

**Engineering Consulting
Services for Transportation
Environmental Assessments
(EA) as Part of the Growth
Development Projects - Salem
Development Area**

Conceptual Design Report



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Sign-off Sheet

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Introduction
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1.0 INTRODUCTION

On January 28, 2014, the City of Barrie (City) issued a Notice of Completion for numerous Schedule B projects as specifically identified in Master Plans previously prepared to accommodate the growth forecasted for Barrie to 2031. The City has retained Stantec Consulting Ltd. (Stantec) to provide specialized expertise in the design of provincial and municipal transportation systems, conceptual design of water, wastewater and drainage systems and experience in completing Phases 3 and 4 of the Class EA process.

The purpose of this report is to develop a conceptual design for the trunk watermain and trunk sanitary sewers which are compatible with proposed transportation improvements.

This Conceptual Design Report (CDR) has been prepared by Stantec for review by the City and in support of the plan and profile drawings provided. Upon completion of the City's review of the final draft of the CDR, the City will sign-off the CDR document. The CDR could then be used as a basis for completing all subsequent preliminary and detailed design stages.

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Watermain Design
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2.0 WATERMAIN DESIGN

2.1 WATERMAIN SIZING

Based on the Water Distribution and Storage Master Plan (October 2013) prepared by AMEC Environment & Infrastructure, the proposed trunk distribution system required to meet Maximum Day potable water and Fire Flow demands throughout the study area includes the following:

- 500 mm north-south main on Veterans Drive from Salem Road to McKay Road West
- 400 mm east-west main on McKay Road from McKay study boundary to East of Street I
- 400 mm east-west main on McKay Road from east limit of Interchange to Street K
- 500 mm east-west main on Salem Road from Veterans to Essa Road
- 400 mm main on Essa Road from Mapleview Drive West to the Phase 1 Boundary south of Salem Road
- 750 mm feedermain on Lockhart Road from Saunders to Huronia
- 750 mm feedermain on Huronia Road from PS3 to Lockhart Road

Based on the City of Barrie Water Transmission and Distribution Policies and Design Guidelines, May 2015 (Design Guidelines) the maximum allowable velocity for watermains is not to exceed 1.5 m/s (Section 4.3.4) and the maximum Head Loss Gradient under normal operating pressures is 2.5 m/km (Section 4.3.5). Stantec confirmed through the City's Hydraulic Model runs (Maximum Day Scenarios from 2016 to 2051) that all proposed watermains are within these parameters, indicating that at the Conceptual Design stage, sizing of the proposed watermains is sufficient. It is noted that as part of this Environmental Assessment, water demands for future development were provided in the Hydraulic Model by the City. The allocation and total water demands shall be reviewed and modified to suit specific development as it progresses. At the detailed design stage the City's Hydraulic Model should be used to re-evaluate final watermain sizing and ensure that both velocities and head losses are within the Design Guidelines.

2.2 REFERENCE DESIGN STANDARDS

The proposed watermain and all system components will be designed and constructed in accordance with all applicable City standards and guidelines; including but not limited to:

- Water Transmission and Distribution Policies and Design Guidelines (May 2015).
- Approved Manufacturers' Products for Linear Water Systems (January 2016).



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- Water Transmission & Distribution Standards Drawings.

2.3 WATERMAIN MATERIALS

Based on the City's Design Guidelines, as well as the City's Approved Manufacturers' Products for Linear Water Systems and the latest revision of the Standards of the American Waterworks Association (AWWA), the proposed watermains shall be:

- Concrete Pressure Pipe (CPP) in accordance with AWWA C301 or C303 for 500 mm diameter pipe and C301 for 600 mm diameter pipe and greater; or
- Ductile Iron Pressure Class 53 with Tyton and/or restrained Joints as per OPSS 441.05.02, with cement lined fittings.

Applicable Standard Drawings will be referenced where appropriate on the conceptual design drawings. All watermain piping and appurtenances (for example, valves, couplings, joint restraints) will be in accordance with the City's Approved Products List and confirmed during preliminary and detailed design.

2.4 PRESSURE RATING OF WATERMAIN

It is anticipated at this time that the system hydraulic test pressure will be 1,035 kPa (150 psi), at the highest elevation along the proposed alignment consistent with the Ontario Provincial Standard Specification.

Based on Stantec's review of the City's Hydraulic Model (Maximum Day Scenarios from 2016 to 2051), operating pressures for the proposed watermains are within 276 kPa (40 psi) to 690 kPa (100 psi) and generally found between (50 psi) and (60 psi). Therefore standard pressure ratings for the proposed watermains are considered adequate. At the detailed design phase it is recommended that specific development water demands and site plan information is added to the City's Hydraulic Model and that the model is used to verify adequate service pressures will be provided.

During Preliminary and Detailed Design, the Designer and City should confirm the operating pressures of the proposed watermain.

2.5 TRENCHLESS CROSSING

Based on the alignment of the proposed watermain and sanitary sewers, possible trenchless crossings include:

CN rail spur crossings:

- 750 mm diameter watermain along Lockhart Road



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- Sanitary sewer along McKay Road East

Major water course crossings:

- 750 mm diameter watermain along Lockhart Road
- 750 mm diameter watermain along Huronia Road
- 500 mm diameter watermain along Veterans Drive
- 400 mm diameter watermain along Essa Road

2.5.1 Trenchless Considerations on Lockhart Road at CN Railway Crossing

The railway overpass on Lockhart Road is located approximately 385 m west of the intersection with Rawson Avenue and crosses over the road on a north to south orientation. The existing railway bridge is a single span structure with concrete abutments and wing walls. The span of the bridge is approximately 10 m long and 5 m wide.

Depending on the railway bridge modifications required for road widening, it may be preferred to install the watermain using open cut methodology. Whether the watermain is installed by open cut or trenchless, however, it is a requirement of CN Rail to encase the watermain in a steel casing.

Boreholes in the area of the railway bridge are approximately 20 metres in depth which is sufficient to provide geotechnical conditions necessary for preliminary and detailed design.

2.5.2 Trenchless Considerations on Huronia Road

A large diameter corrugated steel pipe (CSP) passes under Huronia Road at a location approximately 35 m south of the intersection with Lockhart Road. The existing Culvert has a diameter of approximately 1 m and length of 20 m.

Installation of this section is dependent on road widening, typical of all sections for this Conceptual Design. Considerations for using a trenchless methodology include:

- Permitting Requirements
 - If covered under road widening project (Conservation Authority, Permit to Take Water, Dewatering), open cut is likely preferred, provided the culvert can be supported in place or removed temporarily and replaced;

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- o If watermain is to be installed first, trenchless installations can allow for trenchless pits to be installed outside of regulated area, reducing permitting requirements (Conservation Authority);

Boreholes in the area of the CSP are approximately 9 metres in depth which is sufficient to provide geotechnical conditions necessary for preliminary and detailed design. During preliminary design, additional geotechnical investigations required for the trenchless or open cut methodology should be identified, both for soil parameters and depth.

2.5.3 Trenchless Considerations at Lockhart Road Culvert

A double-box concrete culvert passes under Lockhart Road at a location approximately 140 m west of the intersection with Rawson Avenue. The culvert has a length of approximately 20 m. The boxes exposed on the south side of Lockhart Road each have a height of approximately 1 m and a width of approximately 3.5 m. On the north side of Lockhart Road, the outlet appears to consist of a single box with a height of approximately 1 m and a width of approximately 5 m.

Typically it is recommended to install significant infrastructure such as the proposed watermain outside of the concrete culvert structure. This allows for easier access and maintenance in the future. Installation of this section is dependent on road widening, typical of all sections for this Conceptual Design. Considerations for using a trenchless methodology include:

- Permitting Requirements
 - o If covered under road widening project (Conservation Authority, Permit to Take Water, Dewatering), open cut is likely preferred, provided adequate property is obtained outside of the ROW and that the culvert can be protected in place;
 - o If watermain is to be installed first, trenchless installations can allow for trenchless pits to be installed outside of regulated area, reducing permitting requirements (Conservation Authority), again depending on available property/easement;

Boreholes in the area of the double-box concrete culvert are approximately 9 metres in depth which is sufficient to provide geotechnical conditions necessary for preliminary and detailed design. During preliminary design, additional geotechnical investigations required for the trenchless or open cut methodology should be identified, both for soil parameters and depth.

2.5.4 Geotechnical Conditions at Essa Road Culvert

An open-footed concrete box culvert passes under Essa Road at a location approximately 65 m south of the intersection with Athabaska Road. The existing culvert is a concrete box, with a height of approximately 1 m and a width of approximately 3 m. The culvert is approximately 20 m in length.



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Similar to the Lockhart Road culvert, typically it is recommended to install significant infrastructure such as the proposed watermain outside of the concrete culvert structure. This allows for easier access and maintenance in the future. Installation of this section is dependent on road widening, typical of all sections for this Conceptual Design. Considerations for using a trenchless methodology include:

- Permitting Requirements
 - If covered under road widening project (Conservation Authority, Permit to Take Water, Dewatering), open cut is likely preferred, provided adequate property is obtained outside of the ROW and that the culvert can be protected in place;
 - If watermain is to be installed first, trenchless installations can allow for trenchless pits to be installed outside of regulated area, reducing permitting requirements (Conservation Authority), again depending on available property/easement;
 - With open footed culverts, it may be a requirement to conduct a geomorphological study to confirm required depth under the bottom of the watercourse. This would be addressed during preliminary and detailed design.

Boreholes in the area of the double-box concrete culvert are approximately 9 metres in depth which is sufficient to provide geotechnical conditions necessary for preliminary and detailed design. During preliminary design, additional geotechnical investigations required for the trenchless or open cut methodology should be identified, both for soil parameters and depth.

2.5.5 Trenchless Technology Review

Three trenchless methods of installing the potential trenchless crossings can be considered, including Horizontal Directional Drilling (HDD), Pipe Jacking and Auger Boring (Jack & Bore) and Pipe Ramming. The following discussion is intended to provide an overview of the methodologies to be considered during preliminary and detailed design.

2.5.6 Horizontal Directional Drilling

Horizontal directional drilling (HDD) is a surface-launched system and is widely used by construction companies for the installation of flexible conduits (HDPE, PVC, steel, etc.), often under rivers or other surface obstructions. A pilot hole is drilled, which determines the path of the installed pipe. A small diameter drilling string with a steering head penetrates the ground at the prescribed entry location and a predetermined angle, usually between 8 and 18. The steerable drilling string is pushed through the ground along a pre-determined alignment and returns to the surface on the other side of the obstacle or waterway. Next, a back-reamer is attached to the drilling string to cut a tunnel for the conduit to be pulled through. The final size of the back-reamed tunnel is generally 30% to 50% larger than the outside diameter of the product pipe. This overcut provides adequate annular space for drilling fluids and spoils to return to the surface; this



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also facilitates the bending of the pipeline during the pull-back process. A bentonite-based drilling fluid is used to lubricate and stabilize the excavated cavity. Finally, the pipeline or conduit, connected to the drill pipe using a pulling head and a swivel, is pulled into the freshly excavated bore hole until it reaches the drill rig. Installation of pipes and conduits ranging from 50 mm up to 1,200 mm in diameter and from 50 m to 800 m in length are relatively common in the industry. Longer installations, up to 2,400 m, are possible but less common.

2.5.7 Jack and Bore

Auger boring, also known as jack and bore, is a mechanical process of creating a horizontal borehole from entry to exit shafts by the means of an auger flight and rotating head. The helically wound auger rotates the head that cuts the soil, and transports the spoil from the borehole towards the power source. At the same time, the machine thrust inserts the casing pipe into the borehole. The steel or CPP casing minimizes the risk of soil collapse and ensures the stability of the borehole. The presence of the casing also improves the accuracy of the method. As a general rule, this is a limited guidance installation method and care is needed when setting up the initial alignment in the launching shaft. The boring machine is often mounted on the track to provide the jacking and rotating force to the casing and augers. The track mounted boring machine will install the casing pipe joint by joint, requiring the machine to move to the rear of the track at every successful installation of a joint a pipe so the next joint and auger stem can be lowered and tied into the existing casing and auger string.

Auger boring installations commonly range between 300 mm to 2,000 mm, and are typically up to 150 m in length. Auger boring is not as accurate as microtunneling; however, the recent development of pilot-tube guided auger boring technology enabled to improve the accuracy of the installations as well as to increase drive lengths to over 200 m. However, Jack & Bore is typically not recommended for crossings where gravel, cobbles or flowing sands might be present.

2.5.8 Pipe Ramming

Pipe ramming is a technique for installing steel casing from a drive shaft to a reception shaft utilizing the dynamic energy from a percussion hammer attached to the end of the pipe. A continuous casing support is provided and over-excavation or water/drilling fluids is not required. Pipe ramming is a 2-stage process, whereby the casing pipe is inserted through the entire length of the crossing first, and once installed, the soil is augered out from within the casing.

Pipe ramming installations commonly range between 300 mm to 2,000 mm, and are typically up to 75 m in length. Pipe ramming is not as accurate as microtunneling; however, the recent development of pilot-tube guided pipe ramming technology may be employed to improve the accuracy of the installations.

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2.5.9 Recommended Trenchless Methodology

The above are all viable methods for trenchless technology. It is recommended that the geotechnical information be reviewed during preliminary and detailed design to select the appropriate method for required trenchless crossings.

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Chambers, Valves and Appurtenances
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3.0 CHAMBERS, VALVES AND APPURTENANCES

There will be several chambers along the route for appurtenances including line valve (isolation), air release (high point), and drain valves (low point), etc. The exact location and contents of these chambers will be dependent on detailed road and intersection design. Refer to the attached Plan and Profile drawings for proposed chamber locations based on available information.

In accordance with the City's Design Guidelines (May 2015) Section 4.7, all valves on watermains equal to or larger than 500 mm in diameter will be set in precast waterproof concrete valve chambers and all pipe shall be ductile iron (where possible) within the chambers.

3.1 DISTRIBUTION SYSTEM CONNECTIONS

It is recommended that the distribution system connections and configurations be determined during preliminary and detailed design stages. Local connections are also to be confirmed during this time and as required by Development Plans.

3.2 WATER SERVICES AND HYDRANTS

Based on the relatively large size of the transmission watermains it is assumed that water services will not be directly connected to the proposed watermains, but instead connected to local distribution mains.

During preliminary and detailed design the requirement of hydrants should be confirmed by the City, specifically the Operations group. However, in accordance with the Design Guidelines, Section 4.4.10, and based on the proposed watermains not having final tie-in locations at all points, hydrants have been included on the Conceptual Plan and Profile drawings at all dead ends.

3.3 LINE VALVES

In accordance with the City's Water Transmission and Distribution Policies and Design Guidelines (May 2015) Section 4.6, Line Valves shall be installed with a maximum spacing of 305 metres. Three (3) valves shall be located at tee intersections, unless pipe isolation is critical, where four (4) valves will be installed at cross intersections. All valves are to be resilient seat gate valves, complete with valve box, on watermains up to and including 600 mm. Valves may be mechanical joint or push-on. Butterfly valves shall be used on all watermains larger than 600 mm in size unless otherwise specified.

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The preliminary locations of these valves and associated chambers have been identified on the attached plan and profile drawings. The final locations are to be confirmed during detailed design and in accordance with current City Standard Drawings.

3.4 AIR AND VACUUM RELEASE VALVE CHAMBERS

Air and vacuum release valve chambers shall be used to remove accumulated air and prevent a vacuum from developing within the watermains. Generally, combination air and vacuum release valve chambers will be installed at localized high points. Where possible, air and vacuum release valve chambers should be combined with line valve chambers.

The final location and contents of these chambers are to be determined during detailed design.

3.5 DRAIN CHAMBERS

Drain chamber locations coincide with the low points along the transmission main route. Where possible, drain chambers have been combined with line valve chambers.

The final location and contents of these chambers are to be determined during detailed design.

3.6 SWAB LAUNCHING AND RECEIVING STATIONS

Given the size of transmission mains proposed, dedicated risers will be required and properly restrained above ground, with reference to BSD-510.

The exact locations of swab launch/catch stations are to be determined during detailed design.

3.7 CATHODIC PROTECTION

Cathodic protection shall be provided in a manner suitable to the pipe material selected, to the pipe manufacturers' specifications and to City standards (Design Guidelines Section 4.5.5). This applies to appurtenances as well. It is recommended that the geotechnical investigation of subsurface soils will consider the corrosivity of soil conditions. At the detailed design stage, the consultant will work with the pipe suppliers, geotechnical sub-consultant, and the City to develop any additional required specifications for the cathodic protection system. It is recommended that these requirements will be included in the tender documents.

3.8 VALVE AUTOMATION (SCADA AND ELECTRICAL REQUIREMENTS)

It is understood that valve automation will not be required for this assignment, however confirmation is recommended during preliminary and detailed design.

Sanitary Sewer Design
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4.0 SANITARY SEWER DESIGN

4.1 SANITARY SEWER SIZING

Based on the Wastewater Collection Master Plan (October 2013) prepared by AMEC Environment & Infrastructure, the proposed trunk sanitary sewer improvements for the Salem Road study include:

- Huronia Road from Lockhart Road to Municipal Boundary
- McKay Road from Huronia Road to east limits of McKay Interchange.
- McKay Road from the west limits of the McKay Interchange to Street F.

The proposed sanitary sewers are shown on the plan views, based on the City's standards with an alignment along the centre-line of the road. The sanitary sewer sizing is dependent on final development types and future locations of roads, etc. and should be developed during preliminary and detailed design phases.

4.2 REFERENCE DESIGN STANDARDS

The trunk sanitary sewer and all system components will be designed and constructed in accordance with all applicable City standards and guidelines, including but not limited to:

- Sanitary Sewage Collection System Policies and Design Guidelines (September 2012).
- Sanitary Design Sheets.
- Sanitary Standards Drawings.
- Ministry of the Environment – Design Guidelines for Sewage Works (2008)
- Relevant Ontario Provincial Standard Specifications and Drawings

4.3 SANITARY SEWER MATERIALS

Based on the Approved Products List, the sanitary sewer pipe materials shall be the following material:

- Concrete
- Polyvinylchloride

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- Polyethylene

Applicable Standard Drawings for the selected pipe and related appurtenances will be referenced on the design drawings.

4.4 CAPACITY ANALYSIS

It is anticipated that a capacity analysis and model update will be completed to reflect future scenarios for the proposed trunk sanitary sewer upgrades based on final Development plans. It is recommended that sizing and final alignment of the sanitary sewer be based on an updated model and subsequent analysis.

4.5 MAINTENANCE STRUCTURES

It is understood that new maintenance structures will be required as part of sewer installation.

4.6 BYPASS PUMPING

It is not anticipated that bypass pumping will be required for the duration of construction. It is recommended that the consultant work with the City during detailed design to confirm bypass and shutdown requirements, options for isolation, and design of a bypass pumping system, if required.

5.0 IMPACT OF CONSTRUCTION WORKS

5.1 CONSTRUCTION METHODOLOGY

The installation of the watermain and sanitary sewer will be by open cut methodology and trenchless crossings. At connection points with existing infrastructure and where existing infrastructure is in place, a SUE Level 'B' investigation should be completed prior to detailed design. Both plan and profile drawings also must accommodate future utilities, and preliminary and detailed design should proceed in parallel with all other utility relocations/installations.

5.2 CONSTRUCTION STAGING

Construction staging will be dictated by road widening staging. However, commissioning of the proposed transmission mains, and trenchless installations should be accounted for in the road widening staging plans.

5.3 REQUIRED PERMITS

Once the preferred watermain and sewer alignments are established and accepted by the City, it is recommended that the following agencies be contacted to obtain permits:

- Nottawasaga Valley Conservation Authority and Lake Simcoe Region Conservation Authority - for work within Regulated Areas at water/culvert crossings
- CN Rail – for the spur line trenchless crossing
- MOECC – ECA for sanitary sewer, Form 1 for watermain, and EASR registration (or PTTW)

In addition, other utility and agency stakeholders including MTO, Union Gas, PowerStream Inc. and Bell should be engaged to provide input and acceptance of the detailed design proposed alignment, illustrating acceptable vertical and horizontal clearances to existing and future utilities.

It is anticipated that the proposed watermain improvements will require the completion of Form 1 in accordance with the requirements of the Drinking Water Works Permit and License. It is recommended to coordinate with the City regarding approvals throughout the design.

5.4 COMMISSIONING PLAN

It is recommended that a detailed Commissioning Plan in support of the detailed design be provided and used to develop a valve testing plan, ahead of future construction. The Commissioning Plans shall also include details on source water available for testing.

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Project Status
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6.0 PROJECT STATUS

6.1 PLAN AND PROFILE DRAWINGS

The preliminary plan and profile drawings are attached as Appendix A.

These drawings include as-built, topographic survey, and other background information provided by the City with the RFT as well as preliminary plan and profile and tie-in locations for the proposed watermain and sanitary sewer. The diameter of the watermain was recommended in the Water Distribution and Storage Master Plan (October 2013) prepared by AMEC. The diameter of the sanitary sewer was recommended in the Wastewater Collection Master Plan (October 2013) prepared by AMEC. The conceptual alignment of the watermain and sanitary sewer are presented in the plan and profile drawings and based on the City's Design Guidelines.

6.2 SITE SURVEY AND SUE LEVEL 'B' INVESTIGATION

The topographical survey, was provided by the City and subsequently incorporated into the Conceptual Design drawings. Additional surveys may be required with approval at the conceptual design stage and will be completed by Stantec.

The SUE Level 'B' investigation has not yet been completed. The information provided in the SUE Level 'B' investigation is to be used during further design stages in areas of existing infrastructure.

6.3 GEOTECHNICAL INVESTIGATION

As part of the Transportation Environmental Assessment for the Salem Growth Development Area, Stantec was required to complete a geotechnical report including a desktop review of existing documents and information for the study area and a field investigation including boreholes at the locations of the CN Rail Crossing and the three (3) existing culverts that may be upgraded/replaced.

Stantec has completed a draft geotechnical report that includes the results of the field investigation and provides preliminary geotechnical parameters and recommendations for consideration in the preliminary design process. Future preliminary and detailed design may require

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Opinion of Probable Cost
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7.0 OPINION OF PROBABLE COST

The following table is our opinion of probable cost, based on diameters and depths as shown in Appendix M of the ESR, are provided in the following table including 20% Contingency:

Location	Watermain and Appurtenances (Chamber/Valves/Tie-ins)	Sanitary	Total
Salem Road	\$2,500,000	\$0	\$2,500,000
Essa Road	\$1,500,000	\$0	\$1,500,000
McKay Road East	\$520,000	\$12,600,000	\$13,120,000
Veterans Drive	\$1,680,000	\$0	\$1,680,000
Lockhart Road	\$2,640,000	\$0	\$2,640,000
McKay Road West	\$1,900,000	\$4,000,000	\$5,900,000
Huron Road	\$0	\$1,700,000	\$1,700,000

The above opinion of probable cost is highly dependent on efficiencies during construction including incorporating roadworks, sanitary, and water installations under the same contract, and also on construction methodologies. For example, if culvert crossings can incorporate open cut installations instead of trenchless methods a cost savings may be realized.

