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REPORT

WaterSMART Solutions Ltd.

Greenview Industrial Gateway Raw Water Pipeline Alignment Option



AUGUST 2023



Platinum
member

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1 INTRODUCTION

The Municipal District of Greenview (Greenview) is currently undertaking the development of the Greenview Industrial Gateway (GIG), a 7,500-hectare (18,600-acre) eco-industrial zone designed to promote value-added industrial growth in Alberta's natural gas supply chain. The GIG's first development zone, termed the Project Area for purposes of this report, spans approximately 810 hectares (2,000 acres) of land and is expected to host several petrochemical facilities. It is important to note that this report focuses exclusively on the Project Area of the GIG and does not encompass the entirety of the GIG.

To ensure a reliable and cost-effective raw water supply for the planned industrial processing operations, Greenview aims to establish an industrial water utility within the Project Area to provide a continuous raw water supply for its members. Operating under a single water diversion license, this utility will employ water management infrastructure, including intake structures, pumps, transmission pipelines, and water storage, to serve the facilities (Greenview Industrial Gateway, June 2021). Greenview's intent for the water diversion license is to secure 24,000,000 m³ per year for the Project Area.

This report presents an assessment of the raw water pipeline concepts to convey raw water from the proposed raw water intake structure located along the Smoky River to the Project Area. This report includes a summary of the key data and background information collected and reviewed, the key design criteria and assumptions, an evaluation of the raw water pipeline alignment concepts, a review of the preliminary pipeline hydraulic design, and our Opinion of Probable Cost. The report concludes with recommendations and next steps.

2 DATA COLLECTION AND REVIEW

The following data and background information were collected and reviewed for the preparation of this report.

- Reports and documents listed in the Bibliography section of this report;
- LiDAR elevation data with a 15 m x 15 m horizontal resolution;
- Aerial photos and orthophotos from Greenview, dated 2016, as well as the latest images from Google Earth dated 2023;
- Cadastral and property lines from GIS data provided by Greenview, dated May 27, 2022;
- Existing pipeline alignments from GIS data provided by Greenview, dated May 27, 2022;
- Boundaries for the GIG and the Project Area by Greenview; and
- Pipe manufacturer/supplier information.

3 DESIGN CRITERIA AND ASSUMPTIONS

The conceptual design of the raw water pipeline considered the following design criteria and assumptions.

Phasing Approach

- It is estimated that six lots will be developed within the project. These are assumed to be developed over three phases, with two lots developed per phase. These are referred to as Phase 1, Phase 2, and Phase 3 in this report.
- This study proposes that three parallel raw water pipelines be constructed from the river intake structure to the water storage ponds to service the Project Area. It is expected that one pipeline would be constructed per phase. This staging considers initial construction costs, pipe size, and pipe material availability.

Water Demands

- It is estimated that each lot will require 10,000 m³ of water per day based on similar industrial use in the area. Assuming two lots developed per phase, that is 20,000 m³/day/phase (0.23 m³/s/phase).
- The raw water pipeline and the raw water ponds must be sized to meet the annual water demands from the Project Area, assuming that raw water withdrawal will not be possible for up to 18 weeks per year due to low flow conditions.
- During the November 9, 2022, project meeting, it was discussed that 0.355 m³/s of pipeline capacity is needed for each phase (1.065 m³/s for all three phases). This flow rate considers that there would be no pumping for 18 weeks (126 days) during dry years. The equation is: $20,000 \text{ m}^3/\text{d} * 365 \text{ days} / [365 \text{ days} - 126 \text{ days}] = 0.35 \text{ m}^3/\text{s}$. The meeting minutes acknowledges that this is different than the flow rates requested on the water diversion licence (described below).
- In June 2021, Greenview applied for a water diversion licence to Alberta Environment and Protected Areas for an annual maximum volume of 24,000,000 m³, which was the projected peak water demand for the Project Area. That is 66,000 m³ per day (0.76 m³/s), or 11,000 m³ per lot per day (estimating six lots). The maximum requested instantaneous diversion rate is 1.27 m³/s during the months May to August and the minimum instantaneous diversion rate is 0.68 m³/s during the months December to February. The higher May to August diversion rate enables Greenview to fill water storage cells during high-flow periods (Greenview Industrial Gateway, June 2021).

Pond Storage

- The GIG will provide water storage for the Project Area, allowing uninterrupted raw water supply to the Project Area developments for an estimated 18-week period. This is to account for periods of low flow within the Smoky River when water withdrawal may not be permitted.

Pipe Sizing

- As mentioned above, the required flow rate for the Phase 1 raw water pipeline is 0.355 m³/s.
- Velocity in the pipe must be kept below 1.5 m/s (Associated Engineering, October 2022).
- Minimum supply pressure to the pond is 138 kPa (20 psi).

Pipe Material and Physical Properties

- The water pipes must be designed to withstand the regular operating water pressures as well as any surge pressures, such as water hammer, which may occur in the pipeline to prevent failures and ensure the reliability of the water supply.
- At locations where trenchless construction is needed or recommended, the water pipe should be suitable for the specific trenchless construction method used.
- For this study, HDPE pipes were proposed for all pipeline sections where the maximum anticipated pressure does not exceed 1,380 kPa (200 psi), based on HDPE DR 11 pipe material. The feasibility of using HDPE pipes for pipeline sections with higher pressures will be reviewed at future design stages.
- For sections with pressures exceeding 1,380 kPa, steel Schedule 30 pipes were proposed. Steel pipes have a greater pressure rating than HDPE given the same pipe thickness.
- A Hazen-Williams roughness coefficient of 130 used for steel, HDPE, and PVC pipes to calculate the friction losses and ensure the accurate sizing of the pipelines.

Existing Infrastructure

- Cadastral, GIS data, and air photos were used to locate existing above and below ground infrastructure, such as pipelines, roads, and railways, as well as existing developments and wells.
- The latest available air photo, from 2023, indicates that more infrastructure and developments have occurred in the area over recent years. Consequently, it is possible that the latest air photo is also missing features constructed since the photo was taken, which could impact the design and construction of the raw water storage and distribution system.
- As the project progresses, additional site surveys and field investigations may be necessary to verify the location and condition of existing infrastructure and to ensure that the design is compatible with the most recent information available.

Geotechnical Conditions and Considerations

- An initial geotechnical investigation was undertaken by MPE Engineering Ltd. (MPE) in June 2023. The investigation included five boreholes, three at the river intake site, one was located in the proposed pond location, and one was located adjacent to the proposed pond location. and two where the ponds were initially proposed to be located. At the river intake, the ground was found to be primarily sandstone, and the pond location was found to be primarily clay material.
- There was no geotechnical investigation done along the water pipeline alignment path. Once the alignment has been confirmed geotechnical services can be coordinated.
- For cost estimating purposes, it was assumed that about half of the pipeline alignment (closest to river) will be constructed in at least some bedrock. Open cut construction in bedrock was assumed to be about twice as expensive as in non-bedrock.

Environmental Conditions and Considerations

- In 2022, Associated Engineering (September 2022) conducted an environmental overview of the Project Area to identify potentially environmentally sensitive areas, including wetlands, vegetation, fish and wildlife, and historical resources.
- In addition to the recent environmental overview, WSP conducted a Desktop Environmental Constraints Assessment in 2021.

Pipeline Alignment

The pipeline alignment should:

- Minimize capital and operating costs.
- Mitigate constructability risks.
- Minimize negative environmental impacts, such as tree removals and impact to wildlife habitats, particularly sensitive species.
- Ensure that the right of way for the raw water pipeline is large enough to accommodate three raw water pipelines and a potential return line.
- The above may be achieved by:
- Avoiding unnecessary conflicts/crossings with existing infrastructure/facilities (e.g., other pipelines, roads, railway, waterbodies, developments).
- Maintaining proximity to existing infrastructure.
- Avoiding bisection of lands where future infrastructure/facilities may be constructed.
- Minimizing alignment length.
- Following an alignment that has suitable geotechnical conditions.
- Considering environmental impacts.
- Minimizing construction through forests.
- Minimizing construction in key wildlife areas and near waterbodies.

Construction Methods

- Due to limited geotechnical information in the area, certain assumptions have been made regarding the construction methods, primarily for cost estimating purposes. As the design progresses, the construction method will be refined based on updated information and detailed geotechnical investigation.
 - All steel pipes were assumed to be constructed via trenchless methods. However, in flat sections, it may be possible to install the steel pipes via open cut to reduce costs.
 - In the steep incline section for all alignments, trenchless construction is recommended for constructability (e.g., slope stability and construction access) purposes.
 - HDPE pipes were assumed to be constructed via open cut, except for the following:
 - Crossing of existing pipelines were assumed to be done using trenchless construction methods.
 - Crossing of the CN railway would be done using trenchless construction methods with a steel casing as per CN requirements.
 - Crossing of existing water courses were assumed to be done using trenchless construction methods.
- The raw water pipeline installed at a minimum depth of 2.75 m to reduce risk of freezing (Aquaterra, 2020).

4 PIPELINE ALIGNMENT CONCEPTS

4.1 Overview

We developed four potential raw water pipeline alignments going from the proposed Smoky River raw water intake structure to the GIG water storage ponds. The four alignment options are shown in **Figure 4-1**. These alignments are further described below and compared at the end of this section. It should be clarified that these alignments are conceptual and will be refined as the design progresses.

4.2 Pipeline Alignment Concept #1

Pipeline Alignment Concept #1, shown in **Figure 4-2**, follows existing pipeline right of ways to the north of the GIG and along the west of the CN railway. This alignment may potentially reduce the environmental impacts of the proposed pipeline as it is in proximity to an existing pipeline corridor.

Key details, challenges and/or risks associated with this alignment are as follows. Other details are summarized in **Table 4-1**.

1. The pipeline would parallel the Smoky River for a length of approximately 0.9 km, and it would cross McMillar Creek at the confluence with Smoky River. This may pose environmental, constructability, and slope stability risks. During a later design phase, shifting the alignment further from Smoky River may be desirable to mitigate those risks, if this alignment is selected.
2. The pipeline would be constructed next to and in proximity to existing pipelines for a total length of 3.7 km. While proximity to the existing pipelines may reduce environment impacts and facilitate construction, it introduces challenges associated with coordinating the alignment with the existing pipeline right of way owner(s), and with avoiding conflicts with their existing and future pipeline infrastructure. The pipeline could be constructed further away from the existing infrastructure to reduce those risks; however, this may increase environment costs and or risks.
3. For approximately 1.1 km, the pipeline would be installed parallel (west) to the existing CN railway. This may reduce environmental impacts as the area has already been disturbed for the construction of the railway. However, paralleling the CN railway alignment may be undesirable as it may not allow other railway infrastructure to be constructed in the future, and add potential restrictions on construction due to CN requirements depending on the proximity to the line.
4. The pipeline would be installed along a relatively steep slope in the section close to the river, which raises concerns over slope stability and constructability of the pipeline. The pipeline would gain 90 m in elevation over approximately 800 m. The ground slope along this steep section averages 12% and is about 20% at its steepest.
5. About 3.0 km of this alignment would be constructed in virgin forests, not next to a road, railway, or another pipeline. Nevertheless, the rest (5.8 km) of the alignment that is beside roads, railways, or pipelines would still require a significant amount of tree clearing to allow construction of the pipeline. Construction in virgin forests may pose significant environmental concerns. The environmental impacts should be further investigated.
6. There are twenty-two pipeline crossings, one railway crossing, and three watercourse crossings along this alignment.

4.3 Pipeline Alignment Concept #2

Pipeline Alignment Concept #2, shown in **Figure 4-3**, follows a relatively direct alignment from the raw water intake to the GIG raw water storage ponds, while staying entirely within the GIG boundary. This alignment mostly goes through virgin forests which may pose greater environmental impacts than the other options. This alignment avoids most other pipelines, roads, and railways (except for crossings) which reduces potential conflicts with other infrastructure.

Key details, challenges and/or risks associated with this alignment are as follows. Other details are summarized in **Table 4-1**.

1. For approximately 2.7 km, the pipeline would be installed along the north GIG boundary. This would minimize the pipeline alignment from bisecting the GIG's potentially developable lands.
2. For approximately 2.5 km (from the raw water intake to the top of the hill), the pipeline could also be installed along the GIG boundary at a small added cost, but the current concept has the pipeline running relatively straight from the raw water intake to Imperial Road.
3. For approximately 0.3 km, the pipeline would be installed along the west of Imperial Road. This may reduce environmental impacts as the area has already been disturbed for the construction of the road. However, following the Imperial Road alignment may be undesirable as it may not allow roadway upgrades or relocation in the future. To utilize the Imperial Road alignment, a road use agreement will likely be required.
4. The pipeline would be installed along a relatively steep slope near the raw water intake, which raises concerns over slope stability and constructability of the pipeline. The pipeline would gain 90 m in elevation over approximately 600 m. The ground slope along this steep section averages 16% and is about 50% at its steepest.
5. Most of the 7.5 km of this alignment would be constructed in virgin forests, which may pose significant environmental concerns. The environmental impacts should be further investigated.
6. There are nine pipeline crossings, one railway crossing, and four watercourse crossings along this alignment.

4.4 Pipeline Alignment Concept #3

Pipeline Alignment Concept #3, shown in **Figure 4-4**, follows the existing Imperial Road alignment to the southeast and the CN railway to the southwest. By following existing infrastructure, this alignment may potentially reduce the environmental impact of the proposed pipeline and facilitate construction.

Key details, challenges and/or risks associated with this alignment are as follows. Other details are summarized in **Table 4-1**.

1. For approximately 3.2 km, the pipeline would be installed along Imperial Road. This may reduce environmental impacts as the area has already been disturbed for the construction of the road. However, following the Imperial Road alignment may be undesirable as it may not allow roadway upgrades or relocation in the future. To utilize the Imperial Road a road use agreement will likely be required.
2. For approximately 3.0 km, the pipeline would be installed north of and parallel to the existing CN railway.
3. For approximately 1.8 km, the pipeline would be installed north of and parallel to an existing pipeline (located just north of the railway).
4. For approximately 1.5 km, the pipeline would be installed north and parallel an existing local road (located just north of the railway).
5. Discussions on pipeline alignment in proximity to existing roads, railways, and existing pipelines:

- a. Paralleling existing infrastructure may reduce environmental impacts as the area has already been disturbed for the construction of the railway, road, and pipeline. However, following this infrastructure may also be undesirable as it may not allow other similar infrastructure to be constructed (expanded) in the future.
 - b. Additional investigations and consultations with CN and road/pipeline/well owner(s) would be required to secure an alignment.
6. The pipeline would be installed along a relatively steep slope near the raw water intake, which raises concerns over slope stability and constructability of the pipeline. The pipeline would gain 90 m in elevation over approximately 600 m. The ground slope along this steep section averages 16% and is about 50% at its steepest.
7. Although 6.2 km of this alignment is paralleling roads or railways, the majority of the alignment will still require a significant amount of tree clearing to allow construction of the pipeline. Construction in virgin forests may pose significant environmental concerns. The environmental impacts should be further investigated.
8. There are nine pipeline crossings, one railway crossing, and four watercourse crossings along this alignment.

4.5 Pipeline Alignment Concept #4

Pipeline Alignment Concept #4, shown in **Figure 4-5**, follows the most direct route out of the alignment concepts from the raw water intake to the GIG raw water storage ponds, but it is mostly located outside of the GIG boundary. This alignment mostly goes through virgin forests which may pose greater environmental impacts than some of the other reviewed alignments. This alignment avoids paralleling most other pipelines, roads, and railways which reduces potential conflicts with other infrastructure.

Key details, challenges and/or risks associated with this alignment are as follows. Other details are summarized in **Table 4-1**.

1. For approximately 0.6 km, the pipeline crosses the McMillar Creek which has a side slope of about 45% at its steepest section.
2. The pipeline would cross the railway yard at the GIG. It would cross the existing CN railway and another four future railway tracks.
3. Near the proposed raw water intake, the pipeline would be installed along a relatively steep slope, which raises concerns over slope stability and constructability of the pipeline. The pipeline would gain 90 m in elevation over approximately 600 m. The ground slope along this steep section averages 16% and is about 50% at its steepest.
4. Most of the 7.0 km of this alignment would be constructed in virgin forests, which may pose significant environmental concerns. The environmental impacts should be further investigated.
5. There are ten pipeline crossings, one railway crossing, and two watercourse crossings along this alignment.

4.6 Environmental Considerations

Tree Clearing – Impact to Sensitive Species

- Tree clearing along the pipeline alignment is recommended to minimize tree root / weight damage to the pipeline, and to facilitate access to the pipeline in case of maintenance, repair, or emergency, regardless of the construction method. Tree removal may trigger an Environmental Impact Assessment (EIA) to be conducted before work can begin.

- All alignments are situated within a region that is home to pileated woodpeckers (Provincial Status: Sensitive) (Associated Engineering, September 2022). The Associated Engineering report states that since pileated woodpeckers have been identified in the area, buffers around active woodpecker nests could constrain developable areas in the short term where the nests are identified. The report also mentions that a woodpecker nest must be abandoned for 36-months before it can be permitted to be damaged, destroyed, removed, or disturbed. Furthermore, the report mentions that if active or inactive nests are found in the work area, additional steps will be required with direction from a qualified professional. The alignment may need to be changed, which may increase design and construction costs, and/or the construction schedule may be delayed.

Watercourses – Restricted Activity Period

- According to the Alberta Government's Code of Practice for Watercourse Crossing (March 2019) and the Grande Prairie Management Area Map (November 2006), Smoky River and McMillar Creek are both Class C waterbodies with a restricted activity period from August 1 to July 15.
- Since all other watercourses or waterbodies within the GIG are unmapped, they are also considered Class C with restrictive period from August 1 to July 15, as per the Code of Practice (Alberta Government, March 2019).

Proximity to Smoky River and Key Wildlife Area

- River valleys are key wildlife areas. Permits and special design considerations may be required for work carried out below the high-water mark of the Smoky River. The required permits will be reviewed during design, but possible required permits are for the Canadian Navigable Waters Act, the Fisheries Act, and the Water Act.
- Permits and special design considerations may be required for work carried out with the floodplain of the Smoky River.
- Alignment #1 parallels the Smoky River south bank for approximately 800 m. It may need to be offset from the riverbank to preserve the key wildlife area.
- Alignments #2, #3, and #4 will be constructed away from the river, but a part of those pipes will still be constructed within the river valley and within key wildlife area.
- The intake structure will be in a key wildlife area, but its design is out of Associated Engineering's scope of work.

Public Lands Act Green Area

- The GIG is in the Green Area, which is forested public land managed by Alberta Sustainable Resources Development under the *Public Lands Act*. This exempts the pipeline from the requirement to obtain an approval under EPEA (Alberta Government, December 2002).

4.7 Comparison of Alignment Options

The following **Table 4-1** compares the three alignment concepts. **Table 4-2** lists the main advantages and disadvantages of the alignment concepts.

Table 4-1 Comparison of Pipeline Alignment Concepts

	Alignment Concept #1	Alignment Concept #2	Alignment Concept #3	Alignment Concept #4
Alignment Details				
Total Length	8.8 km	7.5 km	9.9 km	7.0 km
Inside/Outside GIG Boundary	5.0 km (57%) of pipeline alignment is outside GIG boundary.	Entirely inside of GIG boundary.	Entirely inside of GIG boundary.	4.3 km (61%) of alignment is outside GIG boundary.
Constructability/Conflicts/Crossings				
Other Pipelines	• Crosses twenty-two (22) existing pipelines. • Near existing pipelines for approximately 3.7 km.	• Crosses nine (9) existing pipelines. • Does not parallel any existing pipelines.	• Crosses nine (9) existing pipelines. • Parallels existing pipelines for approximately 1.8 km.	• Crosses ten (10) existing pipelines. • Parallels existing pipelines for approximately 1.0 km.
CN Railway	• Crosses the CN railway once. • Parallels the west side of the CN railway for approximately 1.1 km.	• Crosses the CN railway once. • Does not parallel the CN railway.	• Crosses the CN railway once. • Parallels the northeast side of the CN railway for approximately 3.0 km.	• Crosses CN railway once. • Crosses proposed GIG rail yard which will ultimately include four tracks, plus the existing CN railway. • Parallels CN railway for approximately 1.0 km.
Roads	• Crosses one (1) local road (outside of GIG). • Does not parallel any roads.	• Does not cross any roads. • Parallels the west side of Imperial Road for approximately 0.3 km.	• Does not cross any roads. • Parallels the west side of Imperial Road for approximately 3.2 km. • Parallels the northeast side of a local road parallel to the CN railway for approximately 1.5 km.	• Does not cross any roads. • Does not parallel any roads.
Smoky River	• Pipeline parallels the Smoky River riverbank for a length of approximately 0.9 km.	• Pipeline does not parallel the river.	• Pipeline does not parallel the river.	• Pipeline does not parallel the river.
Environmental Concerns	• Requires tree clearing along pipeline right of way. • Potential for rare plants along alignment.	• Most of the pipeline alignment would be constructed in virgin forests, following a new alignment, which would bisect the virgin forest. • Requires tree clearing along pipeline right of way, and potentially additional tree clearing for construction access. • Potential for rare plants along alignment.	• Requires tree clearing along the pipeline right of way. This alignment is the longest, and therefore, requires the most tree clearing for the pipeline right of way. • Potential for rare plants along alignment.	• Most of the pipeline alignment would be constructed in virgin forests, following a new alignment, which would bisect the virgin forest. • Requires tree clearing along pipeline right of way, and potentially additional tree clearing for construction access. • Potential for rare plants along alignment.

	Alignment Concept #1	Alignment Concept #2	Alignment Concept #3	Alignment Concept #4
Other Watercourses /Waterbodies	• Crosses three (3) watercourses, including McMillar Creek (at confluence with Smoky River) and two tributaries to McMillar Creek. • Alignment is beside a wetland for approximately 0.4 km.	• Crosses four (4) watercourses including McMillar Creek and three tributaries to McMillar Creek.	• Crosses four (4) watercourses including McMillar Creek and three tributaries to McMillar Creek.	• Crosses two (2) watercourses including McMillar Creek and one tributary to McMillar Creek.

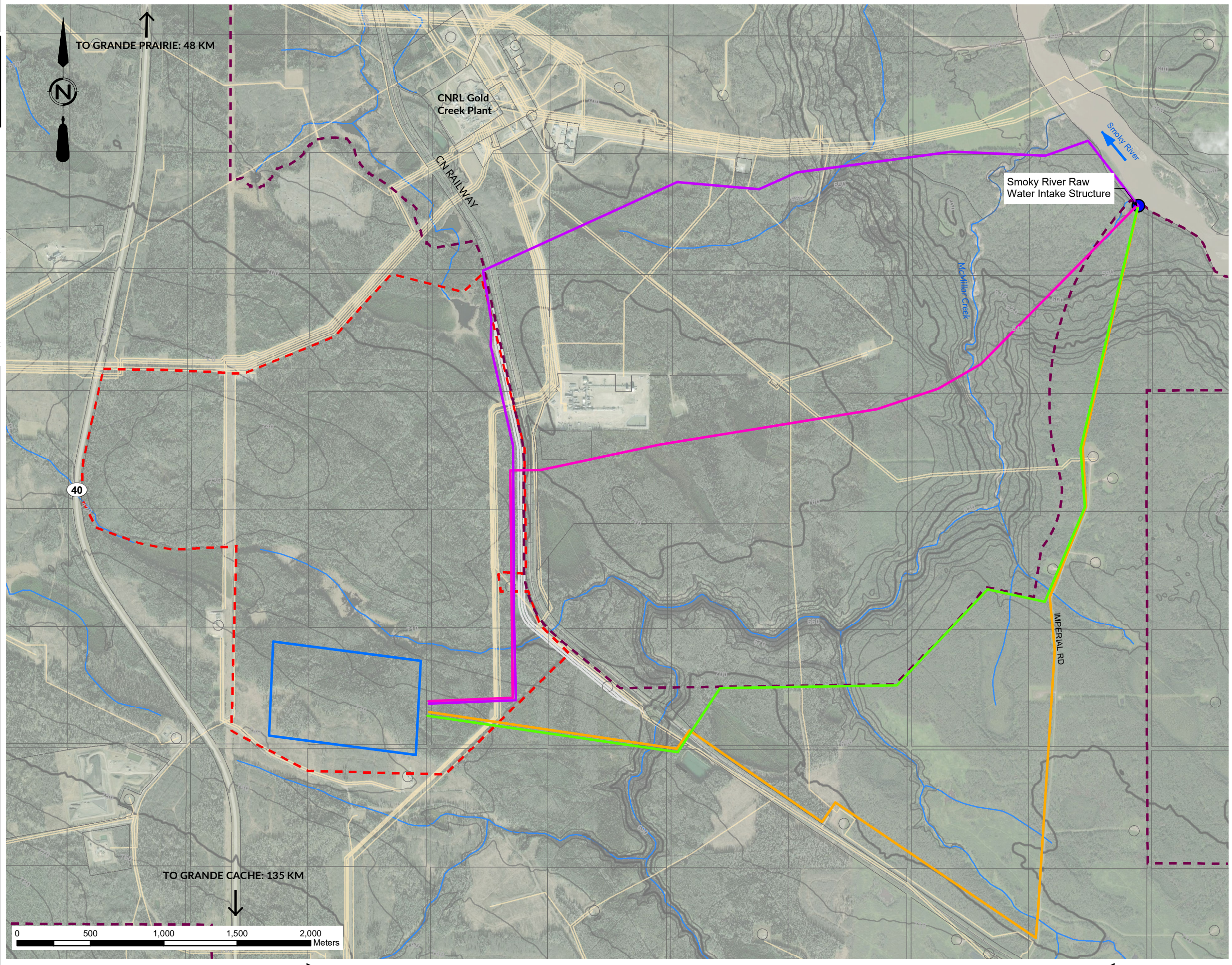
Table 4-2 Key Advantages and Disadvantages of Pipeline Alignment Concepts

	Alignment Concept #1	Alignment Concept #2	Alignment Concept #3	Alignment Concept #4
Advantages	• Near existing pipelines for approximately 3.7 km, and the railway for 1.1 km. This may reduce environmental impacts and constructability risks. • Least amount of construction in virgin forests with about 3.0 km.	• Short alignment at 7.5 km in length. • Alignment along GIG boundary reduces risk of pipeline bisecting future development and minimizes potential conflicts with future infrastructure. • The entire pipeline alignment is located within the proposed GIG boundary.	• Parallels an existing pipeline for 1.8 km, existing roads for 4.7 km and the existing railway for 3.0 km, thus likely reducing environmental impacts and facilitating construction. • The entire pipeline alignment is located within the proposed GIG boundary.	• Shortest alignment at 7.0 km in length.
Disadvantages	• 5.0 km of this alignment is outside of the GIG boundary, which may pose land acquisition issues, and potentially increase capital costs. • 0.9 km of this alignment is constructed next to the Smoky River, which may pose environmental impacts, as well as constructability and slope stability risks. • Construction adjacent other infrastructure may pose future growth issues (e.g., no space for railway, road, or pipeline expansion).	• Most of the pipeline alignment would be constructed in virgin forests, following a new alignment, thus posing environmental impacts and constructability risks. • Construction access to the pipeline may be limited in some areas and require even more tree clearing.	• Longest alignment at 9.9 km in length. • Construction adjacent to other infrastructure may pose future growth issues (e.g., no space for railway, road, or pipeline expansion).	• 4.3 km of this alignment is outside of the GIG boundary, which may pose land acquisition issues, and potentially increase capital costs. • Most of the pipeline alignment would be constructed in virgin forests, following a new alignment, thus posing environmental impacts and constructability risks. • Widest creek crossing. • Crosses GIG railway yard.

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IF NOT 25 mm ADJUST SCALES

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE



Legend:

- Smoky River Raw Water Intake Structure
- Pipeline Alignment #1
- Pipeline Alignment #2
- Pipeline Alignment #3
- Pipeline Alignment #4
- Existing Pipelines
- Contours (10 m interval)
- Watercourse
- Railway
- Railyard
- Property Lines
- GIG Raw Water Storage Pond (Approximate Area)
- GIG First Development Area
- GIG Project Area

FIGURE 4-1

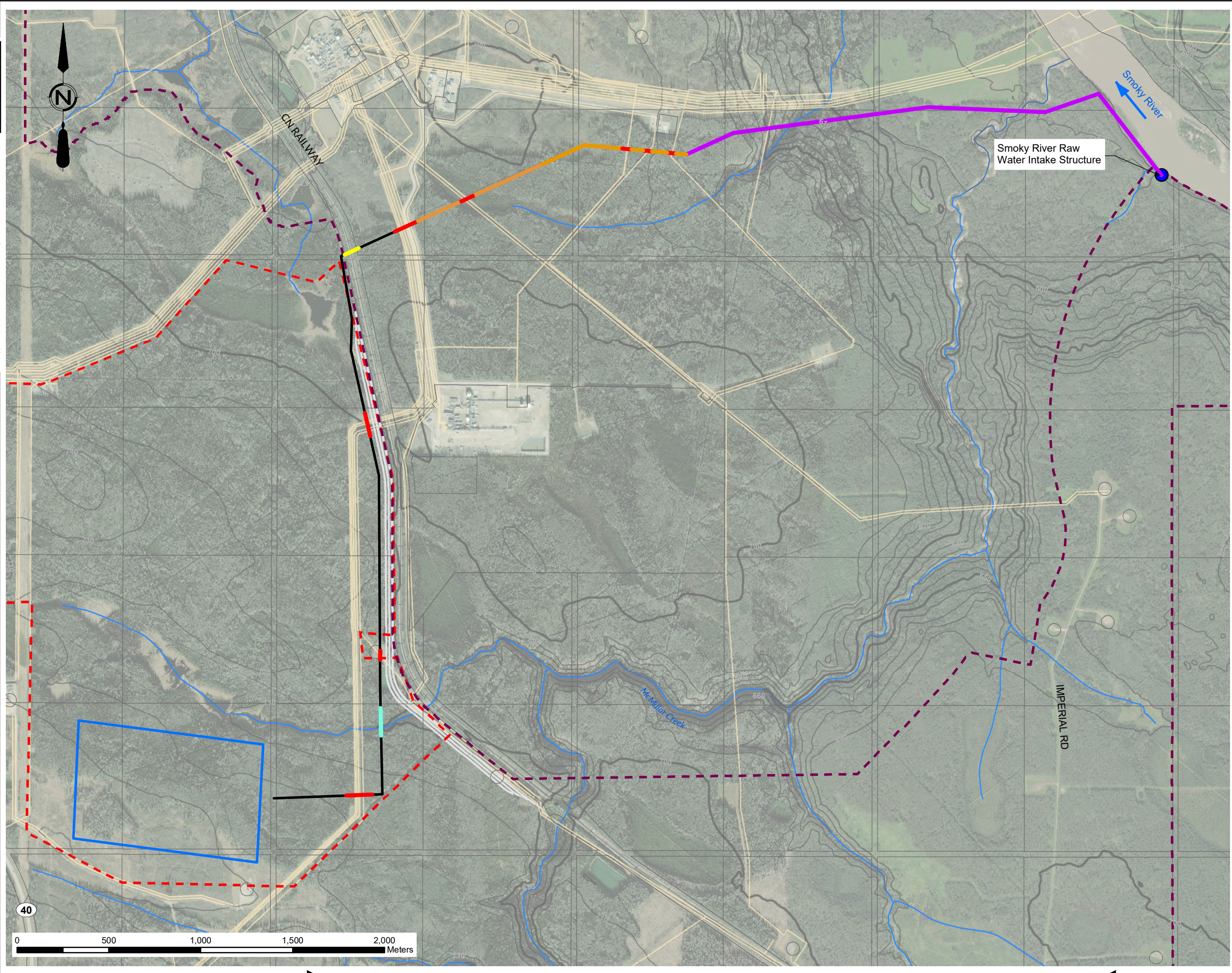
MUNICIPAL DISTRICT OF GREENVIEW
WATERSMART

RAW WATER PIPELINE
ALIGNMENT OPTIONS

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DESCRIPTION	ISSUED FOR REVIEW

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- Legend:**
- Smoky River Raw Water Intake Structure
 - Existing Pipelines
 - Contours (10 m interval)
 - Watercourse
 - Railway
 - Railyard
 - Property Lines
 - GIG Raw Water Storage Pond (Approximate Area)
 - GIG First Development Area
 - GIG Project Area
- Pipe Material and Construction Method**
- Trenchless through bedrock (Steel)
 - Open cut through bedrock (HDPE)
 - Pipeline Crossing, trenchless (HDPE)
 - Railway Crossing, trenchless (HDPE)
 - Watercourse Crossing, trenchless (HDPE)
 - Standard open cut (HDPE)

FIGURE 4-2

MUNICIPAL DISTRICT OF GREENVIEW
WATERSMART

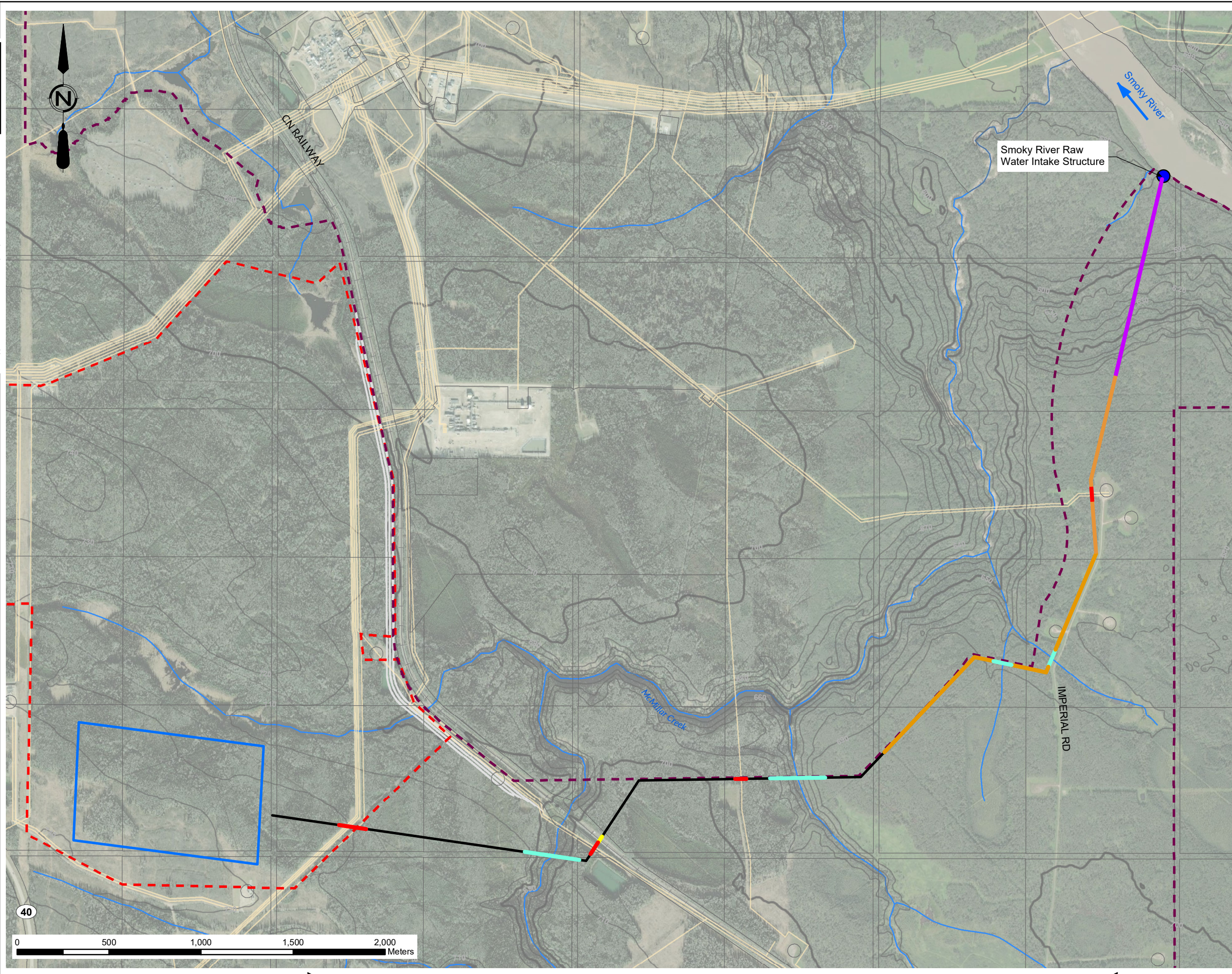
RAW WATER PIPELINE ALIGNMENT
CONCEPT #1

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Legend:

- Smoky River Raw Water Intake Structure
- Existing Pipelines
- Contours (10 m interval)
- Watercourse
- Railway
- Railyard
- Property Lines
- GIG Raw Water Storage Pond (Approximate Area)
- GIG First Development Area
- GIG Project Area

Pipe Material and Construction Method

- Trenchless through bedrock (Steel)
- Open cut through bedrock (HDPE)
- Pipeline Crossing, trenchless (HDPE)
- Railway Crossing, trenchless (HDPE)
- Watercourse Crossing, trenchless (HDPE)
- Standard open cut (HDPE)

FIGURE 4-3

MUNICIPAL DISTRICT OF GREENVIEW
WATERSMART

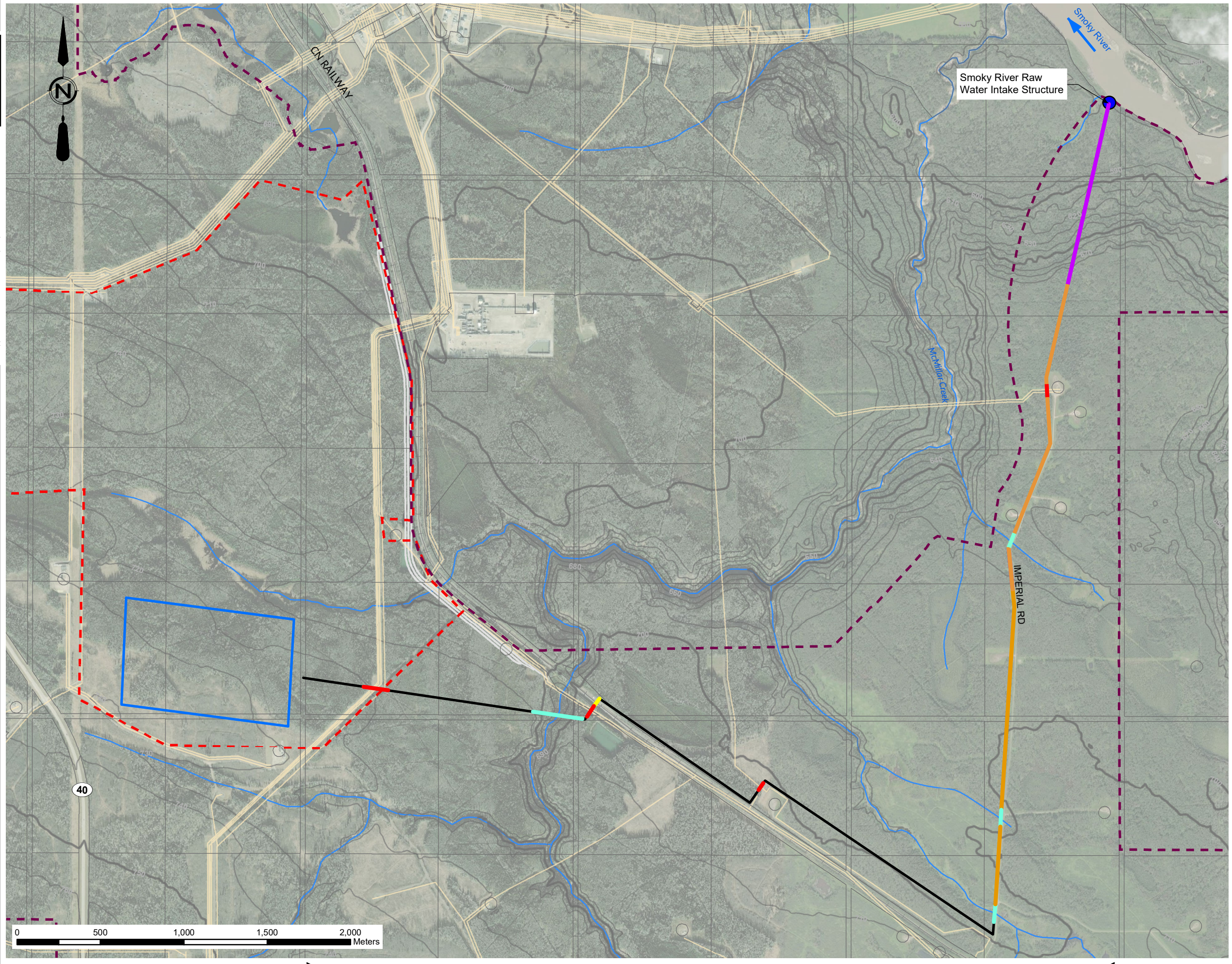
RAW WATER PIPELINE ALIGNMENT
CONCEPT #2

AE PROJECT No.	2022-3376
SCALE	1:20,000
APPROVED	
DATE	2023JAN20
REV	
DESCRIPTION	ISSUED FOR REVIEW

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DATA SOURCE: Source: Esri, Maxar, Earthstar, Geographics, and the GIS User Community

IF NOT 25 mm AS SHOWN SCALES

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE



Legend:

- Smoky River Raw Water Intake Structure
- Existing Pipelines
- Contours (10 m interval)
- Watercourse
- Railway
- Railyard
- Property Lines
- GIG Raw Water Storage Pond (Approximate Area)
- GIG First Development Area
- GIG Project Area

Pipe Material and Construction Method

- Trenchless through bedrock (Steel)
- Open cut through bedrock (HDPE)
- Pipeline Crossing, trenchless (HDPE)
- Railway Crossing, trenchless (HDPE)
- Watercourse Crossing, trenchless (HDPE)
- Standard open cut (HDPE)

FIGURE 4-4

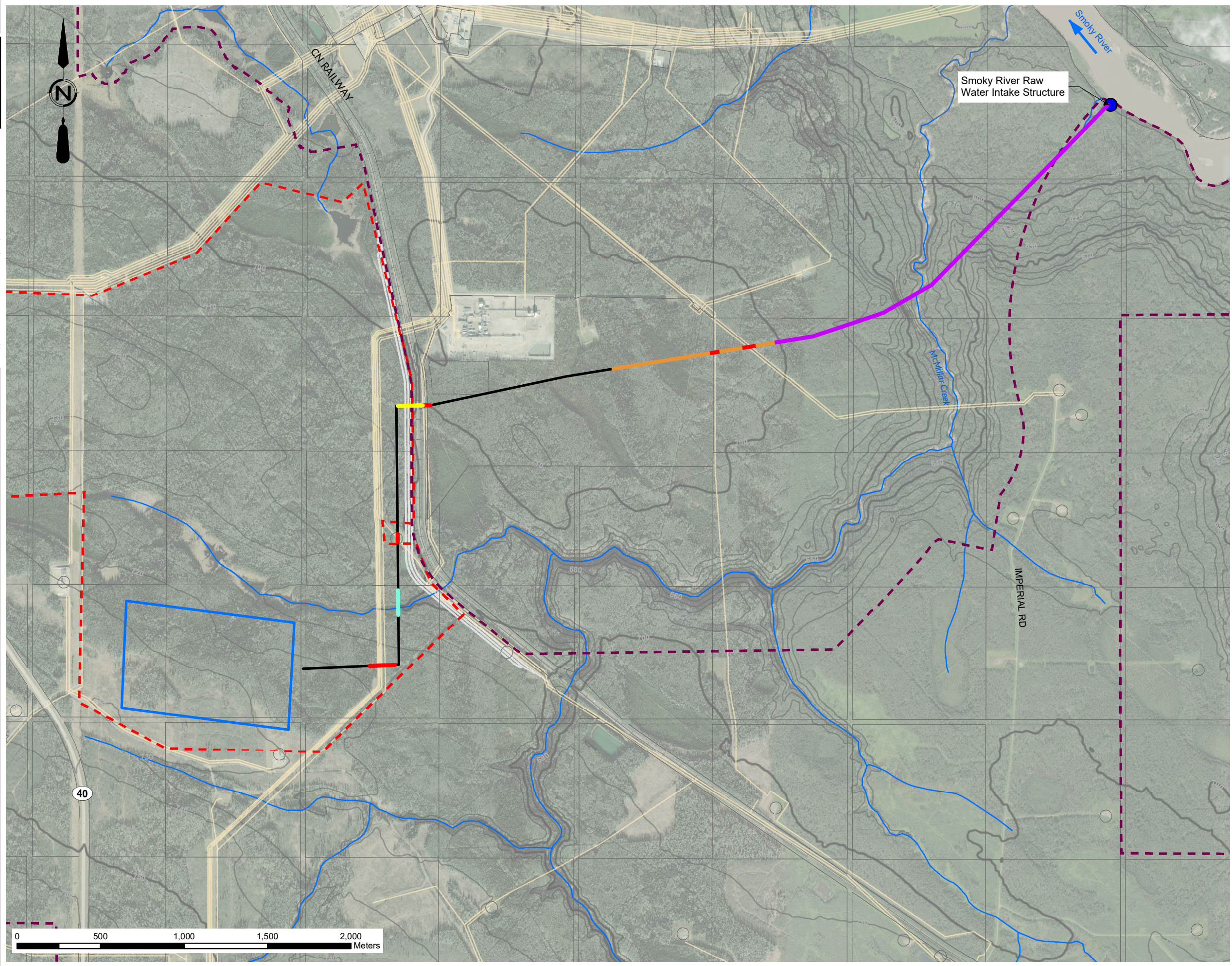
MUNICIPAL DISTRICT OF GREENVIEW
WATERSMART

RAW WATER PIPELINE ALIGNMENT
CONCEPT #3

AE PROJECT No.	2022-3376
SCALE	1:22,000
APPROVED	
DATE	2023JAN20
REV	
DESCRIPTION	ISSUED FOR REVIEW

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DATA SOURCE: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

IF NOT 25 mm AS SHOWN, ADJUST SCALES
SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE



- Legend:**
- Smoky River Raw Water Intake Structure
 - Existing Pipelines
 - Contours (10 m interval)
 - Watercourse
 - Railway
 - Railyard
 - Property Lines
 - GIG Raw Water Storage Pond (Approximate Area)
 - GIG First Development Area
 - GIG Project Area
- Pipe Material and Construction Method**
- Trenchless through bedrock (Steel)
 - Open cut through bedrock (HDPE)
 - Pipeline Crossing, trenchless (HDPE)
 - Railway Crossing, trenchless (HDPE)
 - Watercourse Crossing, trenchless (HDPE)
 - Standard open cut (HDPE)

FIGURE 4-5

MUNICIPAL DISTRICT OF GREENVIEW
WATERSMART

RAW WATER PIPELINE ALIGNMENT
CONCEPT #4

AE PROJECT No.	2022-3376
SCALE	1:22,000
APPROVED	
DATE	2023JAN20
REV	
DESCRIPTION	ISSUED FOR REVIEW

5 PIPELINE HYDRAULICS

5.1 Pipeline Hydraulics Evaluation

For optimal capital cost management and to prevent system oversizing, each phase of the Project Area is planned with a strategic pipeline construction. Initially, the raw water pipeline will be designed to accommodate Phase 1. As the project progresses to Phase 2, a parallel pipeline system will be built to cater to its requirements, and a similar approach will be adopted for Phase 3.

The pipelines were sized using the Hazen-Williams equation. This equation was used to calculate the pressures and flows within the pipeline system. Given the elevation gain near the Smoky River, it is recommended to use steel pipe for each alignment until the top of the ravine bank is reached. Once the pressure is sufficiently reduced, a transition to HDPE pipe is proposed. For all conceptual alignments, 600 mm diameter steel Schedule 30 pipes and 700 mm diameter HDPE DR 11 pipes have been chosen..

Figures 5-1 to 5-4 below show the hydraulic profiles for the four alignment concepts. Each figure shows the ground elevation, pipe invert elevation, hydraulic grade line (HGL), anticipated maximum surge pressure (HGL + water hammer surge), and the pipe rating. For a conservative analysis, the expected maximum surge pressure was designed to stay below the pipe rating for working pressure.

Table 5-1 provides a summary of the hydraulic results for each option. It is estimated that a pressure between 1730 and 1810 kPa at the raw water intake will be required to get water to the Project Area, assuming a delivery pressure of 138 kPa is maintained at the Project Area.

Figure 5-1 Hydraulic Analysis for Alignment Option #1

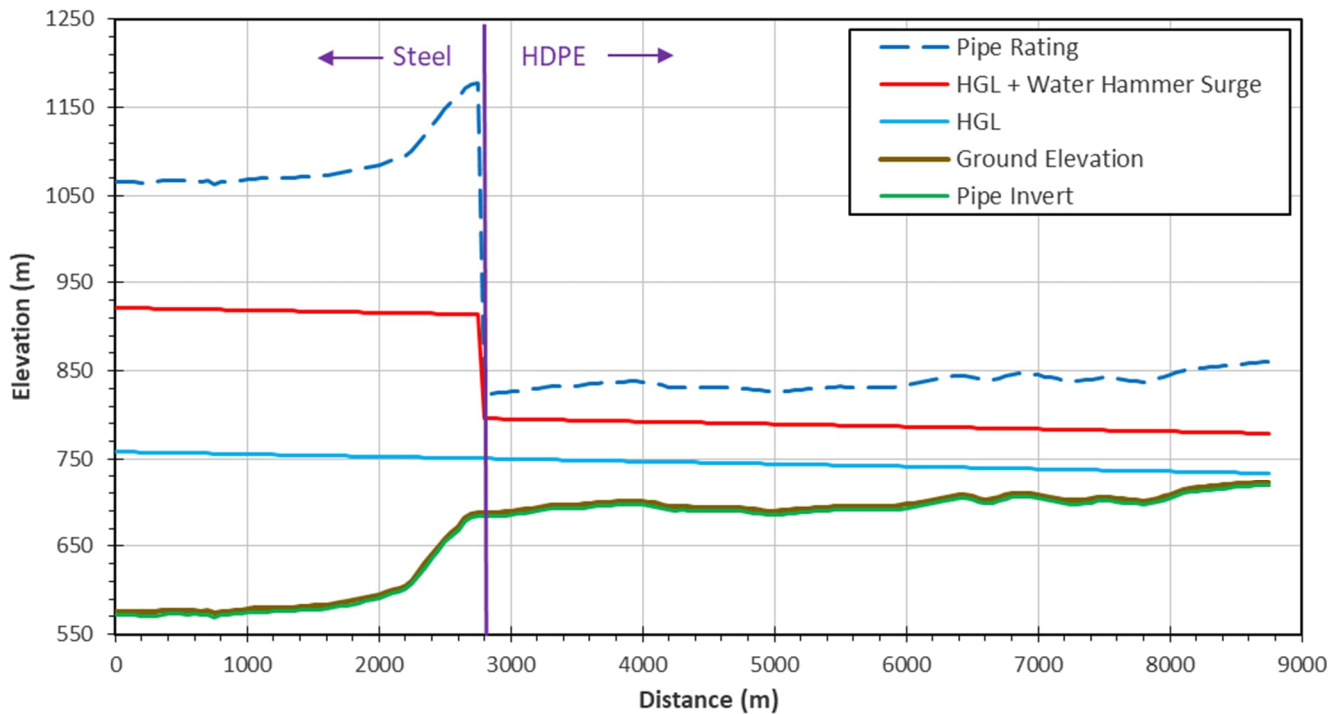


Figure 5-2 Hydraulic Analysis for Alignment Option #2

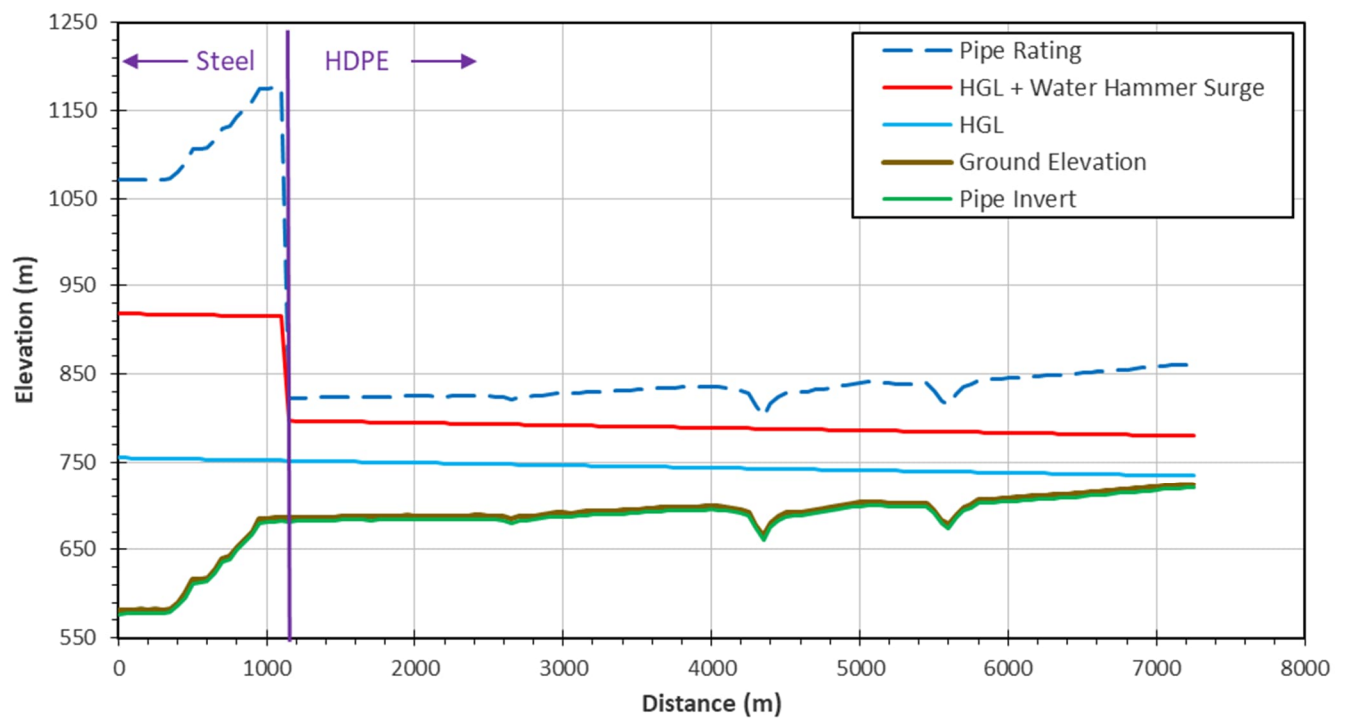


Figure 5-3 Hydraulic Analysis for Alignment Option #3

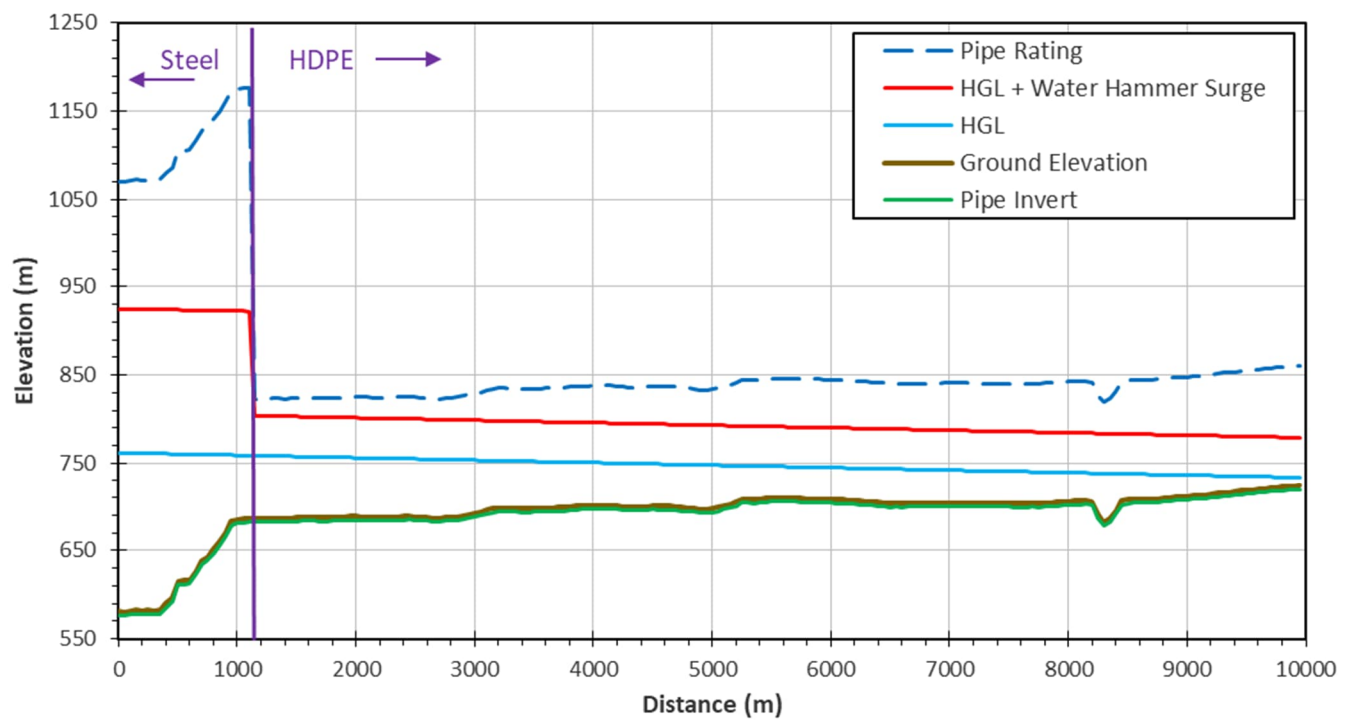


Figure 5-4 Hydraulic Analysis for Alignment Option #4

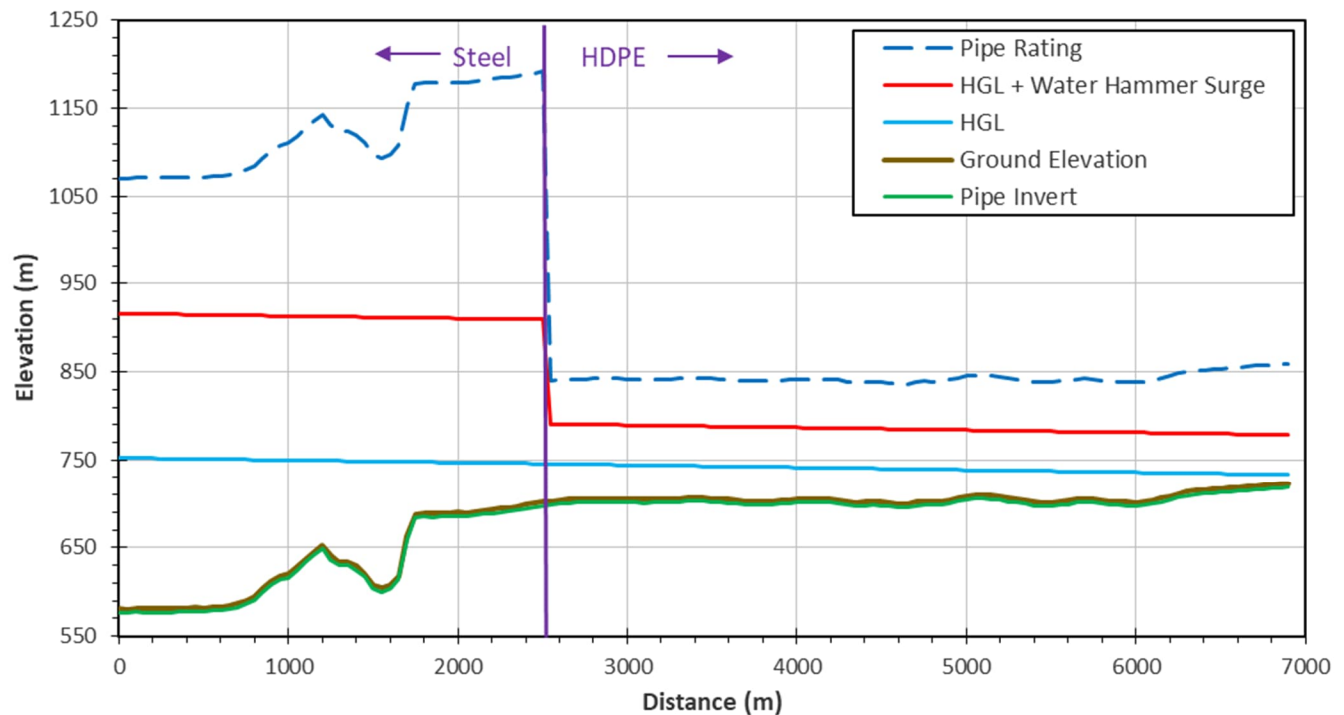


Table 5-1 Hydraulic Analysis Results

	Alignment Concept #1	Alignment Concept #2	Alignment Concept #3	Alignment Concept #4
Total Length	8.8 km	7.5 km	9.9 km	7.0 km
Length of Steel Pipe	2.8 km	1.1 km	1.1 km	2.5 km
Length of HDPE Pipe	6.0 km	6.4 km	8.8 km	4.5 km
Hydraulic Head / Pressure Required at Raw Water Intake	182 m of water (1780 kPa)	178 m of water (1750 kPa)	185 m of water (1810 kPa)	176 m of water (1730 kPa)
Hydraulic Head / Pressure at Project Area Boundary	14 m of water (138 kPa)	14 m of water (138 kPa)	14 m of water (138 kPa)	14 m of water (138 kPa)
Pipe Size / Material Type	600 mm steel Schedule 30, and 700 mm HDPE DR 11			

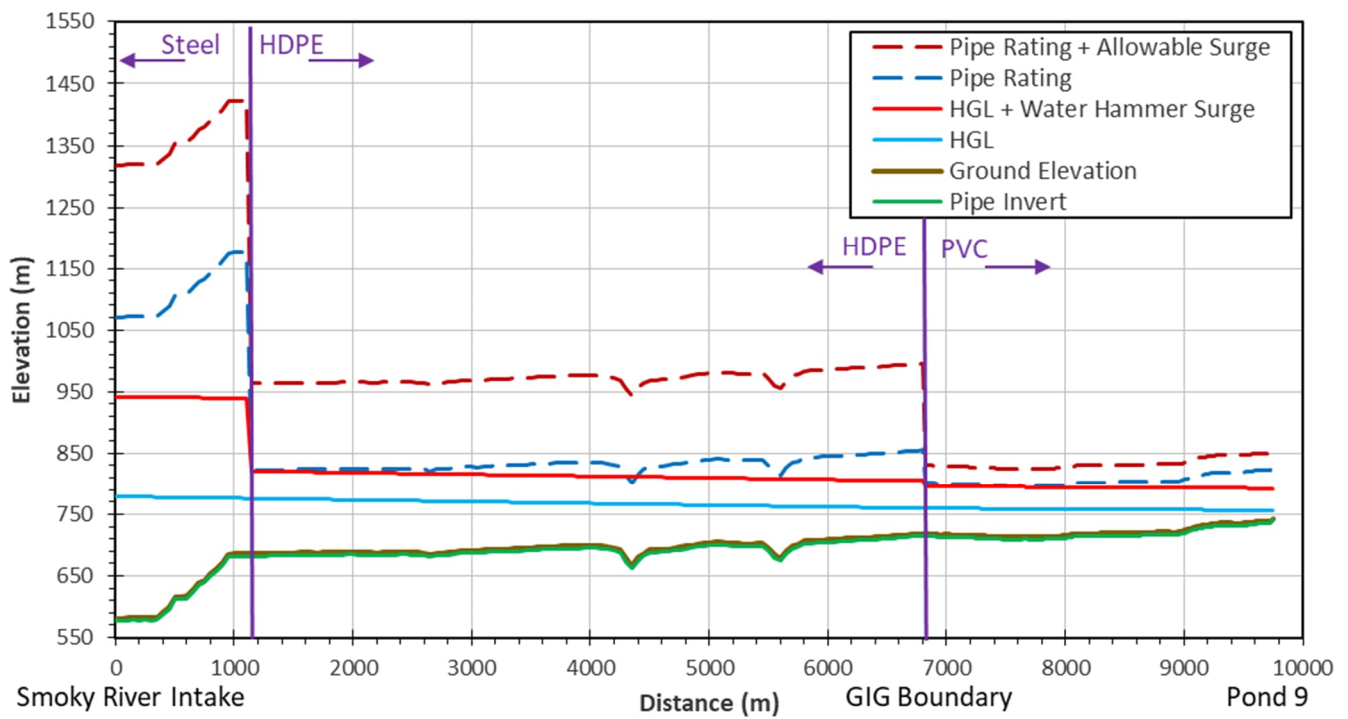
5.2 Revised Pipeline Hydraulics Evaluation in Consideration of Project Area Ponds

The hydraulic analysis presented in [Section 5.1](#) primarily dealt with the design of the raw water pipeline to the Project Area boundary. It did not consider the distribution lines within the Project Area required to fill the storage ponds since the storage pond's layout was not yet determined when this report was first issued. The subsequent "Raw Water Storage Ponds Concept" report (Associated Engineering, August 2023) provides the location and elevation of the

proposed ponds. Due to its location and elevation gain, Pond 9 requires the highest pressure head, with its water surface elevation set at 743.7 m.

Our updated analysis indicates a need for 1980 kPa of pressure at the intake structure, rather than the previously identified 1750 kPa, to ensure Pond 9 receives a minimum supply pressure of 138 kPa. Figure 5-5 A similar increase in pressure (+ 230 kPa) would also be required for the other three alignment options. The specific pressure requirement at the raw water intake should be further adjusted as the design development continues, as well the river crossing will have to be further investigated and a higher rated pipe may be required for those sections.

Figure 5-5 Revised Hydraulic Analysis for Alignment Option #2 to Pond 9



6 OPINION OF PROBABLE COST

An Opinion of Probable Cost (OPC) was developed to a conceptual level for Phase 1 of the project. Each conceptual alignment was broken down by length of construction method, which is presented in [Table 6-1](#). Conceptual unit costs were estimated based on the anticipated pipe and construction method for each section of the pipeline. [Table 6-2](#) lists the estimated unit costs used for this OPC. [Table 6-3](#) summarizes our Opinion of Probable Cost for each alignment concept. These include contingency and engineering. The detailed cost breakdown can be found in [Appendix A](#).

The following assumptions were made to arrive at this estimate:

- The OPC is in 2023 dollars.
- The unit costs are based on recent tender prices for similar projects.
- The pipes used are 600 mm diameter steel Schedule 30 and 700 mm diameter HDPE DR 11.
- General requirements such as insurance, bonding, mobilization, demobilization, and commissioning, were estimated to account for 15% of the construction cost.
- A 40% contingency was included to account for cost uncertainty given the conceptual nature of this OPC and the lack of geotechnical data along the alignment options.
- Engineering services, including design, geotechnical investigation, and construction management, were allocated 15% of the costs.
- Land costs and the establishment of rights-of-way were not included.

Table 6-1 Length of Construction Methods per Alignment

	Alignment Concept #1	Alignment Concept #2	Alignment Concept #3	Alignment Concept #4
Total Length	8.8 km	7.5 km	9.9 km	7.0 km
• Estimated Length of Trenchless Sections Steel Pipe, through Bedrock	2.8 km	1.1 km	1.1 km	2.5 km
• Estimated Length of Open Cut Sections HDPE Pipe, through Bedrock	1.38 km	2.38 km	3.58 km	0.88 km
• Estimated Length of Open Cut Sections HDPE Pipe, no Bedrock	3.65 km	2.78 km	4.18 km	2.88 km
• Estimated Length of Trenchless Sections HDPE Pipe, through Bedrock, and not in Steel Casing (Pipeline and Watercourse Crossings)	0.23 km	0.28 km	0.28 km	0.13 km
• Estimated Length of Trenchless Sections HDPE Pipe, not in Steel Casing (Pipeline and Watercourse Crossings)	0.70 km	0.93 km	0.73 km	0.43 km
• Estimated Length of Trenchless Sections HDPE Pipe, in Steel Casing (CN Railway Crossing)	0.05 km	0.05 km	0.05 km	0.20 km

Table 6-2 Opinion of Probable Costs – Unit Costs

Item	Estimated Unit Cost
Trenchless Construction	
• Steel Pipe, through Bedrock	\$8,000/m
Open Cut Construction	
• HDPE Pipe, through Bedrock	\$6,000/m
Open Cut Construction	
• HDPE Pipe, no Bedrock	\$3,500/m
Trenchless Construction	
• HDPE Pipe, through Bedrock, not in Steel Casing (Pipeline and Watercourse Crossings)	\$7,000/m
Trenchless Construction	
• HDPE, no Bedrock, not in Steel Casing (Pipeline and Watercourse Crossings)	\$5,000/m
Trenchless Construction	
• HDPE Pipe, no Bedrock, in Steel Casing (CN Railway Crossing)	\$10,000/m
CAV	
• (Five CAV estimated per alignment)	\$2,500 each
Tree Clearing	
• (Estimated at 25 m width tree clearing per metre length of pipe)	\$10,000/ha
General Requirements, Mobilization, Demobilization, and Commissioning	15%
Engineering	15%
Contingency	40%

Table 6-3 Opinion of Probable Cost – Summary

Alignment Concept	Estimated Cost	Cost per Length
Alignment Concept #1	\$89,900,000	\$10,200/m
Alignment Concept #2	\$73,200,000	\$9,750/m
Alignment Concept #3	\$93,600,000	\$9,450/m
Alignment Concept #4	\$74,000,000	\$10,600/m

7 RECOMMENDATIONS AND NEXT STEPS

We recommend that Pipeline Alignment Concept #2 be carried over for further analysis. This is based on the following:

1. This alignment has the lowest probable cost of all evaluated options at an estimated \$73.2 M.
2. This alignment is entirely within the GIG boundary.
3. The short length of this alignment minimizes the amount of land dedicated as a pipeline right of way and reduces the amount of tree cutting.
4. The shorter pipeline length results in more manageable hydraulic pumping requirements compared to the longer options.
5. This alignment avoids construction of the pipeline adjacent and parallel to other surface and underground infrastructure (e.g., roads, railway, pipelines), which would require coordination with the owner of those infrastructure, and potentially require the alignment to be shifted further into the virgin forest.
6. Most of this alignment follows the GIG boundary and the top of the McMillar Creek ravine. This reduces the risk of the pipeline from cutting through future developable lands. There are also less conflicts with other infrastructure along this alignment.

The following are the proposed next steps for this project, as they relate to the scope of work presented in this report.

1. **Geotechnical Investigation:** Perform detailed geotechnical investigations along the selected pipeline alignment to gather data on soil and groundwater conditions, which are essential for refining the design of the water pipelines, and for reducing cost uncertainties. Obtain geotechnical recommendations to further inform the project's constructability, including pipe material and construction methods.
2. **Environmental Considerations:** Conduct an Environmental Impact Assessment (EIA) to address potential impacts on sensitive species, tree clearing, watercourses, and restricted activity periods. Implement necessary mitigation measures and obtain required permits before construction begins.
3. **Topographical Survey and Site Investigation:** Conduct a comprehensive topographical survey of the selected pipeline alignment to verify existing ground elevations. Accurately identify and survey the location of existing pipelines, watercourses, and railway crossings to determine their precise horizontal and vertical positions. Coordinate crossing requirements and agreements with the owner(s) of those infrastructures.
4. **Design Flow Optimization:** Collaborate with industrial lot members to finalize their water demands, and refine the design of the raw water pipelines. Additionally, confirm the phasing approach for the water pipelines.
5. **Detailed Design:** Develop detailed designs for the raw water pipelines from the raw water intake to the Project Area, incorporating the findings from the EIA and geotechnical investigations. Complete further hydraulic analysis to verify that the proposed design will function as intended.
6. **Cost Estimate Revisions:** Update the Opinion of Probable Cost based on the results of the EIA, geotechnical investigation, and detailed design to provide a more accurate cost estimate for the project.
7. **Land Acquisition and Rights-of-Way:** Secure land and establish rights-of-way required for constructing the project components, including water pipelines.

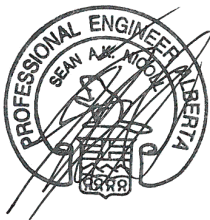
CLOSURE

This report was prepared for the WaterSMART Solutions Ltd. to evaluate and recommend a preferred design concept for the proposed raw water pipelines from the river to the raw water storage ponds in support of the Greenview Industrial Gateway project.

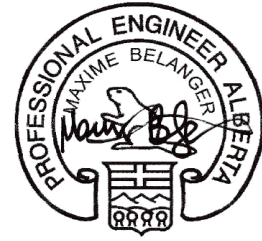
The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,

Associated Engineering Alberta Ltd.



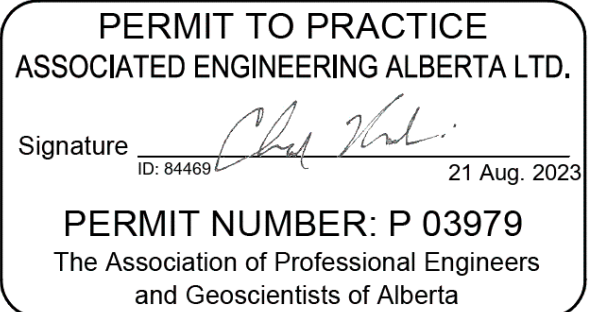
Sean Nicoll, P.Eng.
Project Manager



Maxime Belanger, M.Sc., P.Eng.
Project Engineer

A handwritten signature in black ink that reads "Raeanna Born".

Raeanna Born, E.I.T.
Civil Engineer-In-Training



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APPENDIX A – OPINION OF PROBABLE COST – DETAILED BREAKDOWN

Table A-1 Opinion of Probable Cost

		Alignment Concept #1	Alignment Concept #2	Alignment Concept #3	Alignment Concept #4
Total Length of Alignment (m)		8800	7500	9900	7000
Trenchless Bedrock (steel)	Length (m)	2800	1100	1100	2500
	Cost (\$8,000/m)	\$22,400,000	\$8,800,000	\$8,800,000	\$20,000,000
Trenchless Crossing Bedrock (HDPE)	Length (m) Pipeline Crossings	225	75	75	125
	Length (m) Creek Crossings	0	200	200	0
	Cost (\$7,000/m)	\$1,575,000	\$1,925,000	\$1,925,000	\$875,000
Trenchless Crossings (HDPE)	Length (m) Pipeline Crossings	550	275	275	275
	Length (m) Creek Crossings	150	650	450	150
	Cost (\$5,000/m)	\$3,500,000	\$4,625,000	\$3,625,000	\$2,125,000
Railroad Crossing (HDPE with steel casing)	Length (m)	50	50	50	200
	Cost (\$10,000/m)	\$500,000	\$500,000	\$500,000	\$2,000,000
Open Cut - in bedrock (HDPE)	Length (m)	1375	2375	3575	875
	Cost (\$6,000/m)	\$8,250,000	\$14,250,000	\$21,450,000	\$5,250,000
Standard Open Cut (HDPE)	Length (m)	3650	2775	4175	2875
	Cost (\$3,500/m)	\$12,775,000	\$9,712,500	\$14,612,500	\$10,062,500
CAV	# CAV	5	5	5	5
	Cost (\$2,500 each)	\$12,500	\$12,500	\$12,500	\$12,500
Tree Clearing	Area (ha)	22	18.75	24.75	17.5
	Cost (\$10,000/ha)	\$220,000	\$187,500	\$247,500	\$175,000
General Requirements, Mobilization, Demobilization, Commissioning	Cost (15%)	\$8,700,000	\$7,100,000	\$9,100,000	\$7,200,000
Subtotal		\$57,932,500	\$47,112,500	\$60,272,500	\$47,700,000
Engineering (15%)		\$8,700,000	\$7,100,000	\$9,100,000	\$7,200,000
Contingency (40%)		\$23,200,000	\$18,900,000	\$24,200,000	\$19,100,000
Total		\$89,832,500	\$73,112,500	\$93,572,500	\$74,000,000