10.0 Analysis of Infrastructure Alternatives for East Irrigation District

10.1 GENERAL APPROACH

The East Irrigation District is the only area of the Niagara Region where a successful municipal irrigation system already exists. This presents a special situation with the following broad sets of alternative solutions:

10.1.1 UPGRADE AND EXPAND THE EXISTING IRRIGATION SYSTEM (OPEN CHANNEL DISTRIBUTION)

The first approach will involve building additional components in line with the existing system and upgrading certain components of the existing system. The distribution system will remain essentially an open channel distribution system.

The NOTL Irrigation Committee has indicated interest in the following improvements[29]:

- Additional Gravitational Supply from Welland Canal (Lock 6/Lock 3 area) "through existing culvert under QEW, along West to East corridor to discharge into existing open channel drainage ditches flowing South to North".
- Planned Expansion and Improvements to Existing System:
  - Airport, Bright, Lavigne System – "expansion of existing system (Phase 2) with new piping from Stewart Rd to Niagara Stone Rd., additional security fencing and security lighting"
  - Dee Rd System – "expansion of existing system (Phase 2), piping along Line 9, securing fencing and lighting"
  - Carlton System – "new roadside piping until entry into farm property"
  - Four Mile Creek System – "dredging of reservoirs for additional water capacity, including sediment testing, trucking and testing, if necessary"

The proposed gravitational supply would provide a long-term solution for the expansion of the existing irrigation system. We see this supply to be a gravitational pipeline providing a means of distributing water from an elevated source to the existing drainage ditches. NOTL Irrigation Committee proposed two locations from the Welland Canal as the intake source for this pipeline. Both locations (upstream of Lock 3 and upstream of Lock 6) have water elevations higher than the serviced areas; therefore, either point can serve as sources for the proposed gravitational supply. Both proposed locations fall under Source Alternative 3, which is one of

[29] Letter from NOTL Irrigation Committee (A. Kirkby) to Stantec (S. Soltani), July 9, 2005.

the short-listed alternatives for the East Irrigation District. Niagara River and Lake Ontario (short-listed Source Alternatives 8 and 9) are not applicable to this supply arrangement due to their low elevations (gravitational flow to the proposed distribution pipeline is not possible). However, Alternative 7, Supply from Outlet of OPG Tunnels, can conceivably serve as a third alternative supply point for the gravitational supply pipeline. We will discuss these three supply points in the sub-section 10.2.

The proposed gravitational supply could be integrated into the existing irrigation system in two ways. It could supply the entire demand of the system, hence replacing all existing supply sources, or it could complement the existing supply sources as an additional source. The first approach would require a large supply pipeline (mostly 1200 to 1500 mm in diameter) to extend through the south side of the town from the vicinity of Welland Canal to close to Niagara River. The second approach would reduce both the diameter and the length of this pipeline by about one half. The gravity supply would extend from the vicinity of Welland Canal to close to Four Mile Creek. This would allow extension of the irrigation servicing to a significant area south of the Airport, Bright, Lavigne System. We have assumed that the difference between the potential irrigation land in the East Irrigation District (10,441 acres, refer to Table 3-8) and the service area of the existing NOTL Irrigation System (8,000 acres) would be largely due to an expansion in this area; therefore, the reduced supply arrangement would service an area of 2,441 acres.

The continuing use and expansion of an open channel distribution system may have some environmental impacts. According to Figure 2-3, the majority of water streams in NOTL are classified as 'Important" fish habitat (Type 2) while a few have been classified as 'Critical' (Type 1). Some of these 'Important' and 'Critical' fish habitat are being used as conveyance channels of the existing irrigation systems. Furthermore, the expansion of the irrigation system could potentially use additional portions of the 'Important' water streams currently not used for irrigation conveyance. The impact of the irrigation system on these streams has not specifically been studied yet; however, the lack of control by the irrigation authority over the quantity of water taken by individual growers is a concern. The occasional drying of the streams would be detrimental to fish habitat. On the other hand, some of the streams may be subject to frequent drying even if they were not used as irrigation conveyance routes. It would be useful to conduct a study on the impacts (both positive and negative) of the irrigation system on the fish habitat if an open channel distribution alternative is selected. Furthermore, control over individual water taking should definitely be put in place both for environmental reasons, and to ensure that all users are fairly provided with irrigation water.

The irrigation conveyance efficiency of an open channel distribution system is in general substantially lower that a pipeline system due to evaporation losses, seepage, and tail flows. The irrigation conveyance efficiency is highly dependent on the management of the irrigation system. Environmental factors such as temperatures, humidity, groundwater levels also have a major impact on the efficiency of the system (losses in drier years are generally higher than losses during a humid year). We will use a preliminary efficiency of 70% in our calculations. A more accurate estimate may be obtainable by a study of the irrigation conveyance efficiency of the existing NOTL system.

Significant Issues

The following are some of the main issues regarding upgrading and expanding the existing NOTL Irrigation System:

- There is less construction disturbance associated with this irrigation distribution system, but there is potential for ongoing impact during the operation of the system due to introducing substantial quantities of imported water into the waterways. Environmental impacts of using the open channels especially on the natural water courses should be carefully studied.

- The management of water in the trenches is a challenge, as the upstream users can potentially draw more than their fair shares, causing the drying of the lower reaches of the system. This problem is likely to be more pronounced during the dryer periods. Also, if a natural waterway is used, there is potential for extracting more water by the individual farmers than was added to the waterway, hence causing occasional drying of the natural stream.

- Water quality is likely to deteriorate in the lower reaches of the system due to erosion, evaporation, and drainage from the upstream fields. This represents a significant challenge and added cost to growers who use or would like to use drip or trickle irrigation.

- The implementation of an irrigation project using an open channel distribution system is likely to require more effort and time to carry out environmental studies and address concerns from environmental groups. The inherent lower conveyance efficiency of the system may raise further objections from various stakeholders.

10.1.2 CONSTRUCT A NEW IRRIGATION SYSTEM (PIPELINE DISTRIBUTION)

An alternative approach is to replace the existing irrigation distribution system with a pipeline irrigation distribution system. Certain components of the existing irrigation system, such as its pumps, can be incorporated into a pipeline based irrigation system. Different alternative pipeline irrigation systems based on the short-listed source alternatives from Table 7-1 are discussed in sub-section 10.3. All these alternatives, however, have fairly similar pipeline distribution networks.

A pipeline distribution system allows the efficient distribution of water with a consistent quality from the source to the consumers. A pipeline distribution system in the East Irrigation District will be composed of a trunk main pipeline traversing the potential irrigation areas, and a number of laterals conveying the irrigation water from the trunk main to the consumers. The direction of the trunk main (north-south or east-west) will depend on the location of the source. The laterals will in general be perpendicular to the trunk main. The pipelines will generally be constructed within the road right-of-way. The preliminary layouts of the distribution systems for all alternatives are shown in sub-section 10.3.

The distribution pipelines will need to cross a number of waterways. The construction of these waterway crossings may be completed using existing bridges. As the pipeline is not likely to be operational during winter, exposed crossing conduits, which are substantially less disruptive than pipelines requiring winter protection, will be allowed.

The pipeline may need to pass by a number of woodlands. The construction impact can be minimized using special construction methods to prevent erosion from open trenches and other impacts. Alternatively, the more sensitive areas may be avoided, using alternative pipeline routes.

Theoretically, the irrigation conveyance efficiency of a pipeline system can be 100%. However, in practice, some loss is unavoidable. Losses due to pipe and joint leaks normally occur in pipeline system and increase as the system ages. An irrigation conveyance efficiency of 95% may be reasonable if a good pipeline maintenance program is put in effect. We will use this conveyance efficiency in our preliminary calculations.

The lateral pipeline system will make water available to most users at the farm gate. Water provided to the growers will generally have “residual pressure”. In lower lands and at points closer to the supply source, this pressure may be sufficient to operate low pressure irrigation systems such as drippers, sprayers, and low to medium range sprinklers. The conceptual design, however, is not based on providing a minimum pressure at the farm gate, and it is assumed that the growers will provide the on-farm pressure requirement of the supplied raw water. The system, however, could be designed to provide a minimum pressure to the users at a later stage with minimal modifications, if the cost of the additional system pressurizing justifies the savings of on-farm pumping.

The consistent water quality delivered to the farm gate with piped systems can be an important attribute for growers who operate or are considering conversion to using drip or other high efficiency irrigation technologies.

There are a range of alternative intake points for intakes in Welland Canal (Alternative 3), Niagara River (Alternative 8) and Lake Ontario (Alternative 9). Locations close to the mid-points of the shorelines are the optimum supply points from the perspective of pipeline distribution hydraulics; hence the midpoints are used as preliminary intake locations. In the case of the Welland Canal, the positioning of the intake in the upper reaches of the canal would take advantage of the higher water levels. We have, therefore considered two alternative intake locations for the Welland Canal. An intake upstream of Lock 2 is considered due to its distribution system advantage. An intake upstream of Lock 6 is considered due to sufficient water elevation to eliminate pumping. An intake upstream of Lock 3 would be a compromise, but has not been considered in this study since it is likely to require pumping if it is used for a pipeline distribution system (the pressure requirement of a pipeline distribution system is higher than an open channel distribution system).

Significant Issues

The following are some of the main issues regarding the use of this type of water distribution:

- There is substantial general disturbance during construction. The significant construction impacts include erosion, stream disturbance, traffic disturbance, and construction noise. Some of these impacts can be substantially mitigated; however, a degree of disturbance will be unavoidable.

- A pipeline irrigation distribution system substantially reduces the amount of on-farm pumping required for the other irrigation alternatives. This will reduce capital, operating and maintenance costs and management effort at the farm level. The pressure provided by the system to the farmers can be increased with relatively minor modifications, allowing elimination of on-farm pumping for low-pressure irrigation systems. This would provide additional incentive for the growers to move toward more efficient low-pressure systems such as drippers and spray irrigation.

- The supply of water to the users is secure and the on-going environmental impacts of irrigation water taking can be minimized by improved control over water taking and water distribution.

10.2 ALTERNATIVES FOR EXPANSION OF EXISTING OPEN CHANNEL SYSTEM

10.2.1 ALTERNATIVES 3A & 3B: EXISTING SYSTEM WITH ADDITIONAL SUPPLY FROM WELLAND CANAL UPSTREAM OF LOCK 3

This alternative will consist of the construction of an intake in Welland Canal upstream of Lock 3. The water level is at an elevation of at least 116 meters at this point and can be conveyed by a gravity pipeline to supply the existing drainage ditches of NOTL along the southern side of the municipality. These ditches will then distribute the irrigation water to the growers. The transmission line will have to cross the Queen Elizabeth Way, but can be placed under an existing bridge or culvert.

There are two variations of this alternative, as follows:

Alternative 3A: This variation will supply the entire demand of the East Irrigation District (10,441 acres) from Welland Canal upstream of lock 3 using the existing open channel distribution network. This alternative is illustrated in Figure 10-1.

Alternative 3B: This variation will supply only the south-west portion of the municipality which currently does not have access to irrigation water (2,441 acres) using the above-mentioned intake in Welland Canal upstream of lock 3. This alternative is illustrated in Figure 10-2.

Significant Issues

The following are some of the main issues associated with this intake alternative (issues related to the distribution network are stated in sub-section 10.1.1):

- The use of this source will require approval by St. Lawrence Seaway Authority (to install an intake in the canal).
- The transmission line will be constructed within the road right of way through the Escarpment Natural Areas and woodlots. Also, at least one stream will have to be crossed.
- Due to the relatively low elevation differences between the source and the discharge points (about 10 meters) and substantial distances and flow quantities, the pipelines will be large.

10.2.2 ALTERNATIVES 3C & 3D: EXISTING SYSTEM WITH ADDITIONAL SUPPLY FROM WELLAND CANAL UPSTREAM OF LOCK 6

This alternative will consist of the construction of an intake in Welland Canal upstream of Lock 6. Water has an elevation of at least 158 meters at this point and can be conveyed by a gravity pipeline to supply the existing drainage ditches of NOTL along the southern side of the municipality. These ditches will then distribute the irrigation water to the growers. The transmission line will have to cross the Queen Elizabeth Way, but can be placed under an existing bridge or culvert.

Due to significant elevation difference between the source and the discharge points of the gravity main pipeline, the pipeline can have smaller diameters than the pipeline required for the Alternatives 3A and 3B (upstream of Lock 3). However, the pipeline will be some three kilometers longer.

There are two variations of this alternative, as follows:

Alternative 3C: This variation will supply the entire demand of the East Irrigation District (10,441 acres) from Welland Canal upstream of lock 6 using the existing open channel distribution network. This alternative is illustrated in Figure 10-3.

Alternative 3D: This variation will supply only the south-west portion of the municipality which currently does not have access to irrigation water (2,441 acres) using the above-mentioned intake in Welland Canal upstream of Lock 6. This alternative is illustrated in Figure 10-4.

Significant Issues

The following are some of the main issues associated with this intake alternative (issues related to the distribution network are stated in sub-section 10.1.1):

- The use of water from this source may impact the water available for hydro power generation. If the use of this source does result in a reduction of water available for hydro power generation, a loss of hydro generation revenue estimated at $1.10 per cfs-hr (1.1 cents per m^3) should be considered.

- The use of this source may be governed by the Niagara Treaty and as such may require approval through the Department of Foreign Affairs. This may cause delays to the implementation of the project.

- The use of this source will require approval by St. Lawrence Seaway Authority (to install an intake in the canal).

- The transmission line will be constructed within the road right of way through the Escarpment Natural Areas and woodlots. Also, at least one stream will have to be crossed.

- The velocity of flow in the gravity pipeline is likely to be high, requiring special operation procedures and system components to address the potential for water hammer.

10.2.3 ALTERNATIVES 7A & 7B: EXISTING SYSTEM WITH ADDITIONAL SUPPLY FROM OUTLET OF OPG TUNNELS

This alternative will consist of the construction of a new intake at the outlet of the OPG tunnels. Water has an elevation of approximately 170 meters at this point and can be conveyed by a gravity pipeline to supply the existing drainage ditches of NOTL along the southern side of the municipality. These ditches will then distribute the irrigation water to the growers. The transmission line will have to cross Highway 405.

Similar to Alternatives 3C and 3D (upstream of Lock 6), there is significant elevation difference between this source and the discharge points of the gravity main pipeline. The pipeline may have similar diameters as the pipeline from upstream of Lock 6, but it will be approximately one to one and a half kilometers longer. The pipeline may have a siphon portion, requiring priming capability and design for negative pressures in the initial section of the pipeline.

There are two variations of this alternative, as follows:

Alternative 7A: This variation will supply the entire demand of the East Irrigation District (10,441 acres) from the outlet of OPG Tunnels using the existing open channel distribution network. This alternative is illustrated in Figure **10-5**.

Alternative 7B: This variation will supply only the south-west portion of the municipality which currently does not have access to irrigation water (2,441 acres) using the above-mentioned intake. This alternative is illustrated in Figure 10-6.

Significant Issues

The following are some of the main issues associated with this intake alternative (issues related to the distribution network are stated in sub-section 10.1.1):

- The use of water from this source may impact the water available for hydro power generation. If the use of this source does result in a reduction of water available for hydro power generation, a loss of hydro generation revenue estimated at $1.10 per cfs-hr (1.1 cents per m^3) should be considered.

- The use of this source may be governed by the Niagara Treaty and as such may require approval through the Department of Foreign Affairs. This may cause delays to the implementation of the project.

- The use of this source will require approval by OPG (to install an intake in the canal).

- The transmission line will be constructed within the road right-of-way through the Escarpment Natural Areas and woodlots.
- The velocity of flow in the gravity pipeline is likely to be high, requiring special operation procedures and system components to address the potential for water hammer. Also, the initial sections of the pipeline may require a priming mechanism and allowance for the development of negative pressures.

10.3 ALTERNATIVES FOR NEW PIPELINE DISTRIBUTION SYSTEM

10.3.1 ALTERNATIVE 3E: PIPELINE SYSTEM WITH SUPPLY FROM WELLAND CANAL UPSTREAM OF LOCK 2

This alternative will consist of the construction of an intake in Welland Canal upstream of Lock 2 and a pump house to supply the distribution system. The conceptual layout of the system is shown in Figure 10-7.

Significant Issues

The following are some of the main issues associated with this intake alternative (issues related to the distribution network are stated in sub-section 10.1.2):

The use of this source will require approval by St. Lawrence Seaway Authority (to install an intake in the canal).

10.3.2 ALTERNATIVE 3F: PIPELINE SYSTEM WITH SUPPLY FROM WELLAND CANAL UPSTREAM OF LOCK 6

This alternative will consist of the construction of an intake in Welland Canal upstream of Lock 6 and construction of a trunk main from the new intake to NOTL. There is no need for a pumping station for this alternative since the water elevation is sufficient to transmit and distribute the irrigation water throughout NOTL. The transmission line will have to cross the Queen Elizabeth Way, but it can be placed under an existing bridge or culvert. The conceptual layout of the system is shown in Figure 10-8.

Significant Issues

The following are some of the main issues associated with this intake alternative (issues related to the distribution network are stated in sub-section 10.1.2):

- The use of water from this source may impact the water available for hydro power generation. If the use of this source does result in a reduction of water available for hydro power generation, a loss of hydro generation revenue estimated at $1.10 per cfs-hr (1.1 cents per m^3) should be considered.

- The use of this source may be governed by the Niagara Treaty and as such may require approval through the Department of Foreign Affairs. This may cause delays to the implementation of the project.

- The use of this source will require approval by St. Lawrence Seaway Authority (to install an intake in the canal).

- The transmission line will be constructed within the road right of way through the Escarpment Natural Areas and woodlots. Also, at least one stream will have to be crossed.

10.3.3 ALTERNATIVE 7C: PIPELINE SYSTEM WITH SUPPLY FROM OUTLET OF OPG TUNNELS

This alternative will consist of the construction of a new intake at the outlet of the OPG tunnels. There is no need for a pumping station for this alternative since the water elevation is sufficient to transmit and distribute the irrigation water throughout NOTL. The pipeline may have a siphon portion, requiring priming capability and design for negative pressures in the initial section of the pipeline. The transmission line will have to cross Highway 405. The conceptual layout of the system is shown in Figure 10-9.

Significant Issues

The following are some of the main issues associated with this intake alternative (issues related to the distribution network are stated in sub-section 10.1.2):

- The use of water from this source may impact the water available for hydro power generation. If the use of this source does result in a reduction of water available for hydro power generation, a loss of hydro generation revenue estimated at $1.10 per cfs-hr (1.1 cents per m^3) should be considered.
- The use of this source may be governed by the Niagara Treaty and as such may require approval through the Department of Foreign Affairs. This may cause delays to the implementation of the project.
- The use of this source will require approval by OPG (to install an intake in the canal).
- The transmission line will be constructed within the road right of way through the Escarpment Natural Areas and woodlots.

10.3.4 ALTERNATIVE 8: PIPELINE SYSTEM WITH SUPPLY FROM NIAGARA RIVER

This alternative will consist of the construction of an intake in Niagara River downstream of OPG facilities and a pump house to supply the distribution system. The conceptual layout of the system is shown in Figure 10-10.

There are no significant issues associated with this intake alternative, with the exception of the fact that the elevation of water at this point is relatively low and will require significant pumping (issues related to the distribution network are stated in sub-section 10.1.2).

10.3.5 ALTERNATIVE 9: PIPELINE SYSTEM WITH SUPPLY FROM LAKE ONTARIO

This alternative will consist of the construction of an intake in Lake Ontario and a pump house to supply the distribution system. The conceptual layout of the system is shown in Figure 10-11.

There are no significant issues associated with this intake alternative, with the exception of the fact that the elevation of water at this point is relatively low and will require significant pumping (issues related to the distribution network are stated in sub-section 10.1.2).

10.4 DISCUSSION OF PROBABLE COSTS

Probable costs for alternatives discussed in this section are shown in Table 10-1. The following observations are made from Table 10-1:

- Expansion of the existing open channel system is significantly less costly than replacing the system with a new pipeline system. Furthermore, maintaining the existing supplies and using the new supply to service only the expansion areas is significantly less costly than full supply of the irrigation system from a new supply point.

- There are substantial differences between the costs of the pipeline alternatives. The alternatives that have the trunk main in the east-west direction and the laterals in the south-north direction (upstream of Lock 2 and Niagara River) are the least costly. The cost of pump houses for these alternatives is more than compensated for by the reduction in the sizes of the lateral and trunk mains.

- The least costly alternative, both in terms of the initial costs and operation and maintenance costs, is Alternative 3B - Existing System with Additional Supply from Welland Canal upstream of Lock 3. This alternative will provide substantial benefits with relatively little investment.

- Alternative 3E, Pipeline System with Supply from Welland Canal upstream of Lock 2, will provide full benefits from the irrigation system at the lowest initial and operating costs compared to other pipeline alternatives. A combination of this alternative with Alternative 8, Pipeline System with Supply from Niagara River, will further reduce pipeline costs but will increase pumping costs. This combination may be considered at a later stage if it is decided to proceed with the implementation of this alternative.

The last line of Table 10-1 provides an indication of the probable annual cost of the different alternatives (operation and maintenance plus repayment of initial cost). These preliminary results show that the annual costs of all alternatives discussed in this section are substantially higher than what NOTL irrigation participants are paying at the present time (approximately $28/acre). It should be noted that the NOTL system was constructed over a number of years with substantial contributions from the different levels of government. Nevertheless, any financial burden significantly higher than the current payment by the NOTL participants is likely to be rejected by the farmers, unless a tangible additional benefit is provided.

Table 10-1 Costs of Regional Infrastructure Alternatives for East Irrigation District (Million Dollars except for Costs per Acre)[30]

Distribution System Type	Expansion Alternatives Full Supply			Expansion Alternatives Limited Supply			New Pipeline Distribution Alternatives				
Alternative	**3A**	**3C**	**7A**	**3B**	**3D**	**7B**	**3E**	**3F**	**7C**	**8**	**9**
Figure	10-1	10-3	10-5	10-2	10-4	10-6	10-7	10-8	10-9	10-10	10-11
Estimated Quantities											
Net Peak Demand (m^3/d)	216,056	216,056	216,056	50,512	50,512	50,512	216,056	216,056	216,056	216,056	216,056
Net Average Annual Demand (m^3/year)	6,017,021	6,017,021	6,017,021	1,406,719	1,406,719	1,406,719	6,017,021	6,017,021	6,017,021	6,017,021	6,017,021
Estimated Efficiency	70%	70%	70%	70%	70%	70%	95%	95%	95%	95%	95%
Gross Peak Demand (m^3/d) (1)	308,651	308,651	308,651	72,160	72,160	72,160	227,427	227,427	227,427	227,427	227,427
Gross Peak Demand (acre-feet/d) (1)	250	250	250	59	59	59	184	184	184	184	184
Gross Average Annual Demand (m^3/year) (2)	8,595,744	8,595,744	8,595,744	2,009,598	2,009,598	2,009,598	6,333,706	6,333,706	6,333,706	6,333,706	6,333,706
Gross Average Annual Demand (acre-feet/year) (2)	6,971	6,971	6,971	1,630	1,630	1,630	5,137	5,137	5,137	5,137	5,137
Length of Laterals (m)	-	-	-	-	-	-	89,500	89,500	112,600	89,400	112,600
Length of Trunk Mains (m)	10,500	13,500	15,000	6,000	9,000	10,500	11,000	16,800	13,300	11,000	10,300
Probable Initial Costs											
Laterals	$ -	$ -	$ -	$ -	$ -	$ -	$ 18.5	$ 18.5	$ 22.8	$ 18.5	$ 22.8
Trunk Mains	$ 13.6	$ 13.4	$ 12.2	$ 3.0	$ 3.4	$ 3.6	$ 10.6	$ 19.1	$ 15.0	$ 10.6	$ 9.4
Pumphouse	$ -	$ -	$ -	$ -	$ -	$ -	$ 2.4	$ -	$ 4.2	$ 3.7	$ 3.7
Subtotal of Major Components	$ 13.6	$ 13.4	$ 12.2	$ 3.0	$ 3.4	$ 3.6	$ 31.5	$ 37.7	$ 42.0	$ 32.8	$ 35.8
Contingencies (30%)	$ 4.1	$ 4.0	$ 3.6	$ 0.9	$ 1.0	$ 1.1	$ 9.4	$ 11.3	$ 12.6	$ 9.8	$ 10.8
Engineering & Studies (15%)	$ 2.0	$ 2.0	$ 1.8	$ 0.5	$ 0.5	$ 0.5	$ 4.7	$ 5.7	$ 6.3	$ 4.9	$ 5.4
Allowance for Upgrading Existing Components (3)	$ -	$ -	$ -	$ 1.0	$ 1.0	$ 1.0	$ -	$ -	$ -	$ -	$ -
Probable Infrastructure Cost	**$ 19.7**	**$ 19.5**	**$ 17.6**	**$ 5.4**	**$ 5.9**	**$ 6.3**	**$ 45.7**	**$ 54.6**	**$ 60.8**	**$ 47.6**	**$ 52.0**
Probable Annual O&M Costs											
Energy Costs	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.065	$ -	$ -	$ 0.118	$ 0.118
OPA Lost Revenue	$ -	$ 0.095	$ 0.095	$ -	$ 0.022	$ 0.022	$ -	$ 0.070	$ 0.070	$ -	$ -
Other O & M (1% of Capital)	$ 0.197	$ 0.195	$ 0.176	$ 0.054	$ 0.059	$ 0.063	$ 0.457	$ 0.546	$ 0.608	$ 0.476	$ 0.520
Probable O & M Costs	**$ 0.197**	**$ 0.289**	**$ 0.271**	**$ 0.054**	**$ 0.081**	**$ 0.085**	**$ 0.522**	**$ 0.616**	**$ 0.678**	**$ 0.594**	**$ 0.638**
Probable Annual Costs											
Amortization Period (yrs)	20	20	20	20	20	20	20	20	20	20	20
Interest Rate	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Annual Capital & Interest Payments	$ 1.6	$ 1.6	$ 1.4	$ 0.4	$ 0.5	$ 0.5	$ 3.7	$ 4.4	$ 4.9	$ 3.8	$ 4.2
Probable Total Annual Cost and Payments	**$ 1.8**	**$ 1.9**	**$ 1.7**	**$ 0.5**	**$ 0.6**	**$ 0.6**	**$ 4.2**	**$ 5.0**	**$ 5.6**	**$ 4.4**	**$ 4.8**
Probable Costs per Acre											
Estimated Service Area (acres)	10,441	10,441	10,441	2,441	2,441	2,441	10,441	10,441	10,441	10,441	10,441
Initial Cost Per Acre	**$ 1,887**	**$ 1,865**	**$ 1,687**	**$ 2,205**	**$ 2,428**	**$ 2,566**	**$ 4,374**	**$ 5,233**	**$ 5,826**	**$ 4,555**	**$ 4,977**
Total Annual Cost and Payments per Acre	**$ 170**	**$ 177**	**$ 161**	**$ 199**	**$ 228**	**$ 241**	**$ 401**	**$ 479**	**$ 532**	**$ 422**	**$ 460**

[30] It should be emphasized that the figures shown in this table are preliminary estimates based on the available data. Significant data gaps will need to be addressed before these figures can be relied on for budgeting purposes.