement of Intake and Discharge Piping and Gravity Flow Conveyance

Under this scenario, the existing intake and discharge piping would be replaced with a larger diameter conveyance system consisting of 600-millimetre Schedule 40 / Standard carbon steel pipe. With the increased pipe diameter and based on available hydraulic

grade assumptions, this configuration could convey the required flow entirely by gravity, without the need for pumping.

Two approaches are being considered to achieve continuous gravity flow:

- Pipe over the berm with reservoir tank: water is conveyed over the berm supported by upstream storage to maintain gravity-driven flow.
- Trenchless pipe installation through the berm: water is conveyed by a micro-tunnel pipe through the berm

Certain configurations may require specialized systems, such as pressurized sections or other measures, to maintain uninterrupted flow over high points along the alignment.

The intake structure under this scenario would require appropriately designed screening to limit debris entry, protect downstream infrastructure, and ensure reliable long-term operation of the gravity-fed system.

This scenario eliminates the need for a pumping unit at the Eastchester Pump Station, potentially reducing long-term operational and maintenance costs. However, its feasibility is dependent on confirmation of available water surface elevations and hydraulic grade differences and technical, economic and constructability consideration to support a sufficient driving head is available to sustain gravity flow under all operating conditions. A summary of the alternatives for this scenario, including technical, economic, and constructability considerations, is provided in Table 29.

Table 29: Summary of Evaluation of Gravity-Flow Conveyance Alternatives from the Welland Canal

Alternative	Recommended Solution	Technical Considerations	Economic Considerations	Constructability Considerations
Siphon	A siphon over the Welland Canal and a reservoir tank to provide a gravity supplied system	Working on Berm, loss hydraulic head would require larger conveyance system pipes.	Lower cost than pumping system, once system is primed very little noise	Uses conventional and locally available contractors, equipment and materials.
Trenchless	Tunnelling pipe through the Welland Canal and a reservoir tank to provide a gravity supplied system	Tunnelling through berm, work on private property (seaway), high risk project	Very low operating cost, high construction costs, very little noise	Required speciality engineering and construction

For option 1 there are some data limitations and next steps that need to be considered. These scenarios are based on assumed water surface elevations derived from previous studies. Updated water level data from the St. Lawrence Seaway Authority were received immediately prior to submission of the report. Due to the timing of receipt, the

feasibility, capacity, and reliability of each solution will be reassessed, and recommendations refined accordingly. Further evaluation during subsequent design stages will include confirmation of hydraulic assumptions, detailed intake and outlet design, screening requirements, and operational considerations to support a reliable and resilient gravity-fed irrigation water supply.

6.4.1.3 Proposed Upgrade Option 2 – Required to Meet Peak Demand

This option evaluates the feasibility of providing additional pumping capacity at the Eastchester Pump Station through the installation of larger-capacity pump unit(s) to meet the projected peak irrigation demand of approximately 1,000 litres per second (15,850 US gallons per minute). The option is assessed against a conservative peak-demand scenario representing extended drought conditions, which are anticipated to occur infrequently (approximately once every ten years) and persist for a relatively short duration of approximately two weeks.

In evaluating this option, several preliminary considerations must be addressed, including the availability of space for the proposed pump station location at the end of Eastchester Road (Figure 45) to accommodate required pump units, the number of pumps required to meet peak demand and provide an appropriate level of redundancy, and the compatibility of the proposed configuration with intake and discharge infrastructure. Consideration must also be given to permitting requirements associated with increased water takings, electrical power availability and capacity, and the need for new or modified mechanical, electrical, and control systems. Additional factors include site access and constructability, operational flexibility during non-peak periods, and consistency with the scale and configuration of comparable irrigation pumping facilities, such as the Dee Road Pump Station.

Figure 45: Approximate location of the Proposed Pump Station



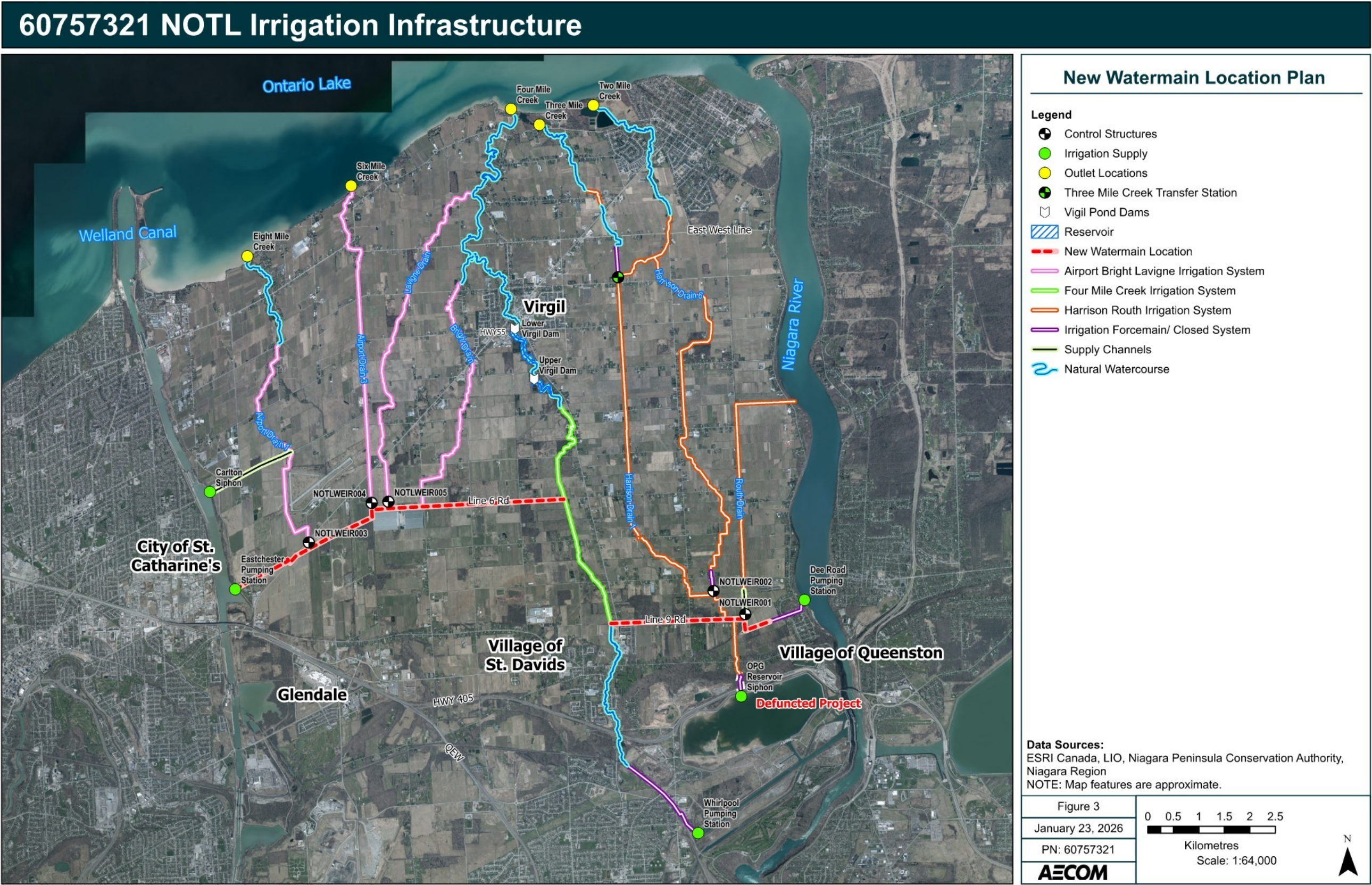
6.4.2 Airport Bright Lavigne Piped System

Based on the irrigation committee's requested demand and discussions with the Irrigation Committee, there is interest in adding piping to the existing irrigation system, as the existing irrigation channels are at capacity. A piped system would also allow lands to the south to be serviced, which the current system cannot. An outlet into Four Mile Creek would provide additional capacity to the Four Mile Creek system if the Whirlpool Pumping Station is down and would provide a reliable source of water to irrigators in the area.

From desktop reviews and site visits, a piped force main would follow the existing irrigation channel route, with an extension to Four Mile Creek along Line 6 Road. The pipe would run along the edge of the existing pavement and, in an unopened right-of-way, would be below the top of the bank of the existing channel. As the channel will no longer be required if a force main is added, it can be filled in, and some of the spoil may be used to fill part of the existing channel. After reviewing engineering locates, there are fewer utilities on the south side of Eastchester Road and on the north side of Line 6 Road.

- estimated 6 hydro, 1 gas, and 5 telecommunications conflicts
- 25 driveway/laneway crossings
- 6 minor road crossings
- 2 Regional Road crossing.

Figure 46: Proposed Watermain Plan



As with the Harrison-Routh system, two options were considered for piping the Airport Bright Lavigne system. A 900-millimetre diameter pipe, a 750-millimetre diameter pipe system. One system is based on the calculated irrigation demand, and the other on the irrigation committee's requested demand of 3,3028 litres per minute (8,000 gallons per minute). The piped system would run along the south side of Eastchester Road, cross Niagara Stone Road, and continue along the Eastchester Right-of-Way until Airport Drain 3, where it would jog north and, at Station 3+200, reduce to a 750-millimetre or 900-millimetre pipe before turning east along the north side of Line 6 Road. Between Airport Drain 3 and the Lavigne Drain Station 3+540, the pipe size would be reduced further to 600-millimetres or 750-millimetres, and between the Lavigne Drain and the Bright Drain Station 3+780, it would be reduced to 525-millimetres or 600-millimetres. The watermain would continue along the north side of Line 6 Road, with a pipe size of 250-millimetres or 300-millimetres, before entering the Four Mile Creek Drain.

Table 30: Airport Bright Lavigne Irrigation Pipe Details

System	Stations	Size of Pipe (millimetre)	Length (metre)
Requested flow	0+000 to 3+200	750	3200
Requested flow	3+200 to 3+540	600	340
Requested flow	3+540 to 3+780	525	240
Requested flow	3+780 to 8+000	250	3220
Calculated demand flow	0+000 to 3+200	900	3200
Calculated demand flow	3+200 to 3+540	750	340
Calculated demand flow	3+540 to 3+780	600	240
Calculated demand flow	3+780 to 8+000	300	3222

As the lands south of Eastchester Road were not included in the original petition for the irrigation works, an additional petition would be required under Bill Pr88. To supply future demand if land is petitioned to the south of Eastchester Road, a capped, valved tee would be installed at each existing road crossing. A total of 6 would be proposed to supply the land south of Eastchester Road. The valve and tee systems would future proof the system, allowing future connections at minimal cost now and avoiding damage in the future.

6.4.2.1 Non-pumped System

Based on the alternatives for an ABL non-pumped system, the following changes and concerns should be considered for the pipe system. A storage building would be required to provide a constant head for the piped system. From the storage building, a pipe near the elevation of the Welland Canal water level would convey the water along the same route as the pumped system, but under gravity. The non-pumped system

would only service the existing ABL service area. The siphon system would require larger-diameter pipes to meet the requested flow rates. The system may be extended to Four-Mile-Creek, but due to the head, the flow into Four-Mile-Creek would be reduced. The raw waterline would be at a head of about 2-4 metres, putting considerably less pressure on the pipe.

6.4.2.2 Hybrid

A hybrid system could be constructed: it would have a pump beside the storage building and be used only during peak-demand periods. A tee and valve could be used to shut off the siphon and pressurize the raw waterline. The hybrid system would provide the calculated irrigation demand. The addition of a pump would allow the land to the south to be served; such upgrades may be assessed primarily against the lands if a petition is signed.

6.4.2.3 System

The proposed route would require at least 5 bends and 7 outlet structures. The same two piped outlet designs as the Line 9 pipe system can be considered.

The watermain pipe would be approximately 8,000 metres in length and between 250-millimetres and 900-millimetres in diameter. Running a force main along mostly existing ROW, with few utilities and two road crossings, and performing focused municipal drain clean-outs, the piped system would provide the requested flows to the irrigators at minimal cost, loss, and time, and would be considered a preferred alternative.

6.4.3 Carlton Street Siphon Upgrade

6.4.3.1 Carlton Street Siphon – Existing System

The Carlton Street Siphon originally consisted of two pipes with diameters of 100-millimetre and 150-millimetres. The 150-millimetre pipe was decommissioned, and a new 200-millimetre PVC pipe was added to the siphon system, which consists of approximately 50 metres of PVC pipe and has an estimated conveyance capacity of slightly more than 126 litres per second (2,000 US gallons per minute). Downstream of the siphon, the pipeline discharges on the south side of Carlton Street and continues east for approximately 1,760 metres before discharging into Airport Road 1.

Figure 47: The location of the Carlton Street Siphon

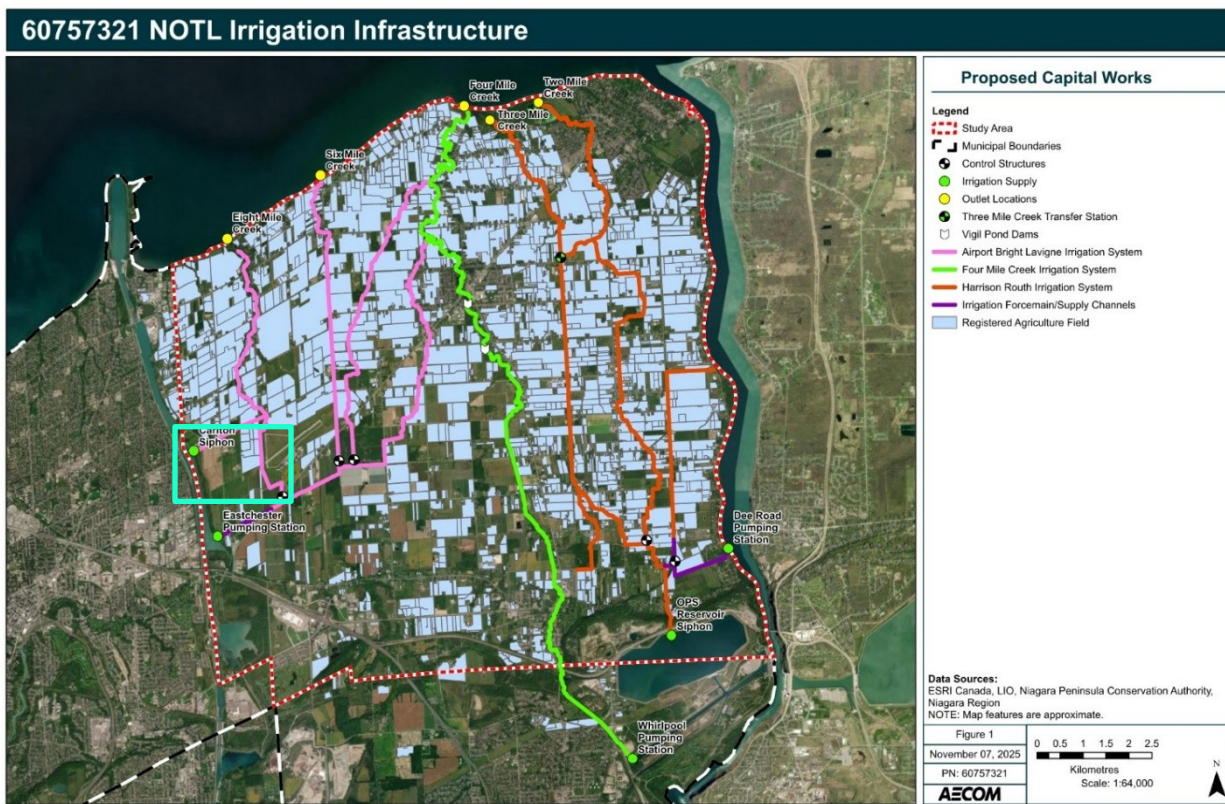


Figure 48: Existing 200-millimetre Pipe



Figure 49: Discharge of Existing 200-millimetre



It was observed that since the previous irrigation season, a continuous flow has been entering the downstream ditch of the Carlton Street siphon, originating from the previously decommissioned 150-millimetre pipe. The source and cause of this flow are currently unknown. This condition is illustrated in Figure 50 and Figure 51.

**Figure 50: Water Discharges of the Decommissioned
150-millimetre Carlton Street Siphon**



Figure 51: 150-millimetre Pipe Outlet



A manually operated gate valve and an inline flow metre are installed at the siphon. A solar panel powers the flow metre–supplied electrical system (Figure 52). At the time of inspection, the metre was observed to be functioning within normal operating parameters. Audible noise was noted at the gate valve during operation. Additional assessment is recommended to confirm the source of the noise and to evaluate any potential implications for valve performance and service life. When the valve is in the fully open position, the recorded discharge is approximately 132 litres per second. Operationally, the valve is typically closed during the first week of December and reopened during the first week of March, in accordance with permit conditions and prevailing weather. Flow metre readings are obtained on a weekly basis, with supplementary site visits conducted as required to verify active flow conditions.

Figure 52: Solar Panel–Supplied Electrical System for the Flowmeter



6.4.3.2 Proposed Upgrade to the Carlton Street siphon

The original Weibe Report identified a 300-millimetre diameter PVC pipe for the Carlton Street siphon; however, the existing installation consists of a 200-millimetre diameter PVC pipe. Under existing conditions, the downstream ditch is operating near its hydraulic capacity.

One proposed upgrade option is to increase the siphon diameter to 300-millimetre PVC, consistent with the original design intent. This upgrade would provide increased conveyance capacity and would serve as a supplementary supply to the Eastchester pumping system, enhancing overall system resilience for the approximately 500 hectares serviced by this irrigation network.

Implementation of a 300-millimetre siphon would require additional downstream improvements. Specifically, the existing road ditch and culvert infrastructure would need to be upgraded to accommodate the increased flow. This would likely involve approximately doubling the width of the existing road ditch and increasing culvert sizes. Constructability may be challenging, as these works would need to be undertaken within the existing Right-Of-Way. In addition, increasing siphon capacity would require a revised agreement with the Seaway Authority to permit higher diversion rates.

If the siphon upgrade proceeds, it is recommended that the 300-millimetre diameter pipeline be extended downstream by approximately 1,750 metres to the Airport Drain 1 outlet to fully realize the benefit of the increased conveyance capacity.

7. Constructability and Implementation

7.1 Overall Review

The Design Options section of this report covered the updates and changes required to the system from a technical standpoint. In this section, the solutions will be evaluated in terms of potential timelines, construction phasing to minimize operational disruption, ownership, logistics, risk assessment, and mitigation strategies. A feasibility rate is assigned to each solution investigated that is based on economic, constructability, environmental requirements, need, timeline and neighbour consultation. Each of the alternatives that were investigated was assigned a feasibility rating based on the following:

- A feasibility rate of 1: There are major concerns with the final implementation of this alternative.
- A feasibility rate of 2: There are concerns about the final implementation of this alternative within the proposed timelines.
- A feasibility rate of 3: there are minor concerns with the final implementation of this alternative, which could be implemented within the proposed timelines.
- A feasibility rate of 4: There are a few concerns about the final implementation of this alternative within the proposed timelines.
- A feasibility rate of 5: there are no concerns with the final implementation of this alternative, which could be implemented now.

Table 31: Constructability and Implementation Summary

Alternative ID	Solution	Constructability	Implementation	Feasibility Rating
Overall System	Vegetation Management and Phragmites Control	Uses conventional, locally available contractors, equipment, and materials. Town staff routinely perform this work.	Continual maintenance, a log to focus maintenance on bottleneck areas	5
Overall System	Sediment Removal in channels	Uses conventional and locally available contractors, equipment and materials.	Continual maintenance, a log to focus maintenance on bottleneck areas	5
Overall System	Hydraulic Bottleneck Remediation	Uses conventional and locally available contractors, equipment and materials	Will require time to consult with local landowners, utilities and stakeholders. Rounding road closures during construction	4
Overall System	Storage	Uses conventional, locally available contractors, equipment, and materials; land purchase costs are high at 80,000\$/ha.	It will require major legal and time to acquire the land.	1
17	Repairs and Upgrades to OPG Reservoir and Siphon	Uses specialized contractors, equipment and materials, permits to work on OPG, NPC and MTO property.	On private properties, the site is gated. Berm is a critical assessment for OPG; work on the Niagara Escarpment is needed.	2
18	Dee Road Pumping Station	Uses conventional and locally available contractors, equipment and materials	Currently owned by the irrigation board, quick construction	5
19	Virgil Dam upgrades	Uses specialized contractors, equipment and disposal site for spoil.	Will require time to consult with local landowners, a staging area needed, transport and storage of spoil, and will require major survey work	1
3	Line 9 force main expansion from Dee Road	Uses conventional and locally available contractors, equipment and materials	Will require time to consult with local landowners, utilities and stakeholders. Rounding road closures during construction	5
20	Whirlpool pumping station upgrade	Due to the age of the station Uses specialized contractors and equipment	On private properties, the site is gated and requires more engineering investigation	2
12	Eastchester Pumping Station Upgrades	The new station Uses specialized contractors, equipment	On private property, work on the berm is critical to Canal operations. Consult with neighbours regarding construction staging and obtain operating noise permits from Seaway.	3
12	ABL piped system	Uses conventional and locally available contractors, equipment and materials	Will require time to consult with local landowners, utilities and stakeholders. Rounding road closures during construction	3
16	Carlton Street Siphon Upgrade	Uses conventional and locally available contractors, equipment and materials. Would require working on private property.	Will require time to consult with local landowners, legal counsel, and stakeholders regarding land purchases, utilities, and related matters. Rounding road closures during construction	2

7.2 Alternatives

7.2.1 Ontario Power Generation Siphon

The Ontario Power Generation siphon has been non-operational for several years due to past damage, though the northern section remains in good condition. Previous repair plans proposed replacing the 300-millimetre PVC with a continuous HDPE pipe to withstand ice and seasonal fluctuations, with careful inlet placement and a winter drain system. The siphon passes over sensitive OPG berm infrastructure and near the highway, requiring specialized construction and close coordination with OPG and the Ministry of Transportation.

From a constructability and scheduling perspective, repair is feasible but complex. The outlet must be extended safely north of the Bruce Trail, potentially requiring a bridge or a piped crossing, and obtaining approvals from the Bruce Trail Conservancy, the Niagara Parks Commission, Ministry of Transportation and the Niagara Peninsula Conservation Authority. Operationally, the siphon would serve as a secondary water source, providing about 35% of the Harrison/Routh system supply. Implementation should be phased to address permitting, access, pipe replacement, and outlet extension, with careful timing around seasonal reservoir levels.

7.2.2 Dee Road Pumping Station

The existing pumps Dee Road Pumping Station is in good mechanical and operational condition, with relatively modern equipment installed in 2017 and sufficient physical space within the existing structure to accommodate a third pump. The proposed addition of a third 150-kilowatt (200 horsepower) pump is technically feasible and can be implemented within the existing station footprint with minimal structural modifications. The existing 750-millimetre discharge force main is hydraulically adequate to convey the increased flow; however, the intake screen requires replacement to accommodate the higher design capacity.

Two potential upgrade options for the Dee Road Pumping Station have been identified to support increased pumping capacity and future system expansion. Option 1 reflects the irrigation committee's requested demand to add a third pump at the station and can meet the peak Harrison/Routh irrigation demand of 820 litres per second; however, it provides limited operational redundancy and only partial supply to the Four Mile Creek system during peak conditions. Option 2 proposes larger-capacity pumping upgrades informed by the water demand analysis for both the Harrison-Routh and Four Mile Creek systems, while maintaining appropriate system redundancy.

From a constructability perspective, Option 1 (addition of a third pump and upgraded intake screen) represents a relatively straightforward upgrade that can be staged to maintain continuous operation of the existing two pumps during construction. Electrical upgrades, control integration, and intake modifications will require careful coordination but are not anticipated to present significant implementation risks.

Option 2 would involve more substantial mechanical, hydraulic, and electrical modifications and would require additional investigation during detailed design to confirm feasibility within the existing building and downstream system constraints.

7.2.3 Line 9 Road Force Main

The watermain pipe would be between 3,215 metres and 4,310 metres in length, and between 375-millimetres and 800-millimetres in diameter. Installation of the force main along Line 9 would use conventional construction techniques, and local contractors would have the knowledge, equipment and materials to construct the pipe. Both the Niagara Region and the Town of Niagara-on-the-Lake have installed similar pipelines in the area, and this type of work is well established in the industry. Extensive consultation with the adjacent landowner would be required before construction commences. The north-side pipe layout may allow one-way public access along the road during construction and shorten the length of crossings for the outlet pipes. At the same time, there is a line to the Queenston golf club. A tee could be constructed with a line to provide water to the golf club.

Based on the calculated irrigation demand, an additional 1,095 metres of pipe is needed. This pipe would run through the village of Queenston and involve additional landowner consultations, utility crossings, and roads, making this option considerably more costly and time-consuming.

7.2.4 Whirlpool Pump Station

The Whirlpool Pumping Station is the sole source of irrigation for central Four Mile Creek. While partially rebuilt in 2017–2018, key components such as the intake pipe, gate valve, and electrical systems are aging, and the downstream force main has uncertain capacity. Flood-prone surroundings complicate inspection and maintenance, and the current system may not reliably support increased flows to meet the target 300 litres per second. Intake turbulence, and the decommissioned pump further highlight operational and hydraulic limitations that must be addressed.

From a constructability and implementation perspective, upgrades are feasible but require careful coordination. Intake inspection and gate repair are critical first steps, followed by pump replacement or reconfiguration and electrical modernization.

Downstream pipe and reservoir assessments should proceed in parallel to confirm system capacity. A phased schedule prioritizing intake reliability, then pumping and electrical improvements, will enable practical, safe construction while maintaining system operability.

7.2.5 Virgil Reservoirs and Storage

The Virgil dams were constructed in 1968, on the Four Mile Creek upstream of the Village of Virgil. The dams form two reservoirs: the upper reservoir and the lower reservoir, at 7.9 hectares and 11 hectares, respectively. The reservoir had approximately 160,000 cubic metres of storage. The Virgil Dams were originally designed as storage elements for the area and as a buffer during drought periods to irrigate the adjacent farmlands.

An alternative storage area near the upstream end of the Airport Lavigne Bright was investigated; there is vacant land around Eastchester Road. A 10-hectare storage pond in this area could serve as a buffer during droughts.

From a constructability and implementation perspective, upgrades are not feasible, as the costs for excavation, land acquisition, spoil disposal, and timeline would make construction prohibitive. The clean-out of the reservoir would also not provide a water source in an area where the irrigators want water. A more feasible alternative is to use existing or new farm ponds to provide the buffer irrigators need during drought periods, as there is potential farm pond area within the municipality of 30 hectares. The municipality can create an inventory of existing farm ponds and provide an incentive project for irrigators to create new ones on their property.

7.2.6 Eastchester Pump Station

The Eastchester Pumping Station, constructed in 2001, withdraws water from the Welland Canal and conveys it via 400-millimetres force main to an open irrigation ditch. The existing self-priming pump has a rated capacity of 252 litres per second. The current intake and discharge piping limits maximum achievable flow to roughly 312 litres per second, below the target upgrades, and the open-ditch conveyance introduces variability and potential flow losses. Upgrades are needed to reliably meet future irrigation demands, either by increasing pumping capacity, replacing or enlarging conveyance pipes, or implementing a closed or gravity-fed system.

From a constructability and implementation perspective, doubling the pumping capacity or meeting peak demands of up to 1,000 litres per second is technically feasible but will require careful coordination of intake, pumping, and discharge infrastructure. Phased implementation is recommended: address suction and intake reliability first, followed by

installation of upgraded pumps, electrical systems, and screening, and finally modifications to conveyance (closed conduit or gravity-fed systems). Gravity-flow options could reduce long-term operational costs but may require specialized engineering and verification of hydraulic grades. Overall, both pumping and gravity-fed upgrades are achievable, with constructability and scheduling dependent on site access, water levels, and integration with downstream irrigation networks.

7.2.7 Carlton Street Siphon

The Carlton Street Siphon currently consists of a 200-millimetre PVC pipe with an estimated conveyance capacity of roughly 126 Liters per second. The system includes a manually operated gate valve and solar-powered flow metre, both functioning within normal parameters, though further assessment will support a reliable operation. Downstream ditches are operating near hydraulic capacity, and flow from the previously decommissioned 150-millimetre pipe has been observed, with the source currently unknown. Under existing conditions, the siphon provides adequate service but offers limited capacity to support future irrigation expansion or increased reliability for the Eastchester Pumping System.

Upgrading the siphon to a 300-millimetre diameter pipe would increase conveyance and system resilience but requires additional downstream improvements, including widening the road ditch and enlarging culverts, all within the existing ROW. Constructability is feasible with conventional methods, though careful coordination is needed due to ROW constraints and permitting requirements with the Seaway Authority. Implementation should proceed in phases, first, address permitting and downstream conveyance constraints, then install the larger siphon and extend it approximately 1,750 metres to Airport Drain 1 to fully realize capacity benefits.

7.2.8 Airport Bright Lavigne Piped System

The watermain pipe would be approximately 8,000 metres in length and between 250-millimetres and 900-millimetres in diameter. Installation of the raw watermain along Line 6, road and Eastchester would use conventional construction techniques, and local contractors have the knowledge, equipment, and materials to construct the pipe. The Niagara Regional and Town of Niagara-on-the-Lake have installed a similar line in the area. The system could be installed with or without upgrading the pumping station, but to supply the required water flows, the Eastchester pumping station would need to be upgraded. Extensive consultation with the adjacent landowner would be required before construction commences. With some focused municipal drain clean-out, this could provide the requested flows to the irrigators at minimal cost, loss and time.

Due to the high traffic on Airport Road and Niagara Stone Road, Jack and Bore prefer to minimize the impact on road traffic. The proposed work on Eastchester Road and Line 6 Road may allow one-way public access along the road during construction and shorten the length of crossings for the outlet pipes. Permission from the landowner should be obtained as the road between the airport drain 3 and the bright drain is a private road.

Based on the calculated irrigation demand, the pipe size would need to be increased. As the ABL system has a much greater capacity to accommodate additional lands entering irrigation, a demand higher than the requested level should be considered. The change from a pumped to a non-pumped system would change the pipe sizes and costs, but future demand and helper pump pads could be constructed to account for it.

8. Cost Estimates and Budgeting

8.1 Estimate Classification

The current level of project definition supports the development of a Class 4 cost estimate. Table 32 summarizes the applicable cost estimate classifications as defined by Treasury Board, PSPC, and AACE standards.

Table 32: Estimate Classification and Target Accuracy

Estimate Class	Estimate Type	Description	Accuracy Range
5	Pre-feasibility, conceptual or trade-off study	Very basic engineering only and costs based upon typical unit costs	L: -50% H: +100%
4	Feasibility or advanced conceptual	Engineering ~10% complete and costs based upon typical unit costs	L: -30% H: +50%
3	Budget authorization or control	Engineering ~30% complete and costs based upon semi-detailed unit costs with assembly line items	L: -20% H: +30%
2	Preliminary or budget level	Detailed engineering ~60% complete, and costs based on a detailed take-off upon a verbal quote	L: -15% H: +20%
1	Definitive or construction phase	Based upon detailed engineering take-offs and written quotes	L: -10% H: +15%

Based on this classification, the estimates presented are considered to have an expected accuracy range of -30% to +50%. Based on comparable past projects, the methodology applied generally produces estimates near the mid-range of tender pricing; however, a wide range of contractor bids is typical for infrastructure works of this nature.

8.2 Methodology for Estimate Development

The estimate has been developed using a combination of:

- Conceptual quantity take-offs (where information was available)
- Parametric and system-level costing
- Unit rates are based on comparable infrastructure projects
- Historical cost data and industry benchmarks
- Professional judgment based on similar works

All costs are expressed in 2026 dollars unless otherwise noted. Escalation, contingency, and risk allowances have been incorporated consistent with Class 4 maturity.

Direct construction costs include labour, materials, and equipment associated with defined work elements. Indirect costs, contractor overhead, and allowances have been applied separately. The sum of direct and indirect costs, together with appropriate contingencies and escalation, forms the total estimated construction cost.

Desktop Review of the cost estimate for some of the alternatives determined some of the alternatives cost prohibitive and a detailed cost estimated was done the most feasible options investigated only. In this section, pricing for the upgrades to the Dee Road Pumping Station, Line 9 Road watermain, Eastchester Pumping Station and Eastchester Road and Line 6 Road watermain have been considered. Full cost breakdown can be found in Appendix E.

8.3 Pumping Stations

Capital cost estimates for the rehabilitation and upgrade of the Dee Road Pumping Station, Eastchester Pumping Station and Whirlpool Pumping Station have been developed using a structured, implementation-focused approach consistent with Class 4 estimating principles, as defined in AACE International Recommended Practice 18R-97. The estimates are organized around the consolidated scope categories identified in the recommended solutions. Each site location has been estimated independently.

8.3.1 Pumping Stations Assumptions

8.3.1.1 Dee Road Pumping Station

- Installation of a third 150-kilowatt (200-horsepower) centrifugal pump, rated at 5,000 US gallons per minute (315 litres per second)
- 48-inch (1.22 metre) diameter × 140-inch (3.56 metre) long intake screen
- New process piping, supports, and system tie-ins
- Instrumentation (ultrasonic level transmitters and float switches)
- No allowance for standby generator
- Testing and commissioning of mechanical and control systems
- Dee Road pump station has space to accommodate new equipment and existing PLC panel to be used for new pump.

8.3.1.2 Eastchester Pumping Station

- Installation of three self-priming centrifugal pumps rated at 4,000 US gallons per minute (252 litres per second), arranged in a 2+1 configuration (two pumps in duty, one pump on standby).
- 42-inch (1.07 metre) diameter × 158-inch (4.01 metre) long intake screen
- 660-gallon (2,500 litre) airburst cleaning system
- New process piping and instrumentation
- Precast control building with RVSS starter panel
- No allowance for standby generator
- Valve chamber construction
- Testing and commissioning
- The costing related to site work in Section 8.3.1.4.

8.3.1.3 Whirlpool Pumping Station

- Installation of three 56-kilowatt (75-horsepower) Vertical Turbine Pumps
- Installation of intake pipe screen
- New process piping and Instrumentation
- No allowance for standby generator
- Existing building to be reused for new pumps at Whirlpool Pump Station
- It is assumed that the wet well conditions are satisfactory. An inspection is required to confirm their condition, and additional costs may apply depending on the findings.

8.3.1.4 Site Works

- Site grading and drainage
- Electrical ducts
- Asphalt access roads
- Fencing, gates, bollards
- Erosion and sediment control
- Final restoration (topsoil, seeding)

8.3.2 Budget Summary Pumping Stations

Total project costs have been prepared in accordance with the Canadian Institute of Quantity Surveyors (CIQS) estimating standards. A summary of the capital cost estimates is shown in Table 33.

Table 33: Summary of Cost Estimates for Process Works

Description	Quantity	Alternative 18 Dee Road Pumping Station	Alternative 12 Eastchester Pumping Station	Alternative 20 Whirlpool Pumping Station
Direct Construction Costs	sum	\$1,593,500	\$3,986,400	\$2,136,100
General Requirements	23%	\$336,500	\$916,900	\$491,300
Design and Estimating Contingency - undefined scope of work	30%	\$478,100	\$1,195,900	\$640,800
Site Constraints	10%	\$196,000	\$490,330	\$262,740
Project Contingency	10%	\$263,400	\$659,000	\$353,100
Escalation (Assume 1 year)	Excl			
Total Construction Costs including Escalation		\$2,897,500	\$7,248,530	\$3,884,040

8.4 Watermain

Watermain on Line 9 Road and Eastchester Road and Line 6 Road, include the cost to supply and install the watermain on Line 9 Road and Eastchester Road from the existing watermain on Dee Road to Four Mile Creek and New Eastchester Pumping Station to Four Mile Creek. This would include bends and joints and road crossings and repairs.

8.4.1 Watermain Assumptions

- Pressure pipe sizes ranging from 250-millimetres to 750-millimetres
- Bends and associated hydraulic fittings
- Directional drilling at major road crossings (typically 25 metres / 80 feet)
- Drill pits and trenchless mobilization
- Watercourse protection measures
- No allowance for rock blasting
- Outlet manholes and future connection tees
- Driveways restoration

- Full-depth roadway restoration (50-millimetre HL8 base + 40-millimetre HL3 surface)
- Utility crossings (hydrovac allowance)
- Spoil along roads to be removed off-site
- Spoil along unopen ROW's levelled on-site
- Outlet manholes to drainage ditches
- Final restoration (topsoil, seeding)

8.4.2 Budget Summary Watermains

Table 34: Cost Summary of Cost Estimates for Process Works

Description	Quantity	Alternative 3 Line 9 Road Watermain	Alternative 12 Eastchester Road and Line 6 Road Watermain
Direct Construction Costs	sum	\$3,886,800	\$7,815,800
General Requirements	23%	\$446,950	\$1,797,700
Design and Estimating Contingency – undefined scope of work	30%	\$1,166,000	\$2,344,700
Site Constraints	10%	\$478,070	\$961,350
Project Contingency	10%	\$642,500	\$1,292,000
Escalation (Assume 1 year)	Excl		
Total Construction Costs including Escalation	Quantity	\$7,067,270	\$14,211,550

8.5 Siphons

The OPG siphon is a 43 metre long fused HDPE DR 11 pipe, over the existing OPG reservoir and an extension of the existing 300 millimetre PVC past the Bruce trail. The Carlton siphon would replace the existing 200 millimetre pipe with a 300 millimetre fused HDPE pipe about 50 metres long. The existing roadside ditch will be upgraded and driveway and road culverts.

8.5.1 Siphon Assumptions

- Pressure pipe sizes ranging from 300-millimetres to 350-millimetres
- 350 millimetre HPDE fused pipe
- Trail to be restored by reggrading over the proposed pipe
- All culvert in existing ditch will be replaced and upgraded
- No allowance for rock blasting

- Driveways restoration and saw cut driveways
- Spoil along roads to be removed off-site
- Spoil along outside roads levelled on-site
- No land acquisition would be needed.
- No new instrumentation is required
- Existing intake screens are used

8.5.2 Budget Summary Siphons

Table 35: Cost Summary of Cost Estimates for Process Works

Description	Quantity	Alternative 16 Carlton Siphon	Alternative 17 OPG Siphon
Direct Construction Costs	sum	\$285,600	\$142,100
General Requirements	23%	\$65,600	\$59,200
Design and Estimating Contingency - undefined scope of work	30%	\$85,700	\$42,600
Site Constraints	10%	\$35,120	\$17,480
Construction Contingency	10%	\$47,200	\$23,500
Escalation (Assume 1 year)	Excl		
Total Construction Costs including Escalation		\$519,220	\$258,380

8.6 Summary

The following summaries the cost of each alternative invested a detailed price list can be found Appendix E.

Table 36: Cost Summary of Cost Estimates for Process Works

Description	Total Cost (\$)
Line 9 Road Watermain	\$ 7,067,270
Dee Road Pumping station	\$ 2,897,500
ABL Watermain	\$ 14,211,550
Eastchester Pumping station	\$ 7,248,530
Whirlpool Pumping station	\$ 3,884,040
OPG Siphon	\$ 425,030
Carlton Siphon	\$ 472,020
Virgil Reservoirs	\$ 27,200,000

9. Conclusions and Recommendation

The Town of Niagara-on-the-Lake's irrigation system is an essential component of the region's agricultural productivity, supporting one of Ontario's most valuable specialty crop areas. Through this engineering review, supported by historical documentation, field investigations, hydraulic modelling, climate-based demand assessments, user engagement, and environmental considerations, the system is at a pivotal stage. Aging assets, hydraulic constraints, operational limitations, and increasing irrigation demand driven by climate variability and agricultural growth show the need for substantial reinvestment and modernization.

The overall report covers the system's history and confirms that the existing supply and conveyance infrastructure cannot meet peak irrigation demand, particularly during severe drought conditions. Current system capacity satisfies only a portion of the required 51-millimetre application depth within a two-week cycle, resulting in service level gaps for all three irrigation systems. These deficiencies are amplified by sedimentation, invasive vegetation (phragmites), undersized culverts, and manual operational practices that limit the system's responsiveness during critical periods.

This report, along with the 2021 Master Plan, identifies several targeted priorities that, when implemented in phases, will substantially improve the entire irrigation network. The following were considered for in-depth analysis: increase pumping capacity (Alternatives 12, 18, and 20), repair siphons (Alternatives 16 and 17), add reliable piped infrastructure (Alternatives 3 and 12), and address overall storage, operation, and convenience (Overall Solutions).

- Alternative 3: Line 9 force main expansion from Dee Road
- Alternative 12: Eastchester Pumping Station Upgrades and ABL piped system
- Alternative 16: Update Carlton Street's existing siphon
- Alternative 17: Repairs and Upgrades to OPG Reservoir and Siphon
- Alternative 18: Dee Road Pumping Station
- Alternative 20: Whirlpool pumping station upgrade
- Overall Solutions
 - Vegetation Management
 - Sediment Removal
 - Storage

The alternatives are all technically feasible and aligned with long-term agricultural needs, and many can be implemented in accordance with the Town's existing maintenance requirements (Vegetation Management and Sediment Removal) and using

the Town and Irrigation Users' existing water body infrastructure (Storage). Alternative 19: Virgil Dam Upgrades would not be feasible at this time, based on construction estimates and lack of bathymetric data, but could be considered in the future. Control Structures and Automation, although a favourable solution for the overall system that would automate operations, provide real-time monitoring, and provide reporting of the system, could have varying costs for initial setup based on the tier of automation, equipment and vendor selected and have unanticipated lifecycle costs such as licensing, subscriptions and system required upgrades. Installing control and automation equipment at one pumping station to start may be preferred to determine whether it is worth it for the Town and Users before implementing system wide.

Environmental and regulatory considerations in this report, including timing windows for in-water work, species-at-risk protections, Fisheries Act requirements, and Conservation Authority permitting, will shape the design, scheduling, and implementation of the proposed works as AECOM proceeds into Task 2: Detailed Design. Overall, the recommended solutions are compatible with the natural and regulatory landscape, provided that appropriate planning and mitigation measures are incorporated into both the design and construction phases.

The following is a list of recommended solutions to provide the requested irrigation water to the existing Town of Niagara-on-the-Lake's irrigation service area. The solutions are in preferred order and should be considered for future improvements and as part of the detailed design for this project:

■ System

- Focused maintenance, vegetation removal and ditch/culvert/channel clean out
- Irrigation pond inventory
- Create a capital project reserve fund for future repairs

■ Upgrades and Construction

- Upgrade the Dee Road pumping station with a third pump
- New watermain on Line 9 road from Dee Road
- Upgrade the Eastchester Pumping Station
- New watermain on Eastchester and Line 6 Road in ABL System (potential to stop at Airport 3 Drain)
- Update Carlton Street's existing siphon
- Whirlpool Pumping Station Repair
- OPG Siphon Repair